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Web Development: FrontController

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(Based on material from Atle Geitung, 2021)

Home

Agenda: Back to Web Development

- Backend Web Developement.
- More about MVC.
- More about the design pattern "FrontController".
- Command Design pattern.
- FrontController with FlowManager.
- Pure J2EE Servlets (later we'll take a look at Frameworks that build on J2EE).

Syllabus for this lecture

Web-tier Archecture (Chapters to - and including - 4.4.2.1.4 Example)

Link: http://fitxers.oriolrius.cat/1797/web-tier5.html

Demo: demo-01-several-controllers

- Smal demo applications keeping track of Inventory (Items).
- Maven project: pom.xml
- *Code: demo-01-several-controllers.zip (see course overview)*

Model: Item

```java
package no.hvl.dat152.model;

import java.io.Serializable;

public class Item implements Serializable {

   private static final long serialVersionUID = 1L;

   private String id;
   private String name;
   private Double price;
   private String description;

   public Item() {
   }

   public Item(final String id) {
         this.id = id;
   }

   public Item(final String id, final String name, final Double price, final S
      ...
   }
}
```

Repository: interface ItemDAO

```java
package no.hvl.dat152.repositories;

import java.util.List;
import no.hvl.dat152.model.Item;

public interface ItemDAO {

   default void init() {
      createItem(new Item("9991", "Item01", 1D, "Item01 Description"));
      createItem(new Item("9992", "Item02", 2D, "Item02 Description"));
      createItem(new Item("9993", "Item03", 3D, "Item03 Description"));
   }

   List< Item > findAllItems();
   Item findItem(String id);
   void createItem(Item item);
   void updateItem(String id, Item itemdata);
   String getNextId();
}
```

Repository: ItemDAOMemorySingleton

```java
package no.hvl.dat152.repositories;

import java.util.*;
import no.hvl.dat152.model.Item;

public final class ItemDAOMemorySingleton implements ItemDAO {

   private final List< Item > items = new ArrayList< >();
   private static final Integer FIRST_INDEX = 10000;
   private Integer nextId = FIRST_INDEX;

   // Singleton-things
   private static ItemDAOMemorySingleton instance;

   private ItemDAOMemorySingleton() {}

   public static synchronized ItemDAOMemorySingleton getInstance() {
      if (instance == null) {
         instance = new ItemDAOMemorySingleton();
         instance.init();
      }
      return instance;
   }
   ...
```

Repository: ItemDAOMemorySingleton

```java
    ...

    @Override
    public List< Item > findAllItems() {
        return items;
    }

    @Override
    public Item findItem(final String id) {
        final int index = items.indexOf(new Item(id));
        return index >= 0 ? items.get(index) : null;
    }

    @Override
    public synchronized void createItem(final Item item) {
        final int index = items.indexOf(item);
        if (index == -1) {
            items.add(item);
        }
    }

    ...
}
```

Repository: ItemDAOMemorySingleton

```java
    ...

    @Override
    public synchronized void updateItem(final String id, final Item itemdata) {
        final int index = items.indexOf(new Item(id));
        if (index >= 0) {
            items.get(index).setName(itemdata.getName());
            items.get(index).setPrice(itemdata.getPrice());
            items.get(index).setDescription(itemdata.getDescription());
        }
    }

    @Override
    public synchronized String getNextId() {
        nextId++;
        return nextId.toString();
    }
}
```

Mapping: src/main/webapp/WEB-INF/web.xml

```xml
< ?xml version="1.0" encoding="UTF-8"?>
< web-app>
< servlet>
   < servlet-name>ViewItemController< /servlet-name>
   < servlet-class>no.hvl.dat152.controller.ViewItemController< /servlet-class
< /servlet>
< servlet>
   < servlet-name>ViewShoppinglistController< /servlet-name>
   < servlet-class>no.hvl.dat152.controller.ViewShoppinglistController< /servl
< /servlet>
...
< servlet-mapping>
   < servlet-name>ViewItemController< /servlet-name>
   < url-pattern>/viewitem< /url-pattern>
< /servlet-mapping>
< servlet-mapping>
   < servlet-name>ViewShoppinglistController< /servlet-name>
   < url-pattern>/viewshoppinglist< /url-pattern>
< /servlet-mapping>
...
< /web-app>
```

