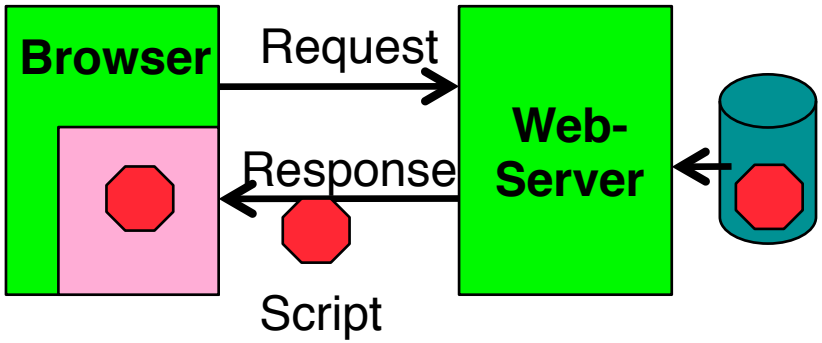
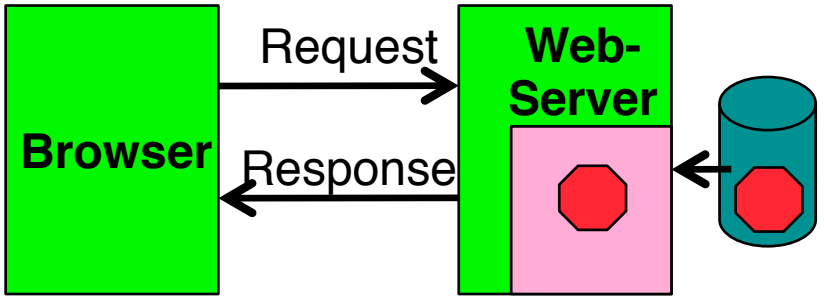
# 3 Web Programming with Java

3.1 Client-Side Java: Applets
3.2 Server-Side Java: Servlets
3.3 Java-Based Markup: Java Server Pages (JSP)
3.4 Dynamic Web Applications with Java Server Faces (JSF)

# Server-Side vs. Client-Side Realisation




- Client-side realisation:
  - Browser contains execution engine for scripts
  - Web server does not need to execute scripts
  - Script is sent to client as part of server response
  - Examples: JavaScript, **Java Applets**

- Server-side realisation:
  - Web server contains execution engine for scripts
  - Browser does not need to execute scripts
  - Script is executed on server and computes response to client
  - Examples: PHP, **Java Servlets, Java Server Pages, Java Server Faces**

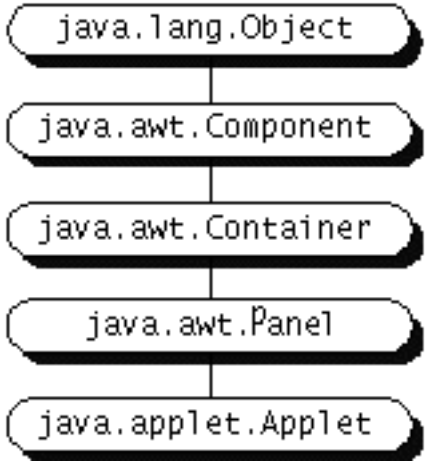
# Applets

- *Applet:*
  - “application snippet”
  - Java program, embedded in HTML page
  - Executed by browser software
    - » directly or via *plugin*
  - Does not contain a "main()" method!
- *Application:*
  - *Stand-alone* Java program
  - Contains a static "main()" method

# Example: Hello-World Applet (1)

```
import java.applet.Applet;
import java.awt.Graphics;

public class HelloWorldApplet extends Applet {
    public void paint(Graphics g) {
            g.setFont(new Font("SansSerif", Font.PLAIN, 48));
            g.drawString("Hello world!", 50, 50);
    }
}
```

- Class for applet derived from **`Applet`**
- **`Applet`** derived from **`Component`**
  - Calls **`paint`** method
  - Redefining the **`paint`** method means it is executed at display time
- Similar to Java Swing, Java 2D



# Example: Hello-World Applet (2) – Old Version

```
<html>
  <head>
     <title> Hello World </title>
  </head>
  <body>

     The Hello-World example applet is called: <br>

     <applet code="HelloWorldApplet.class" width=300>
     </applet>

  </body>
</html>
```

This is frequently used but deprecated HTML syntax!

# Example: Hello-World Applet (2) – New Version

```
<html>
  <head>
     <title> Hello World </title>
  </head>
  <body>

     The Hello-World example applet is called: <br>
     <object type="application/x-java-applet"
      height="100" width="400">
          <param name="code" value="HelloWorldApplet" />
     </object>
  </body>
</html>
```

Modern HTML5 syntax
(Note : "**classid**" not supported in HTML5!)
Assuming "HelloWorldApplet.class" exists

# Parameter Passing in HTML – Old Version

Applet:

```
public class HelloWorldAppletParam extends Applet {

    public void paint(Graphics g) {
      String it = getParameter("insertedtext");
      g.setFont(new Font("SansSerif", Font.PLAIN, 48));
         g.drawString("Hello "+it+" world!", 50, 50);
    }
}
```

HTML:

```
<html>
  ...
     <br>
     <applet code="HelloWorldAppletParam.class"
           width="800">
           <param name="insertedtext" value="wonderful">
     </applet>
  ...
</html>
```

# Parameter Passing in HTML – New Version

Applet:

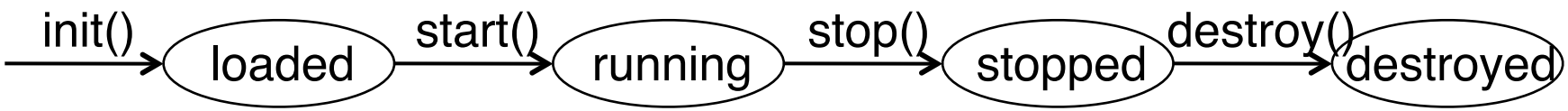
```
public class HelloWorldAppletParam extends Applet {

    public void paint(Graphics g) {
      String it = getParameter("insertedtext");
      g.setFont(new Font("SansSerif", Font.PLAIN, 48));
         g.drawString("Hello "+it+" world!", 50, 50);
    }
}
```

HTML:

```
<html>
   ...
      <br>
      <object type="application/x-java-applet"
        height="100" width="800">
            <param name="code" value="HelloWorldAppletParam" />
            <param name="insertedtext" value="wonderful" />
            Java Applets not supported.
      </object>
   ...
</html>
```

This is modern HTML5.

