CSE 510
Web Data Engineering

Java Servlets

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Install and Check Tomcat

Installing Tomcat

- Install stable production release
  - We will be using Apache Tomcat version 6.0.20
  - Do not install alpha, beta, milestone or nightly builds
- You need Java SE Development Kit (JDK) 6
- On Windows, use the self-extracting .exe and follow directions

Starting and Testing Tomcat

- Start Tomcat using bin/startup.bat or "Start Tomcat" icon in program group
  - Preferably, do not set up Tomcat as an "automatic start" service
- You can also use a Tomcat Launcher Plug-in within Eclipse
- Open http://localhost:8080/
  - You should see Jakarta project home page
- Open http://localhost:8080/examples/jsp/dates/date.jsp

HTTP Requests and Responses

HTTP Basics

- TCP/IP protocol used by web servers
- Synchronous
  - Client sending request waits for response
- Stateless
  - All info needed by server-side must be contained in HTTP request
  - Using appropriate session management techniques, we can go around restrictions of statelessness
- We show next the request and response message strings that go back and forth in interactions
  - Only for educational purposes
  - You will never code such strings directly
  - The application server will do it for you

Syntax of an HTTP Request

- `<method> <request URI> <HTTP-version>`
  - Important ones: GET & POST
  - See Table 3.1 of textbook for explanations of other methods: HEAD, PUT, DELETE, CONNECT, OPTIONS, TRACE
- Header fields
  - `Accept: text/html, text/xml, …`
    (acceptable response types)
- Message body (optional) (after blank line)

Example

```
GET / HTTP/1.1
Host: db.cse.buffalo.edu
User Agent: IE/5.0
Accept: text/html, text/xml
…
```

Syntax of an HTTP Response

- `<HTTP-version> <status-code> <reason>`
  - For example, status codes from 500-599 indicate server-side errors
  - See Table 3.2 for typical HTTP response codes
- Header fields
  - `Content-Type: text/html` (or other type)
- Message body (optional) (after blank line)

Communicating Data Provided in Forms: GET, POST and Parameters

- Consider the multiplication page

```
<html>
  <head><title>Multiplier Form</title></head>
  <body>
    Welcome to the page that multiplies by 3 <p />
    <form method="GET" action="multiply">
      Provide the number to be multiplied:
      <input type="text" name="num"/> <p />
      <input type="submit" value="Click to Submit"/>
    </form>
  </body>
</html>
```

When and How to Use POST (Instead of GET)

- Upon submitting "3" the browser emits URL

```
http://localhost:8080/multiplier/multiply?num=4
```

```
GET /multiplier/multiply?num=4 HTTP/1.1
Host: localhost:8080
```

- If your HTML form may create more than 255 characters use **<form method="POST"** …
  - Form data will be in body of http request

```
POST /multiplier/multiply HTTP/1.1
Host: localhost:8080

num=4
```

More Input Forms: Dropdown Menus

More Input Forms: Checkboxes

Encoding URIs

- HTTP only permits letters, digits, underscores and a few more
- Browsers take care of “special” symbols, using the RFC2277 encoding

Example of Encoding Characters in a URI Using the RFC2277

- Consider a page asking for emails

```
<html>
  <head><title>Email Submit Page</title></head><body>
    <form method="GET"
          action="http://localhost:8080/subemail.jsp">
      Type your e-mail here:
      <input type="text" name="eml"/> <p />
      <input type="submit" value="Click Here"/>
    </form></body></html>
```

- User types mpetropo@buffalo.edu

```
GET /subemail.jsp?eml=mpetropo%40buffalo.edu HTTP/1.1
Host: localhost:8080
```

