

Part 1: Servlet/JSP

1 Web App Architecture

1.1 Introduction

How do web clients and web servers talk to one another?

Our goal is to build a web application that clients around the globe can access.

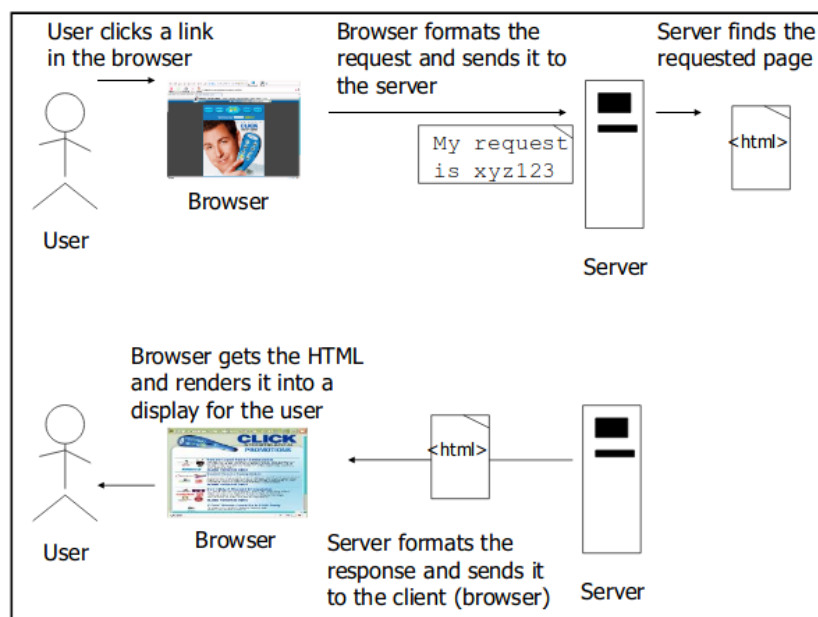
1.2 Client/Server

Web Server

Takes a client request and gives something back to the client.

Client

Lets the user request something on the server, and shows the user the result of the request.



1.3 Clients and servers know HTML and HTTP

HTML

1. Server answers request
2. Server sends content to browser
3. Browser displays

Servers often send the browser a set of instructions written in HTML. All web browsers know what to do with HTML.

HTTP

1. Client sends HTTP request
2. Server answers with HTTP response

When a web server sends an HTML page to the client, it sends it using HTTP.

What is the HTTP protocol?

Key elements of the request stream

- HTTP method: the action to be performed
- The page to access: a URL
- Form parameters: like arguments to a method

Key elements of the response stream

- A status code: for whether the request was successful
- Content-type: text, picture, ...
- The content; the actual HTML, images, ...

What is the request?

First thing you will find is an HTTP method name.

The method name tells the server the kind of request that's being made, and how the rest of the message will be formatted.

The HTTP protocol has several methods, but the ones you'll use most often are **GET** and **POST**

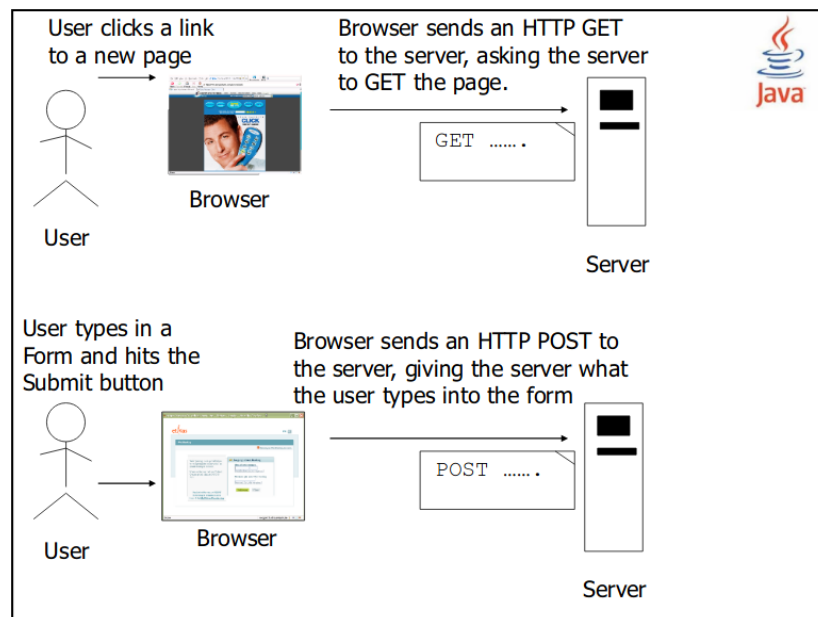
GET and POST

GET

The simplest HTTP method, the point is to get something back from the server.

POST

The more powerfull request, you can request something and at the same time send form data to the server.

