95-702 Distributed Systems

Project 1

Assigned: Friday, September 8, 2023

Due: Friday, September 22, 2023, 11:59 PM

Late by one minute is late!

This project has five objectives:

First, you are introduced to IntelliJ and TomEE. You already have some practice with these. In this assignment, you'll build several web apps to gain more experience.

Second, you build your first set of distributed systems. These are two small web applications using Servlets and Java Server Pages.

Third, you are introduced to web scraping, API processing, and JSON records.

Fourth, you are introduced to the MVC pattern if you have not used it before.

Fifth, as in all projects this semester, you should reflect on the functional and non-functional characteristics (e.g. security, scalability, failure handling, interoperability) of your solutions. There will be questions on the final exam concerning these characteristics. You should be able to demonstrate a nuanced comprehension of course content and be able to explain the technical aspects in relation to potential real-world applications. For each project task, software documentation is required. The software that you write (Java files and so on) must contain comments that describe what each significant piece of code is intended to accomplish. Points will be deducted if code is not well documented. Read the documentation-related links provided on the course schedule (for class #1) to understand what is expected. Be sure to consult the rubric for details on grading.

and **sixth**, **optionally** you may use ChatGPT and Copilot to create some of your code. Task 1 and Task 2 **must** be done on your own. There will be exam questions that ask specifically about the code in these two tasks. While you are allowed to use AI tools to help with Task 3, it is totally optional. There will be questions about this code, too, but these questions will be more generic (since different students may code Task 3 using different techniques). So pay attention to the more general issues in Task 3 (like, what is MVC and what are the benefits of using it?).

Deliverables

There are two parts to deliver, all zipped into one file for upload, with the name Project1_andrewID.zip, where "andrewID" is replaced with your actual andrew id:

- one PDF containing relevant screeenshots of all the parts followed by code snippets (which is relative: how much to include is up to you for each part) that produced the result shown in the screenshot. Each section of the PDF must be clearly labeled.
- your three projects, each zipped, with all of the three tasks zipped together.

See the end for more detail, but read the project task descriptions first so that you know what the details are talking about.

Task 1

Use the IntelliJ Project Name: Project1Task1

Create an index.jsp page that asks the user to enter a string of text data, and to make a choice of two hash functions using radio buttons. The hash function choices should be MD5 and SHA-256, with MD5 being the default. When the submit button is pressed a request is sent to a servlet. The servlet must be named ComputeHashes.java. The servlet will compute the requested cryptographic hash value (MD5 or SHA-256) from the text transmitted by the browser. You will need to employ the Java crypto API to compute the hash of the text. The original text will be echoed back to the browser along with the name of the hash, and the hash value. The hash values sent back to the browser should be displayed in two forms: as hexadecimal text and as base 64 notation. We will discuss the use of such hash values later in the course. To compute the MD5 and SHA-256 hashes, use these standard java packages:

```
import java.security.MessageDigest;
import java.security.NoSuchAlgorithmException;
```

To print the Base64 encoding, use the following method:

```
javax.xml.bind.DatatypeConverter.printBase64Binary
```

To print the hexadecimal encoding, use the following method:

```
javax.xml.bind.DatatypeConverter.printHexBinary
```

Be sure to provide a simple and user friendly interface. If you are unfamiliar with HTML forms, a simple explanation can be found at:

```
http://www.w3schools.com/html/html_forms.asp .
```

