Lab: Creating Custom-Made MVC Framework using Servlets

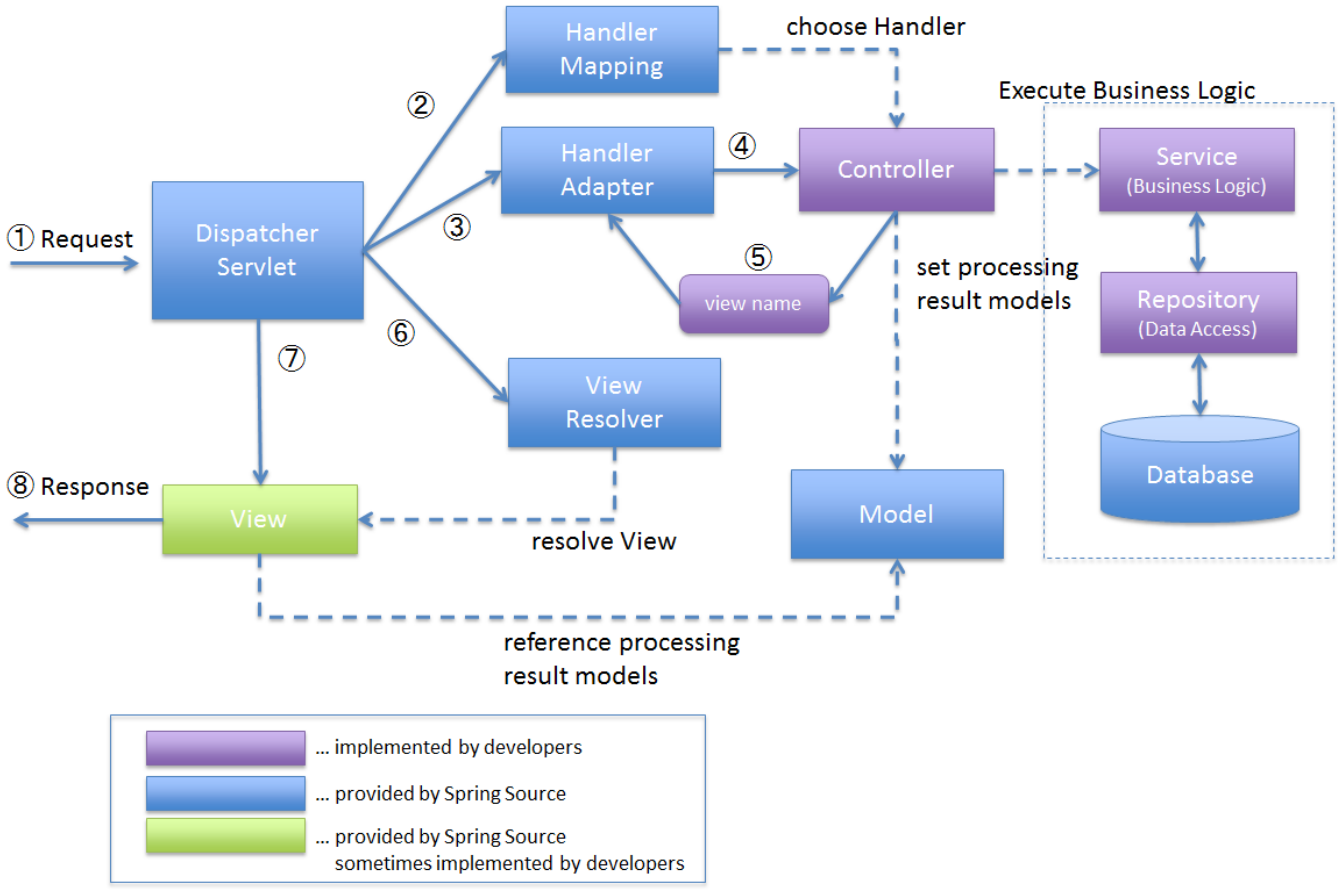
This **tutorial** provides step-by-step guidelines to build a **MVC framework** in Java, Servlets and Tomcat. The framework should implement **@Controller, @GetMapping, @PostMapping, @PathVariable, @RequestParam** annotations.