# Applet Life Cycle




Callback methods:

```
public class ... extends Applet {
    . . .
    public void init() { . . . }
    public void start() { . . . }
    public void stop() { . . . }
    public void destroy() { . . . }
    . . .
}
```

# User Interaction in Applets

- Applets are able to react to user input
  - Define an event handler
  - Register during applet initialization (init())
- Applets are executed locally, and therefore have full access to local input
  - Mouse movements, key press, …
  - This is not possible with server-side code!
- Applets can make use of graphics libraries
  - For instance Java 2D
  - This is not easily possible with server-side code!

# Example: Mouse Interaction in an Applet

```
public class ClickMe extends Applet implements MouseListener {
    private Point spot = null;
    private static final int RADIUS = 7;

    public void init() {
      addMouseListener(this);
    }

    public void paint(Graphics g) {
      . . .
      g.setColor(Color.red);
      if (spot != null) {
            g.fillOval(spot.x - RADIUS, spot.y - RADIUS,
            RADIUS * 2, RADIUS * 2);
        }
    }

    public void mousePressed(MouseEvent event) {
      if (spot == null)
            spot = new Point();
      spot.x = event.getX();
      spot.y = event.getY();
      repaint();
    }
    . . .
}
```

ClickMe.html

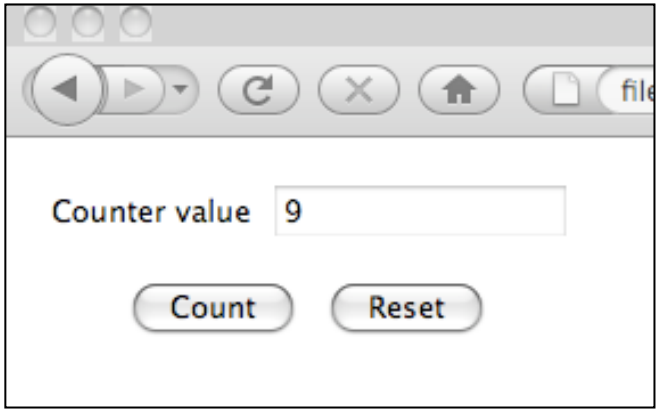
# Swing Applets

- Class **`javax.swing.JApplet`**
  - Derived from **`Applet`**
  - Is a top level Swing Container
- All Swing GUI components can be used
- Particularities of Swing Applets:
  - Add panels, layout managers etc as with **`JFrame`**
  - Default layout manager is **`BorderLayout`**
  - Direct drawing into a Swing applet is not recommended!
  - Redefine method **`paintComponent()`**
  - Call parent method:

```
public void paintComponent(Graphics g){
   super.paintComponent(g);
   . . .
}
```

# Example: Counter as Swing-Applet (1)

```
public class CounterSwingApplet extends JApplet {

    CounterPanel counterPanel;

    public void init() {
      counterPanel = new CounterPanel();
      add(counterPanel);
   }
}

// The View
class CounterPanel
      extends JPanel implements Observer {

   private Counter ctr;

   JPanel valuePanel = new JPanel();
   JTextField valueDisplay = new JTextField(10);

   JButton countButton = new JButton("Count");
   JButton resetButton = new JButton("Reset");
   JPanel buttonPanel = new JPanel();

   . . .
```




Counter.html

# Example: Counter as Swing Applet (2)

```
  public CounterPanel () {                    class CounterPanel (contd.)

      ctr = new Counter();
      valuePanel.add(new Label("Counter value"));
      . . .
      add(valuePanel,BorderLayout.NORTH);

      countButton.addActionListener(new ActionListener() {
          public void actionPerformed (ActionEvent event) {
              ctr.count();
          }
      });
      . . .
      ctr.addObserver(this);
   }

   public void update (Observable o, Object arg) {
      valueDisplay.setText(String.valueOf(ctr.getValue()));
   }

   public void paintComponent(Graphics g){
        super.paintComponent(g);
  }
}

class Counter extends Observable { . . . }
```

# Organisation of Bytecode Files

- **`<object>`** and **`<applet>`** tags allow
  - Declaration of a "codebase" directory (attribute **`codebase`**)
  - Declaration of a Java archive (JAR) file (attribute **`archive`**)
- Advantages of codebase:
  - Java bytecode concentrated at one location
  - Fits with Java file conventions
- Advantages of archives:
  - Less files, less HTTP connections, better performance
  - Lower bandwidth requirements due to (LZW) compression

Cubic.html

# Applets and Security

- "Sandbox security":
  An applet is not allowed to
  - Open network connections (except of the host from which it was loaded)
  - Start a program on the client
  - Read or write files locally on the client
  - Load libraries
  - Call "native" methods (e.g. developed in C)
- "Trusted" Applets
  - Installed locally on the client, or
  - Digitally signed and verified
  - Such applets may get higher permissions, e.g. for reading/writing files

# Advantages and Disadvantages of Java Applets

- Advantages:
  - Interaction
  - Graphics programming
  - No network load created during local interactions
  - Executed decentrally – good scalability
- Disadvantages:
  - Dependencies on browser type, browser version, Java version
  - Generally known as a not very reliable technology
  - Debugging is problematic

