Waukesha County Technical Institute
152-198 Distributed Java

Class 3 Plan and Assignments

Discussion Activities:

- **Due Today:**
    1. Do to problems with some student computers and lack of time we did not complete the lecture from Class 2 Plan. Therefore, there is nothing due today and we will simply continue with the balance of the Class 2 Plan activities listed below.

- **Your first web application**:
  We'll create a sample project named "FirstWebApp" for this demo in class today:

    - Create a new project (using choice #1 above), and give it the name above without any spaces or other punctuation. Click through the project wizard and make sure you select Glassfish for your server (4.1 or 4.1.1) and "EE 7" for version of the Enterprise Edition of Java. The version is important because it defines the kind of web app servers you can use and the language features available. If we were using an older server, for example Tomcat 6, we would want EE version 5, because Tomcat 6 does not support EE 7 features.
    - After creating a new project in Netbeans, immediately Git enable it by selecting "Team > Git > Initialize Repository". Then from the File menu select "generate gitignore file" and search for the "netbeans" configuration. It's important that you always do these two steps immediately after creating a new project. Otherwise it gitignore may not ignore some things. The purpose of gitignore is to not send stuff to GitHub that is not needed. This saves disk space and time to transfer.
    - As soon as the wizard is done completing your new project you will see it appear in Netbeans along with a home page in your editor called "index.jsp". Your home page can have any name you choose, however, "index" is the most common name for a home page. Others are "default", "home", "home" and more.
    - Web page names must NEVER have spaces or odd symbols in the name. Stick to alphanumeric phrases. Capitalization is up to you but most people use camel case. Also, the extension ".jsp" is not the only one available. Depending on the language there may be other extensions used. For example in Java we will use ".jsp".
    - The **extension is important** because it tells the server the type of resource being requested, and what if anything the server has to do next before sending data back to the client in a response.

- Next, right-click on your project and in the pop-up menu select "Properties". In the dialog box that follows click the "Libraries" category and verify that you are using JDK 1.8. Further verify that if you have multiple copies of 1.8 that you are using the latest one.
- In the same properties dialog click on the "Run" category and at right set the **"Relative URL"** to "/index.html". Notice that the **"Context Path"** is set to "/FirstWebApp". The context path is the name of your web app, which appears just after the server name in a URL. So for example, on your local computer your web app is running at the server address http://localhost:8080, where localhost is the default name of your server and "8080" is the port number used to access that server. Port numbers are like apartment numbers. The server address is like the address of the apartment building and the port number is like the address of a particular apartment within that building. In web development the port number is the web server address on that computer. A computer can have more than one web server, hence the need for port numbers.
- The **"Relative URL"** is the name of your web app. Netbeans causes the name of your web app project to be the default name of the web app here. But you can easily change this to something else (NO SPACES). If you forget to set this your app will not display the home page when started. In the future we'll see how can use a file called "web.xml" to provide this and more features. The relative url shows up as a suffix in the URL:

  http://localhost:8080/FirstWebApp

  Having this is not mandatory. It most useful when there are multiple web apps running on a single server. That way you can target each app by name. But sometimes you will only have only large app running on a server, and in that case the Context Path would be left blank. So in effect there would be no app name. Think of the app name as a sub-directory on the server. You app code will either go into a sub-directory (app name) or at the root (no app name).

- Pause here for a quick review by your instructor about HTML basics. For those who need a more detailed review, or for those who need entry-level training, please go through the tutorial at http://www.w3schools.com/html/default.asp

  IMPORTANT: knowledge of HTML is mandatory in this class and you are expected to know it as a prerequisite. Make sure you study this if needed so that you can successfully complete the course.

- The **"method"** attribute of the HTML form element indicates how the client request is being made and how optional data will be sent to the server. POST is the choice of preference for web forms because there are no data size limits and the data is supplied invisibly to the server for better

security. But you could set this to “GET” and it would still work because the data size is small.