Controller: ViewShoppinglistController

```java
package no.hvl.dat152.controller;
...
import no.hvl.dat152.model.Item;
import no.hvl.dat152.repositories.ItemDAOMemorySingleton;

public class ViewShoppinglistController extends HttpServlet {

   private static final long serialVersionUID = 1L;

   @Override
   protected final void doGet(final HttpServletRequest req,
                              final HttpServletResponse resp)
         throws ServletException, IOException {

      final List< Item > items =
            ItemDAOMemorySingleton.getInstance().findAllItems();
      req.getSession().setAttribute("items", items);
      req.getRequestDispatcher("shoppinglist.jsp").forward(req, resp);
   }
}
```

View: src/main/webapp/shoppinglist.jsp

```
<%@ page contentType="text/html"%>
<%@ taglib prefix="c" uri="http://java.sun.com/jsp/jstl/core"%>

<html>
<body>
  <%@include file="myHeader.html"%>
  <p><a href="createitem">Create item</a></p>

  <table border=1>
  <tr>
    <th>Id</th>
    <th>Name</th>
    <th>Price</th>
    <th>Description</th>
  </tr>
  <c:forEach var="item" items="${items}">
    <tr>
      <td>${item.id}</td>
      <td>${item.name}</td>
      <td>${item.price}</td>
      <td>${item.description}</td>
      <td><a href="viewitem?id=${item.id}">View item</a></td>
    </tr>
  </c:forEach>
  </table>

</body>
</html>
```

Demo: demo-01-several-controllers

Let's run the code.

MVC: Model 1 vs Model 2

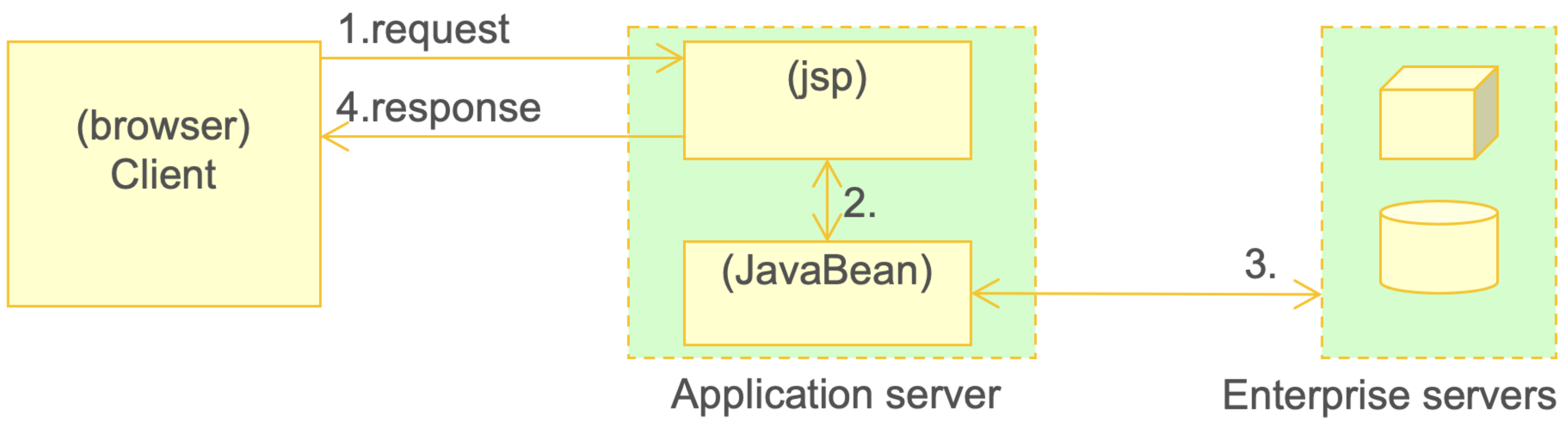
Model 1

- Decentralized and page-centric architecture
- No controller
- Map directly to the next JSP