# 3 Web Programming with Java

3.1 Client-Side Java: Applets

3.2 Server-Side Java: Servlets

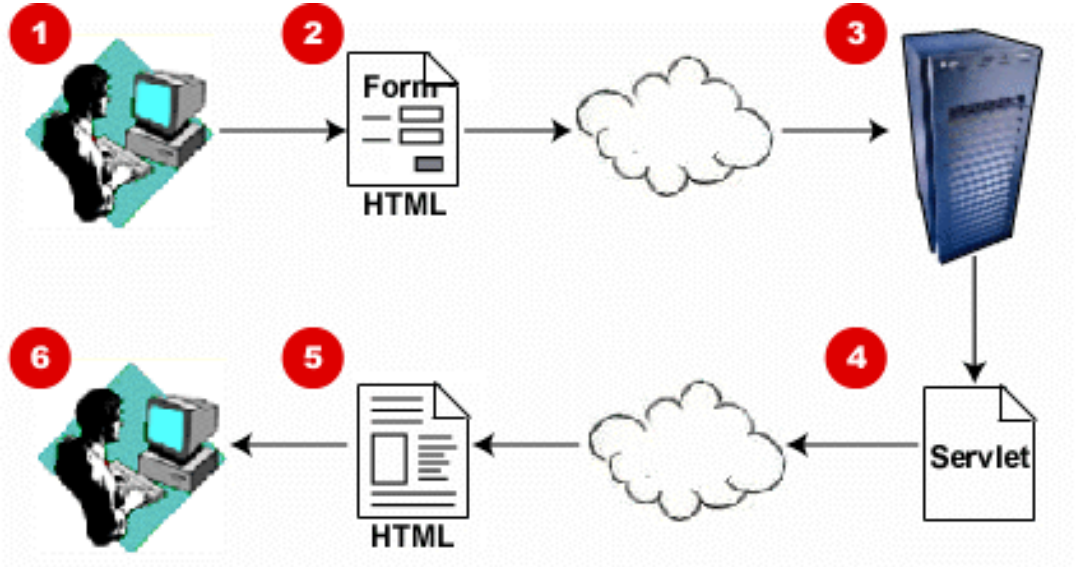
3.3 Java-Based Markup: Java Server Pages (JSP)

3.4 Dynamic Web Applications with Java Server Faces (JSF)

Literature:

http://java.sun.com/products/servlet/docs.html
http://glassfish.java.net/

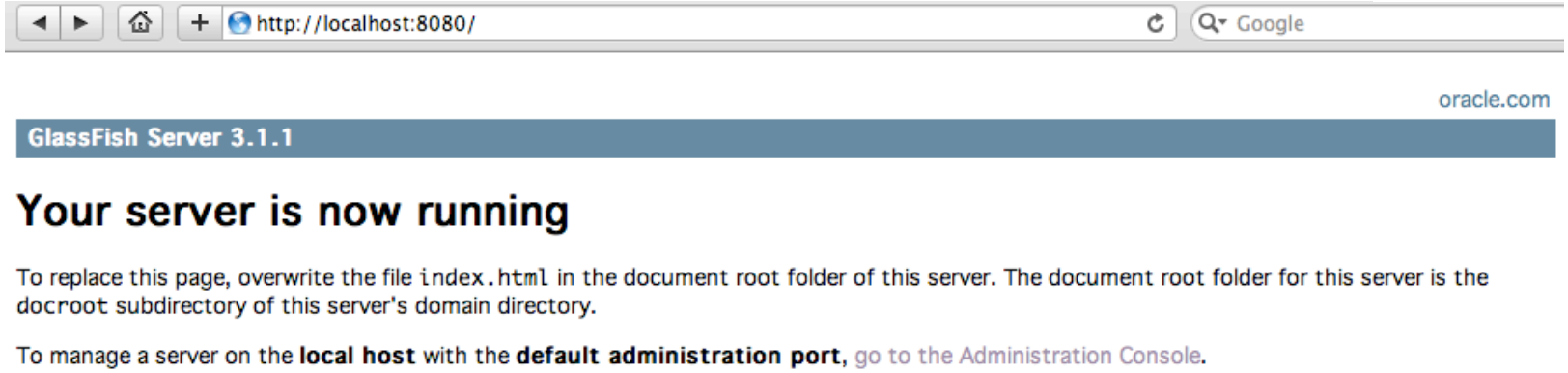
# Basic Principle: Server-Side Execution




1. User fills form
2. Form is sent as HTTP request to server
3. Server determines servlet program and executes it
4. Servlet computes response as HTML text
5. Response is sent to browser
6. Response, as generated by servlet, is displayed in browser

# Java-Enabled Web Server

- Servlets are part of Java *Enterprise* Edition (Java EE)
- Prerequisite:
  - Web server must be enabled for Java *servlets*
    - » Recognize servlet requests
    - » Administer servlets
    - » Execute servlets *(servlet container)*
- Before doing any experiments:
  - Install Servlet Container software
  - E.g. Apache Tomcat or Oracle GlassFish



# Java Servlets

- Java Servlet Specification (JSS):
  - Part of Java Enterprise Edition (EE)
  - First version: 1996 (Java: 1995)
  - Current version: 3.0 (with Java EE 6)
  - Java Server Pages: 1997–1999
  - Java Server Faces: 2001 –
- Reference implementation for a “servlet container”:
  - “GlassFish” (Oracle)
- Other well-known Java EE servers:
  - Apache Tomcat (Catalina), BEA Weblogic (now Oracle), JBoss, jetty
- Basic principle very similar to PHP:
  - Web server calls (Java) servlet code on request from client
  - Servlet determines response to client
    - » Most obvious usage: Produces a HTML page
    - » Other usages: Acts as server-side partner in AJAX-like technologies

# Servlet-API: Basics

- **`abstract class javax.servlet.GenericServlet`**
  - Declares method **`service()`**
- **`abstract class javax.servlet.http.HttpServlet`**
  - Subclass of GenericServlet for HTTP servlets
  - Defines standard implementation for method **`service()`**, calls
    - » **`doPost(), doGet(), doPut()`**

```
protected void doGet(HttpServletRequest req,
    HttpServletResponse resp)
protected void doPost(HttpServletRequest req,
    HttpServletResponse resp)
```

