Core Servlets

Advanced Topics in Java

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Overview

- Web Applications
- Servlet Model/ Architecture
- Servlet Container and Servlet Life Cycle
- Creating Servlets
  - Interface `Servlet` and class `HttpServlet`
  - HTTP methods
- Deploying Servlets
  - Web Application Structure
  - Customizing the Servlet: `web.xml`
- Using Servlets
  - HTML Forms
  - GET and POST requests
- Handling requests: `ServletRequest/HttpServletRequest`
- Sending responses: `ServletResponse/HttpServletResponse`
- Servlet Configuration: `ServletConfig`
- Servlet Context: `ServletContext`

Server-side Programming: Java Servlets

- A servlet is a *server extension*, i.e. a piece of code that extends the functionality of a *web server*.
  - It resides in a *servlet container* and generates *dynamic* content in *response* to client *requests*.
  - It is a Java class that implements the `javax.servlet.Servlet` interface.
- A HTTP servlet is a servlet that implements the `javax.servlet.htpp.HttpServlet` *subinterface* and services HTTP requests.

Servlet Container

- A servlet container (also called a *servlet engine*) is a separate module used by the web server to *load* and *run* servlets.
- We will use *Tomcat* (5.5.*x*) (`http://jakarta.apache.org/tomcat/`) -- which can be run *standalone*, as a web server and a servlet container integrated into a single program.
  - implements Java API Servlet 2.4 and JSP (Java Server Pages) 2.0 specification (`http://jcp.org/en/jsr/detail?id=154`, `http://jcp.org/en/jsr/detail?id=152`)
- Some other servlet containers: Resin, JRun, Weblogic, WebSphere.

Practical Considerations

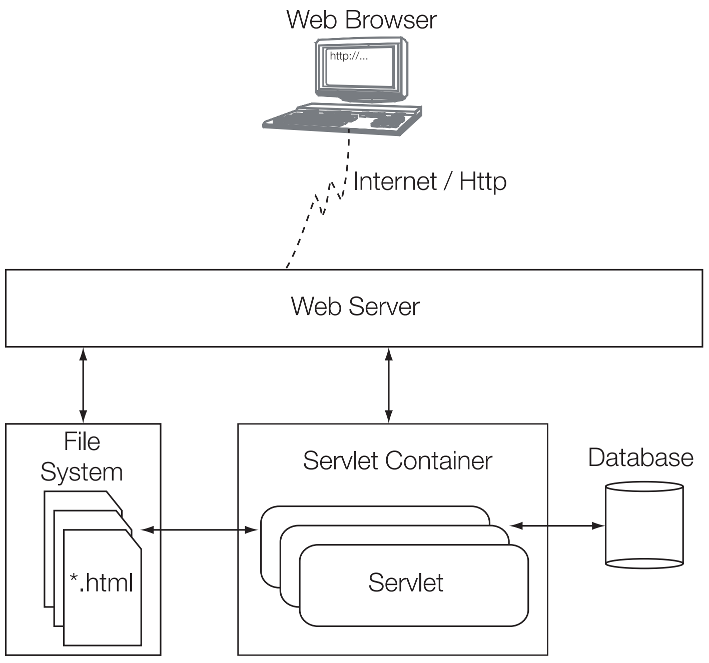
- Install Tomcat (5.5.*x*) (`http://jakarta.apache.org/tomcat/`).
- Set environment variables (Windows):

```
TOMCAT_HOME = C:\jakarta-tomcat-5.5.x

CATALINA_HOME = C:\jakarta-tomcat-5.5.x

JAVA_HOME = C:\Program Files\Java\jdk1.5.0_y

CLASSPATH = .;%TOMCAT_HOME%\common\lib\servlet-
api.jar;%TOMCAT_HOME%\common\lib\jsp-api.jar
```

- Use Tomcat Manager (`http://hostname/manager/html`).
  - To start, stop and reload.
  - Requires user authentication.
- Reference the Servlet API doc:

```
- http://hostname/tomcat-docs/index.html
- C:\jakarta-tomcat-5.5.x\webapps\tomcat-docs\servletapi\index.html
```

Web Application Architecture



Web-based Application

Active and Passive Resources

- A *passive resource* does not do any processing. It usually has *static content* which is retrieved by the client.

  For example: HTML and image files

  `http://www.ii.uib.no/~khalid/index.html`

- An *active resource* has processing capabilities. The result of the processing (*dynamic content*) is returned to the client.

  For example: servlets and JSP scripts.

  `http://www.google.com/search?sourceid=navclient&ie=UTF-8&q=servlet+jsp`

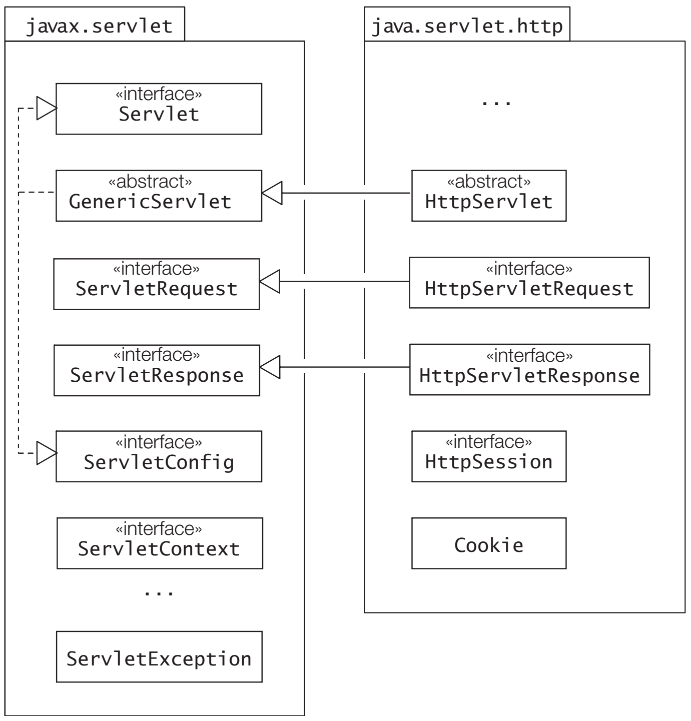
Web Applications and Components

- A *web application* comprises several *web components* which together provide a set of services over the Web.
- A web component can be a passive or an active resource, providing specific task capabilities.

Servlet API Specification

- The Servlet API (Application Programming Interfaces) Specification provides a standard, platform-independent framework for communication between servers and servlets.
- The servlet container implements and is compliant with the Servlet API specification.
- Developing servlets involves understanding how this communication takes place through the Servlet API.
- The Servlet API is a part of J2EE (Java 2 Enterprise Edition) and is comprised of two packages: `javax.servlet` and `javax.servlet.htpp`.
  – The `javax.servlet.htpp` package provides support for HTTP servlets.
  – Support for HTTP servlets is most prevalent.

Key Classes and Interfaces of the Servlet API


javax.servlet
«interface» Servlet
«abstract» GenericServlet
«interface» ServletRequest
«interface» ServletResponse
«interface» ServletConfig
«interface» ServletContext
...
ServletException
java.servlet.http
...
«abstract» HttpServlet
«interface» HttpServletRequest
«interface» HttpServletResponse
«interface» HttpSession
Cookie

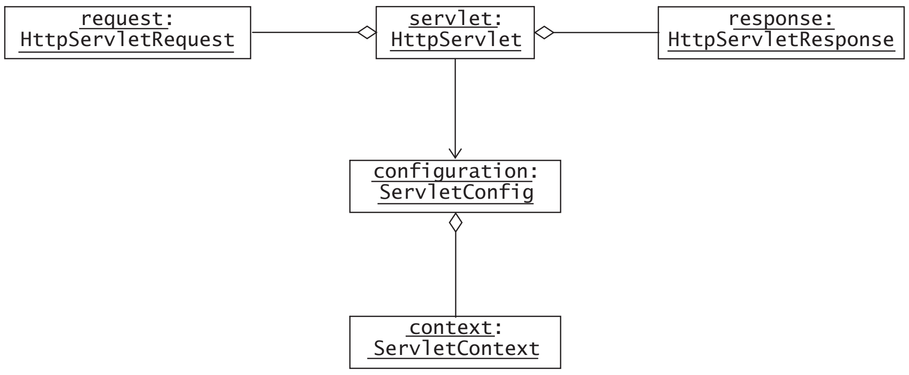
The `javax.servlet` Package

Class/Interface	Description
`interface Servlet`	The main interface that every servlet must implement. It defines the key methods that a servlet container calls to control the servlet.
`abstract class GenericServlet`	This abstract class can be used as the starting point for implementing servlets. In particular, it implements all the methods of the `Servlet` interface except the `service()` method. This abstract class also implements the `ServletConfig` interface which allows the servlet container to pass information to the servlet.
`interface ServletRequest`	This interface provides the methods to extract information from a client request.
`interface ServletResponse`	This interface provides the methods to create and send an appropriate response to a client request.
`interface ServletConfig`	This interface which allows the servlet container to pass information to a servlet.
`interface ServletContext`	This interface allows the servlet to communicate with its container.
`class ServletException`	A general exception class to signal servlet runtime errors.