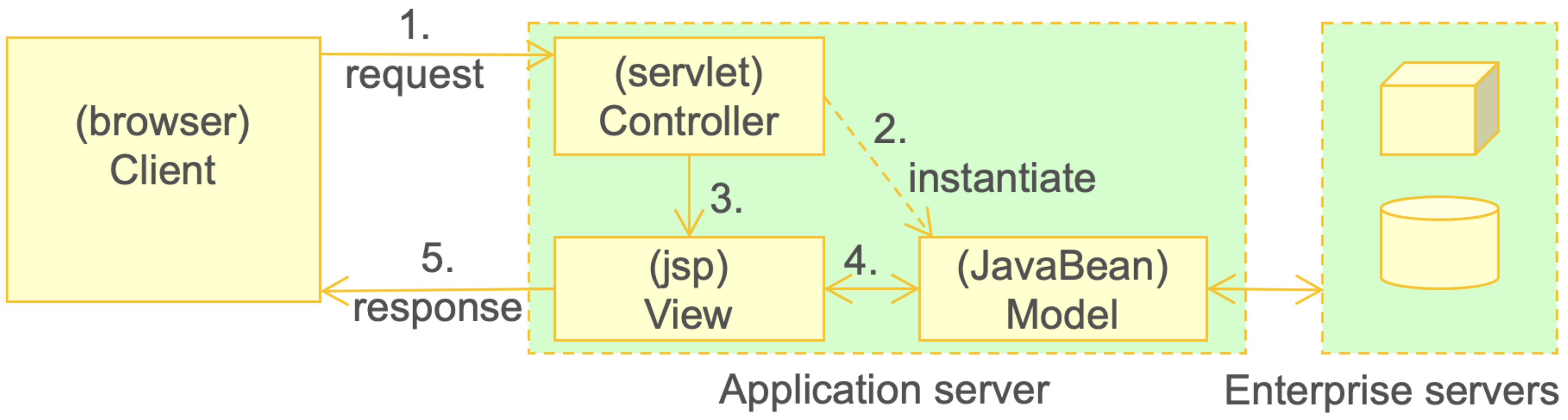
Model 2

- Centralized architecture
- Requests goes through Controller (Servlet)
- Controller determines next view (JSP)

Web MVC: Model 1



Web MVC: Model 2



Recap: How we have done web development so far

- Used MVC in a special way: One controller per application (or page)
- Used *web.xml* for static dispatching av requests.
- Our earlier architecture is most simular to Model 1: decentralized.
- A little similar to Model 2: used controller Servlets and made the MVC for each use case.

Issues with this method:

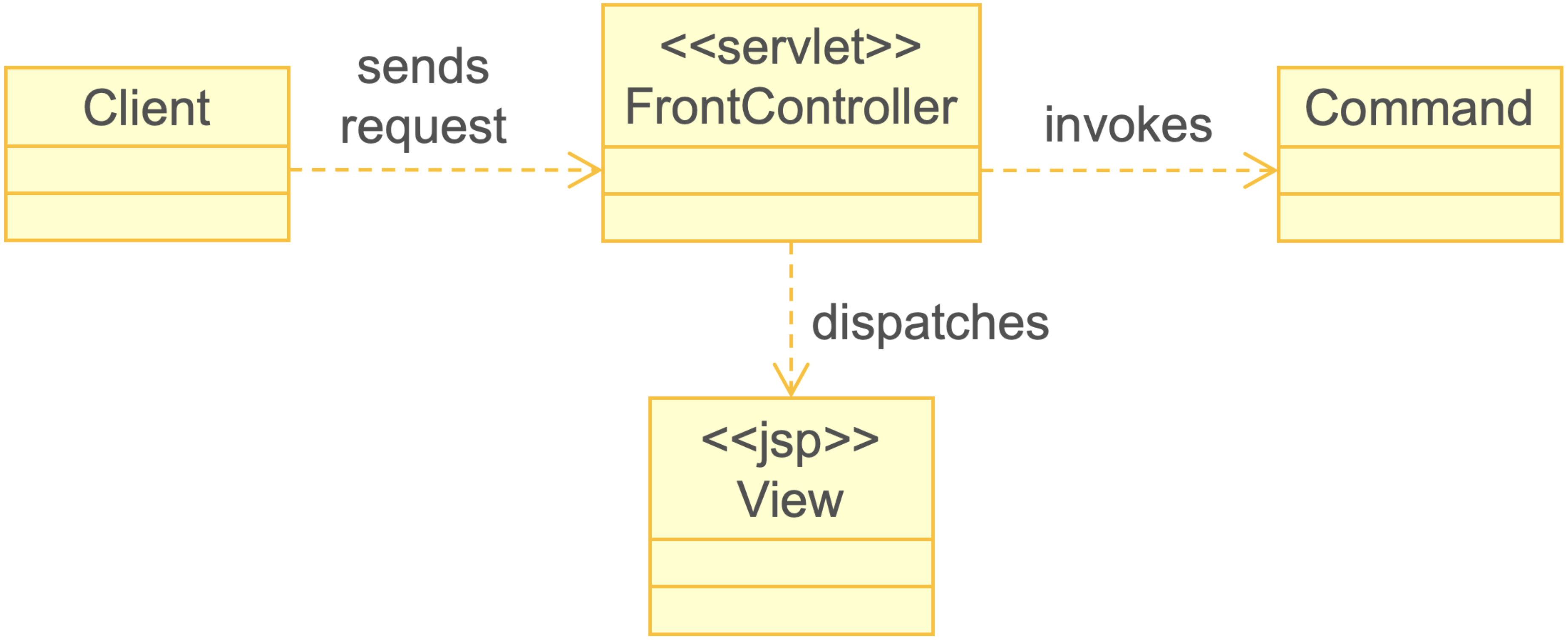
- Hard to find a good location for key tasks
  - General controller logic
  - Checking headers and cookies
  - Authentication and authorization
  - Logging
- End up writing a lot of code which is bundled to and dependant on the Servlet API.