- **`interface javax.servlet.http.HttpServletRequest`**
  - Provides information about request, method examples: **`getAttribute(), getParameter(), getReader()`**
- **`interface javax.servlet.http.HttpServletResponse`**
  - Access to response construction, method examples: **`setContentType(), getWriter()`**

# Example: Hello-World Servlet

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

public class HelloWorld extends HttpServlet {

    public void doGet(HttpServletRequest request,
                      HttpServletResponse response)
      throws IOException, ServletException
    {
        response.setContentType("text/html");
        PrintWriter out = response.getWriter();
        out.println("<html>");
        out.println("<head>");
        out.println("<title>Hello World!</title>");
        out.println("</head>");
        out.println("<body>");
        out.println("<h1>Hello World!</h1>");
        out.println("</body>");
        out.println("</html>");
    }
}
```

# Example: Very Simple Dynamic Servlet

HTML page showing current date and time

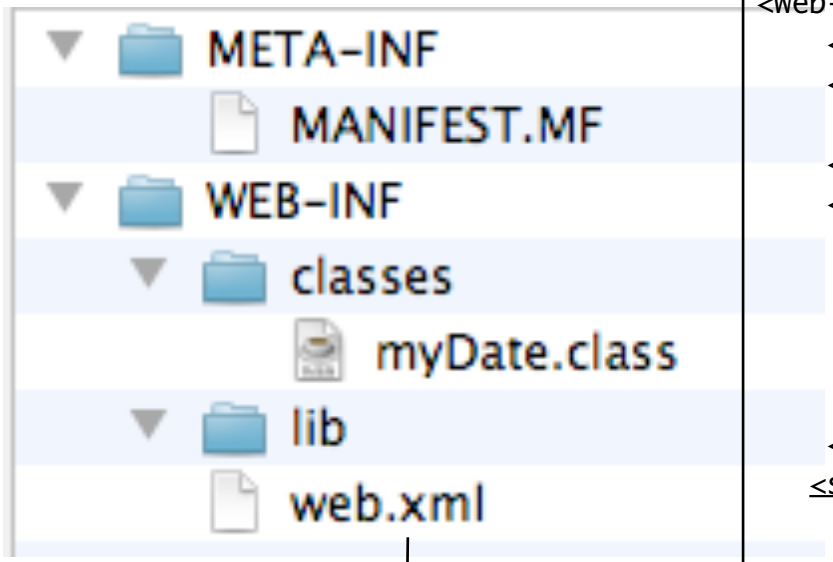
```
public class myDate extends HttpServlet {

      private static final long serialVersionUID = 11L;

public void doGet (HttpServletRequest request,
                   HttpServletResponse response)
               throws ServletException, IOException {

    String title = "Date Servlet Page";
    response.setContentType("text/html");

    PrintWriter out = response.getWriter();
    out.println("<html><head><title>");
    out.println(title);
    out.println("</title></head><body>");
    out.println("<h1>" + title + "</h1>");
    out.print("<p>Current time is: ");
    out.println(new java.util.GregorianCalendar().getTime());
    out.println("</body></html>");
    out.close();
  }
}
```


http://localhost:8080/myDateServlet/

# Deployment of Servlet Application

- Servlet is a Java code file (myDate.java)
  - Needs to be compiled
  - Needs to be made known to the Servlet Container
- *Deployment:*
  - Installation of new server-side java code in the server software
  - Provide a location (directory), called *context path*
  - Provide metadata on the new application
- Usually a Dynamic Web application is archived (with jar) in a single archive file with ".war" extension (Web application archive)
- Several ways for deployment exist
  - E.g. administrative Web interface of GlassFish
  - E.g. through development environments
    - » e.g. NetBeans, Eclipse (with GlassFish Plugin)

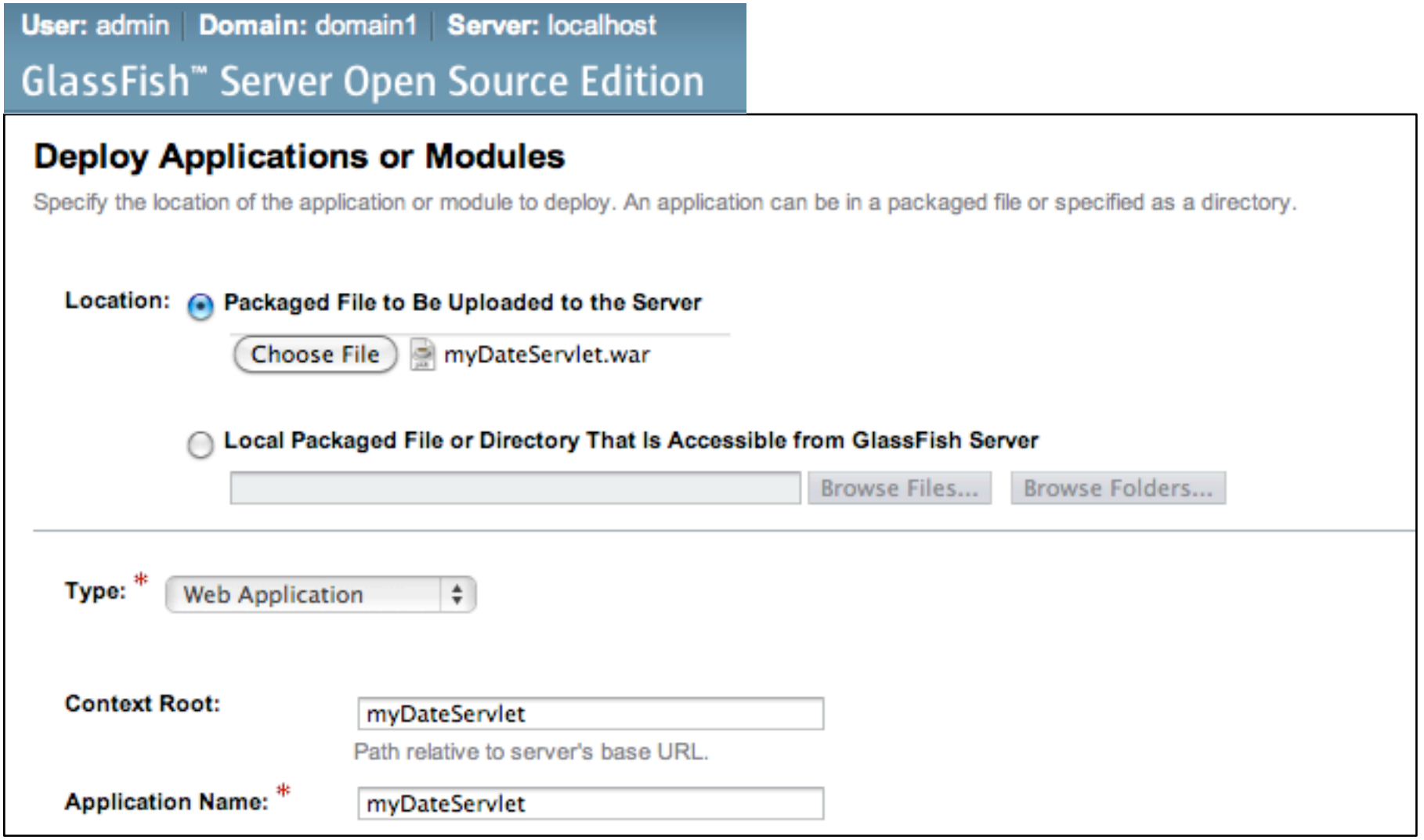
# File Structure for Deployment




Meta information