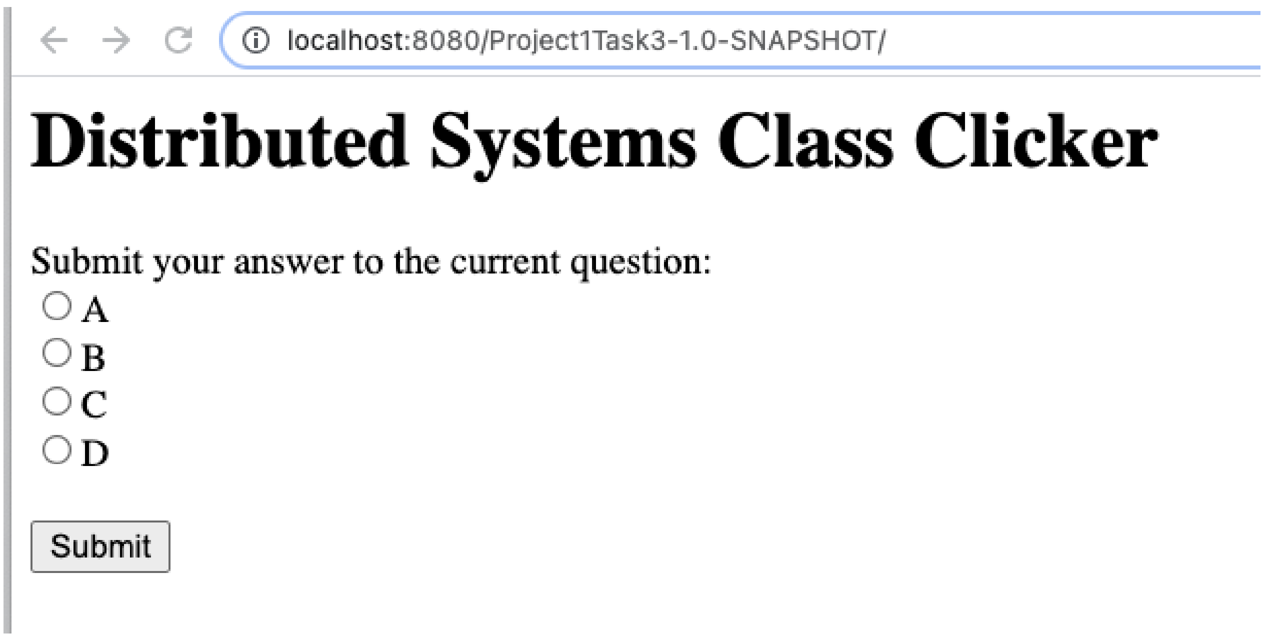
Because Task 1 is fairly simple, you do not have to use MVC for it. Do the simplest thing possible (however, feel free to use MVC if you'd like).

Be sure to create screen shots of your working application and submit them as described in the Submission section at the end of this document.

Task 2

Use the IntelliJ Project Name: Project1Task2

Create a web application that implements a simple desktop and mobile “clicker” for class. Your app should allow users to submit answers to questions posed in class, and should provide a separate URL end point for getting the results of the submitted responses. The welcome page for your app should be similar to Figure 1. You can make it more stylish if you like, but it is not required.


localhost:8080/Project1Task3-1.0-SNAPSHOT/

Distributed Systems Class Clicker

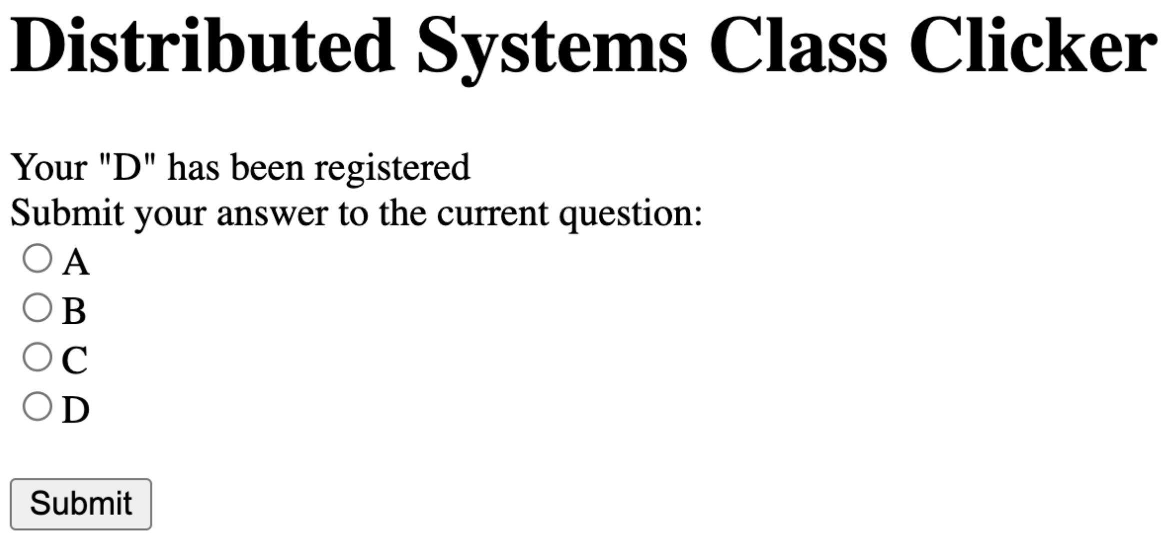
Submit your answer to the current question:

- ○ A
- ○ B
- ○ C
- ○ D

Figure 1

When the user makes a choice and hits "submit", their answer should be stored in your MVC model. The response should be similar to The first line of Figure 2. Notice that it is **required** to provide feedback to the user regarding the choice that they made (i.e. "D" in this example).

The user should also have the ability to submit another answer as shown in the screenshot.

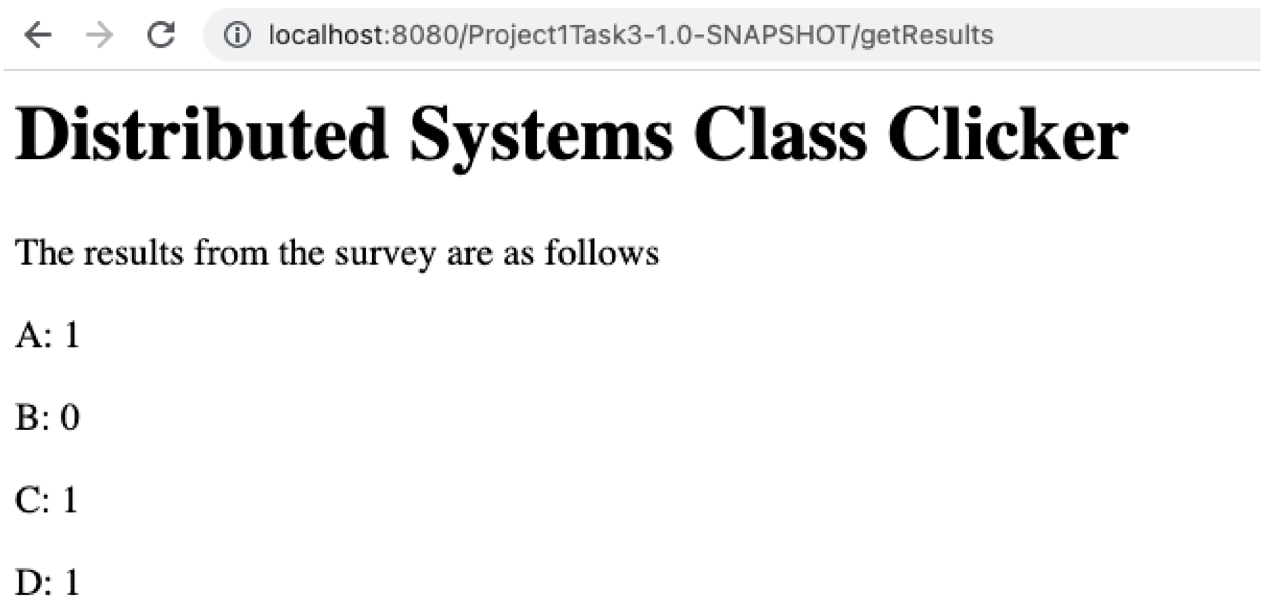

Distributed Systems Class Clicker

Your "D" has been registered
Submit your answer to the current question:

- ○ A
- ○ B
- ○ C
- ○ D

Figure 2

You can test the application by repeatedly submitting answers and allowing your model to tally the results. Your web app should also have a URL path "/getResults" (shown in Figure 3) for listing the results of user voting.