Design Pattern: FrontController

- A design pattern dealing with centralization of processing of requests and selections of views in a single component (the frontcontroller).
- The application gets a single access point where all requests go through.
- The wanted command is provided either as part of the URL, or as parameters in the request.

  Examples:

  - http://mittdomene/minapp/front?cmd=visansatte
  - http://mittdomene/minapp/front/visansatte


Client
sends request
<<servlet>> FrontController
invokes
Command
dispatches
<<jsp>> View

Implementing the FrontController

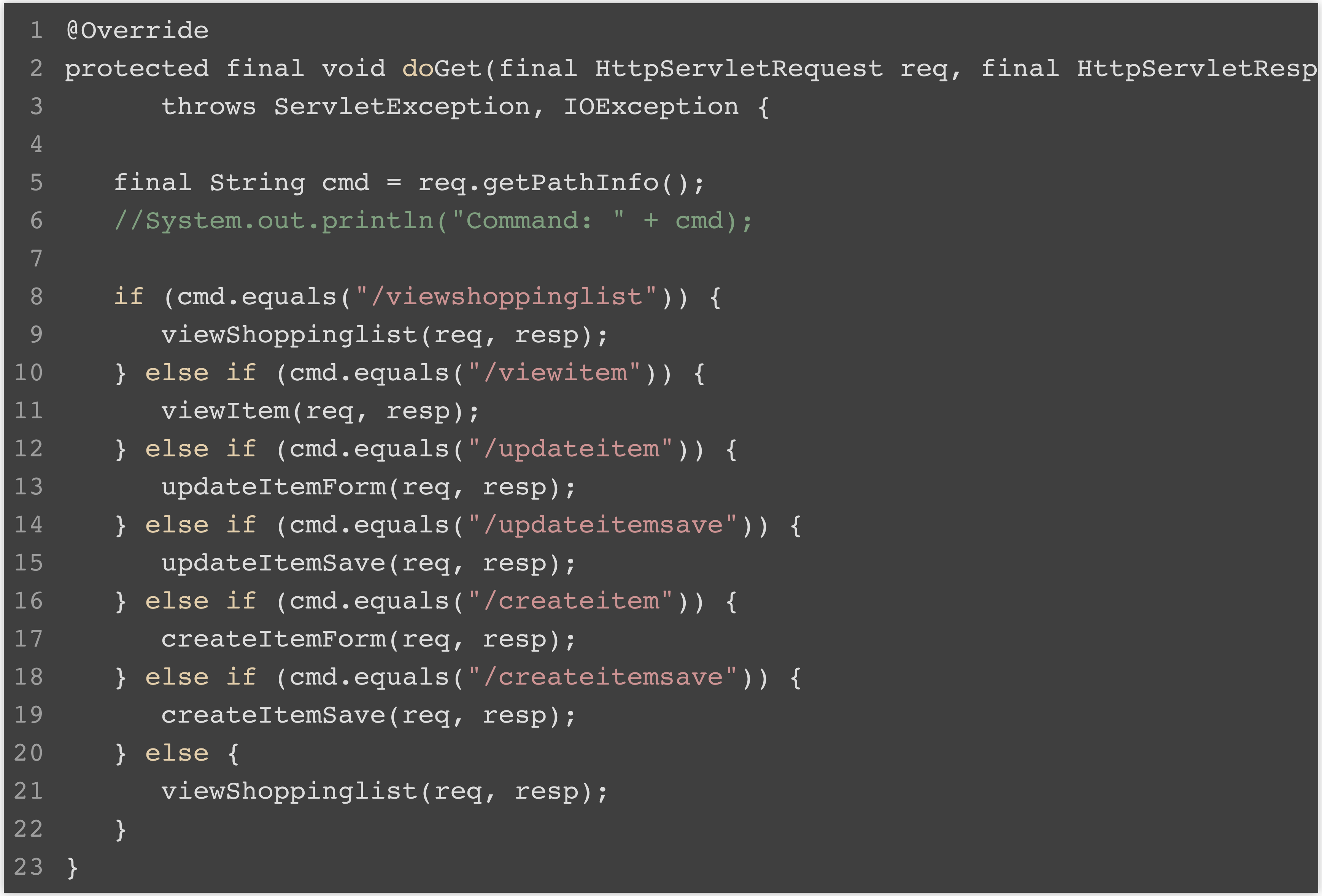
- The FrontController should be able to process many types of requests.
- First we'll look at a "simple" Front Controller
- It can, for example look like this:

```
if (cmd.equals ("/viewshoppinglist")) {
... Doing all the work here
} else if (cmd.equals("/viewitem")) {
... Doing all the work here
} else if ... etc. ...
```