Project Specification

Design and implement a **MVC framework** in Java, Servlets and Tomcat. Create 5 **annotations** with the following functionality:

- **@Controller**
  - Indicates that any class will be used as a controller and it will contain mapping actions
- **@GetMapping**
  - Provides a route to any method within a controller for **get requests**
- **@PostMapping**
  - Provides a route to any method within a controller for **post requests**
- **@PathVariable**
  - A variable within a method action that indicates **dynamic path**
  - /edit/{id} – **{id}** will be **dynamic** and should be contained in the **annotated parameter**
- **@RequestParam**
  - Indicates any **parameter** coming from a **post or get request**

1. MVC Spring-Like Architecture



- **DispatcherServlet** receives the request.
- **DispatcherServlet** dispatches the task of selecting an appropriate controller to HandlerMapping. HandlerMapping selects the controller which is mapped to the incoming request URL and returns the (selected Handler) and Controller to DispatcherServlet.
- **DispatcherServlet** dispatches the task of executing of business logic of Controller to HandlerAdapter.
- **HandlerAdapter** calls the business logic process of Controller.
- Controller executes the business logic, sets the processing result in Model and returns the logical name of view to HandlerAdapter.
- **DispatcherServlet** dispatches the task of resolving the View corresponding to the View name to ViewResolver. ViewResolver returns the View mapped to View name.
- **DispatcherServlet** dispatches the rendering process to returned View.
- View renders Model data and returns the response.

2. Project Setup

Create a new maven project called Bookhut. Add Java EE Web Application Framework support to the project. This is a recommended pom file:

pom.xml

```
<properties>
    <maven.compiler.source>1.8</maven.compiler.source>
    <maven.compiler.target>1.8</maven.compiler.target>
```

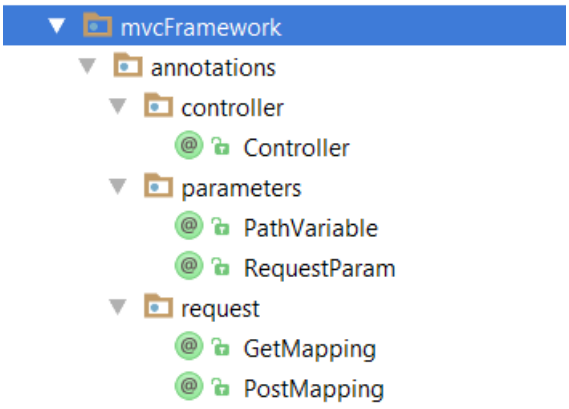
```
</properties>

<dependencies>
    <dependency>
        <groupId>javax</groupId>
        <artifactId>javaee-api</artifactId>
        <version>7.0</version>
    </dependency>
    <dependency>
        <groupId>jstl</groupId>
        <artifactId>jstl</artifactId>
        <version>1.2</version>
    </dependency>
</dependencies>
```

3. Create Annotations

Create 5 main annotations for the framework:

- **@Controller**
  - Applicable on classes only
- **@GetMapping**
  - Applicable on methods only
  - Has value element
- **@PostMapping**
  - Applicable on methods only
  - Has value element
- **@PathVariable**
  - Applicable on parameters only
  - Has value element
- **@RequestParam**
  - Applicable on parameters only
  - Has value element



4. Create ControllerActionPair Class

Create a class called ControllerActionPair. It will be used as data traveler between different components.

