COMP S380F Web Applications: Design and Development
Lab 3: Servlet: Parameters and Attributes

This lab will cover the following topics. Answers are available in the different commits of the branch `lab03ans` in the GitHub repository https://github.com/cskeith/380_2024 .

- Differences between the Context init parameter, Servlet init parameter, and Context attribute
- Using the "synchronized" code block for thread safety of shared memory
- Request parameters with multiple values

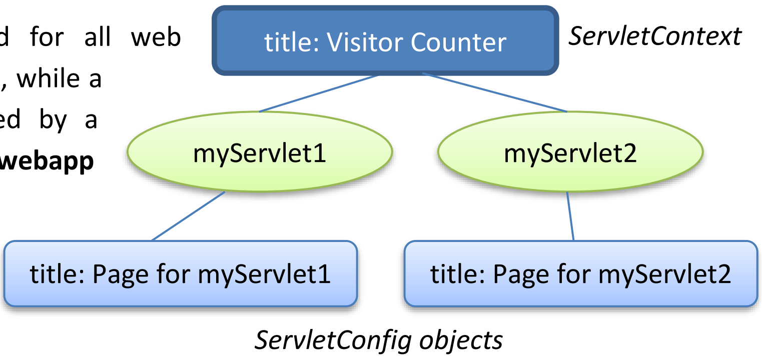
Task 1: Context and Servlet init parameters, Context attributes, and the use of "synchronized"

We will create a web application that has a visitor counter, which counts the visits on all servlets.

1. In IntelliJ, create a **Gradle Web Application** project with the following properties:
    - Category: **Jakarta EE**
    - Name: **Lab03**
    - Template: **Web application**
    - Application Server: **Tomcat 10.1**
    - Build system: **Gradle**
    - Group: **hkmu.comps380f**
    - Jakarta EE Version: **Jakarta EE 10**

2. Right-click on **src > main > java** to create a Servlet class **hkmu.comps380f.VisitCounterServlet**.

3. A **context init parameter** can be used for all web components (e.g., servlets) in the web app, while a **servlet init parameter** can only be used by a particular servlet. Expand **src > main > webapp** and open the **deployment descriptor /WEB-INF/web.xml**. Add the following servlet name, URL pattern, context init parameter and servlet init parameter:



```
<context-param>
    <param-name>title</param-name>
    <param-value>Visitor Counter Site</param-value>
</context-param>

<servlet>
    <servlet-name>myServlet1</servlet-name>
    <servlet-class>hkmu.comps380f.VisitCounterServlet</servlet-class>
    <init-param>
        <param-name>title</param-name>
        <param-value>Page for myServlet1</param-value>
    </init-param>
</servlet>
<servlet-mapping>
    <servlet-name>myServlet1</servlet-name>
    <url-pattern>/visit1</url-pattern>
</servlet-mapping>
```

4. Put the following `doGet` method (for serving an HTTP GET request) to `VisitCounterServlet`:

```
@Override
protected void doGet(HttpServletRequest request, HttpServletResponse response)
        throws ServletException, IOException {
    ServletContext context = this.getServletContext();
    Integer count;
    synchronized (context) {
        count = (Integer) context.getAttribute("counter");
        if (count == null) {
            count = 1;
        } else {
            count++;
        }
        context.setAttribute("counter", count);
    }

    ServletConfig config = this.getServletConfig();
    response.setContentType("text/html");
    response.setCharacterEncoding("UTF-8");
    PrintWriter out = response.getWriter();
    out.append("<!DOCTYPE html>\r\n")
            .append("<html>\r\n")
            .append(" <head>\r\n")
            .append(" <title>" + config.getInitParameter("title") + "</title>\r\n")
            .append(" </head>\r\n")
            .append(" <body>\r\n")
            .append("<h1>" + config.getInitParameter("title") + "</h1>\r\n")
            .append(" The site " + context.getInitParameter("title"))
            .append(" was visited for " + count + " times.\r\n")
            .append(" </body>\r\n")
            .append("</html>\r\n");
}
```

5. In the deployment descriptor `/WEB-INF/web.xml`, create another servlet **myServlet2** of the same servlet class with similar servlet init parameter and URL pattern, where “1” is updated to “2”.

   Useful hotkey: In `web.xml`, select the <servlet> and <servlet-mapping> tags of myServlet1, and use the hotkey **Ctrl + D** to duplicate the selected content. Update the <servlet-name>, <servlet-class>, <param-value>, and <url-pattern> for myServlet2.

6. Study the above `doGet()` method, which involves the Integer variable `count` and the **context attribute** `counter`. Different from parameters, attributes are like variables in the Java program. The web container will create/allocate a thread for each servlet request. At the same time, all the threads can access the `ServletContext` object and hence its context attribute `counter`.

   Using the **`synchronized`** code block guarantees that at most one thread can run the code block at any time. Using **`synchronized(context)`** makes the context object the lock for this code block. In other scenarios, we can also use the servlet object as a lock, i.e., **`synchronized(this)`**.