Demo: demo-02-front-controller

- Same functionallity as "demo-01".
- One Controller: FrontController with if-then-else.
- *Code: demo-02-front-controller.zip (see course overview).*

```xml
<?xml version="1.0" encoding="UTF-8"?>
<web-app>
    <welcome-file-list>
        <welcome-file>index.jsp</welcome-file>
    </welcome-file-list>
    <servlet>
        <servlet-name>front-controller</servlet-name>
        <servlet-class>no.hvl.dat152.controller.FrontController</servlet-class>
    </servlet>
    <servlet-mapping>
        <servlet-name>front-controller</servlet-name>
        <url-pattern>/do/*</url-pattern>
    </servlet-mapping>
</web-app>
```



```java
@Override
protected final void doGet(final HttpServletRequest req, final HttpServletResp
        throws ServletException, IOException {

    final String cmd = req.getPathInfo();
    //System.out.println("Command: " + cmd);

    if (cmd.equals("/viewshoppinglist")) {
        viewShoppinglist(req, resp);
    } else if (cmd.equals("/viewitem")) {
        viewItem(req, resp);
    } else if (cmd.equals("/updateitem")) {
        updateItemForm(req, resp);
    } else if (cmd.equals("/updateitemsave")) {
        updateItemSave(req, resp);
    } else if (cmd.equals("/createitem")) {
        createItemForm(req, resp);
    } else if (cmd.equals("/createitemsave")) {
        createItemSave(req, resp);
    } else {
        viewShoppinglist(req, resp);
    }
}
```

```java
@Override
protected final void doPost(final HttpServletRequest req,
                            final HttpServletResponse resp)
      throws ServletException, IOException {
   doGet(req, resp);
}
```