The `javax.servlet.http` Package

Class/Interface	Description
`abstract class HttpServlet`	This abstract class extends the `GenericServlet` class and is used for implementing HTTP servlets, i.e. servlets which use HTTP for requests and responses. In particular, it provides stubs for the `do`*HttpRequestMethodName*`()` methods which correspond to the HTTP method used in the request (GET, POST, HEAD, etc.). A concrete servlet can override the appropriate methods to handle the different HTTP request methods.
`interface HttpServletRequest`	This interface extends the `ServletRequest` interface to handle HTTP requests.
`interface HttpServletResponse`	This interface extends the `ServletResponse` interface to create and send an appropriate HTTP response to an HTTP request.
`interface HttpSession`	This interface provides a way to identify a user across more than one page request or visit to a Web site and to store information about that user.
`class Cookie`	This class provides support for cookies to be used in requests and responses.

Core HTTP Servlet Object Diagram

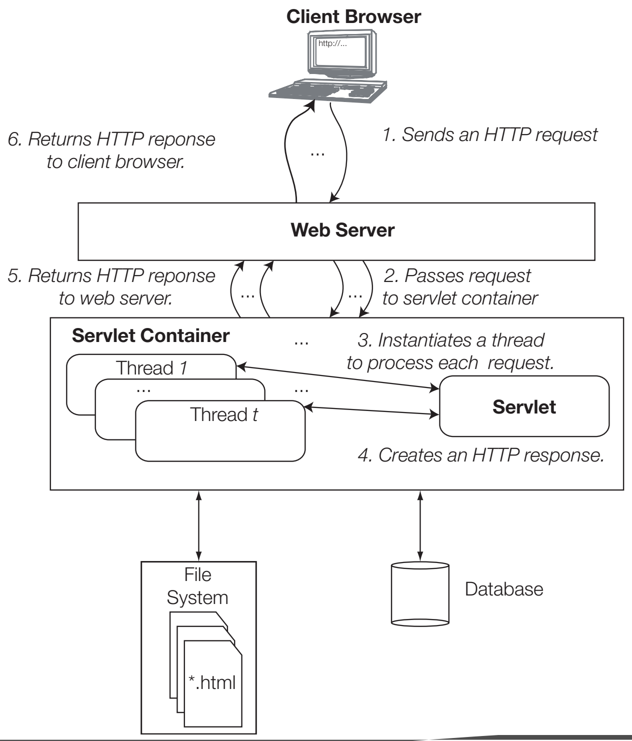


How the objects in the above diagram function and interact is essential to developing and deploying servlets.

Advantages of Servlets to extend Server Functionality

- *Flexibility*
  - A new servlet can be plugged in without changing the server.
- *Separation of Responsibilities*
  - The server takes care of the network connections and communication.
  - The servlets takes care of application logic: generating appropriate responses to client requests.
- *Compiled language implementation*
  - Advantages of a compiled high-level language as compared to a scripting language like Perl.
- *Scalability*
  - Multi-threaded servlets more efficient than process-based scripts in handling large number of client requests.
- *Portability*
  - A servlet can be ported to another web server as long as the server provides a compatible servlet container.
- *More flexible and less Security Restrictions than Applets*

Request Handling Cycle



Client Browser
http://...
6. Returns HTTP reponse to client browser.
1. Sends an HTTP request
Web Server
5. Returns HTTP reponse to web server.
2. Passes request to servlet container
Servlet Container
3. Instantiates a thread to process each request.
Thread 1
Thread t
Servlet
4. Creates an HTTP response.
File System
*.html
Database

Servlet Life Cycle Methods

- The abstract `javax.servlet.http.HttpServlet` class provides the key methods *invoked on the servlet by the servlet container* during the servlet's life time.

`void init(ServletConfig config) throws ServletException`	The servlet container invokes this method only once on the servlet after the servlet class has been loaded and instantiated, supplying it a `ServletConfig` object. A servlet can override the `init()` method (without any parameters) to do its own initialization.

`void service( ServletRequest request, ServletResponse response) throws ServletException, IOException`
`void service( HttpServletRequest request, HttpServletResponse response) throws ServletException, IOException`
	The servlet container invokes the first method on the servlet for each request received for this servlet.
	Information about the request is contained in the `ServletRequest` object, and the servlet can deliver a suitable response using the `ServletResponse` object.
	The first method calls the second method which dispatches the request to an appropriate `do`*HttpRequestMethodName*`()` method depending on the HTTP method used in the request.
	A servlet should override the appropriate `do`*HttpRequestMethodName*`()` methods.

`void destroy()`	The servlet container invokes this method on the servlet when the servlet is no longer needed. The servlet can no longer process requests after it is destroyed. A servlet can override this method to execute cleanup code.

HTTP Request Handling Methods

- The abstract `javax.servlet.http.HttpServlet` class provides *default implementation* for the `do`*HttpRequestMethodName*`()` methods which have the following *method prototype*:

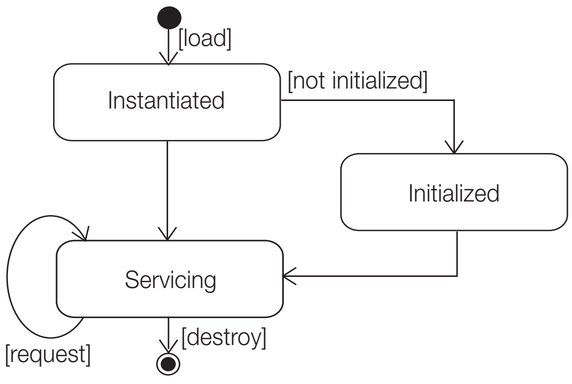
```
protected void doHttpRequestMethodName( HttpServletRequest request,
                                        HttpServletResponse response)
                                        throws ServletException, IOException;
```

HTTP Request Method Name	`HttpServlet` **Method Name**
`GET`	`doGet`
`HEAD`	`doHead`
`POST`	`doPost`

- Depending on the HTTP method in the request, the corresponding servlet method is invoked.
- The default implementation of a `do`*HttpRequestMethodName*`()` method returns a `HttpServletResponse.SC_BAD_REQUEST` response (error code 400).
- The servlet should override the appropriate request handling methods depending on the business logic.

Servlet States

- Before a servlet can process requests, it must be *loaded* by the servlet container.
- The servlet container *loads* and *instantiates* the servlet class.
- The servlet is *initialized* once during its life time. As part of the initialization, the `init()` method of the servlet is also called.
- Once instantiated and loaded, the servlet is ready for *servicing* requests. This ultimately involves one of the servlet methods `do`*HttpRequestMethodName*`()` to handle the request. Each request is executed in a separate thread.
- When no longer needed, the servlet is *destroyed* by the servlet container. Before destroying the servlet, the container calls the `destroy()` method of the servlet.



- Several threads can share the servlet instance. Thus, fields *cannot* be assumed to be *thread-safe*.