```
<?xml version="1.0" encoding="ISO-8859-1"?>

<!DOCTYPE web-app PUBLIC "-//Sun Microsystems, Inc.//DTD Web Application 2.3//EN"
                         "http://java.sun.com/dtd/web-app_2_3.dtd">

<web-app>
    <display-name>My little Date Application</display-name>
    <description>
      Small demo example, by Heinrich Hussmann, LMU.
    </description>
    <context-param>
      <param-name>webmaster</param-name>
      <param-value>husmann@ifi.lmu.de</param-value>
      <description>
        The EMAIL address of the administrator.
      </description>
    </context-param>
   <servlet>
      <servlet-name>myDate</servlet-name>
      <description>
           Example servlet for lecture
      </description>
       <servlet-class>myDate</servlet-class>
   </servlet>
   <servlet-mapping>
      <servlet-name>myDate</servlet-name>
      <url-pattern>/</url-pattern>
   </servlet-mapping>
    <session-config>
      <session-timeout>30</session-timeout>    <!-- 30 minutes -->
    </session-config>
</web-app>
```

# Administration Interface for Server



# 3 Web Programming with Java

3.1 Client-Side Java: Applets

3.2 Server-Side Java: Servlets

3.3 Java-Based Markup: Java Server Pages (JSP)

3.4 Dynamic Web Applications with Java Server Faces (JSF)

Literature:

http://java.sun.com/products/jsp

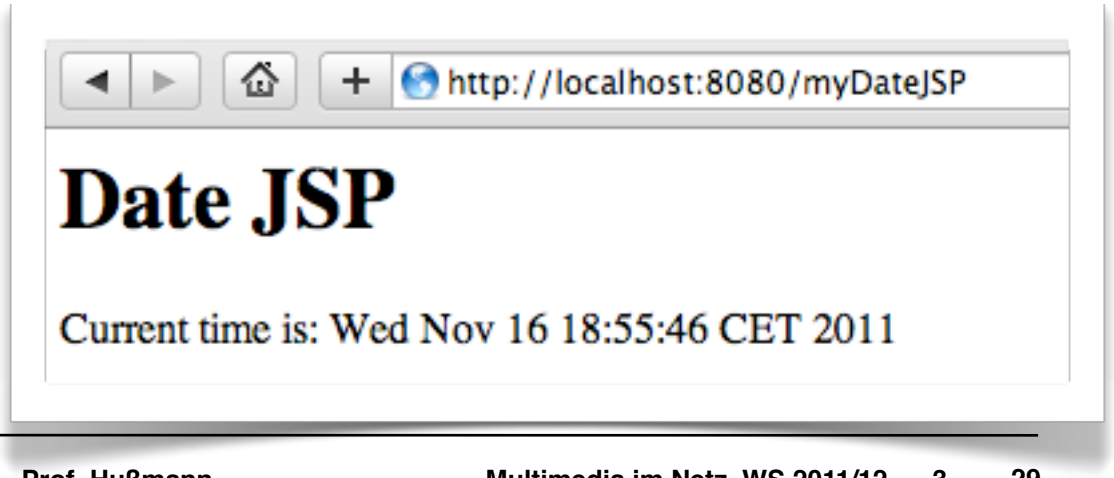
http://courses.coreservlets.com/Course-Materials/csajsp2.html

# Introductory Example: Java Server Page (JSP)

HTML page with current date/time