It should have the **class, the method and the path variables** of the found **controller**:

- **Class controllerClass;**
- **Method method;**
- **Map<String, String> pathVariables;**

5. Create Dispatcher Servlet

You would need a **dispatcher servlet** that will take care of the incoming **requests**:

Dispatcher.java

```
public interface Dispatcher {

    ControllerActionPair dispatchRequest(HttpServletRequest request);

    String dispatchAction(HttpServletRequest request, ControllerActionPair
controllerActionPair);
}
```

DispatcherServlet.java

```
@WebServlet("/")
public class DispatcherServlet extends HttpServlet implements Dispatcher {

    private HandlerMapping handlerMapping;

    private HandlerAction handlerAction;

    public DispatcherServlet() {
       this.handlerMapping = new HandlerMappingImpl();
       this.handlerAction = new HandlerActionImpl();
    }


    @Override
    protected void doGet(HttpServletRequest req, HttpServletResponse resp) throws
ServletException, IOException {
        //TODO Handle the requests
    }

    @Override
    protected void doPost(HttpServletRequest req, HttpServletResponse resp) throws
ServletException, IOException {
        //TODO Handle the requests
    }

    @Override
    public ControllerActionPair dispatchRequest(HttpServletRequest request) {
        //TODO Send the request to the Handle Mapping
    }

    @Override
    public String dispatchAction(HttpServletRequest request, ControllerActionPair
controllerActionPair) {
        //TODO Send the ControllerActionPair to the Handle Action
    }

    private void handleRequest(HttpServletRequest request, HttpServletResponse response){
        //TODO Handle the request and return the controller view to the web client
    }
}
```

6. Create Handler Mapping

The Handler Mapping is responsible to find the **controller** listening to the incoming **request route**.

HandlerMapping.java

```
public interface HandlerMapping {

    ControllerActionPair findController(HttpServletRequest request) throws IOException,
ClassNotFoundException, InstantiationException, IllegalAccessException;
}
```

HandlerMappingImpl.java

```
public class HandlerMappingImpl implements HandlerMapping {

    @Override
    public ControllerActionPair findController(HttpServletRequest request) throws
IOException, ClassNotFoundException, InstantiationException, IllegalAccessException {
        String urlPath = request.getRequestURI();
        String projectPath = request.getServletContext().getRealPath("/WEB-INF/classes");
        //TODO Find all controllers
        for (Class controller : controllers) {
            Method[] methods = controller.getDeclaredMethods();
            for (Method method : methods) {
                //TODO Find method path
                if (methodPath == null) {
                    continue;
                }

                //TODO If paths are matching return a new ActionPairController with the
appropriate class, method and path variables
            }
        }

        return null;
    }

    private void addPathVariables(ControllerActionPair controllerActionPair, String
urlPath, String methodPath) {
        String[] uriTokens = urlPath.split("/");
        String[] methodTokens = methodPath.split("/");
        //TODO If there is path variable add it to the ControllerActionPair
    }


    private boolean isPathMatching(String urlPath, String methodPath) {
        boolean isPathMatching = true;
        String[] uriTokens = urlPath.split("/");
        String[] methodTokens = methodPath.split("/");
        //TODO If the lengths are different return false

        //TODO If there is a path variable {some id} ignore and continue to check if the
path is the same
    }

    private String findMethodPath(HttpServletRequest request, Method method) throws
IllegalAccessException, InstantiationException {
        //TODO Find the method path
    }

    private List<Class> findAllControllers(String projectDirectory) throws
ClassNotFoundException, IOException {
        List<Class> controllerClasses = new ArrayList<>();
        File directory = new File(projectDirectory);
        File[] files = directory.listFiles();
        for (File file : files) {
            if (file.isFile()) {
                //TODO Check if the class for that file is not null
```

```
                //TODO Check if the class has @Controller
            } else if (file.isDirectory()) {
                //TODO Recursively check all directories for classes
            }
        }

        return controllerClasses;
    }

    private Class getClass(File file) throws ClassNotFoundException {
        String absolutePath = file.getAbsolutePath();
        //TODO Find the correct regex
        Class currentClass = null;
        if (matcher.find()) {
            //TODO Replace / with .
            if (!className.endsWith("DispatcherServlet")) {
                currentClass = Class.forName(className);
            }
        }

        return currentClass;
    }
}
```

7. Create Handler Action

Handler Action will be responsible for the executing the controller action.