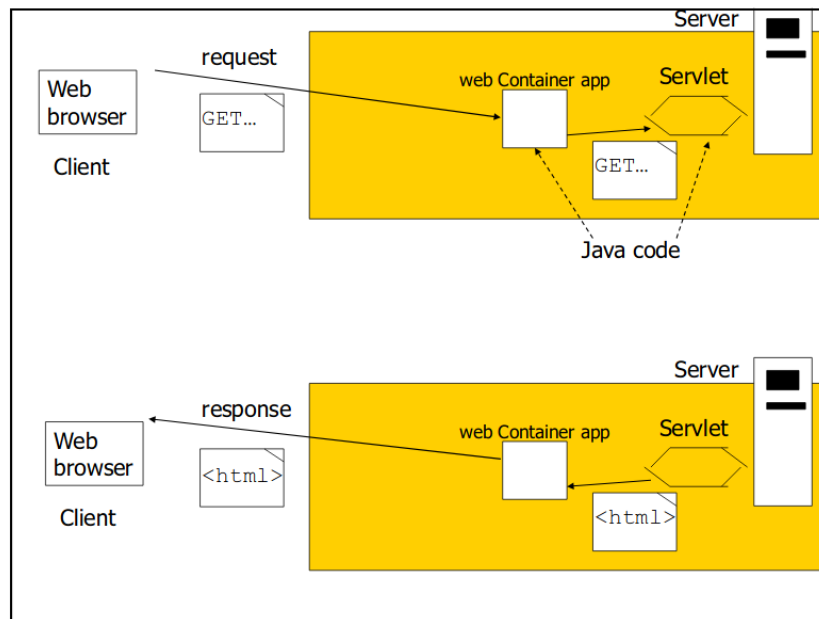


Container

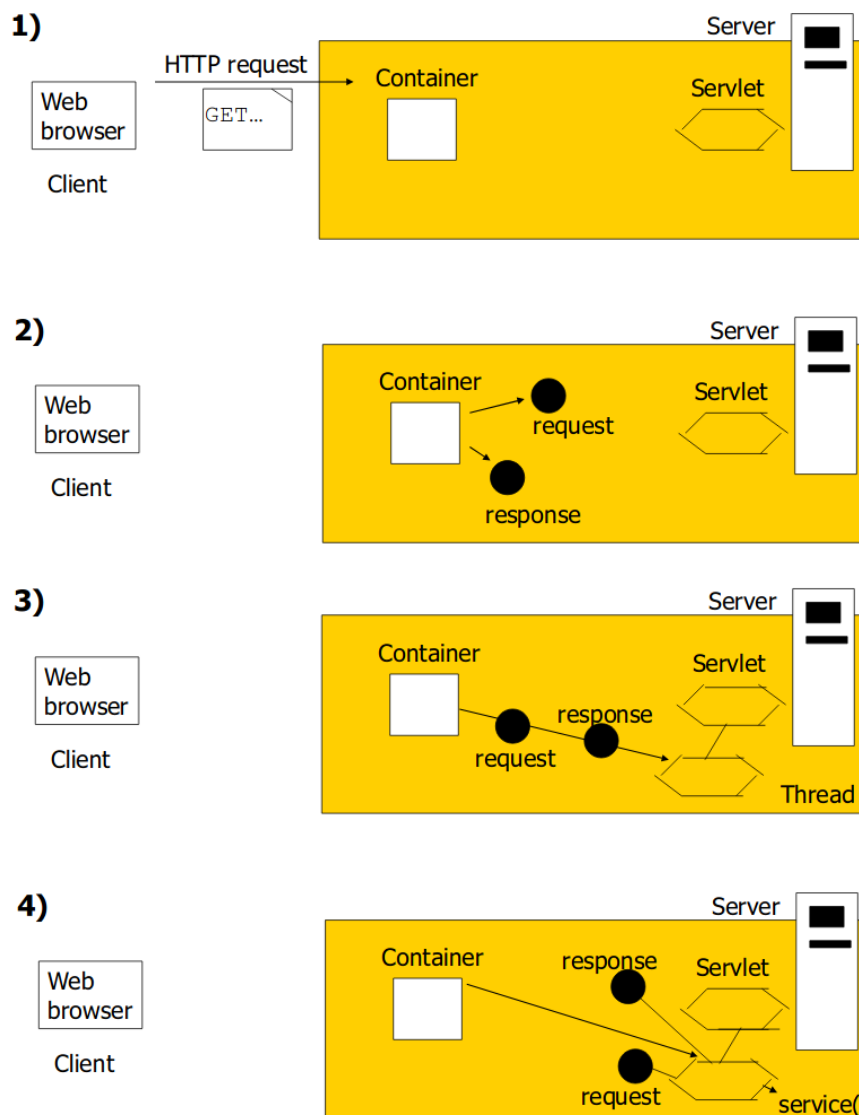
Servlets don't have a `main()` method. They are under the control of another Java application called a **container**.

When your web server application gets a request for a servlet, the server hands the request not to the servlet itself, but to the Container in which the servlet is deployed.

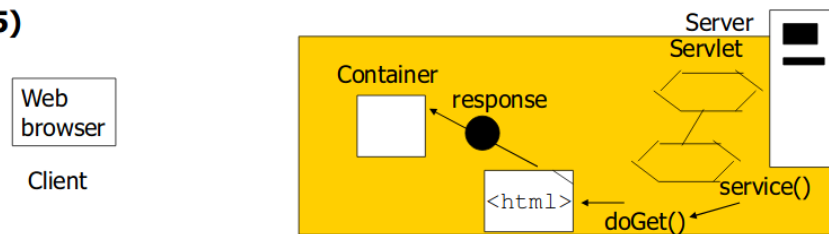
It is the Container that gives the servlet the HTTP request and response, and it is the Container that calls the servlet's method.