```
<html>
<%! String title = "Date JSP"; %>
<head><title> <%=title%> </title></head>
<body>
<h1> <%=title%> </h1>
<p>Current time is:
<% java.util.Date now = new GregorianCalendar().getTime(); %>
<%=now%></p>
</body></html>
```

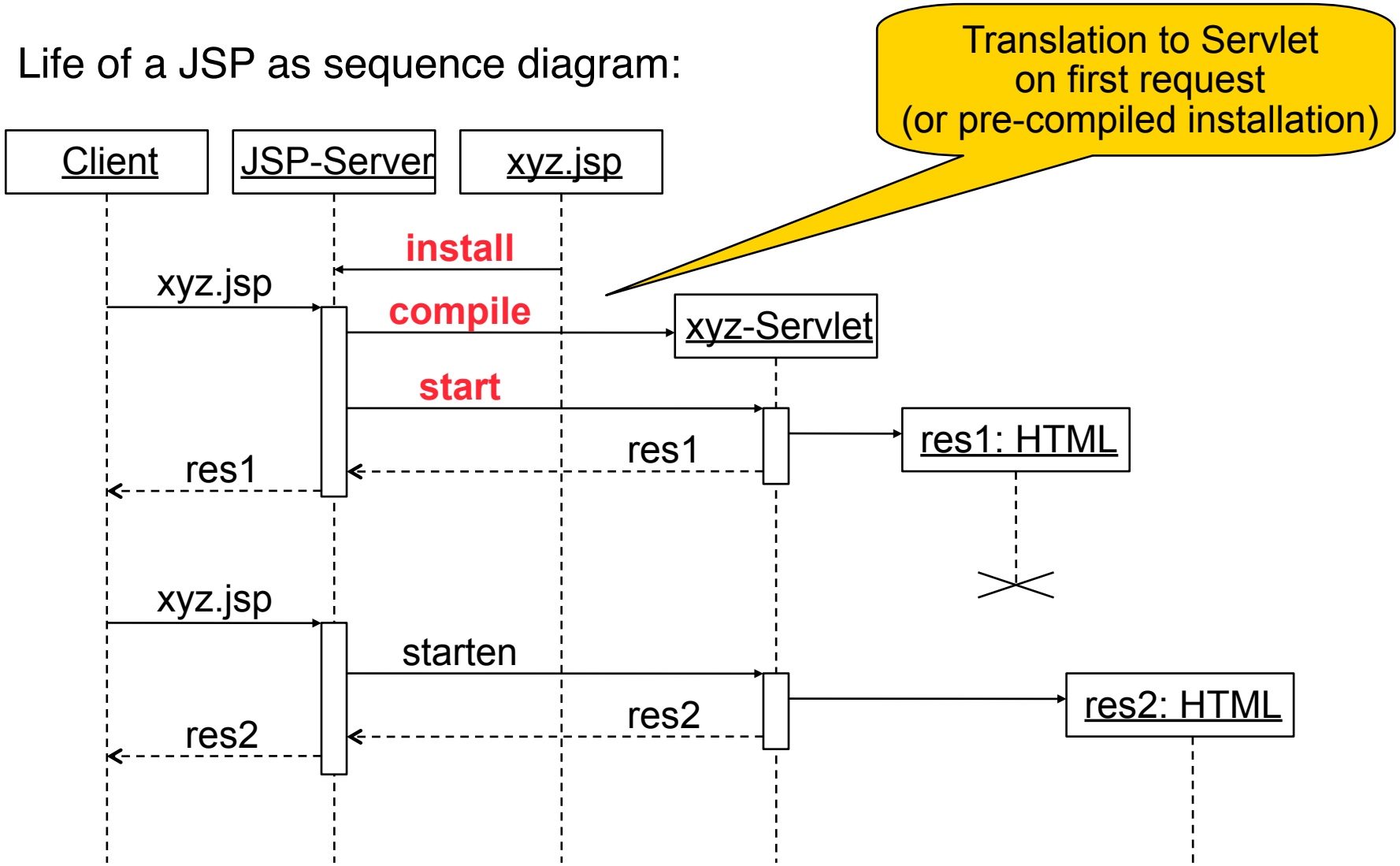
- Basic idea for Java Server Pages:
  - Scripts embedded in HTML ("*Scriptlets*")
  - Automatic translation into Java Servlet code




**Java HTML**

# Java Server Pages und Servlets

Life of a JSP as sequence diagram:



# JSP Language Elements

Java Server Pages specification provides markup language to be compiled into Java Servlets

Current version is JSP 2.2, JSP is likely to be superseded by JSF!

JSP can be used to generate arbitrary texts, not only HTML

Interesting target language: XML

Language elements:

- Script elements

  Embedding of Java code

- Implicit objects

  Access to important parts of servlets

- Directives

  Global instructions for compilation

- Actions

  Standard elements for runtime behaviour

# Embedding of Scriptlets in HTML

Two options for embedding:

- JSP-specific syntax: Tags with special symbols

  `<%, <%!, <%=, <%@, %>, <%--, --%>`

  – Not elegant, but very practical

- XML-Syntax with *name spaces*

  » XML name space (xmlns) prefix, e.g. "jsp"

  » Prefix definition is bound to a URL

  » Tags take the form **`<jsp: xyz>`**

  » Used for JSP actions in particular

# JSP Script Elements

- Declarations
  - Syntax: `<%! declarations %>`
    `<jsp:declaration> declarations </jsp:declaration>`
  - Example: `<%! String title = "Date JSP"; %>`
  - Is translated into instance variable of generated class, i.e. visible in all methods of the class.
- Anweisungen (*Scriptlets*)
  - Syntax: `<% commands %>`
    `<jsp:scriptlet> commands </jsp:scriptlet>`
  - Example:
    ```
    <% java.util.Date now = new
         GregorianCalendar().getTime(); %>
    ```
  - Local variables are not visible in other methods.
- Expressions
  - Syntax: `<%= expression %>`
    `<jsp:expression> expression </jsp:expression>`
  - Example: `<%= now %>`
  - Equivalent to `<% out.print(now); %>`

# Implicit Objects in JSP Scripts

The most important implicit objects:

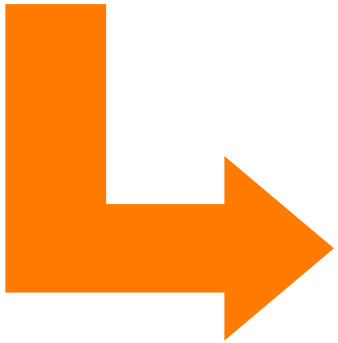
- **`request (javax.servlet.http.HttpServletRequest)`**
  - To read HTTP headers, parameters, cookies etc. from request
- **`response (javax.servlet.http.HttpServletResponse)`**
  - To write HTTP headers, cookies etc. into the response
- **`session (javax.servlet.http.HttpSession)`**
  - Tracking of associated interactions ("sessions")
- **`out (javax.servlet.jsp.JspWriter)`**
  - Output stream (result test)
  - Standard **`print()`** and **`println()`** commands

- Example:

```
<% if (request.getParameter("CountButton")!=null) {
     counter.count();
   }; %>
```

# Generated Servlet Code (Excerpt)