HandlerAction.java

```
public interface HandlerAction {

    String executeControllerAction(HttpServletRequest request, ControllerActionPair
controllerActionPair) throws InvocationTargetException, IllegalAccessException,
InstantiationException, NoSuchMethodException;
}
```

HandlerActionImpl.java

```
public class HandlerActionImpl implements HandlerAction {
    @Override
    public String executeControllerAction(HttpServletRequest request,
ControllerActionPair controllerActionPair) throws InvocationTargetException,
IllegalAccessException, InstantiationException, NoSuchMethodException {
        //TODO Get the controller and it respective method to execute
        for (Parameter parameter : parameters) {
            if(parameter.isAnnotationPresent(PathVariable.class)){
              //TODO Set the path variable value
            }

            if(parameter.isAnnotationPresent(RequestParam.class)){
              //TODO Set the request parameter value
            }

            if(parameter.getType().isAssignableFrom(Model.class)){
              //TODO Pass the model values to the view
            }

        }

        //TODO Finally, Invoke the method
    }
```

```
    private <T> T getPathVariableValue(Parameter parameter, PathVariable
pathVariableAnnotation, ControllerActionPair controllerActionPair) {
        //TODO Find path variable value
    }

    private <T> T getParameterValue(Parameter parameter, RequestParam
requestParamAnnotationClass, HttpServletRequest request) throws IllegalAccessException,
InstantiationException {
        //TODO Find request parameter value
    }

    private <T> T convertArgument(Parameter parameter, String pathVariable){
        Object object = null;
        //TODO Find the correct regex can receive different types of parameters
    }
}
```

Note: Make sure you put your controllers in the dependency container and NOT calling controller.newInstance(), because the dependency injection provided by CDI @Inject will not be functional.

HandlerActionImpl.java

```
public class HandlerActionImpl implements HandlerAction {
    @Override
    public String executeControllerAction(HttpServletRequest request,
ControllerActionPair controllerActionPair) throws InvocationTargetException,
IllegalAccessException, InstantiationException, NoSuchMethodException {

        //TODO Finally, Invoke the method
        Context context = new InitialContext();
        String str = controller.getSimpleName();
        Object conotrollerInstance = context.lookup("java:global/" + str);
    }
}
```

8. Create Model

The Model will carry key-value pairs of data that should be passed to the view

Model.java

```
public class Model {

    private HttpServletRequest request;

    private Map<String, Object> attributes;

    public Model(HttpServletRequest request) {
        //TODO Initialize fields    }

    public void addAttribute(String key, Object value){
        //TODO Add the parameters and then pass them to the view
    }

    public Map<String, Object> getAttributes() {
        return attributes;
    }
}
```

9. Test Your Framework

If you are done with the framework create a **new project** and add it as a **dependency**.

BeerController.java

```
@Controller
public class BeerController {

    @GetMapping("/beer")
    public String getBeer(){
        return "beer";
    }

    @GetMapping("/beer/{id}")
    public String getBeerId(@PathVariable("id") int id, Model model){
        System.out.println(id);
        model.addAttribute("id", id);
        return "beer";
    }

    @PostMapping("/beer")
    public String postBeerBrand(@RequestParam("brand") String brand){
        System.out.println(brand);
        return "redirect:/beer";
    }
}
```

beer.jsp

```
<%@ page contentType="text/html;charset=UTF-8" language="java" %>
<html>
  <head>
    <title>Beer</title>
  </head>
  <body>
  Beer Stuff:
  Id: ${id}
  <form method="post">
      <input type="text" placeholder="Enter a beer brand" name="brand">
      <input type="submit" value="Submit">
  </form>
  </body>
</html>
```