Skeleton of a HTTP Servlet

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

public class ServletSkeleton extends HttpServlet {
    public void init() throws ServletException { /* implementation */ }    // (1)

    public void doPost(HttpServletRequest req,                             // (2)
                       HttpServletResponse resp)
                       throws ServletException, IOException
                       { /* implementation */ }

    public void doGet(HttpServletRequest req,                              // (3)
                      HttpServletResponse resp)
                      throws ServletException, IOException
                      { /* implementation */ }

    public void destroy() { /* implementation */ }                         // (4)

    public String getServletInfo() { /* implementation */ }                // (5)
}
```

HTTP Request Methods Revisited

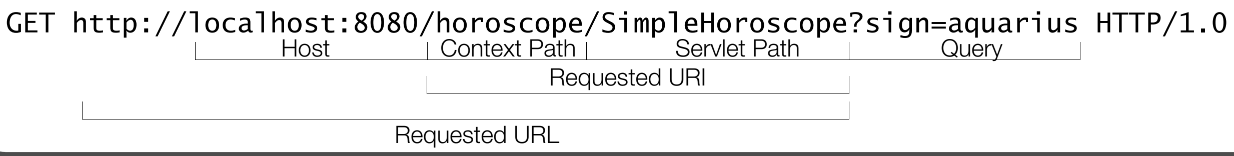
- The browser sends an HTTP request to a web server when such events as the following occur:
  - A hyperlink is clicked on a HTML page.
  - A form is filled on a HTML page and submitted.
  - A URL is specified for the browser to retrieve a resource.
- The browser uses the GET request method by default to send the request.
- A GET request has no entity-body, and therefore limited in the amount data it can send in the request.
  - A GET request is suitable for retrieving a passive resource.
  - A query string in a GET request specifies the parameters that are submitted in the request.
  - A GET request is therefore prone to a security risk.
- A POST request is suitable for retrieving an active resource, and can specify any additional information in the entity-body.
  - The entity-body in a POST request specifies the parameters that are submitted in the request.

Handling Servlet Requests: the `HttpServletRequest` Interface

- The `javax.servlet.http.HttpServletRequest` interface extends the `javax.servlet.ServletRequest` interface.
- A (`Http`)`ServletRequest` object is created by the servlet container and passed to the servlet in the `service()` method, and subsequently to the appropriate `do`*HttpRequestMethodName*`()`.

- The following methods supply *protocol-*, *method- and path-related information* in the request:

`String getMethod()`	Returns the name of the HTTP method in this request. For example: GET, POST, or HEAD.
`String getScheme()`	Returns the name of the scheme used to make this request, for example, *http* or *ftp*.
`String getProtocol()`	Returns the name and version of the protocol used in the request. The form is *protocol/majorVersion.minorVersion*, for example, HTTP/1.1.
`StringBuffer getRequestURL()`	Reconstructs the URL the client used to make the request.
`String getRequestURI()`	Returns the part of URL in this request that follows the host and port number up to the query string in the method line.
`String getServletPath()`	Returns the part of the URL that calls the servlet.
`String getContextPath()`	Returns the portion of the request URI that indicates the context of the request. The context path always comes first in a request URI. The path starts with a "/" character but does not end with a "/" character.



```
GET http://localhost:8080/horoscope/SimpleHoroscope?sign=aquarius HTTP/1.0
```

`String getQueryString()`	Returns the query string that is specified after the path.
`String getPathTranslated()`	Returns any extra path information after the servlet name but before the query string, and translating it to a *real path*.
`String getPathInfo()`	Returns any extra path information associated with the URL in this request.

- The following methods supply information about the *headers* in the request:

`String      getHeader(String name)`	Returns the `String` value of the specified header `name`.
`int        getIntHeader(String name)`	Returns the `int` value of the specified header `name`.
`Enumeration getHeaders(String name)`	Returns an enumerator of `String`s containing all the values associated with the specified header `name`.
`Enumeration getHeaderNames()`	Returns an enumerator of `String`s containing all the header names.

- The following methods supply information about the *client request parameters* submitted in the request:

`String   getParameter(String name)`	Returns *one value* for the parameter `name` if specified in the request, `null` otherwise. Note a parameter name can have several values associated with it.
`String[] getParameterValues( String name)`	Returns all the values for the parameter name if specified in the request, `null` otherwise.
`Enumeration getParameterNames()`	Returns an enumerator of `String`s containing the parameter names.

- Other misc. methods for various kinds of information pertaining to the request:

`String`	`getServerName()`	Returns the hostname of the server that received the request.
`Cookies[]`	`getCookies()`	Returns an array with all the *cookies* sent in the request.
`HttpSession`	`getSession(boolean instantiate)`	Returns the current *session* associated with the request if there is one. Otherwise creates one if argument `instantiate` is `true`.
`HttpSession`	`getSession()`	This method is equivalent to `getSession(true)`.

Creating Servlet Responses: the `HttpServletResponse` Interface

- The `javax.servlet.http.HttpServletResponse` interface extends the `javax.servlet.ServletResponse` interface.
- A (`Http`)`ServletResponse` object is created by the servlet container and passed to the servlet in the `service()` method, and subsequently to the appropriate `do`*HttpRequestMethodName*`()`.
- The servlet uses the `HttpServletResponse` object to formulate a response to the request.
- The following methods can be used to set specific *headers* in the response:

`void setStatus(int code)`	Sets the status `code` of the response.
`void setContentType(String type)`	Sets the MIME content type to the specified `type`.
`void setContentLength(int size)`	Sets the content length to the specified `size`.
`void addCookie(Cookie cookie)`	Adds a `cookie` to the response.

- The `HttpServletResponse` interface provides constants for the HTTP status codes:

```
HttpServletResponse.SC_OK              // HTTP Status-Code 200: OK
HttpServletResponse.SC_NOT_FOUND       // HTTP Status-Code 404: Not Found
HttpServletResponse.SC_NOT_IMPLEMENTED // HTTP Status-Code 501: Not Implemented
```

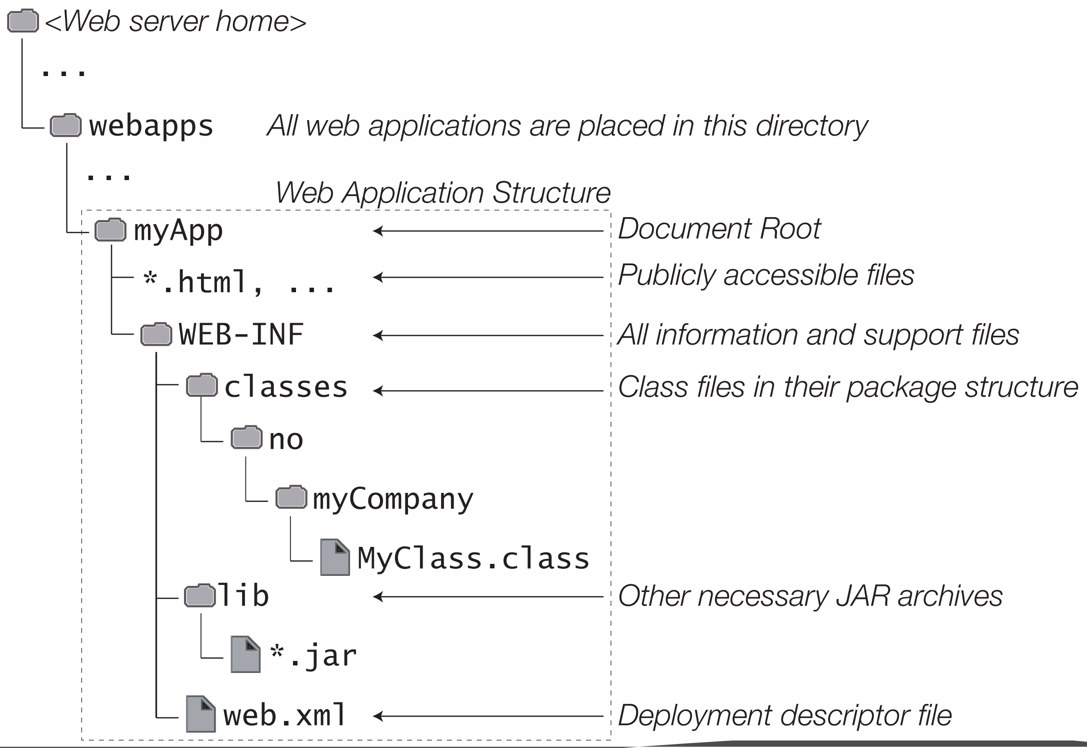
- The following methods can be used to set any *headers* in the response:

`void setHeader(String name, String value)`	Sets the specified response header `name` to the specified `value`.
`void addHeader(String name, String value)`	Adds the specified `value` to the specified multi-valued response header `name`.
`void setDateHeader(String name, long msecs)`	Sets the specified response header `name` to the date value specified in milliseconds.
`void addDateHeader(String name, long msecs)`	Adds the date value in milliseconds to the specified multi-valued response header `name`.
`void setIntHeader(String name, int value)`	Sets the specified response header `name` to the `int value`.
`void addIntHeader(String name, int value)`	Adds the `int value` to the specified multi-valued response header `name`.

Other Misc. Methods for Handling the Response:

`PrintWriter getWriter()`	Returns a `PrintWriter` that can send characters in the entity-body of the response. Calling the `flush()` method on the writer *commits* the response.
`ServletOutputStream getOutputStream()`	Returns a `ServletOutputStream` that can send binary data in the entity-body of the response. Calling the `flush()` method on the writer *commits* the response. Note that both a writer and a servlet output stream cannot be used for the entity-body of the response, only one of them.
`void sendRedirect(String location)`	Sends a temporary *redirect response* to the client using the specified redirect location URL.
`void sendError(int statusCode)` `void sendError(int statusCode, String message)`	Send the specified error code in the response, and the message if it is specified.

Deployment Structure for Web Applications



<Web server home>
...
webapps
All web applications are placed in this directory
...
Web Application Structure
myApp
Document Root
*.html, ...
Publicly accessible files
WEB-INF
All information and support files
classes
Class files in their package structure
no
myCompany
MyClass.class
lib
Other necessary JAR archives
*.jar
web.xml
Deployment descriptor file

Implementing a Servlet

- When overriding a `do`*HttpRequestMethodName*`()` method, the following procedure is recommended:
  - Read the request data.
  - Write the response headers.
  - Get the response's writer or output stream object.
  - Write the response data.
- In the response, include content type and encoding.
- When using a `PrintWriter` object to return the response, set the content type before accessing the `PrintWriter` object.
- The servlet container must write the headers before *committing* the response, because in HTTP the headers must be sent before the response body.
  - Committing locks some of the features of the servlet, this is specially true with respect to the response.
- A common strategy is to write the response data to an internal stream, and dump this data out to the output stream which is only closed after all data has been flushed.
- Since several threads (one for each request) can be executing the servlet, normal thread-safety precautions apply.

Developing, Deploying and Running a Web Application

1. Implement the classes of the web application (`StopTheWorld.java`):

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

public class StopTheWorld extends HttpServlet {
    public void doGet(HttpServletRequest request, HttpServletResponse response)
                      throws ServletException, IOException {
        String msg = "Stop the world! I want to get off!";
        // (1) Set the content type of the response
        response.setContentType("text/html");
        // (2) Get a writer for the response.
        PrintWriter responseWriter = response.getWriter();
        // (3) Compose the HTML content (entity-body) for the response.
        responseWriter.println("<html><body>");
        responseWriter.println("<h3>" + msg + "</h3>");
        responseWriter.println("</body></html>");
        responseWriter.flush(); // Commit the response.
        responseWriter.close();
    }
}
```