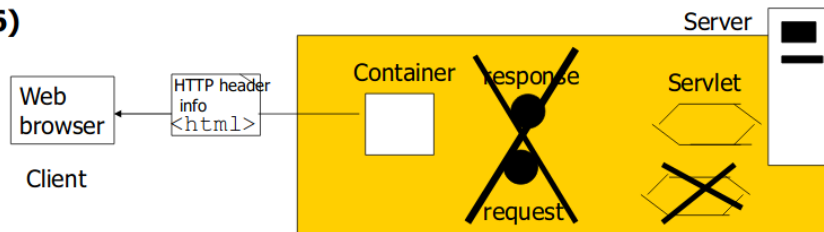
How the Container handles a request



5)



6)



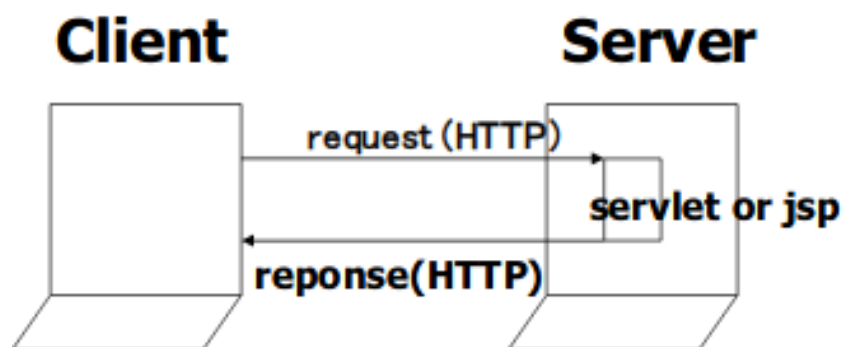
1. User click a link that has a URL to a servlet instead of a static page.
2. The container sees that the request is for a servlet, so the container creates two objects; `HttpServletResponse` and `HttpServletRequest`.
3. The container finds the correct servlet based on the URL in the request, creates or allocates a thread for that request, and passes the request and response objects to the servlet thread.
4. The container calls the servlet's `service()` method. Depending on the type of request, the `service()` method calls either the `doGet()` or `doPost()` method. For this example, we will assume the request was an HTTP GET.
5. The `doGet()` method generates the dynamic page and stuffs the page into the response object. Remember, the container still has a reference to the response object.
6. The thread completes, the container converts the response object into a HTTP response, sends it back to the client, then deletes the request and response objects.

2 Servlets

2.1 Introduction

The client requests that some action is performed, the server performs the action and responds to the client.

This request-response model of communication is the foundation for the highest-level views of networking in Java-Servlets and JavaServer Pages.



What is a SERVLET?

A servlet is a **Java programming language class** used to extend the capabilities of servers that host applications accessed via a **request-response programming model**.

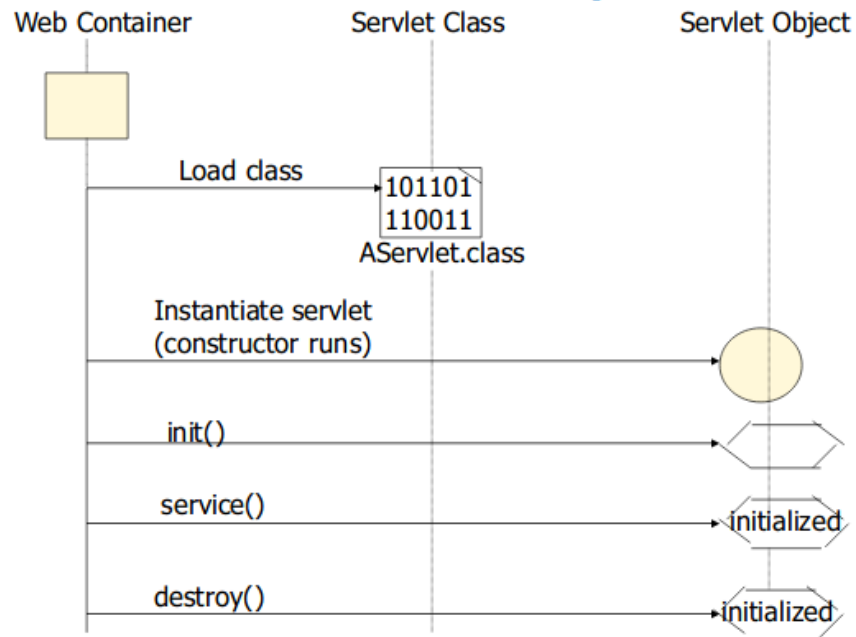
Java Servlet technology defines HTTP-specific servlet classes.

Servlet Life Cycle

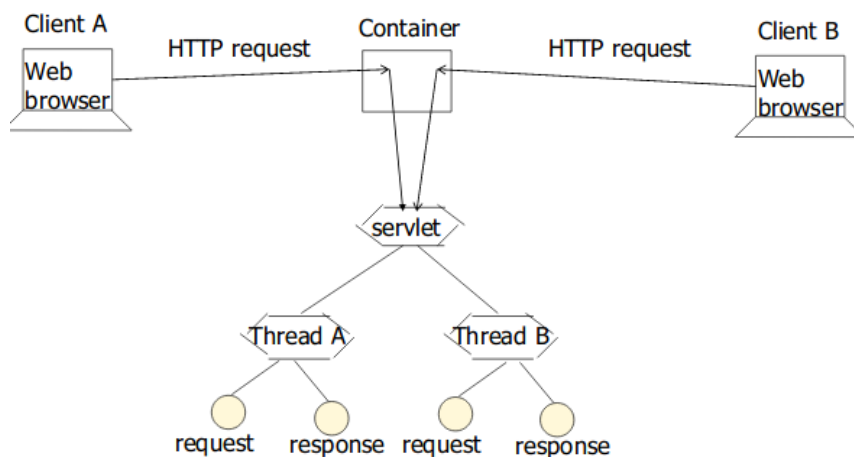
If an instance of a servlet does not exist, the container:

- Loads the servlet class
- Creates an instance of the servlet class
- Initializes the servlet instance by calling the init method
- Invokes the service method, passing a request and response object

If the container needs to remove the servlet, it finalizes the servlet by calling the servlet's destroy method.