- The **“action”** attribute indicates the destination target for the request (the server-side resource). In this case, that resource is the pseudo-name (alias) of the HttpServlet that will be used to process the request. We haven’t created this yet but will soon.
- A **submit** button is used so that when clicked the HTTP protocol will be used automatically to send the form data (make a request) to the resource identified by the action attribute. You could also use a regular <button> tag instead of an <input type=”submit”> tag, but then you would need some client-side JavaScript code to cause a request to happen. With the input tag it’s automatic.
- OK, now let’s create a server-side Java object to process the request and produce a response. Right-click on your project and from the pop-up men select

  New > Other > Web > Servlet

- The servlet wizard will walk you through the creation of this item. Set the class name to “XXXXController”, where “XXXX” describes the purpose of the controller. Set the package to “controller” (always use package names to organize your Java classes into logical groups). Then click “Next”. There are many options for Configuring Servlet Deployment. For now, we just accept all the defaults. Click “Finish”.
- Your servlet class should appear in your editor. Notice that your Controller extends “HttpServlet”. All servlets have this common parent class, which is an abstract class that provides some common, concrete methods such as doPost(), doGet() and init(), which you will want to override. Netbeans provides an additional method processRequest() which is not part of the HttpServlet class or EE 7, but is provided as a convenience. It is used to process both GET and POST requests. Normally this is done by the inherited doGet() and do Post() methods, but processRequest() can be used conveniently to process both of them in one place. See the doGet() and doPost() methods in your servlet and notice that they call processRequest(). Again, this is not standard, but just provided by Netbeans as a convenience. You do not have to use this if you have other needs.
- A servlet is a Singleton, meaning that there will only be one instance object ever created. How can one instance object be used handle thousands of requests coming from thousands of users? By using threads. The server will create on thread for each request and tie that thread to the servlet. This is very important to understand because multithreading comes with hazards – you do not want to share variables with more than one thread. Your instructor will review that here. So make sure that any class properties you create in your servlet are treated as global constants – not as variables – at least not as writeable variables.

- OK, now let's write some code to process the client request from our index.html page. In the processRequest() method provided by Netbeans some sample code is provided. This sample code does not do anything with the request info and simply generates a new web page on the fly. This is not what a servlet is typically used for, but it can be. Let's see what happens if we just run the code as is. Save all changes and run your web project. This will take a while. Netbeans must compile all code, create a ".war" file, deploy that file to the Glassfish server and then start the server and finally load your web app along with the default web browser (change it in Netbeans to Chrome). **Instructor demo to follow**.
- If everything goes according to plan you should eventually see a web page with the message coded in your servlet. Verify this now and let your instructor know if anything failed.
- Great, but this is not what we want. What we want is a message to be dynamically produced by the servlet and returned to the client. To do that we must modify the servlet code.
- **FIRST, you must stop the server**. Do this by clicking on the Glassfish tab in the output window at the bottom of your screen. The Glassfish tab is used to monitor all of the log output from the server which describes what it is doing. This can be useful in debugging later. For now, just click the orange button to stop the server. The button will be in the upper left corner of the output window. It will be orange if the server is running and gray if it is not running.
- **Why do we need to stop the server to make a change?** Often we do not. If making client-side changes (changes to your web pages) you never have to stop the server. It will do what's called a "hot deploy" after saving your changes. However, when making server-side changes, such as modifying a servlet, this is unreliable. It's always best to stop the server before making any changes to server-side code.
- **Now make your changes**
- The "request.setAttribute" statement creates a key-value pair, storing the error message as a value under the key. This key-value pair is set as an attribute of the request object. The purpose of this is to forward the request object to the destination page where it can be used if needed. This page must be a .jsp **Why ".jsp"?**

  Because that page will contain some java code that will be executed on the server BEFORE it's sent back to the client. In otherwords we will be dynamically changing the html via Java code execution, resuting in a new HTML page whose code will be sent back to the browser in a response. No Java will every be sent to the browser – only the resulting HTML. Only a JSP page can do that. This would not work if the page extension was ".html". Why? Because ".jsp" tells the server to excecute the Java code.

- To create a JSP, right-click on our project and from the pop-up menu select

  New > Other > web > JSP

- Give the JSP page a name (the .jsp is added automatically) and save.
- The new JSP page will appear in your editor.

  Notice:

  The <%@ page … tag, which indicates that this is a JSP page with certain attributes.

  The <% and %> symbols are delimiters that indicate the start-stop points at which real Java code is entered into the JSP page. You are mixing regular HTML with Java code in the same page. HOWEVER, the Java code is processed on the server BEFORE the resulting HTML is sent back to the browser. The Java code never ends up in the web page.

  request attributes are retrieved as plain Object data types. These must be cast or changed into the original data types, which in this case are Strings.

  We must test for null before casting or converting, else we would get a NullPointerException.

  Then if not null, we can use the String values in our output. Notice we are not using System.out.println, but rather out.println. Why? Because in this case the out object belongs to a servlet. The JSP page is compiled by the server into an HttpServlet. Where does the data get printed? Not to the console in this case, but rather to the HTML code stream. This is one way that servlets output data.