2. Specify the deployment descriptor for the web application (`web.xml`).

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<web-app version="2.4" xmlns="http://java.sun.com/xml/ns/j2ee"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
      http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd">

    <display-name>myExamples</display-name>
    <!-- A servlet element -->
    <servlet>
        <servlet-name>mySimpleServlet</servlet-name>
        <servlet-class>StopTheWorld</servlet-class>
    </servlet>

    <!-- A servlet mapping element -->
    <servlet-mapping>
        <servlet-name>mySimpleServlet</servlet-name>
        <url-pattern>/SimpleServlet/*</url-pattern>
    </servlet-mapping>

</web-app>
```

XML version and Character set declaration

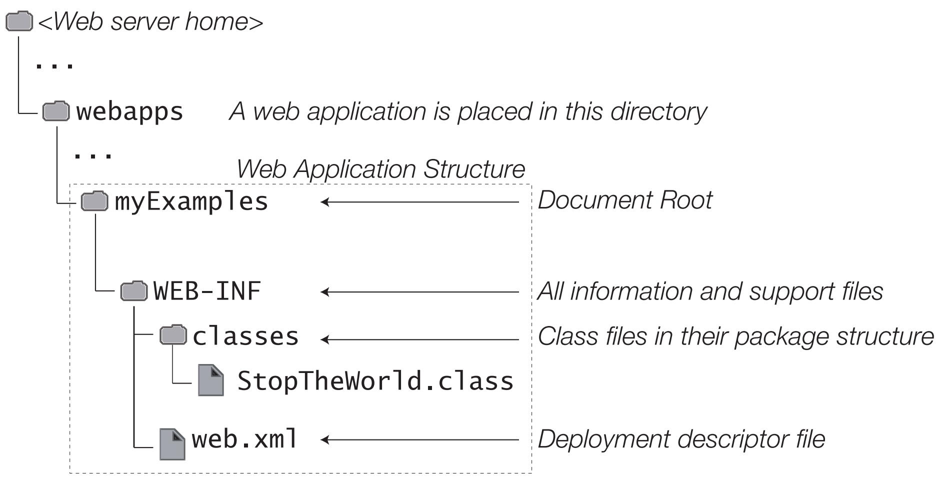
XML Namespace declarations

A servlet element is specified for each servlet in the web application. The servlet name is used to identify pertinent information about the servlet, for example its class.

A servlet mapping element is specified for each servlet in the web application. The url pattern `/SimpleServlet/*` is mapped to the servlet named `mySimpleServlet`. The url pattern need not be the same as the name of the servlet.

The order in which the elements are specified is important.

3. Install the web application in the `webapps` directory.
   - The web application is installed in a new directory called `myExamples`.
   - The `myExamples` directory is the *root document* of this web application.
   - The web application structure describes the application to the servlet container.



<Web server home>
...
webapps
A web application is placed in this directory
...
Web Application Structure
myExamples
Document Root
WEB-INF
All information and support files
classes
Class files in their package structure
StopTheWorld.class
web.xml
Deployment descriptor file

4. Configuring the web application.
   - The *context* of a web application must be specified for each web application.

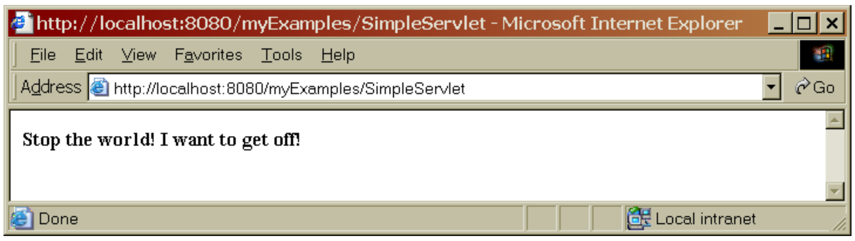
   - For example, the `myExamples` web application has the following context:

```
<Context
    path="/myExamples"
    docBase="/myExamples"
    reloadable="true"
    workDir="/webapps/myExamples/work">
</Context>
```

Two option for specifying the context information:

1. The `server.xml` file in the the `TOMCAT_HOME\conf` directory can be modified to provide the context information for each web application.
2. A *context file* can be created in the `TOMCAT_HOME\conf\Catalina\localhost` directory for each web application (*preferred solution*).
   - For example, the file `myExamples.xml` with the context information above would be placed in the `TOMCAT_HOME\conf\Catalina\localhost` directory.

5. Run the web application in a browser.
   – The web server must be up and running.
   – Enter an appropriate URL in the browser to send a request to the `SimpleServlet`.


http://localhost:8080/myExamples/SimpleServlet - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Address http://localhost:8080/myExamples/SimpleServlet
Go
Done
Local intranet

Stop the world! I want to get off!

- If the class files or the deployment descriptor file change, the web application structure must be updated with the new files.
  – If the application is *reloadable*, Tomcat will update the files.
  – However, it might be necessary to stop and restart the web application, and at times to restart the web server.

HTML Forms: Sending Data in a HTTP Request

- The HTML `FORM` element is an entity for submitting data in a HTTP request (See `SimpleHoroscope.html` in the `horoscope` web-app.).