Each request runs in a separate thread



GET and POST

The two most common HTTP request types

- GET: retrieves information from the server
- POST: sends data to server, such as authentication information or data from a form

HTTPServlet Class

Web-based servlets typically extend class HttpServlet

- method doGet() responds to GET requests
- method doPost() responds to POST requests

2.2 Handling http GET Requests

WelcomeServlet demonstration

The servlet and HTML document demonstrate a servlet that handles HTTP get requests

WelcomeServlet.java

```
@WebServlet("/welcome1")
public class WelcomeServlet extends HttpServlet
{
    //process "get" requests
    @Override
    protected void doGet(HttpServletRequest request, HttpServletResponse response)
        throws ServletException, IOException
    {
        response.setContentType("text/html");
        try(PrintWriter out = response.getWriter()){
            //Write HTML document
        }
    }
}
```

welcomeForm.htm

```
<!DOCTYPE html>
<html>
  <head>
    <title>Handling an HTTP Get Request</title>
  </head>
  <body>
    <form action="/welcome1" method="get">
      <p>
        <label>Click to invoke servlet</label>
        <input type="submit" value="Get HTML doc"/>
      </p>
    </form>
  </body>
</html>
```

The HTML document provides a form that invokes the servlet. The form's action (welcome1) specifies the URL path that invokes the servlet, and the form's method indicates that the browser sends a get request to the server. This results in a call to the servlet's doGet method.

How the container found the servlet

A servlet can have 2 names

- Client-known URL name: e.g. the link to register/registerMe servlet
- Programmer-known file name: e.g. SignUpServlet.class

Mapping servlet names improves your app's flexibility and security

Gives you the flexibility to move things around without having to change the client code that refers to the old location of the servlet files.

Better security: the client doesn't know how things are structured on your server.

Handling http get requests containing data

In WelcomeServlet.java:

```
String firstname = request.getParameter("firstname");
```

In welcomeForm.html:

```
<input type="text" name="firstname"/>
```

2.3 Handling http POST requests

A http post request is often used to post data from an HTML form to a server-side form handler that processes the data.

Browsers often cache web pages so they can quickly reload the pages. The browser minimizes the amount of data that must be downloaded for you to view a web page.

Browsers typically do not cache the server's response to a post request, because the next post might not return the same result.

Differences between GET and POST

- GET requests can be bookmarked, POST requests cannot.
- GET is meant to be used for getting things; POST is meant to be used for sending data to be processed.

Demonstration

WelcomeServlet.java

```
protected void doPost (HttpServletRequest request, HttpServletResponse  
    response)  
    throws ServletException, IOException  
  
    //instead of doGet()
```

welcomeForm.html

```
<form action="welcome1" method="post">
```

2.4 Redirecting Requests to Other Resources

The RedirectServlet.java receives a page parameter as part of a get request, then uses that parameter to redirect the request to a different resource.

Demonstration

RedirectForm.html

```
<a href = "redirect?page=oracle">
```

RedirectServlet.java

```
@WebServlet("/redirect")
public class RedirectServlet extends HttpServlet
{
    //process "get" request from client
    @Override
    protected void doGet(HttpServletRequest request, HttpServletResponse response)
        throws ServletException, IOException
    {
        String location = request.getParameter("page");
        if (location != null)
        {
            if (location.equals("oracle"))
                response.sendRedirect("http://www.oracle ...");
            else
                if (location.equals("welcome"))
                    response.sendRedirect("welcome1");
        }
    }
}
```

Redirect vs Request Dispatch

Request Dispatch

The servlet calls:

```
RequestDispatcher view = request.getRequestDispatcher("result.jsp");
view.forward(request, response);
```

When a servlet does a request dispatch it's like asking a co-worker to take over working with a client.

The co-worker ends up responding to the client. The user never knows someone else took over, because the URL in the browser bar doesn't change.

Redirect

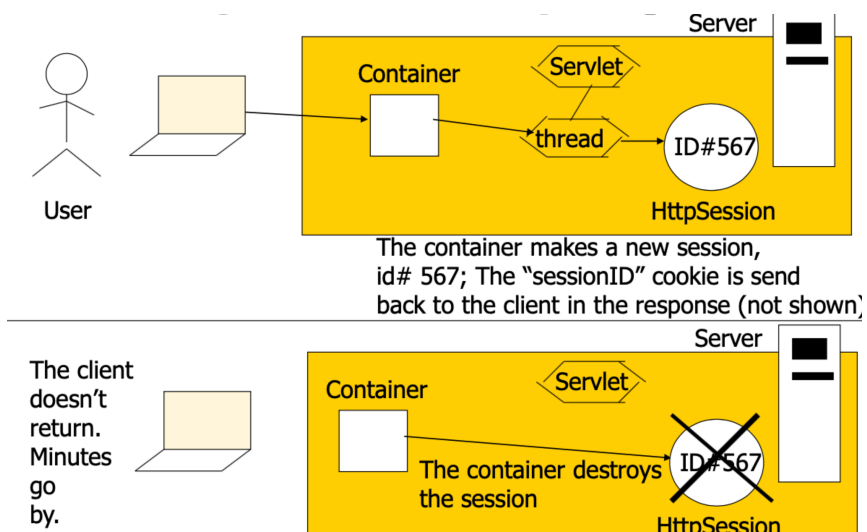
When a servlet does a redirect it's like asking the client to call someone else instead.