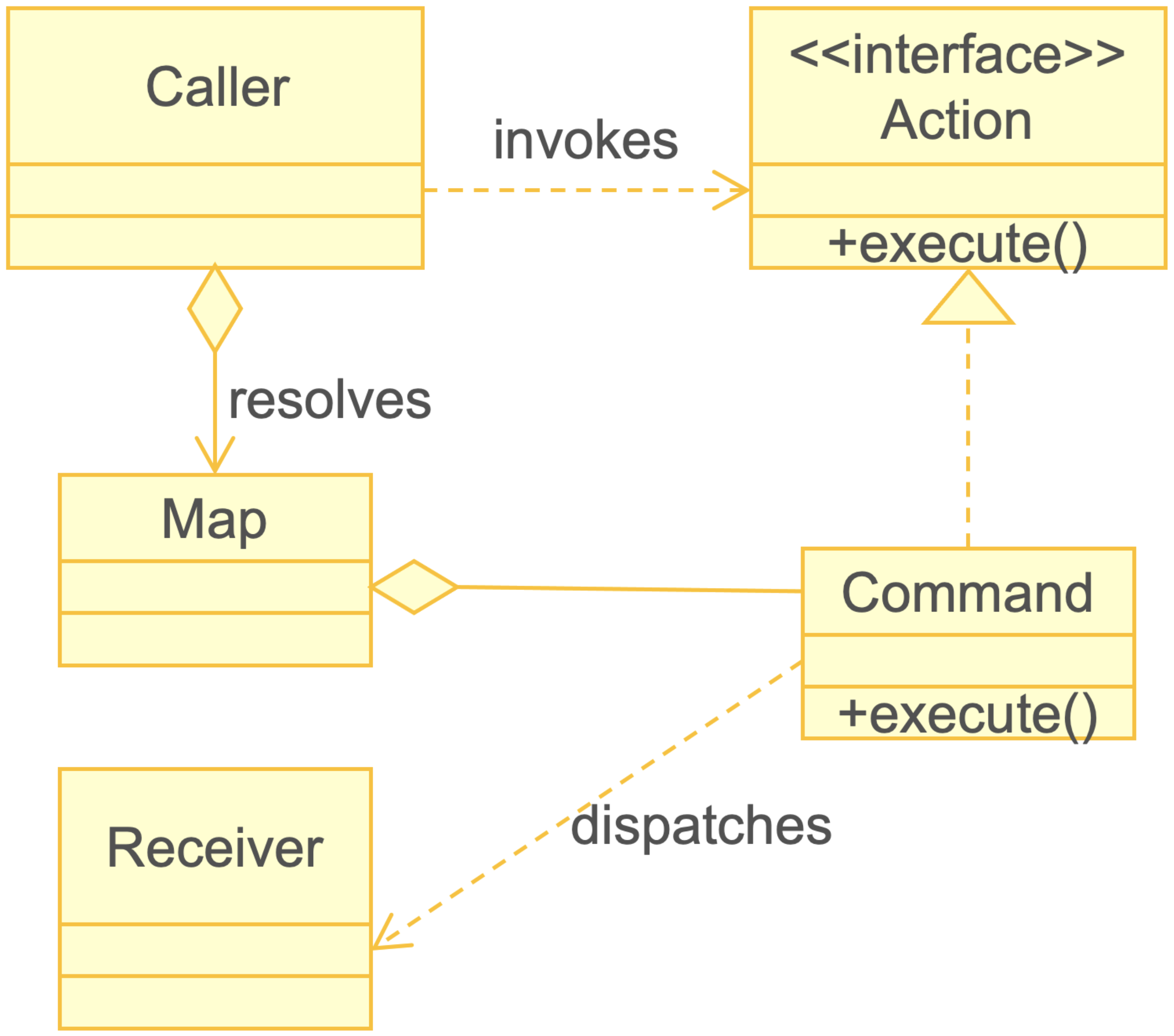
Demo: demo-02-front-controller

- *Let's have a look in Eclipse.*

Design Pattern: Command

- A better solution than if-elseif-else is to use a Command design pattern.
- **Purpose**:
  - Encapsulate a command (for instance "createItem") with associated data and business logic as an object ...
  - .. , and use **polymorphism** instead of if-elseif-else to perform the right command.
- Let us: **Decouple** objects that produce the commands from their consumers