```
<form name="signs" action="SimpleHoroscope" method="post">
    <input type="radio" name="sign" value="aquarius" checked="checked"/>
        Aquarius (Jan 21 - Feb 19) <br/>
    <input type="radio" name="sign" value="pisces"/>
        Pisces (Feb 20 - Mar 20) <br/>
    ...
    <input type="submit" value="Read the stars!"/>
</form>
```

- The attributes in the `FORM` element:

`name`	The name of the form.
`action`	The resource to process the submitted data. The servlet path is mapped to the servlet which will receive the data from the form in a HTTP request.
`method`	The HTTP method to use to submit the request. Default method is the GET method, so the POST method must explicitly be specified.

- Each `INPUT` element specifies properties of the input control using these attributes:

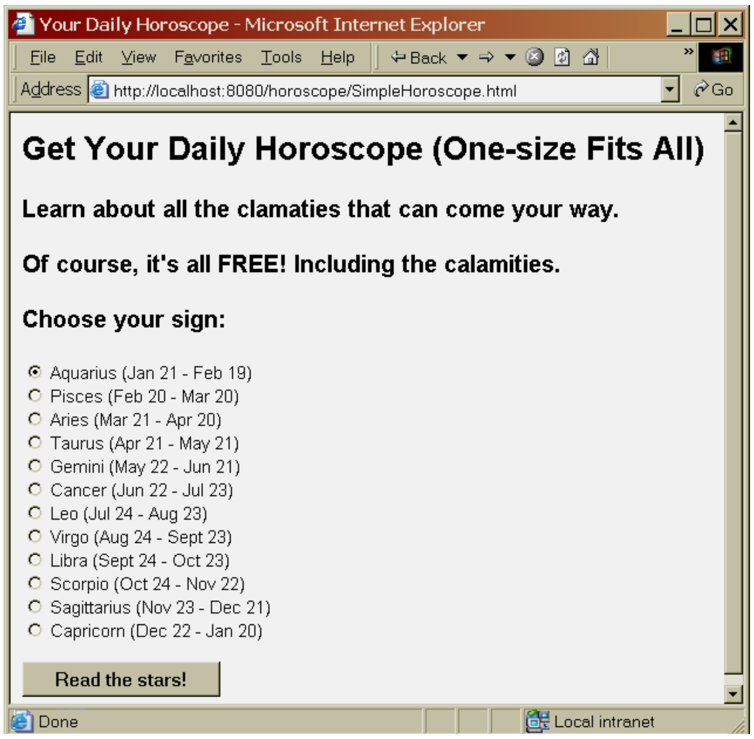
`type`	Specifies the *type of control*. The value `"radio"` indicates a *radio button*, meaning that only one such control can be checked in the form. The `checked` tag means that this button will initially appear checked in the page. Any text appearing after the `INPUT` element is used as label for the radio button. The value `"submit"` indicates a submit button. Some other values are `"text"` (text field) and `"password"` (password field).
`name`	This attribute specifies the name of the input control. Each radio button has the same name (`"sign"`).
`value`	For a radio button, the value of this attribute is associate with the value in the `name` attribute, forming a *parameter-value pair*. For a submit button, specifies the label of the button.

  – For other examples of `INPUT` element, see `HoroscopeWithSelect.html` and `HoroscopeWithTextField.html`.

- Clicking the submit control results in the values of the `name` and `value` attributes of the selected radio button to be submitted in the request.
  – For example, if the aquarious radio button was selected, clicking the submit button would be analogous to submitting the query string `"sign=aquarious"`.
  – Note that all radio buttons have the same name (`"sign"`) but the `value` attributes have different values depending on the star sign.

HTML Rendering of a Form

Note the HTML content of the file is returned by the web-server, not the servlet.


Your Daily Horoscope - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back
Address http://localhost:8080/horoscope/SimpleHoroscope.html
Go
Done
Local intranet

Get Your Daily Horoscope (One-size Fits All)

Learn about all the clamaties that can come your way.

Of course, it's all FREE! Including the calamities.

Choose your sign:

- (●) Aquarius (Jan 21 - Feb 19)
- ( ) Pisces (Feb 20 - Mar 20)
- ( ) Aries (Mar 21 - Apr 20)
- ( ) Taurus (Apr 21 - May 21)
- ( ) Gemini (May 22 - Jun 21)
- ( ) Cancer (Jun 22 - Jul 23)
- ( ) Leo (Jul 24 - Aug 23)
- ( ) Virgo (Aug 24 - Sept 23)
- ( ) Libra (Sept 24 - Oct 23)
- ( ) Scorpio (Oct 24 - Nov 22)
- ( ) Sagittarius (Nov 23 - Dec 21)
- ( ) Capricorn (Dec 22 - Jan 20)

Read the stars!

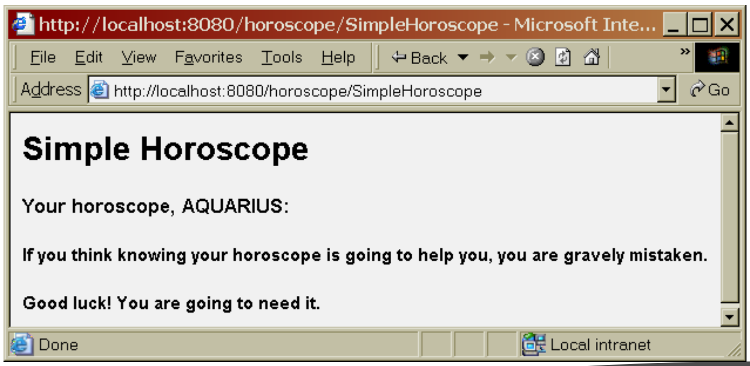
Example: Implementing Simple Horoscope

```
public class SimpleHoroServlet extends HttpServlet {

  protected String servletName = "Simple Horoscope Servlet";

  public void doPost(HttpServletRequest req, HttpServletResponse resp)
              throws ServletException, IOException {

    // Get the sign value
    String sign = req.getParameter("sign").toLowerCase();
    String horoscopeReply = getHoroscope(sign);
    if (horoscopeReply == null)
      horoscopeReply = "Looks like you were born under "
                     + "an as-yet undiscovered star.";

    // Set any response headers
    resp.setContentType("text/html");

    // Get a writer for the response
    PrintWriter out = resp.getWriter();
```

```
    out.println("<html><body><h1>" + servletName + "</h1>");
    out.println("<h3> Your horoscope, " + sign.toUpperCase() + ":</h3>");
    out.println("<h4>" + horoscopeReply + "</h4>");
    out.println("<h4>Good luck! You are going to need it.</h4>");
    out.println("</body></html>");

    // Flush and close the writer.
    out.flush();
    out.close();
  }

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

  protected String getHoroscope(String sign) {
    return "If you think knowing your horoscope "
         + "is going to help you, you are gravely mistaken.";
  }
}
```

Information in Deployment Descriptor (file `web.xml`)

```
...
<servlet>
    <servlet-name>SimpleHoroscope</servlet-name>
    <servlet-class>SimpleHoroServlet</servlet-class>
</servlet>

<servlet-mapping>
    <servlet-name>SimpleHoroscope</servlet-name>
    <url-pattern>/SimpleHoroscope</url-pattern>
</servlet-mapping>
...
```


http://localhost:8080/horoscope/SimpleHoroscope - Microsoft Inte...
File Edit View Favorites Tools Help
Back
Address http://localhost:8080/horoscope/SimpleHoroscope
Go
Done
Local intranet

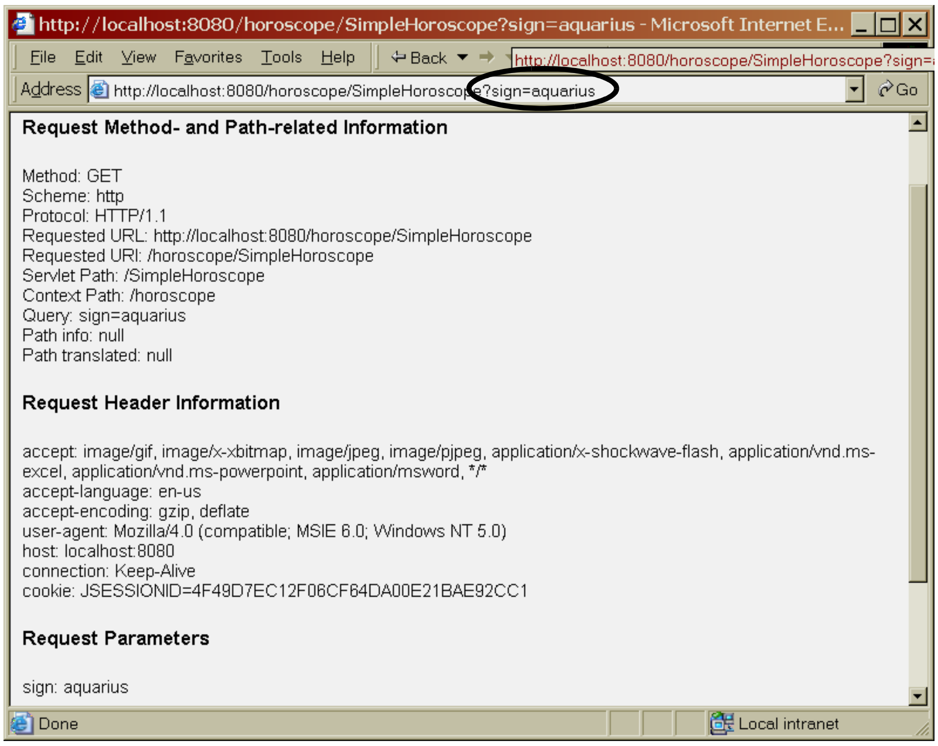
Simple Horoscope

Your horoscope, AQUARIUS:

If you think knowing your horoscope is going to help you, you are gravely mistaken.

Good luck! You are going to need it.

GET Method in the HTTP Request


http://localhost:8080/horoscope/SimpleHoroscope?sign=aquarius - Microsoft Internet E...
File Edit View Favorites Tools Help
Back
http://localhost:8080/horoscope/SimpleHoroscope?sign=
Address http://localhost:8080/horoscope/SimpleHoroscope?sign=aquarius
Go
Done
Local intranet

Request Method- and Path-related Information