   Note also the typical flow for initializing context/session/request attributes. An attribute is an object and its default value is null. If we find that an attribute has a null value, we need to create a new object with the correct type and the suitable initial value and set the attribute with the `setAttribute` method.

7. Whenever you update some Java code in a web app, you need to **build** the web app again and **redeploy** it (Shift + F10). A web browser will be opened and display the default index page of the project at http://localhost:8080/Lab03/ (you need to update the **context root** to `Lab03` (see Lab 2 notes) and note also that the URL is case-sensitive for everything ***after*** the Tomcat's server URL).

8. Run the project and increase the visitor counter by accessing the two mapped URLs, respectively.

9. To **understand the life cycle of a Servlet**, add the following `init()` and `destroy()` methods to `VisitCounterServlet`. Then, deploy the web app, access the URLs again, and finally undeploy it.

```
@Override
public void init() throws ServletException {
    System.out.println("Servlet " + this.getServletName() + " has started.");
}

@Override
public void destroy() {
    System.out.println("Servlet " + this.getServletName() + " has stopped.");
}
```

Task 2: Differences of doGet() and doPost(), and Request Parameter with multiple values

We will create a servlet that displays different HTML pages upon receiving HTTP GET and POST requests. Also, the HTML output for the POST request depends on a request parameter with multiple values.

1. In the package **hkmu.comps380f**, create the servlet **multiValueParameterServlet**, as shown below:

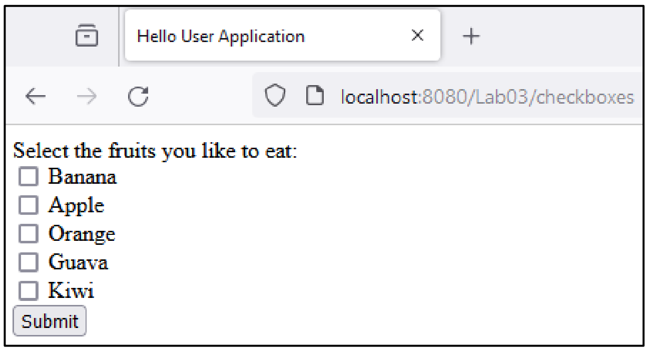
```
@WebServlet(name = "multiValueParameterServlet",
        urlPatterns = "/checkboxes")
public class MultiValueParameterServlet extends HttpServlet {

    @Override
    protected void doGet(HttpServletRequest request, HttpServletResponse response)
            throws ServletException, IOException {
        response.setContentType("text/html");
        response.setCharacterEncoding("UTF-8");
        PrintWriter writer = response.getWriter();
        writer.append("<!DOCTYPE html>\r\n")
                .append("<html>\r\n")
                .append(" <head>\r\n")
                .append(" <title>Hello User Application</title>\r\n")
                .append(" </head>\r\n")
                .append(" <body>\r\n")
                .append(" <form action=\"checkboxes\" method=\"POST\">\r\n")
                .append("Select the fruits you like to eat:<br/>\r\n")
                .append("<input type=\"checkbox\" name=\"fruit\" value=\"Banana\"/>")
                .append(" Banana<br/>\r\n")
                .append("<input type=\"checkbox\" name=\"fruit\" value=\"Apple\"/>")
                .append(" Apple<br/>\r\n")
                .append("<input type=\"checkbox\" name=\"fruit\" value=\"Orange\"/>")
                .append(" Orange<br/>\r\n")
                .append("<input type=\"checkbox\" name=\"fruit\" value=\"Guava\"/>")
                .append(" Guava<br/>\r\n")
                .append("<input type=\"checkbox\" name=\"fruit\" value=\"Kiwi\"/>")
                .append(" Kiwi<br/>\r\n")
                .append("<input type=\"submit\" value=\"Submit\"/>\r\n")
                .append(" </form>")
                .append(" </body>\r\n")
                .append("</html>\r\n");
    }
}
```

2. Note that the Servlet declaration and mapping in the deployment descriptor (web.xml) are now replaced by using the annotation `@WebServlet` on the servlet class.

3. Upon receiving an HTTP GET request, a web form will be shown for the user to choose the favorite fruits from banana, apple, orange, guava, and kiwi.

   The selected fruits will be sent via an HTTP POST request to the same servlet for handling, and they are stored as a **request parameter** `fruit`.



Select the fruits you like to eat:
☐ Banana
☐ Apple
☐ Orange
☐ Guava
☐ Kiwi
Submit

4. Create the `doPost()` method that gets this request parameter, as follows:
   `String[] fruits = request.getParameterValues("fruit");`

   Also, the `doPost()` method should return the following HTML page:

   a. If `fruits` is null:

```
<!DOCTYPE html>
<html>
<head>
    <title>Hello User Application</title>
</head>
<body>
<h1>Your Selections</h1>
You did not select any fruits
</body>
</html>
```

   b. If `fruits` is not null, display all the selected fruits:

```
<!DOCTYPE html>
<html>
<head>
    <title>Hello User Application</title>
</head>
<body>
<h1>Your Selections</h1>
<ul>
    <li>Fruit 1</li>
    <li>Fruit 2</li>
    <li>...</li>
</ul>
</body>
</html>
```