- Double check that you have entered all code accurately, save your changes and run the program again. This time you should see a form where you enter our name. Then click the button and see the respone output.
- Verify this works and if not let your instructor know immediately if there is a problem.
- This concludes our first, very simple, naïve attempt to create an interactive web application using Java. Now we need to consider some more advanced issues.

- **Introducing the Model-View-Controller (MVC) Design Pattern**
  - A **common best-practice** for building web applications in any language is to use the MVC pattern (or variation). The MVC pattern defines a way to separate concerns (responsibilities) into logical groups or modules. This separation decouples code in a way that is beneficial to applications that

may have different user interfaces (smart phone, web browser, standalone GUI, etc.), and different server-side logic (Java, PHP, VB.Net, C#.Net, etc.). The idea is that you should be able to change your UI code with affecting your server-side code and vice versus.

- The **"View"** in MVC is the UI code. In our app it was the HTML or JSP page. But it could have been a native smartphone app or standalone VB or Java app.
- The **"Controller"** in MVC is a Java object (or other language) that has one job – to control data flow between client and server (request-response). In a Java web app this will usually be an HttpServlet, but it could also be some other Java class, depending on the chosen framework being used.
- The **"Model"** in MVC is one or more classes that are regular Java objects that perform the data processing and data persistence work (database, e.g.). All data processing should be performed here, not in the Controller. And here is where we should use the Service Oriented Architecture (SOA) that you learned in Advanced Java.
- The **data flow in MVC** goes like this:

  VIEW ←-→ Controller ← → Model

  Notice that the View is decoupled from the Model by the Controller. This is an important feature. It means that the Model can be modified without affecting the View and vice versus.
- In our examination of the "FirstWebApp" we did not use a Model. Instead we did the data processing in the servlet. This violates the Single Responsibility Principle because the Controller should only control data flow. It should not perform view-related or model-related activity. It should only control flow. What does that mean? It should decide which model object should process a request, and it should decide which view object should be given the response. That's it!!
- You can have as many controllers as necessary. Generally, you want to follow the Single Responsibility Principle here as well and create different servlet controllers for different control jobs.
- Later we fixed our architecture by using a model object to process the request in our FirstWebApp.
- To create any model object you just create a normal class. Right-click on your project and from the pop-up menu select

  New > Other > Java > Java Class

- Name it "XXXXService" and give it a package name of "model"
- You can create other model objects that are not services, but are delegates in the DIP.
- Notice in our "FirstWebApp" example we return the result of the data processing as a String, but we could return any Java object or primitive.

The controller needs this as part of the data flow. The controller's job is to send the data to the appropriate view.

- Now let's examine our HelloController to see how it sends and receives this data:

  Notice the input value in name that came from the View is now being sent to the Model via the HelloService, which in turn delivers a response value back to the Controller. The Controller then forwards that data to the View response page via the RequestDispatcher.

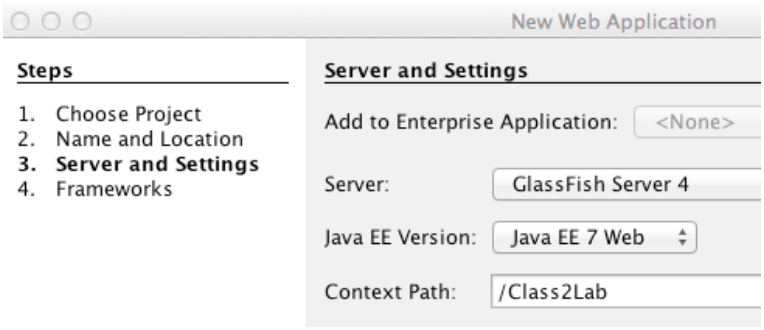
- Run the app again (after stopping and restarting the server) and verify that the app works. Let your instructor know immediately if you have any problems.

- OK, now let's examine a different sample application provided by your instructor. It's on Blackboard and is called "BeerAdvice". Download the zip file, extract and load the project into Netbeans. Then examine the code from View to Controller to Model. Notice how the basic techniques are the same as the app you just built. This is an important thing to understand. You now have a blueprint that you can use to develop other apps, using similar techniques. Use these examples as a study guide for future work.

- **OK, time to practice what you've learned** through a series of lab activities in class and at home if extra time is needed. Please do these one at a time, in order, and **do not continue to the next activity until told to do so.**

  ✓ **Lab Activity #1** (your instructor will guide you … wait for instructions):

  1. Create a Java Web Application named "Class2Lab". Make sure you select Glassfish as the server and EE 7 as the version:



  2. Note that the "Context Path" can be changed, but defaults to the name of your project. NEVER use spaces in your project name because this Path name is what is used in the URL in your browser to access your site, and spaces are not allowed in URLs.
  3. Your web site is running on your computer – not on some remote computer. In a production environment the remote computer would have a domain name, like "wctc.edu" which is the server name.