```
Method: GET
Scheme: http
Protocol: HTTP/1.1
Requested URL: http://localhost:8080/horoscope/SimpleHoroscope
Requested URI: /horoscope/SimpleHoroscope
Servlet Path: /SimpleHoroscope
Context Path: /horoscope
Query: sign=aquarius
Path info: null
Path translated: null
```

Request Header Information

```
accept: image/gif, image/x-xbitmap, image/jpeg, image/pjpeg, application/x-shockwave-flash, application/vnd.ms-
excel, application/vnd.ms-powerpoint, application/msword, */*
accept-language: en-us
accept-encoding: gzip, deflate
user-agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0)
host: localhost:8080
connection: Keep-Alive
cookie: JSESSIONID=4F49D7EC12F06CF64DA00E21BAE92CC1
```

Request Parameters

```
sign: aquarius
```

Reading Request Method and Paths Information

- See file `ServletUtil.java`.

```
public static void echoRequestMethodLineInfo(HttpServletRequest req,
                                             PrintWriter out)
                      throws ServletException, IOException {
    out.print("<h3>Request Method- and Path-related" +
              " Information</h3>");
    out.print("<p>");
    out.print("Method: "        + req.getMethod()      + "<br>");
    out.print("Scheme: "        + req.getScheme()      + "<br>");
    out.print("Protocol: "      + req.getProtocol()    + "<br>");
    out.print("Requested URL: " + req.getRequestURL()  + "<br>");
    out.print("Requested URI: " + req.getRequestURI()  + "<br>");
    out.print("Servlet Path: "  + req.getServletPath() + "<br>");
    out.print("Context Path: "  + req.getContextPath() + "<br>");
    out.print("Query: "         + req.getQueryString() + "<br>");
    out.print("Path info: "       + req.getPathInfo()  + "<br>");
    out.print("Path translated: " + req.getPathTranslated()
                                                       + "<br>");
    out.println("</p>");
}
```

Reading Request Headers

- See file `ServletUtil.java`.

```
public static void echoRequestHeaders(HttpServletRequest req,
                                      PrintWriter out)
                      throws ServletException, IOException {

    out.print("<h3>Request Header Information</h3>");
    out.print("<p>");
    Enumeration enumerator = req.getHeaderNames();
    while (enumerator.hasMoreElements()) {
        String header = (String) enumerator.nextElement();
        String value = req.getHeader(header);
        out.print(header + ": " + value + "<br>");
    }
    out.println("</p>");
}
```

Reading Request Parameters

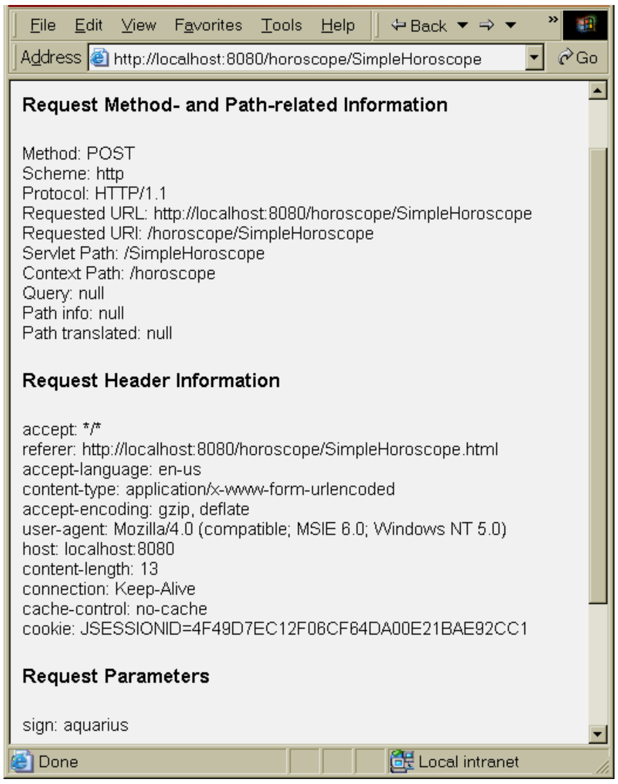
- See file ServletUtil.java.

```
public static void echoRequestParameters(HttpServletRequest req,
                                         PrintWriter out)
                       throws ServletException, IOException {

    out.print("<h3>Request Parameters</h3>");
    out.print("<p>");
    Enumeration enumerator = req.getParameterNames();
    while (enumerator.hasMoreElements()) {
        String paramName = (String) enumerator.nextElement();
        String paramValue = req.getParameter(paramName);
        out.print(paramName + ": " + paramValue + "<br>");
    }
    out.println("</p>");
}
```

HTTP Request

Illustrating:

- Method- and Path-related Information
- Request Headers
- Request Parameters

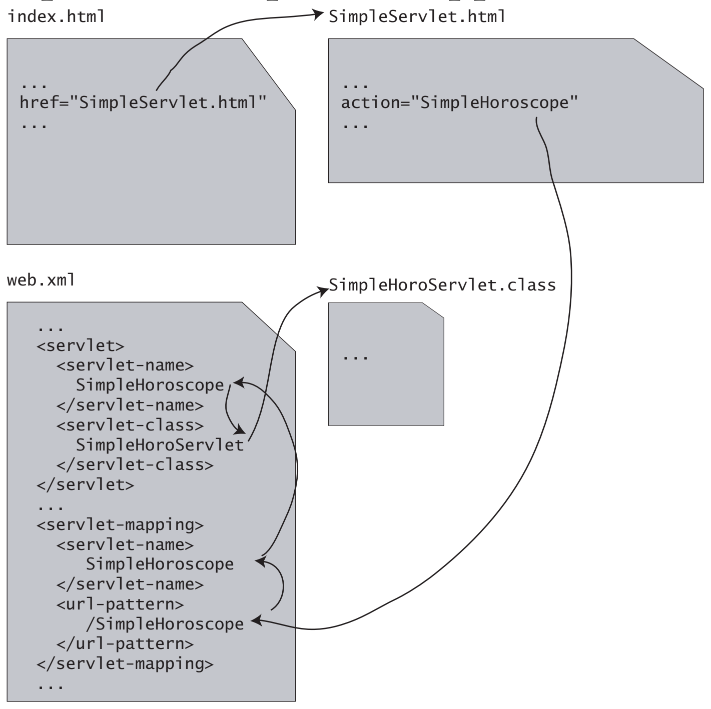

File Edit View Favorites Tools Help
Back
Address http://localhost:8080/horoscope/SimpleHoroscope
Go
Done
Local intranet

```
Request Method- and Path-related Information

Method: POST
Scheme: http
Protocol: HTTP/1.1
Requested URL: http://localhost:8080/horoscope/SimpleHoroscope
Requested URI: /horoscope/SimpleHoroscope
Servlet Path: /SimpleHoroscope
Context Path: /horoscope
Query: null
Path info: null
Path translated: null

Request Header Information

accept: */*
referer: http://localhost:8080/horoscope/SimpleHoroscope.html
accept-language: en-us
content-type: application/x-www-form-urlencoded
accept-encoding: gzip, deflate
user-agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0)
host: localhost:8080
content-length: 13
connection: Keep-Alive
cache-control: no-cache
cookie: JSESSIONID=4F49D7EC12F06CF64DA00E21BAE92CC1