localhost:8080/Project1Task3-1.0-SNAPSHOT/getResults

Distributed Systems Class Clicker

The results from the survey are as follows

A: 1

B: 0

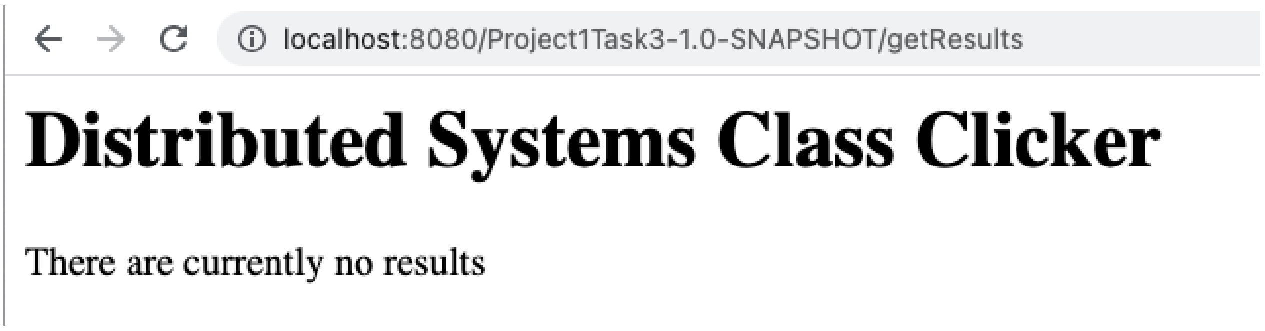
C: 1

D: 1

Figure 3

Requirements for the /getResults path:

1. List each answer that has been given, and the number of times a user has submitted that answer.
2. You do not have to list options that have been chosen zero times.
3. The results should be displayed sorted in alphabetical order.
4. /getResults should also clear the stored results so that a new question can be posed.
5. If there are no results available, then report this as shown in Figure 4.


localhost:8080/Project1Task3-1.0-SNAPSHOT/getResults

Distributed Systems Class Clicker

There are currently no results

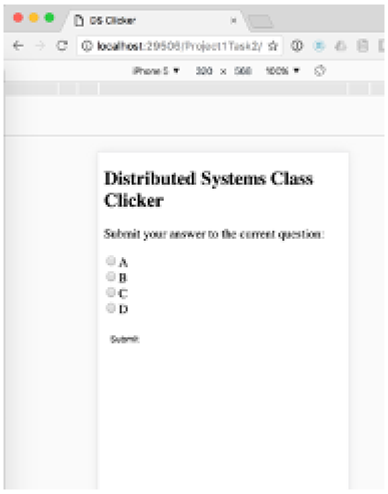
Figure 4

Note that requirement 4 does not adhere to the HTTP standard for a GET request. You should understand why this is bad behavior according to the standard, and how you could fix it (It might be on the exam).

The web app should work with a mobile browser. For this project you can use a simple check like the one that was used in InterestingPicture and then use an appropriate mobile doctype. An easy way to check your web app for mobile is to use the Google Chrome DevTools Using the Google Chrome browser.

- Browse to your web application in Chrome
- Access the Chrome DevTools (https://developers.google.com/web/tools/chrome-devtools/?hl=en#access-devtools).
- Toggle device mode to mobile and choose an Android or iPhone device (https://developers.google.com/web/tools/chrome-devtools/iterate/device-mode/?hl=en)
- Reload the page.
- In addition to testing, you use this to produce a screen shot showing your web app working for mobile. If your page looks like the one Figure 4, even after reloading, then the doctype is not being set correctly.

Figure 5 is what the web app should look like for mobile if the doctype is set correctly.



Distributed Systems Class Clicker

Submit your answer to the current question:

A
B
C
D

Submit

Figure 5

Overall web app requirements:

- You must use MVC to separate concerns.
- Implement only one HttpServlet

Hints:

- You can have multiple URL patterns in a WebServlet annotation. For example, you can indicate that a servlet can be called by two paths such as: urlPatterns = {"/submit", "/getResults"}
    - In order to determine within the servlet which path was actually requested, you can use request.getServletPath();

Produce screen shots of your application:

- With the answer options on desktop
- With the getResults on desktop
- With the answer options on mobile
- With the getResults on mobile

Task 3

Use IntelliJ Project Name: Project1Task3

Task 3 is meant to give you practice with several things: servlet programming, web scraping, API's, JSON, and MVC.

For this assignment, you may **optionally** use ChatGPT and/or Copilot to help you generate a solution; it's not a requirement and you should be able to do the design and coding without it. Keep in mind that:

```
- generated code is not always correct
- the more precise your ChatGPT prompt, the better the solution is likely to be
- how you generate the solution should be repeatable and explainable
- you **must** be able to explain fully the solution, generated by AI or by you, if asked
- you **must** document your use of AI tools. Show the prompt(s) you used to generate sections of code and wh
```

The Baseball App

Create a web app using statistics from the American sport, baseball. You don't have to understand the game and its rules; just know that modern baseball management often uses player statistics to make in-game decisions.