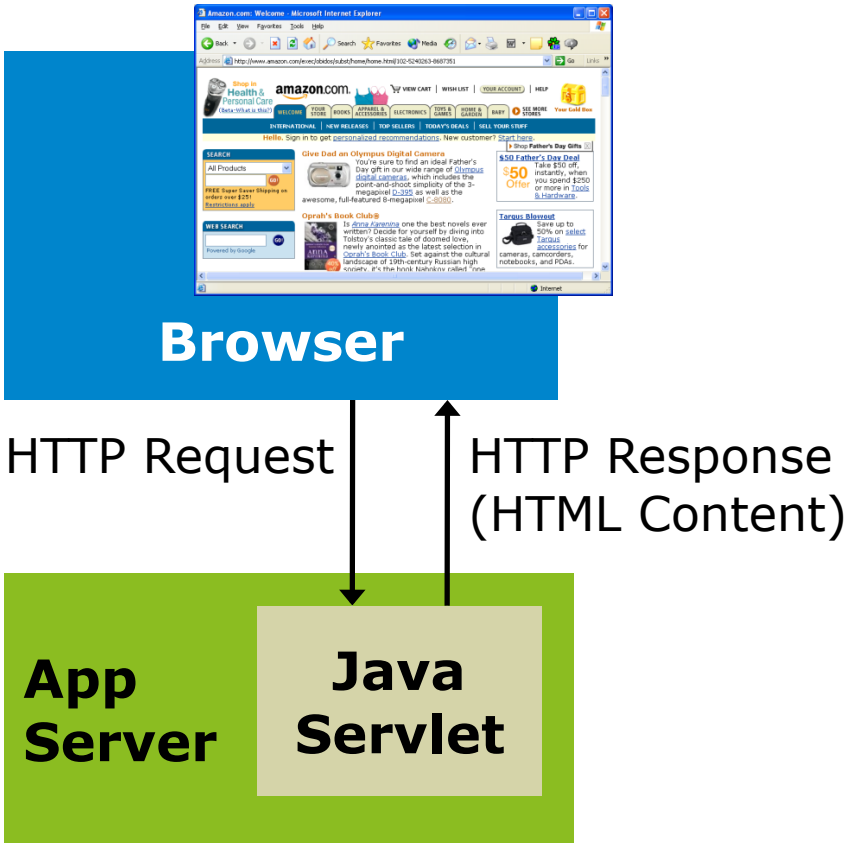
Some Useful Aspects of HTTP

- URI redirection
- Refresh
  - Instruct the browser to reload every N seconds
  - `<meta http-equiv="refresh" content="300">`
  - `Refresh: 300`

Servlets: The 101 of Java-based Web Server-Side Programming

Java-Based Server-Side Programming 101: Servlets

- Servlet: Java program run inside the app server (Tomcat)
- Inputs HTTP requests
  - App server provides them in appropriate object format
- Typically (but not necessarily) return HTTP responses of HTML content type



Multiplication Form and Servlet: The HTML Form Gets Input, Calls Servlet

- Create Web app (directory) `multiplier` under `webapps`
- Place `multiplier.html` in it
- Browse to `http://localhost:8080/multiplier/multiplier.html`
- When form is submitted, browser issues HTTP GET request
  - ACTION specifies URL to be invoked
  - URL of servlet may be relative, as in `multiplier.html`, or absolute:

    `http://localhost:8080/multiplier/multiply`

MyMultiplier.java

```
import java.io.*;
/* following packages encapsulate Servlet API */
import javax.servlet.*;
import javax.servlet.http.*;

public class MyMultiplier extends HttpServlet {
  /* Overrides doGet coming with HttpServlet */
  public void doGet(HttpServletRequest req,
                    HttpServletResponse res)
    throws ServletException, IOException {
```

MyMultiplier.java

```
        res.setContentType("text/html");
        /* By having set content to text/html */
        /* PrintWriter encodes accordingly */
        PrintWriter out = res.getWriter();
        out.println("<html><head><title>Multiply by " + 3
                    + "</title></head><body>");
        String parameter = req.getParameter("num");
        /* Ignoring the possibility that parameter is not
          integer */
        out.println(parameter + " * " + 3 + " = " +
                    3 * (Integer.parseInt(parameter)));
        out.println("</body></html>");
    }
}
```

Compiling & Deploying the Servlet

- Place `MyMultiplier.java` in `multiplier/src`
  - Not necessary, but good principle to separate java sources from classes
- Compile `MyMultiplier.java`
  - Include in CLASSPATH environment variable `<CATALINA_HOME>\lib\servlet-api.jar`
- Place `MyMultiplier.class` in `multiplier/WEB-INF/classes`