Request Parameters

sign: aquarius
```

Files for Simple Horoscope Web Application

The `index.html` *file is a convenient way to group a set of servlets deployed under the same web application.*

The `*.html` *files are placed directly under the document root.*



```
...
<servlet>
  <servlet-name>
    SimpleHoroscope
  </servlet-name>
  <servlet-class>
    SimpleHoroServlet
  </servlet-class>
</servlet>
...
<servlet-mapping>
  <servlet-name>
     SimpleHoroscope
  </servlet-name>
  <url-pattern>
     /SimpleHoroscope
  </url-pattern>
</servlet-mapping>
...
```

Files in Web Application Deployment

Useful Methods of the Abstract `Servlet/ HttpServlet` Class

`ServletConfig getServletConfig()`	A `ServletConfig` object provides access to the servlet's *configuration information*: initialization parameters and servlet context. (*See also the API for the* `ServletConfig` *interface*). Such an object is passed to the servlet at initialization. A servlet can invoke this method to obtain the servlet configuration associated with the servlet. This method is specified in the `Servlet` interface.
`ServletContext getServletContext()`	A `ServletContext` object provides communication between the servlet and the servlet container. (*See also the API for the* `ServletContext` *interface*). A servlet can invoke this method to obtain the *servlet context* associated with the servlet. This method is specified in the `ServletConfig` interface.
`String getServletInfo()`	A servlet implements this method to provide such information as author, version, and copyright information. Servlet container can obtain this information by invoking this method on the servlet. This method is specified in the `Servlet` interface.

- Note that a servlet also implements the `ServletConfig` interface.

Servlet Configuration: the `ServletConfig` Interface

- A `ServletConfig` object is used by the servlet container to pass information to the servlet during initialization.
- The servlet can call the following methods of the `ServletConfig` object to retrieve information about parameters specified in the *deployment descriptor* and to obtain the *servlet context* for the servlet.

`String getInitParameter(String name)`	Returns the value of the parameter name, or `null` if no such parameter is specified in its *deployment descriptor*.
`Enumeration getInitParameterNames()`	Returns a `String` enumerator over the names of all the parameters specified in the *deployment descriptor*.
`String getServletName()`	Returns the name of the servlet as specified in its *deployment descriptor*.
`ServletContext getServletContext()`	Returns the *servlet context* of the servlet.

Servlet Context: the `ServletContext` Interface

- A `ServletContext` object can be used by the servlet to interact with its environment.

`InputStream getResourceAsStream(String path)`	Get an input stream connected to the *passive* resource specified by the path.
`URL getResource(String path)`	Get an URL for the *passive* resource which is mapped to the path. The path is relative to the *document root* of the web application.
`String getRealPath(String virtualPath)`	Returns a `String` containing the *real path* for the specified *virtual path*. For example, the path `/help.html` returns the platform-dependent *absolute file path* on the server's file system that would be served by a request for `http://host/contextPath/help.html`, where `contextPath` is the *context path* of this `ServletContext`.
`void log(String msg)`	*Logs* the specified message to a special servlet file (*log file*).

- The `ServletContext` object is contained within the `ServletConfig` object, which the server provides the servlet when the servlet is initialized.
- For a servlet container that is in a single JVM, every web application running in the container has exactly one servlet context.
  This servlet context is shared by the web components of the web application.

Simple Horoscope II: Overriding the `init()` Method

- The `init()` method can be overridden to setup whatever resources (database connections, files, etc.) the servlet needs for it's operation.
- The Simple Horoscope is extended to use horoscope data from a specific file.
- The `init()` method ensures that the horoscope data has been read in from the file before handling client requests.
- We use a separate class `HoroscopeDataFile` to read the horoscope data files and create a *map* of <*sign, horoscope*> entries.
- The *real path* of the file is obtained through the *servlet context*.
  - Access to resources under the document root should be managed through the servlet context.

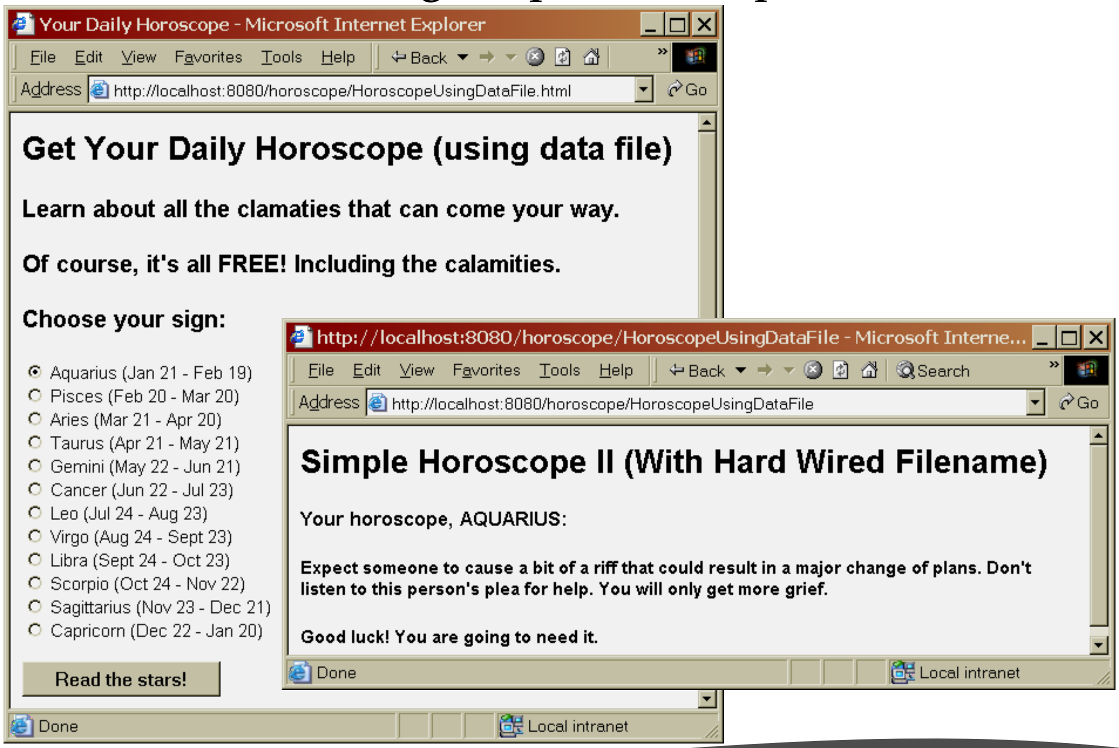
```
public class HoroServletWithHardWiredFile extends SimpleHoroServlet {
    private HoroscopeDataFile horoscopeData;
    public void init() {
      try {
        servletName = "Simple Horoscope II (With Hard Wired Filename)";

        // File with horoscope data.
        String filename = "data/horoscope.data";  // Filename is hardwired.
        System.out.println("Filename: " + filename);

        // Get the real path of the file.
        ServletContext context = getServletContext();
        String realPath = context.getRealPath(filename);
        System.out.println("Real path: " + realPath);
        horoscopeData = new HoroscopeDataFile(realPath);
      } catch(IOException ioe) {
        System.err.println("I/O Error getting horoscope data");
      }
    }
    protected String getHoroscope(String sign) {
      return horoscopeData.getHoroscope(sign);
    }
}
```

The Horoscope File

```
// Horoscope data
public class HoroscopeDataFile {

  // The signs.
  private String[] horoscopeSign = { "aquarius", "pisces", "aries", "taurus",
      "gemini", "cancer", "leo", "virgo", "libra", "scorpio", "sagittarius",
      "capricorn" };

  // Map for <star sign, horoscope> entries.
  private TreeMap<String, String> horoscopeData;

  private String horoscopeFilename;

  public HoroscopeDataFile(String filename) throws IOException {
    horoscopeFilename = filename;
    horoscopeData = new TreeMap<String, String>();
    initHoroscope();
  }
```