Basic offensive statistics include a player's batting average, number of runs batted in (RBI's), walk percentage, and strike out percentage. Basic defensive statistics include a player's fielding average, a pitcher's earned run average (ERA), and a pitcher's won-loss record. There are many other baseball statistics, fueled by data scientist baseball fans.

Your app **must** meet these criteria:

```
1. Scrape baseball data from at least two web sites. Document what sites you used
with an on-screen annotation.

2. Use baseball data from at least two web API's. Document these sites as above.
You **must** use the gson library to handle JSON records.

3. Include at least two baseball-related images. This can be specific
baseball players, pictures of actual games or stadiums. Again,
document the source in the output.

4. Be able to handle different user input - in other words,
do not show the same information in your output each time -
it must be dynamic, not static. It must also be repeatable: if a
user enters the same input data another time, the same output
should be presented.

5. Be coded primarily in Java and JSP. If you use something else,
give a brief but convincing argument why this was **necessary** and
not just a convenience.

6. Present a web site that requires user interaction using a text
field **and** at least two of these:
    - button
    - drop-down menu
    - radio buttons

7. Use at least two web pages for your output.

8. Use the Model-View-Contorller (MVC) pattern and good separation of concerns

9. Handle error conditions in a "reasonable" way.

10. Be well documented - the code, the usage of the app, and the
structure/design of the app, any AI-related things as described above.
```

What baseball statistics you use, and what web sites you get them from, is up to you - but be careful of copying other students' ideas; this **must** be your own work. The overall design of the web app is up to you (subject to the criteria above). If you have questions about sites, citations, or output, ***ASK***.

Again, you *MUST* use the MVC pattern for Task 3.

Notes and hints

Screen Scraping

Screen scraping is programmatically processing the HTML that typically is displayed by a browser and can be a useful tool when your data source does not have an API that provides structured data. Instead, you can search or parse the HTML to find and extract the data that you need. For more information, see

> https://en.wikipedia.org/wiki/Web_scraping

Your application should work similarly to InterestingPicture, but instead of searching Flickr, it will use the sites mentioned above.

- You are allowed to and encouraged to build your solution based on the InterestingPicture code you have been given in class. You MUST refactor it, however, so that it has project, variable, and class names that make sense for your application. For example, **you will lose points** if your class is still named InterestingPictureServlet.
- You do not need to, but you are welcome to, use jsoup (https://jsoup.org/) which is a Java HTML Parser, to do the scraping. It is the Java version of Beautiful Soup, which you may have used in Python. The downsides of using jsoup are you will first need to understand the Document Object Model (DOM) and CSS Selectors. These are both useful to know. The upside of using jsoup is that it makes it much easier to find and select content from HTML (i.e. screen scrape). Refer to the JSON Maven notes below; adding jsoup will require a similar process.

HTML

Refer to http://www.w3schools.com for good help on the basic HTML you need for this task. This has examples of drop-down boxes.

JSON and gson

JSON records are text records containing tag-value pairs, where the tag is the field name - think of it as a dictionary or map with nesting. It is much shorter than XML. In order to find what you need, use the JSON library GSON. To use GSON, download the gson v.2.10.1 jar file to a place you'll remember. To add it to your project, go to File->Project Structure->Modules, choose the Dependencies tab, click the + icon at the bottom choose Jars or Directories, navigate to where you put the jar file, click that, then Apply and OK. It should show up in your pom.xml file as the last entry in as:

```xml
<dependency>
    <groupId>com.google.code.gson</groupId>
    <artifactId>gson</artifactId>
    <version>2.10.1</version>
</dependency>
```

If this does not appear, add the above lines manually to pom.xml.

Finally, reload the Maven dependencies to have this new dependency take effect - an icon will probably appear in the pom.xml window, but if you don't see it, got to the Project View window, find the pom.xml entry (it should be near the bottom of the tree), right click it, choose Maven -> Reload Project. (FYI, Maven is a build management tool, different from the usual Gradle build; Maven uses the Project Object Model (pom) file to keep track of properties and dependencies.)