In this case, the client is the browser, not the user. The browser makes the new call on the users behalf. The user sees the new URL in the browser.

2.5 Session Tracking

- Personalization
- Privacy invasion
- HTTP-stateless protocol
 - does not support persistent information
- Track clients individually
 - Cookies
 - Session tracking
 - Hidden type input
 - URL rewriting

Session tracking with HttpSession



Three ways a session can die

1. It times out

Configuring session timeout in the Deployment Descriptor

```
<servlet>
    ...
</servlet>
<session-config>
    <session-timeout>15</session-timeout>
</session-config>
```

Setting session timeout for a specific session

```
session.setMaxInactiveInterval(20*60);
```

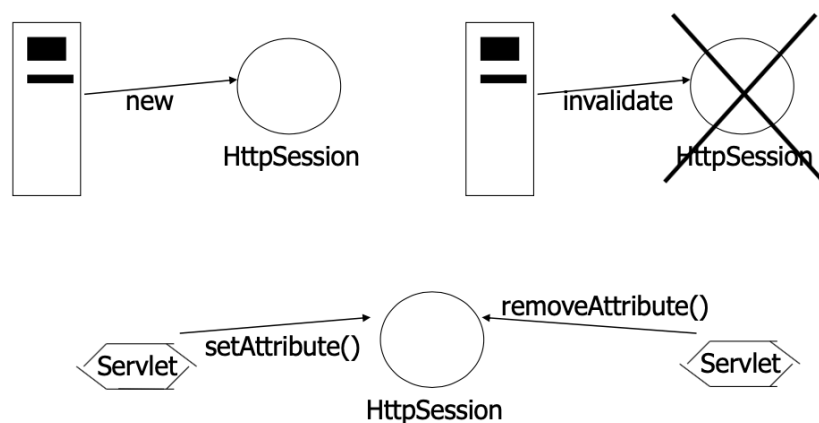
2. You can invalidate() on the session object

```
session.invalidate();
```

3. The application goes down

crashes or is undeployed

Important moments in a HttpSession object's life



Example: Servlet SessionServlet

- Uses HttpSession objects
- Handles both get and post requests

sessionSelectLanguage.html document for selecting a programming language and posting the data to the SessionServlet.

sessionSelectLanguage.html

```
<body>
  <form action="sessions" method="post" >
    Select a programming language: <br><br>
    <input type="radio" name="language" value="C++"/>C++ <br>
    <input type="radio" name="language" value="C#"/> C# <br>
    <input type="radio" name="language" value="Cobol" /> Cobol <br>
  >

  <!--this radio button checked by default -->
  <input type="radio" name="language" value="Java" checked="checked"/> Java <br> <br>
  <input type="submit" value="Submit" />
</form>
</body>
```

SessionServlet.java

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

@WebServlet("/sessions")
public class SessionServlet extends HttpServlet
{
    private final Map<String,String>books = new HashMap<>();
    // initialize Map books
    public void init()
    {
        books.put( "C++", "0130895725");
        books.put( "C#", "0130895717");
        books.put( "Cobol", "0130125075");
        books.put("Java", "0134569555");
    }

    // receive language selection and create HttpSession object
    // containing recommended book for the client
```

```

        protected void doPost( HttpServletRequest request, HttpServletResponse response) throws ServletException, IOException
        {
            String language = request.getParameter("language")

            // Get the user's session object.
            // Uses method getSession of interface HttpServletRequest
            // Create a session (true) if one does not exist.
            HttpSession session = request.getSession( true );

            // add a value for user's choice to session
            session.setAttribute( language, books.get( language ) );

            response.setContentType( "text/html");

            try (PrintWriter out = response.getWriter())
            {
                // send HTML page to client
                out.println("<!DOCTYPE html>");
                out.println( "<html>" );

                // head section of document
                out.println("<head>" );
                out.println( "<title>Welcome to Sessions</title>" );
                out.println( "</head>" );

                // body section of document
                out.println( "<body>" );
                out.println( "<p>Welcome to Sessions! You selected "+language + ".</p>" );

                // display information about the session
                out.println( "<p>Your unique session ID is: "+ session.getId()+ "<br>" );

                out.println( "This " + ( session.isNew()? "is": "is not")
                    +" a new session<br>");

                out.println("The session was created at: " + newDate( session.getCreationTime()) + "<br>" );
                out.println( "You last accessed the session at: "+ newDate( session.getLastAccessedTime()) + "<br>");
                out.println( "The maximum inactive interval is: "+ session.getMaxInactiveInterval()+ " seconds</p>");
                out.println( "<p><a href = \""sessionSelectLanguage.html\">"+ "Click here to choose another language</a></p>");
                out.println("<p><a href = \"sessions\">"+ "Click here to get book recommendations</a></p>" );
            }
        }
    }

```



```

        out.println( "</body>");
        // end HTML documentout.println( "</html>");
    }
}

// read session attributes and create HTML document
// containing recommended books
protected void doGet( HttpServletRequest request,HttpServletResponse
response )
throwsServletException, IOException
{
    // Get the user's session object.
    // Do not create a session (false) if one does not exist.
    HttpSession session = request.getSession( false );