```
<html>
  <%! String title = "Date JSP"; %>
  <head>
     <title> <%=title%> </title>
  </head>
  <body>
     <h1> <%=title%> </h1>
     <p>Current time is:
          <% java.util.Date now = new GregorianCalendar().getTime(); %>
          <%=now%>
  </body>
</html>
```



```
...
out.write("\r\n");
out.write("\t<body>\n");
out.write("\t\t<h1> ");
out.print(title);
out.write(" </h1>\n");
out.write("\t\t<p>Current time is:\n");
out.write("\t\t\t");
java.util.Date now = new GregorianCalendar().getTime();
out.write("\n");
out.write("\t\t\t");
out.print(now);
out.write("\n");
```

# Cleaning Up the JSP Code

- Mixture between Java scriptlets and HTML markup
  - Is confusing
  - Is difficult to maintain
- Approaches to a better structure of the JSP:
  - Use JavaBeans
  - Use Tag Libraries (Markup tags associated with Java implementation)
  - Use Standard Tag Library (JSTL)
  - Use Expression Language (JSP-EL)
  - Use JSPX (XML syntax, easier to handle for editing tools)
- JSP has evolved into its own, rather complex, programming language

# What Is a JavaBean?

- JavaBeans is a *software component* model for Java
  - Not to be confused with Enterprise Java Beans (EJBs)!
- Software components:
  - Units of software which can be stored, transmitted, deployed, configured, executed without knowing the internal implementation
  - Main usage: Tools for composing components
- Driver for JavaBeans technology: User Interfaces
  - AWT and Swing components are JavaBeans
  - GUI editing tools instantiate and configure JavaBeans
- Main properties of a JavaBean:
  - Has a simple constructor without parameters
  - Provides public getter and setter methods for its properties: **`getProp, setProp`**
  - Is serializable
  - Supports listener mechanism for property changes

# JavaBeans in JSP: Action useBean

- Syntax of useBean Aktion:

```
<jsp:useBean id=localName class=className
                        scope=scopeDefn />
```

  scope: "page“ (current page), "request" (current request);
  "session" (current session), "application" (full application)

- Reading properties:

```
<jsp:getProperty   name=localName
                   property=propertyName/>
```

- Writing properties:

```
<jsp:setProperty   name=localName
                   property=propertyName/>
                   value=valueAsString
```

```
<jsp:getProperty   name="counter" property="current"/>
```

is equivalent to:

```
<%=counter.getCurrent();%>
```

# Counter as JavaBean (1)


```
package counter;

public class CounterBean implements java.io.Serializable {

    private static final long serialVersionUID = 12L;

    private int count;
    private int startValue;
    private int incrValue;
    private boolean enabled;

    /** Creates new CounterBean */
    public CounterBean() {
        startValue = 0;
        incrValue = 1;
        reset();
        enabled = true;
    } ...
```

# Counter as JavaBean (2)

```
    public void count () {
        if (enabled) {
            count += incrValue;
         }
    }

    public void reset () {
        count = startValue;
    }

    public int getCount() {
        return count;
    }

    public void setCount(int count) {
        this.count = count;
    }
… (getters/setters for all local properties) …
}
```

# Counter JSP with JavaBeans: HTML Source

```
%@ page contentType="text/html" session="true"%>
<html>
<head><title>Counter Demo Page</title></head>
<body>
    <jsp:useBean id="counter" scope="session" class="counter.CounterBean"/>
    <%  if (request.getParameter("CountButton")!=null) {
            counter.count();
        };
        if (request.getParameter("ResetButton")!=null) {
            counter.reset();
        }
    %>
    <h2>Counter Demo</h2>
    <p>
        Current counter value =
        <jsp:getProperty name="counter"  property="count" /></p>
        <form method="POST" action="CounterJSP.jsp">
            <input name="CountButton" type="submit" value="Count" />
            <input name="ResetButton" type="submit" value="Reset" />
        </form>
</body>
</html>
```

# 3 Web Programming with Java

3.1 Client-Side Java: Applets

3.2 Server-Side Java: Servlets

3.3 Java-Based Markup: Java Server Pages (JSP)

3.4 Dynamic Web Applications with Java Server Faces (JSF)

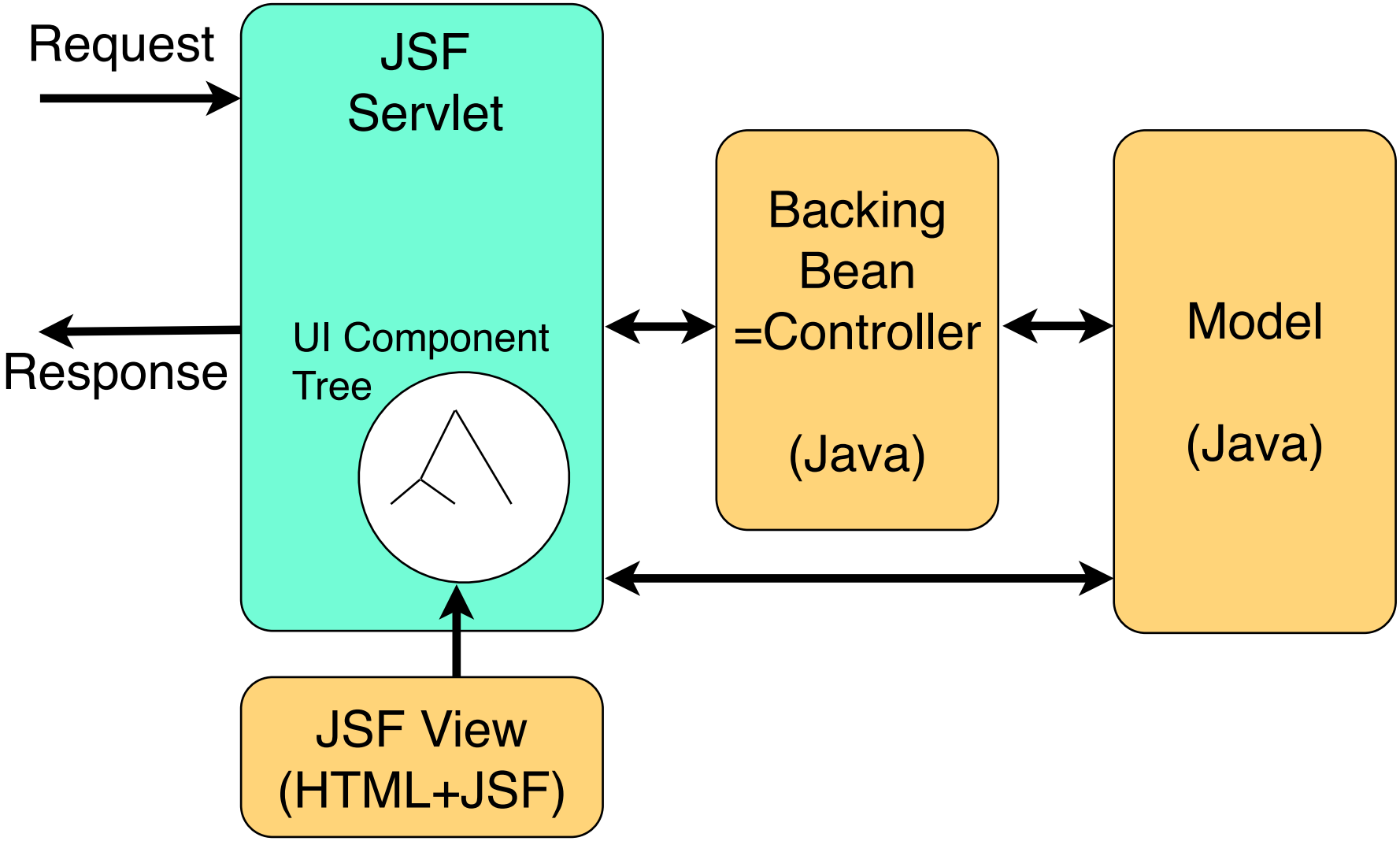
Literature:

B. Müller: Java Server Faces 2.0, 2. Auflage, Hanser 2010
http://www.javaserverfaces.org/
http://balusc.blogspot.com/2011/01/
jsf-20-tutorial-with-eclipse-and.html

# Java Server Faces (JSF)

- Java framework for building Web applications
  - Using a Model-View-Controller architecture
  - Latest version 2.0 (2009)
    - » Heavy update to previous version
- JSF can be used together with JSP (and other technologies), but also as a separate tool for creating dynamic Web applications
  - JSF is likely to replace JSP in the future
- One single servlet: FacesServlet
  - loads view template
  - builds component tree mirroring UI components
  - processes events
  - renders response to client (mostly HTML)
- JSF follows a strict Model-View-Controller (MVC) architecture

# Counter with JSF's MVC Architecture



# Example: Model for Counter

- Counter as Java Bean
  - We can use ***exactly*** the same code as in the JSP example
- Serializable
- All properties exposed as getters and setters

# Example: View for Counter