But for your local computer it defaults to "localhost". Furthermore, in a production environment port 80 is the default and therefore is not needed in the URL, but for development on your local computer, port 8080 is used. This lets you run both a production server and a development server on the same machine. So now the address in your browser (the URL) that you use to access your site will be http://localhost:8080/Class2Lab

4. On the next screen in the New Project wizard, do not select any Frameworks. Finally, complete the wizard.
5. Notice that your project appears in the "Projects" tab in Netbeans and your home page, "index.html" has been created and is open in the editor view. Notice further that the HTML5 Doctype is being used. That means you can use all of the new features of HTML5 if you wish, but you can also use older versions of HTML.
6. CAUTION: as you modify or create new files, never use spaces or other punctuation in file or folder names. The web hates that! Best practice is to use camelcase or all lower case.
7. Now, initialize this project for Git.
8. Next, add a ".gitignore" file before doing anything else. A Git Ignore File is a file that begins with a dot "." And ends with "gitignore". It can best be created using a Netbeans plugin. You may or may not have this plugin installed. To see if you do, go to the Tools > Plugins menu in Netbeans and look for it in the "Available Plugins" tab. If you find it there, it is NOT installed. Check the box next to it and install it. Next, use it to create the file. Here's how: point your mouse cursor at your project name in Netbeans and right-click your mouse on it, which will reveal a popup menu. In that menu, near the bottom, select "Generate gitignore file". This will reveal a dialog box with a list of templates. Scroll through the list or enter "netbeans" in the filter box. Select that. This will reveal a file in your editor containing some rules. These rules tell Git what NOT to push to GitHub. These are things that do not need to be pushed.
9. After adding your .gitignore file, immediately do a Git > Add, followed by a Git > Commit and enter the message "initial commit".
10. Create a GitHub project of the same name and push your project to Git using Git > Remote > Push … (make sure you enter the correct address of your GitHub project and correctly enter your username and password). Report any problems doing this now!!!

✓ **Lab activity #2:**

1. For this activity you will use the same project as in #1 above. Create a package named "activity2" and put all your code there.

2. Your instructor is going to show you how to work with JSPs and Servlets later today, but for now you are going to do some independent research and experimentation.
3. First you need to discover what a "Java Servlet" is. Here are some resources for your research:
    a. Read this first: http://www.developer.com/java/an-introduction-to-java-servlets-.html
    b. More advanced topics: https://docs.oracle.com/javaee/7/tutorial/servlets.htm#BNAFD
4. This is a discovery exercise. You're supposed to feel like a kid in a candy store experimenting with all the tasty treats that Servlets have to offer. It's not about being right or wrong, it's about learning from trial and error.
5. Skills challenge (practice what you've learned)
    a. Create a Servlet named "PageGenerator" and in the New Servlet wizard enter the package name "controller". To get to the wizard, right-click on your project and select "New > Servlet". If you don't see "Servlet" as an option, go to New > Other > web > Servlet. Don't forget, put your code in the "activity2" package mentioned above.
    b. On the next screen verify the Servlet Name is "PageGenerator" and change the URL Pattern to "/pager". This last change, is of course, optional but demonstrates that you can use any alias you choose for the URL Pattern. DO NOT check the box for using "web.xml". Now click Finish.
    c. OK you should be looking at your new servlet in the editor view. If you have trouble with this, ask one of your peers for help. Notice the annotations at the top of the class that configure the servlet. We'll discuss this later.
    d. Netbeans provides a "processRequest" method (this is not part of the servlet API, it's simply an optional convenience method. Notice that your servlet has a "doGet" and "doPost" method that both call this convenience method. Again, you don't have to use this method, but it makes things easier. Write your code in this "processRequest" method.
    e. In this method Netbeans has provided some sample "out.println()" statements that generate a web page. Your challenge is to modify this code to output a simple web page that contains a table with three rows and three columns, and a headline above the table. Content can be anything. Watch for typos!!! String concatenation is extremely fragile!

f. Now run your project to see the results. Enter this URL in your browser:
http://localhost:8080/Class2Lab/pager
Notice that the word "pager" at the end of the URL is the alias name of your servlet (if you followed the instructions above).
g. When done (or ask a peer for help). When done, do a Git add/commit and then a push to GitHub.
h. Time-permitting, experiment with other output in your out.println() statements. You shouldn't be surprised to know that you can generate any legal code that would normally go into an html page – including CSS and JavaScript. Give it a try. Watch out for String typos and concatenation issues!
i. The point of this activity is to show you that an HttpServlet can auto-generate the html, css and JavaScript used in a web page. However, this is the least efficient way to create a web page. Use JSPs instead.