    // get names of session object's values
    Enumeration<String> valueNames;

    if( session != null)
        valueNames = session.getAttributeNames();
    else
        valueNames = null;

    try (PrintWriter out = response.getWriter())
    {
        response.setContentType( "text/html");

        // start HTML document
        out.println("<!DOCTYPE html>");
        out.println( "<html>" );

        // head section of documen
        tout.println("<head>");
        out.println("<title>Recommendations</title>");
        out.println( "</head>" );

        // body section of document
        out.println( "<body>");
        if( valueNames != null&& valueNames.hasMoreElements() )
        {
            out.println( "<h1>Recommendations</h1>" );
            out.println( "<p>");
            String name, value;

            // get value for each name in valueNames
            while( valueNames.hasMoreElements() )
            {
                name = valueNames.nextElement();

```

```

        value = (String) session.getAttribute( name );
        out.println( name + " How to Program. " + "ISBN#: "
+ value + "<br >");
        } //end-while
        out.println( "</p>");
    } //end-if
    else
    {
        out.println( "<h1>No Recommendations</h1>");
        out.println( "<p>You did not select a language.</p>");
    }
    out.println( "</body>" );

    // end HTML document
    out.println( "</html>" );
}
}
}

```

3 JSP - Scripting Components

3.1 Introduction

JSP is an extension of servlet technology

A JSP becomes a servlet. The container looks at your JSP, translates it into a servlet class source (.java) file, then compiles that into a full-fledged JAVA servlet class. After that, it's just servlets all the way down.

3.2 JSP Overview

JSP simply puts Java inside HTML pages.

The request/response mechanism and lifecycle of a JSP is the same as that of a servlet.

3.3 A First JavaServer Page example

We can put JAVA code in a JSP using a scriptlet, which just means Java code within a `<%...%>` tag

We can't put import statements in a JSP. We need a page directive.

```
<%@ page import = "java.util.Date, domein.Rotator" %>
<%@ page contentType = "text/html" pageEncoding = "UTF-8" %>
<!DOCTYPE html>
<html>
  <head>
    <meta http-equiv = "refresh" content = "1"/>
    <title>A Simple JSP Example</title>
    <link rel="stylesheet" href="css/style.css"/>
  </head>
  <body>
    <h1>Simple JSP Example</h1>
    <br>
    <table>
      <tr>
        <td>
          <p>
            <!--JSP expression to insert date/time -->
            <% = newDate() %>
          </p>
        </td>
      </tr>
    </table>
  </body>
</html>
```

3.4 MVC: Servlet = controller, JSP = view

3.4.1 Handling Http get Requests

```
@WebServlet("/welcome1")
public class WelcomeServlet extends HttpServlet {

    // process "get" requests from clients

    protected void doGet( HttpServletRequest request,HttpServletResponse response)
        throws ServletException, IOException
    {
        RequestDispatcher view = request.getRequestDispatcher("view/welcome.jsp");
        view.forward(request,response);
    }
}
```

3.4.2 Handling Http post Requests

WelcomeServlet.java

```
@WebServlet("/welcome1")
public class WelcomeServlet extends HttpServlet {

    // process "post" requests from clients

    protected void doPost ( HttpServletRequestrequest, HttpServletResponse response )
        throws ServletException, IOException
    {
        String firstname = request.getParameter("firstname");
        request.setAttribute("firstName", firstname);
        RequestDispatcher view = request.getRequestDispatcher("view/welcome.jsp");
        view.forward(request,response);
    }
}
```

Welcome.jsp