Design Pattern: Command



Demo: demo-03-command-pattern

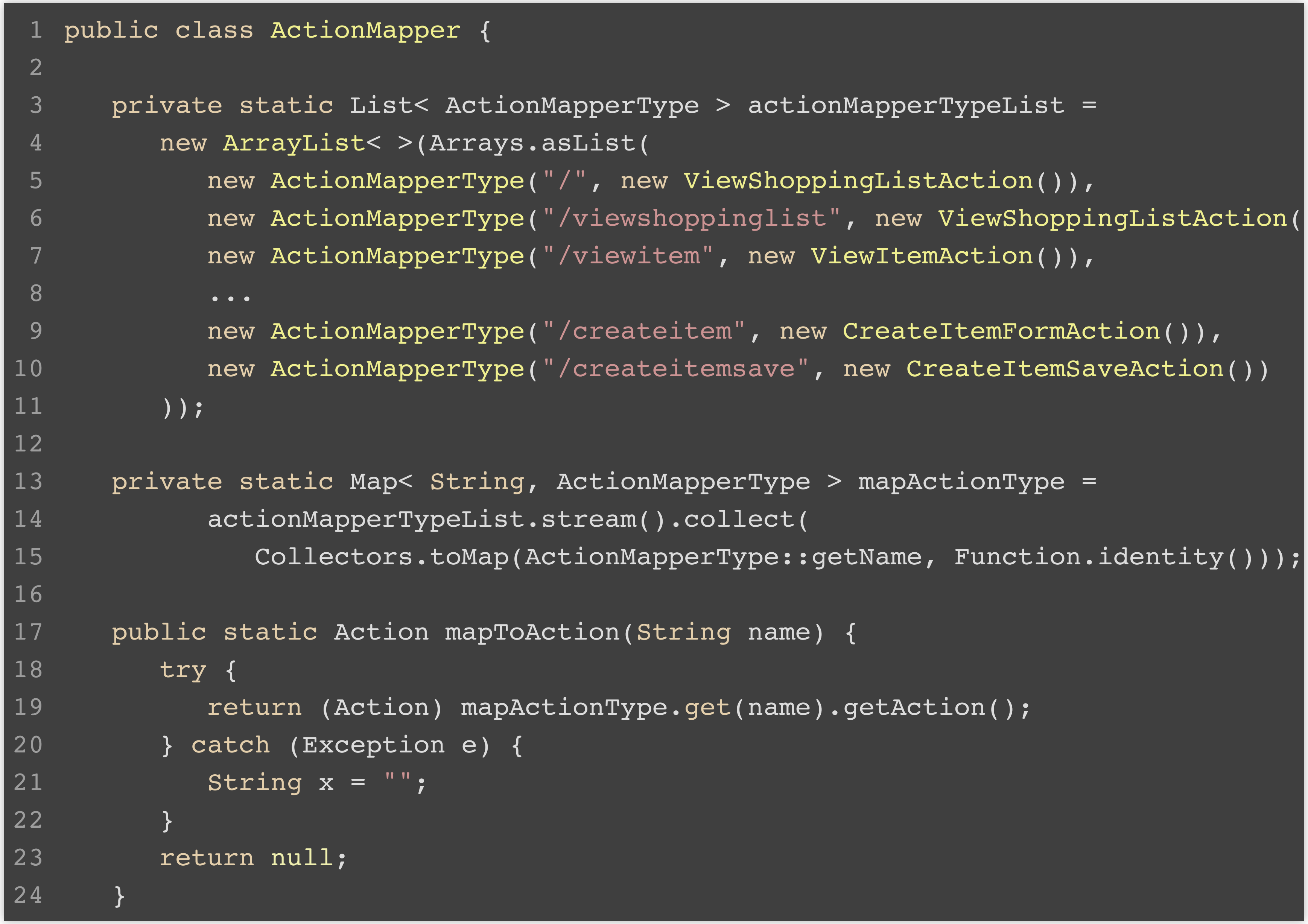
- Same functionallity as "demo-01".
- Applicaton Logic moved out of FrontController.
- *Code: demo-03-command-pattern.zip (see course overview).*

```java
public class FrontController extends HttpServlet {

   private static final long serialVersionUID = 1L;

   @Override
   protected final void doGet(final HttpServletRequest req,
                              final HttpServletResponse resp)
            throws ServletException, IOException {

      String cmd = req.getPathInfo();

      final Action action = ActionMapper.mapToAction(cmd);
      action.execute(req, resp);                // polymorphism happens
   }

   @Override
   protected final void doPost(final HttpServletRequest req, final HttpServlet
            throws ServletException, IOException {
      doGet(req, resp);
   }
}
```

```java
public interface Action {

   void execute(HttpServletRequest req, HttpServletResponse resp)
                                  throws ServletException, IOException;

}
```

```java
package no.hvl.dat152.action;

import java.io.IOException;
...

public class ViewShoppingListAction implements Action {

   @Override
   public final void execute(final HttpServletRequest req,
                             final HttpServletResponse resp)
         throws ServletException, IOException {

      final List< Item > items =
                  ItemDAOMemorySingleton.getInstance().findAllItems();
      req.getSession().setAttribute("items", items);

      req.getRequestDispatcher("/shoppinglist.jsp").forward(req, resp);
   }
}
```

```java
package no.hvl.dat152.action.mapper;

import no.hvl.dat152.action.Action;

public class ActionMapperType {
   private String name;
   private Action action;

   ActionMapperType(String name, Action action) {
      this.name=name;
      this.action=action;
   }

   public String getName() {
      return name;
   }

   public Action getAction() {
      return action;
   }
}
```



```java
public class ActionMapper {

   private static List< ActionMapperType > actionMapperTypeList =
      new ArrayList< >(Arrays.asList(
         new ActionMapperType("/", new ViewShoppingListAction()),
         new ActionMapperType("/viewshoppinglist", new ViewShoppingListAction(
         new ActionMapperType("/viewitem", new ViewItemAction()),
         ...
         new ActionMapperType("/createitem", new CreateItemFormAction()),
         new ActionMapperType("/createitemsave", new CreateItemSaveAction())
      ));

   private static Map< String, ActionMapperType > mapActionType =
         actionMapperTypeList.stream().collect(
            Collectors.toMap(ActionMapperType::getName, Function.identity()));

   public static Action mapToAction(String name) {
      try {
         return (Action) mapActionType.get(name).getAction();
      } catch (Exception e) {
         String x = "";
      }
      return null;
   }
```