✓ **Lab activity #3**:

1. You will use the same project as above and will produce the same results as above, except this time you will use only a single JSP page. This JSP page will be created in the "Web Pages" directory of your project. If you accidentally create it elsewhere, you can drag n drop it into the correct directory.
2. Create a JSP page named PageGenerator2.jsp (the ".jsp" extension is added automatically by Netbeans). Now program it to output the same results as in the previous lab activity. To do this you can simply add the Java scriptlet delimiters shown previously and write similar code as used in your servlet, or you can use the techniques presented by your instructor.
3. When done (or ask for help) do a Git add/commit/push
4. The purpose of this activity is to show you that a JSP can be programmed to do exactly the same things as a servlet – that's because JSPs are compiled into servlets. But you can also take advantage of special features that are only available in JSPs (such as mixing html and java code). So if JSPs are really servlets, should we just use them instead? No? Use JSPs as VIEW objects. Use servles as CONROLLERS.

o **Lab activity #4**:

1. Before starting this activity your instructor will discuss more about servlets and JSPs, and about using "web.xml". He will also discuss the differences between HTTP methods GET and POST as well as how to use Servlets to forward requests to your view pages. You

will need to take notes on this. Your instructor will check to make sure you do!

2. In this activity you are going to use the MVC design pattern to build an app that has a two-page view (both HTML and JSP), a single controller servlet, and a single model class. You will be using the same project as above.
3. Under "Source Packages" create a new package named "model". In that package create a regular Java class named "WelcomeService"
4. In that service class create a private property for the current date using the Calendar data type. Then create two methods:
5. The first method should be written to determine whether it is morning, afternoon or evening. Hint: you can use the before or after methods in the Calendar class to help you do this. Have it return a String containing "morning", "afternoon" or "evening". Come on, it's not that hard, you just have to think! You made it through Advanced Java, you can do this too!
6. Next, create a method that takes a String value for a person's name, and constructor a return String that combines that name plus the date result above into a welcome message. Something like this: "Good afternoon, Jim. Welcome!"
7. Next, create an HTML page named "welcome". Create an appropriate headline and form that takes a person's name and submits the form to a controller that has the alias "greeter". Use what you've learned so far to create the servlet for this alias. In your form don't forget to reference the alias like this:
   ```
   <form id="form1" name="form1" method="POST"
   action="greeter">
   ```
8. Next, create your controller with an appropriate name and the alias mentioned above. In the "processRequest" method remove the boilerplate code provided by Netbeans and replace it with your own. You will need to retrieve the form parameter and pass it to an instance of your model class. The model class will return a String value that you must forward to a result page that is a JSP. In that page you will retrieve that String from the request object and display it on that page. If you don't remember how to do these things, take a look at the sample BeerAdvice app provided by your instructor and use similar techniques. Learn by learning from someone else's code. Again, you are required to do critical thinking to be successful. Bear down and get it done!
9. When done, do a Git add/commit/push. We'll discuss all the lab activities soon, and look at samples of student work.

Lab Activities:

- Demos and walk-throughs

Textbook Chapters (and other resources) covered:

- Java EE v1.7 tutorial: http://docs.oracle.com/javaee/7/tutorial/doc/home.html
- Java SE API (v1.8): http://docs.oracle.com/javase/8/docs/api/
- Java EE API (v1.7): http://docs.oracle.com/javaee/7/api/
- Printed Servlet Tutorial: "java-servlet-tutoria.pdf" provided on Blackboard. Note: this uses Eclipse as an IDE. We will not be using eclipse. So the techniques for doing stuff in the tutorial may vary with those of Netbeans.
- Online tutorials for client-side: http://w2schools.com
- Netbeans web development tutorials: https://netbeans.org/kb/trails/java-ee.html
- Netbeans Git User Guide: http://netbeans.org/kb/docs/ide/git.html
  (don't use SSH – we'll be using the modern HTTPS approach)

Preparation Work for Next Class – 2 points for completion on time:

1. Complete lab challenges #2 and #3 in "Class2Lab" project push your solutions to GitHub.
2. Do the research on your selected topic and be prepared to do a 5 minute presentation to the class the next time we meet.