Please use gson and not some other JSON library.

SSLHandshakeException

Most modern sites require you to make https, not http requests. When you do so from your Java program, you will hit an SSLHandshakeException. We will be covering SSL and related topics in a few weeks. In the meantime, you will have to deal with this exception.

If you use jsoup, you should use validateTLSCertificates(false). (Refer to the jsoup API to understand this when you need it.)

If you do not use jsoup, here is a code to replace the fetch method in InterestingPictureModel to ignore the exception. The parameter "certType" should be set to the string "TLSV1.3".

```java
private String fetch(String searchURL, String certType) {
    try {
        // Create trust manager, which lets you ignore SSLHandshakeExceptions
```

```
            createTrustManager(certType);
        } catch (KeyManagementException ex) {
            System.out.println("Shouldn't come here: ");
            ex.printStackTrace();
        } catch (NoSuchAlgorithmException ex) {
            System.out.println("Shouldn't come here: ");
            ex.printStackTrace();
        }

        String response = "";
        try {
            URL url = new URL(searchURL);
            HttpURLConnection connection = (HttpURLConnection) url.openConnection();

            // Read all the text returned by the server
            BufferedReader in = new BufferedReader(new InputStreamReader(connection.getInputStream(), "UTF-8"));
            String str;
            // Read each line of "in" until done, adding each to "response"
            while ((str = in.readLine()) != null) {
                // str is one line of text readLine() strips newline characters
                response += str;
            }
            in.close();
        } catch (IOException e) {
            System.err.println("Something wrong with URL");
            return null;
        }
        return response;
    }

    private void createTrustManager(String certType) throws KeyManagementException, NoSuchAlgorithmException{
        /**
         * Annoying SSLHandShakeException. After trying several methods, finally this
         * seemed to work.
         * Taken from: http://www.nakov.com/blog/2009/07/16/disable-certificate-validation-in-java-ssl-connection
         */
        // Create a trust manager that does not validate certificate chains
        TrustManager[] trustAllCerts = new TrustManager[] {new X509TrustManager() {
            public X509Certificate[] getAcceptedIssuers() {
                return null;
            }
            public void checkClientTrusted(X509Certificate[] certs, String authType) {
            }
            public void checkServerTrusted(X509Certificate[] certs, String authType) {
            }
        }
        };

        // Install the all-trusting trust manager
        SSLContext sc = SSLContext.getInstance(certType);
        sc.init(null, trustAllCerts, new java.security.SecureRandom());
        HttpsURLConnection.setDefaultSSLSocketFactory(sc.getSocketFactory());

        // Create all-trusting host name verifier
        HostnameVerifier allHostsValid = new HostnameVerifier() {
            public boolean verify(String hostname, SSLSession session) {
                return true;
            }
        };

        // Install the all-trusting host verifier
        HttpsURLConnection.setDefaultHostnameVerifier(allHostsValid);
    }
```

Questions:

If you have questions, you can post them to the class Piazza and tag them as “Project1”. Track Piazza for additional hints and answers to questions.

Summary & Submission:

Be sure to review the Rubric linked on the course schedule for the first day.

Submit ***one*** PDF naned Project1_andrewID.zip, where "andrewID" is replaced with your actual andrew id, containing the following; each part should begin with the headers shown (that is, "Task 1") and subheaders for the subparts. "Code snippet" means a copy of the relevant code, **not** all of the .java or .jsp file.

Task 1:

1. **Screen shots** of input, MD5 and SHA-256 output, both in hex and base 64
2. **Code snippets** of computation of each hash

Task 2:

1. **Screen shots** of input page(s) and output page(s).
2. **Code snippets** for producing clicker output.

Task 3:

1. **Screen shots** of two uses of the input page (two different sets of input data) and the corresponding output pages.
2. **Code snippets** from the Java code that screen scrapes, queries the API, and produces output.

Code:

Create three zip files, each one of which is the zip of your WHOLE project for task 1, 2 and 3. For each project, zip the whole project, you need to use "File->Export Project->To Zip" in IDEA.

Finally:

Zip the one PDF and the three project zip files into one big zip file for submission.