```
<!DOCTYPE html>
<html lang="en"
     xmlns:f="http://java.sun.com/jsf/core"
     xmlns:h="http://java.sun.com/jsf/html"
     xmlns:ui="http://java.sun.com/jsf/facelets">
  <h:head>
    <title>Counter with Java Server Faces</title>
  </h:head>
  <h:body>
    <h2>Counter with JSF</h2>
    <h:form>
      <h:panelGrid columns="2">
        <h:outputLabel for="ctrvalue">Counter value = </h:outputLabel>
        <h:outputText id="ctrvalue" value="#{counterController.counterBean.count}"/>
        <h:commandButton value="Count" action="#{counterController.submitCount}" />
        <h:commandButton value="Reset" action="#{counterController.submitReset}" />
      </h:panelGrid>
    </h:form>
  </h:body>
</html>
```

counter.jsf (or .xhtml)

# Example: Controller for Counter (1)

```
package counter;

import javax.faces.bean.ManagedBean;
import javax.faces.bean.ViewScoped;

@ManagedBean
@ViewScoped
public class CounterController implements java.io.Serializable {

    private static final long serialVersionUID = 11L;

    private CounterBean counter;

    public CounterController() {
        counter = new CounterBean();
    }

  ...
```

Bean instance name is automatically translated to class name with lowercase first letter

# Example: Controller for Counter (2)

```
...
    public void submitCount() {
        counter.count();
    }

    public void submitReset() {
        counter.reset();
    }

    public CounterBean getCounterBean() {
        return counter;
    }

}
```

# Advantages of JSF

- Clean separation of concerns
  - View (JSF/HTML) just specifies appearance
    - » View contains markup only (+references to beans)
  - Model is clearly separated
    - » Usually, access to persistence layers, databases etc.
  - Usage of controller is enforces
    - » Controller is simple Java Bean
- JSF is fully integrated into Java EE architecture
  - Supports load sharing, transactions etc.

# JSF Tag Libraries

- HTML Library (`xmlns:h="http://java.sun.com/jsf/html"`)
  - Forms, input and output
  - Grouping, tables
  - Commands (buttons, links)
  - messages
- Core Library (`xmlns:f="http://java.sun.com/jsf/core"`)
  - Views, subviews
  - Listeners
  - Data converters
  - Validators
  - Internationalisation
- Facelets Library (`xmlns:ui="http://java.sun.com/jsf/facelets"`)
  - Templates for pages
  - Debugging
- + Composite Components Library + JSTL Library

# AJAX Support in JSF

- Special tag in JSF Core Library:
  `<f:ajax>`
- Ajax tag modifies reaction of components in which it is embedded
  - XMLHttpRequest instead of browser-global request updating the view
- Example:

```
<h:inputText ...>
    <f:ajax listener="#{handler.ajaxListener}"
            render= … />
</h:inputText>
```

- On value change event (input into text field), specified handler is called
  - on the server, of course (= asynchronous handling of input)
- Advanced AJAX functionalities for JSF 2.0: *RichFaces* Library (JBoss)
  - E.g. requestDelay, eventsQueue for optimization of request frequency
  - E.g. actualization regions
  - E.g. cyclic polling of server