```
<body>
  <% String name = (String) request.getAttribute("firstName"); %>
  <h1>
    Welcome to Servlets!
    <%=name %>
  </h1>
</body>
```

3.5 Attributes in a JSP

Scope

Page

- JSP object can be accessed only from within the same page where it was created
- For the lifetime of the current request

Request

- Accessed from any pages that serves that request
- More than one page can serve a single request

Session

- Accessible from pages that belong to the same session from where it was created
- Accessible to only those with access to a specific HttpSessionSession

Application

- Accessed from any pages across the application

Access Attributes

- Page
 - JSP
 - `pageContext.setAttribute("vb",vb);`
 - Servlet
 - does not apply
- Request
 - JSP
 - `request.setAttribute("vb",vb);`
 - `<% pageContext.setAttribute("vb",vb,PageContext.REQUEST_SCOPE); %>`
 - Servlet
 - `request.setAttribute("vb",vb);`
- Session
 - JSP
 - `session.setAttribute("vb",vb);`
 - `<% pageContext.setAttribute("vb",vb,PageContext.SESSION_SCOPE); %>`
 - Servlet
 - `request.getSession().setAttribute("vb",vb);`
- Application
 - JSP
 - `application.setAttribute("vb",vb);`
 - `<% pageContext.setAttribute("vb",vb,PageContext.APPLICATION_SCOPE); %>`
 - Servlet
 - `getServletContext().setAttribute("vb",vb);`

3.6 Overview Scripting Components

- Scriptlets (<% and %>)
- Comments (<%-- and --%>)
- Expressions (<% =and %>)
- Declaration (<% !and %>)
- Directive: (<% @and %>)

3.7 Java code in a JSP -> complaints

Your JSP code can quickly become a mix of various HTML tags, JSP tags, and Java code that is difficult to follow, debug, and maintain.

1. Web page designers shouldn't have to know JAVA.
2. Java code in a JSP is hard to change and maintain.

Part 2: Spring Basics

1 Introduction to Spring

1.1 Spring Framework

The Spring Framework is an open source application framework and **Inversion of Control** container for the java platform.

Why use the Spring Framework

Simplifying Java Development

Spring makes existing solutions significantly easier to use, and places them in a consistent architectural approach.

1.2 The core of the Spring Framework

Inversion of Control refers to the generally desirable architectural pattern of having an outside entity (the container) **wire** together objects, such that objects are given their **dependencies** by the container, instead of directly instantiating them themselves.

1.2.1 Dependency Injection

Dependency Injection

- Dependency:
 - Class A need class B to get its job done
 - Class A is dependenton class B
- Injection:
 - Class B will get injected into class A
 - By the IoC container.

Injection Styles

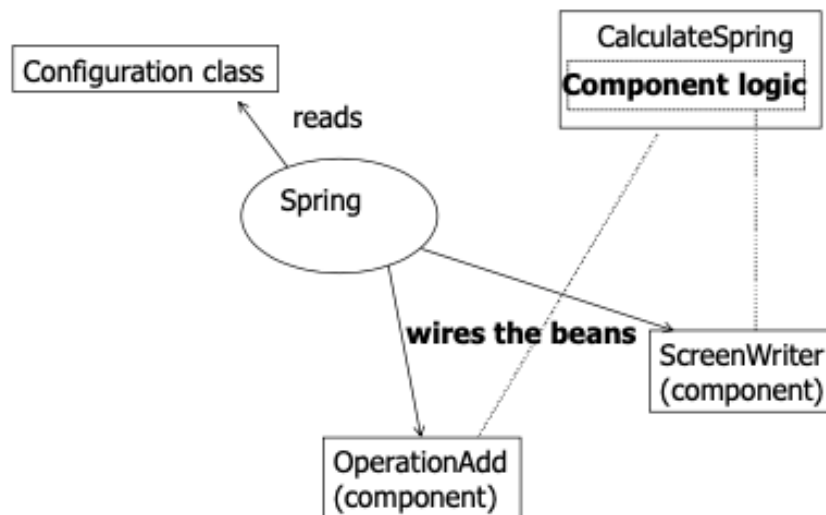
- Constructor injection
 - Via arguments passed to the constructor when an object is created.
- Setter injection
 - Via the setter method , after the object has been created.

Best choice: Setter Injection

- Swap dependencies on the fly without creating a new instance.
- The least effect on your code's usability in non-LoC settings.

1.2.2 Example: wiring in Spring

Use Spring to Configure a Modularized Application



The **Spring container** reads the configuration class, instantiates the beans, and then wires them up according to the configuration information

- Spring framework:
 - Easily wire and rewire reusable Java beans
- Task:
 - Instantiating concrete instances of Operation or ResultWriter
- Class CalculateSpring:
 - Delegates this task to the Spring container

CalculateSpring

```
public class CalculateSpring {

    private Operation ops;
    private ResultWriter writer;

    public void setOps(Operation ops) {
        this.ops = ops;
    }

    public void setWriter(ResultWriter writer) {
        this.writer = writer;
    }

    public void execute(String [] args) {
        long op1 = Long.parseLong(args[0]);
        long op2 = Long.parseLong(args[1]);
        writer.showResult("The result of " + op1 + ops.getName() + op2
+ " is " + ops.operate(op1, op2) + "!");
    }
}
```

StartUp

```
public class StartUp {

    public static void main(String... args) {
        ApplicationContext context =
            new AnnotationConfigApplicationContext(FirstExampleConfigu
ration.class);

        CalculateSpring opsbean =
            context.getBean("opsbean", CalculateSpring.class);
        opsbean.execute(args);
    }
}
```

Bean Factory

The IoC container in Spring is called the bean factory.

Bean Factory = Interface

Will load bean definitions stored in a configuration source (such as a configuration class)

ApplicationContext extends BeanFactory and adds additional facilities.

Configuration Class

```
@Configuration
public class FirstExampleConfiguration {

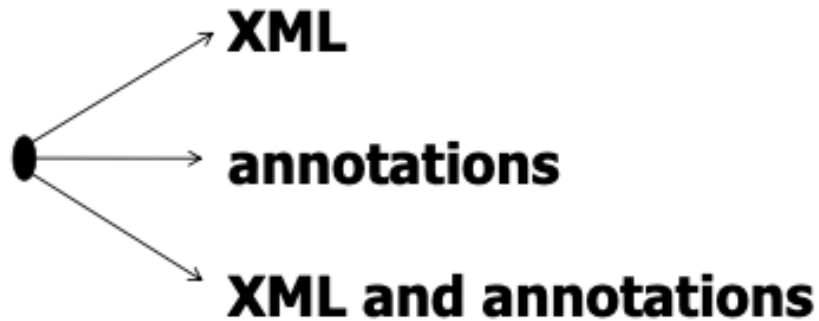
    @Bean
    public ResultWriter resultWriter() {
        return new ScreenWriter();
    }

    @Bean
    public Operation operation() {
        return new OperationAdd();
    }

    @Bean
    public CalculateSpring opsbean() {
        CalculateSpring calculate = new CalculateSpring();
        calculate.setOps(operation());
        calculate.setWriter(resultWriter());
        return calculate;
    }
}
```

2 Wiring Beans

2.1 Spring Configuration



Each approach has its pros and cons.

2.2 Spring Configuration: Annotations

- `@Service("...")`
 - dependency
- `@Autowired`
 - Spring will inject the dependency
 - It can be applied on setter method, constructor or a field
- `@Qualifier("...")`
 - Works by matching the name defined with `@Service` annotation

Spring throws **NoSuchBeanDefinitionException** if the required dependency is not available. We can change this behavior:

`@Autowired(required=false)`

By default, the `@Autowired` resolve dependencies by type.

2.2.1 Setter-based Autowiring