Demo: demo-03-command-pattern

- *Let's have a look in Eclipse.*

Demo: demo-03-command-pattern

- So ... now we have centraliced the dispatching of commands.
- But the page flow is still decentralized

  (every action determines what the next page is).
- Next: How to use a FlowManager to keep track of the page flow.

Demo: demo-04-front-controller-flow

- Same functionallity as "demo-01".
- FlowManager: Centralized Page Flow
- *Code: demo-04-front-controller-flow.zip (see course overview).*

"ViewShoppingListAction" from last example

```java
public class ViewShoppingListAction implements Action {

   @Override
   public final void execute(final HttpServletRequest req,
                            final HttpServletResponse resp)
         throws ServletException, IOException {

      final List< Item > items = ItemDAOMemorySingleton.getInstance()
                                                          .findAllItems();
      req.getSession().setAttribute("items", items);

      req.getRequestDispatcher("/shoppinglist.jsp").forward(req, resp);
   }
}
```

Here we have removed the page flow

```java
public class ViewShoppingListAction implements Action {

   @Override
   public final int execute(final HttpServletRequest req,
                            final HttpServletResponse resp)
         throws ServletException, IOException {

      final List< Item > items = ItemDAOMemorySingleton.getInstance()
                                                       .findAllItems();
      req.getSession().setAttribute("items", items);

      return Action.SUCCESS;
   }
}
```

doGet(): from last FrontController

```java
@Override
protected final void doGet(final HttpServletRequest req,
                           final HttpServletResponse resp)
                        throws ServletException, IOException {

    String cmd = req.getPathInfo();

    final Action action = ActionMapper.mapToAction(cmd);
    action.execute(req, resp);
}
```

doGet(): New FrontController

```java
@Override
protected final void doGet(final HttpServletRequest req,
                           final HttpServletResponse resp)
                        throws ServletException, IOException {

   final String cmd = req.getPathInfo();
   final Action action = ActionMapper.mapToAction(cmd);

   final int result = action.execute(req, resp);

   if (result == Action.SUCCESS) {
      final String nextPage = flowManager.getNextPage(cmd);
      req.getRequestDispatcher(nextPage).forward(req, resp);
   } else {
      // ...
   }
}
```

```java
public class FlowManager {

   private final Map< String, String > pages;

   public FlowManager() {
      pages = new HashMap< >();
      pages.put("/", "../shoppinglist.jsp");
      pages.put("/viewshoppinglist", "../shoppinglist.jsp");
      pages.put("/viewitem", "../item.jsp");
      pages.put("/updateitem", "../updateitemform.jsp");
      pages.put("/updateitemsave", "../item.jsp");
      pages.put("/createitem", "../createitemform.jsp");
      pages.put("/createitemsave", "../shoppinglist.jsp");
   }

   public final String getNextPage(final String cmd) {
      return pages.get(cmd);
   }
}
```

Demo: demo-04-front-controller-flow

- *Let's have a look in Eclipse.*

Summary: Web Development: FrontController

Where are we now?

- Moved towards pure MVC - Model 2.
- FrontController Pattern: Centralized control and common logic.
- Command Pattern: Business logic in regular classes.
- FlowManager: Centralized controll of page flow.

Next

Web Development: Frameworks

Home