Deployment Descriptor & URL Mapping

- Map the servlet class to a URL pattern in the deployment descriptor `multiplier/WEB-INF/web.xml`

```
<web-app>
  <servlet>
    <servlet-name>multiplier</servlet-name>
    <servlet-class>MyMultiplier</servlet-class>
  </servlet>
  <servlet-mapping>
    <servlet-name>multiplier</servlet-name>
    <url-pattern>/multiply</url-pattern>
  </servlet-mapping>
</web-app>
```

- After restarting Tomcat, you can access servlet at
  http://localhost:8080/multiplier/multiply?num=4

Deployment Descriptor & URL Mapping

- URL pattern may include * (wildcard)

```
<servlet-mapping>
  <servlet-name>action</servlet-name>
  <url-pattern>*.do</url-pattern>
</servlet-mapping>
```

- Any URL pattern matching `*.do` will invoke the `action` servlet
- We'll see this again in Struts implementations (indeed this example is from Struts)

Servlet Life Cycle

- First time a servlet is called:
  - `init()` method is invoked
    - Normally provided by `HttpServlet`
    - Unless you want to set up resources that exist for the whole lifetime of the servlet (rare)
  - Object (extending `HttpServlet`) is instantiated and becomes memory resident from now on
    - Class variables exist for entire life of object
- Series of GET, POST, … HTTP calls lead to `doGet()`, `doPost()`, etc method invocations
- Servlet removed with `destroy()`
  - Tomcat may call `destroy()` any time
  - You may write your own `destroy()` to save state

Handling POST Method Calls

- Whether parameters are communicated by GET or POST is normally irrelevant to your code
- However, you have to provide (override) `doPost()` of `HttpServlet`

```
public void doPost(HttpServletRequest req,
                   HttpServletResponse res)
  throws ServletException, IOException {
    doGet(req, res);
}
```

Handling Other Method Calls

- DELETE, HEAD, OPTIONS, PUT, TRACE
- Corresponding `doDelete()`, `doHead()`, etc
- Normally developer does nothing
- `HttpServlet` provides defaults

Servlet Initialization Parameters: Definition in web.xml

- Assume we want to change the multiplication factor without having to change and recompile the `MyMultiplier.java` servlet
- Add initialization parameter in web.xml

```
<web-app>
  <servlet>
    <!-- … servlet stuff we've seen … -->
    <init-param>
      <param-name>times</param-name>
      <param-value>5.0</param-value>
    </init-param>
  </servlet>
</web-app>
```

Servlet Initialization Parameters: Use in Servlets

- Access to initialization parameters by invoking `getInitParameter`

```
String timesStr = getInitParameter("times");
```

Servlet Context Path

- Default context name of Web application is the name of the `webapps` subdirectory
  - In running example, `multiplier`
- Create alias context name if you want to hide the subdirectory name or effect non-default actions on your application's servlets
- Add `Context` element in `conf/server.xml`, inside `<Host name="localhost" …>`
  - `<Context path="/mult" docbase="multiplier"/>`
- Path is matched against URLs' beginning
  - Must be unique
  - Try http://localhost:8080/mult/multiply?num=4

Automatic Reload

- Default configuration does not check whether class files are replaced
  - Appropriate setting in production mode
- We can avoid stopping and restarting Tomcat during development/compilation by enabling automatic reloading of servlet class files
  - For an individual web application, add file `context.xml` under `<WEBAPP_HOME>/META-INF/` and just add

    ```
    <Context path="" reloadable="true">
    ```
  - To effect automatic reload for all applications add, edit file `<CATALINA_HOME>\conf\context.xml`, and add `reloadable="true"` attribute to the `Context` element

What is Wrong with Servlets

- The “look” of the resulting HTML is buried in println() statements
- Web designers cannot work this way
- Business logic and presentation horribly mixed
- other issues…

Some Additional Items for Your "To Do" List

- Automatic Reloading of Servlets
- **Deploy and modify the programs we've seen**