```
public class CalculateSpring {  
  
    private Operation ops;  
  
    @Autowired  
    public void setOps(Operation ops) {  
        this.ops = ops;  
    }  
}
```

2.2.2 Constructor-based Autowiring

```
public class CalculateSpring {  
  
    private Operation ops;  
  
    @Autowired  
    public CalculateSpring(Operation ops) {  
        this.ops = ops;  
    }  
}
```

2.2.3 Field or Property-based Autowiring

```
public class CalculateSpring {  
  
    @Autowired  
    private Operation ops;  
  
}
```

2.3 Example

```
@Service("add")
public class OperationAdd implements Operation { ... }
```

```
@Service("calculate")
public class CalculateSpring {

    private Operation ops;

    @Qualifier("add")
    @Autowired
    public void setOps(Operation ops) {
        this.ops = ops;
    }

    ...

}
```

```
@ComponentScan(basePackages = {"domain", "spring_wiring"})
@Configuration
public class FirstExampleConfiguration {}
```

```
public class StartUp{

    public static void main(String... args) {
        ApplicationContextcontext =
            new AnnotationConfigApplicationContext(FirstExampleConfigu
ration.class);

        CalculateSpringopsbean =
            context.getBean("calculate", CalculateSpring.class);
        opsbean.execute(args);
    }

}
```

A configuration class can be used to read the annotated beans definitions. In this example, the class will no longer need any @Bean

But, to be able to look for bean definitions inside Java classes, component scanning has to be enabled → @ComponentScan

2.4 Automatically Wiring Bean Properties

Obvious wiring → when there's no question about which bean reference should be wired.

The Spring container is able to autowire relationships between beans.

Using autowiring, it is possible to reduce or eliminate the need to specify properties or constructor arguments, thus saving a significant amount of typing.

3 Aspect-Oriented Programming

3.1 OAP

programming paradigm which isolates secondary or supporting functions from the main program's business logic.

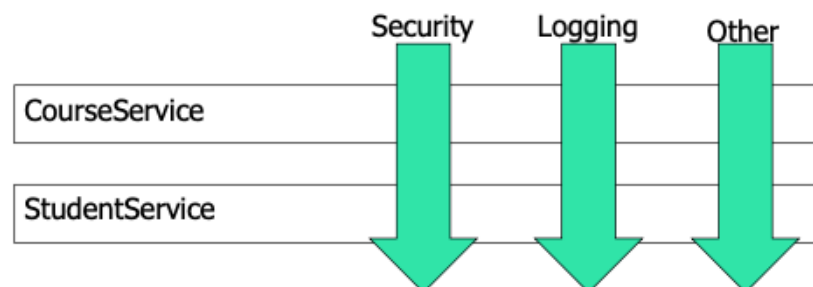
It aims to increase modularity by allowing the separation of cross-cutting concerns, forming a basis for aspect-oriented software development.

3.2 Example

A typical application is broken down into modules.

Each module's main concern

- is to provide services for its particular domain.
- requires similar ancillary functionalities, such as security, logging, ...



3.3 Aspects

Cross-cutting concerns can be modularized into special objects = aspects.

Two benefits:

- The logic for each concern is in one place.
- Our service module contains only their primary concern and secondary concerns have been moved to aspects

3.4 AOP Concepts

Join Point

Point in the execution of the application where an aspect can be plugged in.

This point could be a method being called, an exception being thrown or a field being modified.

Advice

The code that is executed at a particular joinpoint is the advice.

Kinds of advice

- Before
 - Executes before join point
- After
 - Executed regardless of the means by which a join point exits
- After-returning
 - Executed after a join point completes normally
- After-throwing
 - Executed if a method exits by throwing an exception
- Around
 - Advice wraps the advised method, providing some functionality before and after the advised method is invoked

Pointcut

Collection of joinpoints that you use to define when the advice should be executed.

Target Object

Object being advised by one or more aspects. Also referred to as advised or proxied object.

AOP proxy

Object created by the AOP framework, including advice.

Weaving

Assembling aspects to create an advised object.

3.5 Spring's AOP support

Use the AspectJ framework in Spring applications.

AspectJ

- complete and popular AOP framework
- widely-used de-facto standard for AOP
- it uses Java-like syntax

Spring AOP vs AspectJ

Spring AOP	AspectJ
Method-execution pointcut	Method-, constructor- and property-execution pointcut
Weaving dynamically at runtime	Compile-time weaving
Dynamic proxy	

3.6 Example

```
@Aspect
public class Audience {

    @Around("execution(* *.perform(..))")
    public void watchPerformance(ProceedingJoinPoint joinpoint) {

        try{
            System.out.println("The audience is taking their seats.");
            System.out.println("The audience is turning off their cell
phones");
            long start = System.currentTimeMillis();

            //Proceed to advised method
            joinpoint.proceed();

            long end = System.currentTimeMillis();
            System.out.println("CLAP CLAP CLAP CLAP CLAP");
            System.out.println("The performance took " + (end-start) +
" milliseconds.");
        }
        catch(Throwable e){
            //After bad performance
            System.out.println("Boo! We want our money back!");
        }
    }
}
```

Part 3: Spring Web MVC

1 MVC Structure

1.1 Spring Web MVC