```
  private void initHoroscope() throws IOException {
    BufferedReader source =
      new BufferedReader(
        new InputStreamReader(
          new FileInputStream(horoscopeFilename)));
    for (int i = 0; i < horoscopeSign.length; i++) {
      String txtLine = source.readLine();
      if (txtLine == null)
        break;
      horoscopeData.put(horoscopeSign[i], txtLine);
    }
    source.close();
  }

  public String getHoroscope(String sign) {
    return (String) horoscopeData.get(sign);
  }
  // ...
}
```

Running Simple Horoscope II


Your Daily Horoscope - Microsoft Internet Explorer

Address http://localhost:8080/horoscope/HoroscopeUsingDataFile.html

Get Your Daily Horoscope (using data file)

Learn about all the clamaties that can come your way.

Of course, it's all FREE! Including the calamities.

Choose your sign:

- [✓ Aquarius (Jan 21 - Feb 19)]
- Pisces (Feb 20 - Mar 20)
- Aries (Mar 21 - Apr 20)
- Taurus (Apr 21 - May 21)
- Gemini (May 22 - Jun 21)
- Cancer (Jun 22 - Jul 23)
- Leo (Jul 24 - Aug 23)
- Virgo (Aug 24 - Sept 23)
- Libra (Sept 24 - Oct 23)
- Scorpio (Oct 24 - Nov 22)
- Sagittarius (Nov 23 - Dec 21)
- Capricorn (Dec 22 - Jan 20)

Read the stars!

http://localhost:8080/horoscope/HoroscopeUsingDataFile - Microsoft Interne...

Address http://localhost:8080/horoscope/HoroscopeUsingDataFile

Simple Horoscope II (With Hard Wired Filename)

Your horoscope, AQUARIUS:

Expect someone to cause a bit of a riff that could result in a major change of plans. Don't listen to this person's plea for help. You will only get more grief.

Good luck! You are going to need it.

Simple Horoscope III: Specifying Initialization Parameters

- Instead of hardwiring the horoscope data file in the servlet, the filename can be specified in the deployment descriptor as an *initialization parameter.*
- Defining initialization parameters for Simple Horoscope III in the deployment descriptor `web.xml`:

```
...
<servlet>
  <servlet-name>HoroscopeInitParams</servlet-name>
  <servlet-class>HoroServletInitParams</servlet-class>

  <!-- Define initialization parameters -->
  <init-param>
    <param-name>HoroscopeDatafile</param-name>
      <param-value>data/horoscope.data</param-value>
  </init-param>
</servlet>
...
```

  – The `init-param` element specifies parameter `HoroscopeDatafile` having the value `data/horoscope.data` for the servlet named `HoroscopeInitParams`.
  – Note that `init-param` element is a part of the `servlet` element.

Simple Horoscope III: Reading Initialization Parameters

- Initialization parameters can be read conveniently in the `init()` method as part of the servlet's loading process.

```
public class HoroServletInitParams extends SimpleHoroServlet {
  protected HoroscopeDataFile horoscopeData;
  public void init() {
    try {
      servletName = "Simple Horoscope III (With Parameterized Filename)";
      // Read the parameter from the deployment descriptor.
      String filename = getInitParameter("HoroscopeDatafile");
      System.out.println("Filename: " + filename);

      // Get the real path of the file.
      ServletContext context = getServletContext();
      String realPath = context.getRealPath(filename);
      System.out.println("Real path: " + realPath);
      horoscopeData = new HoroscopeDataFile(realPath);
    } catch (IOException ioe) {
      System.err.println("I/O Error getting horoscope data");
    }
  }
```

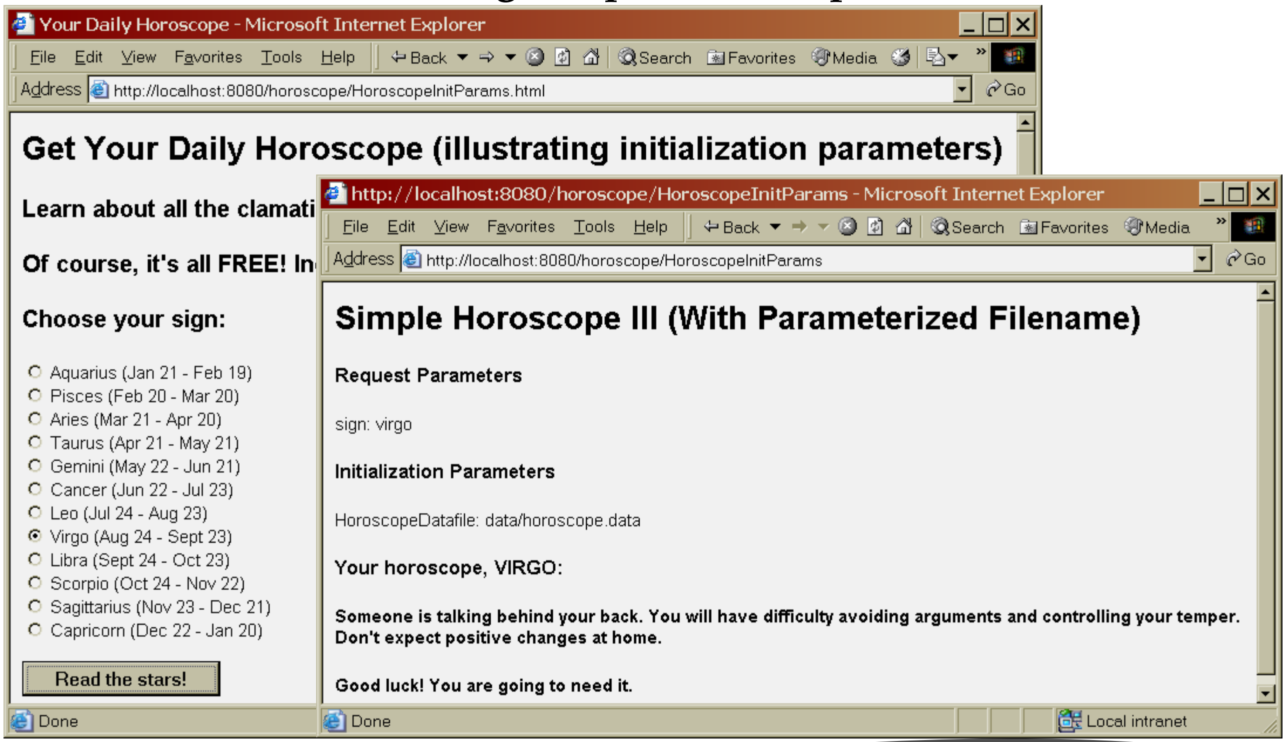
```
  protected String getHoroscope(String sign) {
    return horoscopeData.getHoroscope(sign);
  }
}
```

Servlet Configuration: Reading Initialization Parameters

- The servlet configuration provides access to the initialization parameters.
- See file `ServletUtil.java`.

```
  public static void echoInitParameters(ServletConfig config, PrintWriter out)
      throws ServletException, IOException {
    out.print("<h3>Initialization Parameters</h3>");
    out.print("<p>");
    Enumeration enumerator = config.getInitParameterNames();
    while (enumerator.hasMoreElements()) {
      String paramName = (String) enumerator.nextElement();
      String paramValue = config.getInitParameter(paramName);
      out.print(paramName + ": " + paramValue + "<br>");
    }
    out.println("</p>");
  }
```

Running Simple Horoscope III



Your Daily Horoscope - Microsoft Internet Explorer

Address http://localhost:8080/horoscope/HoroscopeInitParams.html

Get Your Daily Horoscope (illustrating initialization parameters)

Learn about all the clamati

Of course, it's all FREE! In

Choose your sign:

- Aquarius (Jan 21 - Feb 19)
- Pisces (Feb 20 - Mar 20)
- Aries (Mar 21 - Apr 20)
- Taurus (Apr 21 - May 21)
- Gemini (May 22 - Jun 21)
- Cancer (Jun 22 - Jul 23)
- Leo (Jul 24 - Aug 23)
- [✓ Virgo (Aug 24 - Sept 23)]
- Libra (Sept 24 - Oct 23)
- Scorpio (Oct 24 - Nov 22)
- Sagittarius (Nov 23 - Dec 21)
- Capricorn (Dec 22 - Jan 20)

Read the stars!

http://localhost:8080/horoscope/HoroscopeInitParams - Microsoft Internet Explorer

Address http://localhost:8080/horoscope/HoroscopeInitParams

Simple Horoscope III (With Parameterized Filename)

Request Parameters

sign: virgo

Initialization Parameters

HoroscopeDatafile: data/horoscope.data

Your horoscope, VIRGO:

Someone is talking behind your back. You will have difficulty avoiding arguments and controlling your temper. Don't expect positive changes at home.

Good luck! You are going to need it.

File Edit View Favorites Tools Help
Back Search Favorites Media
Go
Done
Local intranet