Spring Boot + Microservices2402

White Board Link:
https://excalidraw.com/#json=WmZ53zgMkD2LAOLGjldPJ,VJTKryP0_IJ49Pc0kMdQHQ

Spring Data JPA : Working on Advance stuffs

Spring Data JPA offers multiple ways to write custom methods in your JPA repositories.

1. Derived Queries (Method Naming Conventions)

   This is the most convenient approach for simple queries.
   Spring Data JPA automatically translates method names into JPA queries based on conventions:

```
 findBy<FieldName>: Find by a specific field (e.g., findByEma

findBy<FieldName1>And<FieldName2>: Find by multiple fields wit

countBy<FieldName>: Count entities by a specific field.

existsBy<FieldName>: Check if an entity exists by a field.
```

2. Query methods

   For more complex queries that don't fit the naming conventions, use the @Query annotation on your repository method.

   You can directly write the JPQL or native SQL query within the annotation:

```
@Query("SELECT c FROM Customer c WHERE c.name = :name AND c.act
  List<Customer> findByNameAndActive(@Param("name") String nam

  native queries:


  @Query(value = "SELECT * FROM customers WHERE name = ?1 AND 
  List<Customer> findByNameAndActiveNative(String name, boolea
```

3. Custom Implementation with Own Logic

   For highly customized logic or complex criteria, you can define separate class and us Entity manager to write custom logic.

```
@Component
    public class CustomerRepositoryImpl {

    @PersistenceContext
    private EntityManager em;

   @Override
    public List<Customer> findCustomersByCriteria(String name, S
    CriteriaBuilder cb = em.getCriteriaBuilder();
    CriteriaQuery<Customer> cq = cb.createQuery(Customer.class);
    Root<Customer> root = cq.from(Customer.class);
    Predicate namePredicate = cb.like(root.get("name"), "%" + na
    Predicate cityPredicate = cb.equal(root.get("city"), city);
    cq.where(cb.and(namePredicate, cityPredicate));
    return em.createQuery(cq).getResultList();
   }
   }
```

Example 1:

Here's how to write a custom JPQL query in a Spring Data JPA repository to join `Product` and `Category` entities and retrieve products along with their categories:

Here's how to write a custom JPQL query in a Spring Data JPA repository to join `Product` and `Category` entities and retrieve products along with their categories:

```
@Entity
public class Product {

  @Id
  private Long id;

  private String name;
  private String description;

  @ManyToMany(mappedBy = "products")
  private Set<Category> categories;

  // Getters, setters, and other methods
}

@Entity
public class Category {

  @Id
  private Long id;

  private String name;
  private String description;

  @ManyToMany(cascade = CascadeType.ALL)
  @JoinTable(name = "product_category",
      joinColumns = @JoinColumn(name = "category_id", referenced
      inverseJoinColumns = @JoinColumn(name = "product_id", refe
  private Set<Product> products;

  // Getters, setters, and other methods
}
```

Create the Repository Interface:

Extend `JpaRepository<Product, Long>` for the `ProductRepository`. Here, we'll define a custom method using the `@Query` annotation:

```
public interface ProductRepository extends JpaRepository<Product

  @Query("SELECT p FROM Product p JOIN FETCH p.categories c WHER
    Product findProductWithCategories(Long productId);
}
```

`JOIN FETCH p.categories c`: Joins the `Category` entity with `p` through the `categories` collection, using `FETCH` to eagerly load the categories along with the product.

Example2:

Here's an example of a JPQL join query in a Spring Data JPA repository that retrieves custom data from joined entities:

Entity Classes:

Let's assume we have entities `Order` and `Customer`, with a One-to-Many relationship (a customer can have multiple orders). We want to retrieve a custom object containing order details and customer name:

```
@Entity
public class Order {

    @Id
    private Long id;

    private String productName;
    private double price;

    @ManyToOne
    private Customer customer;

    // Getters, setters, and other methods
}

@Entity
public class Customer {

    @Id
    private Long id;
```

```
  private String name;
  private String email;

  @OneToMany(mappedBy = "customer")
  private List<Order> orders;

  // Getters, setters, and other methods
}
```

Custom DTO Class:

```
public class OrderDetailsWithCustomerName {
private Long orderId;
private String productName;
private double price;
private String customerName;

// Getters and setters
}
```

Repository Interface:

Extend `JpaRepository<Order, Long>` for the `OrderRepository`. Define a custom method using `@Query` and a constructor expression to create the DTO object:

```
public interface OrderRepository extends JpaRepository<Order, Lo
  @Query("SELECT NEW com.yourpackage.OrderDetailsWithCustomerNam
         "FROM Order o JOIN o.customer c WHERE o.id = :orderId")
  OrderDetailsWithCustomerName findOrderDetailsWithCustomerName(
}
```

SELECT NEW com.yourpackage.OrderDetailsWithCustomerName(...): Uses a constructor expression to create a new instance of OrderDetailsWithCustomerName during the query execution.

JPQL/HQL

JPQL query in a Spring Data JPA repository to join `Product` and `Category` entities and retrieve products along with their categories:

Here's a breakdown of key JPQL features:

1. Basic Structure:

A JPQL query typically consists of the following clauses:

- **SELECT clause:** Specifies the data to be retrieved (e.g., select all fields, specific columns).
- **FROM clause:** Defines the root entity you're querying from.
- **WHERE clause (optional):** Filters the results based on conditions involving entity properties and comparison operators.
- **JOIN clause (optional):** Enables joining multiple entities based on relationships.
- **ORDER BY clause (optional):** Sorts the results based on specified criteria.

2. Selecting Data:

- You can select entire entities or specific properties:
    - `SELECT p FROM Product p`: Selects all `Product` entities.
    - `SELECT p.name, p.price FROM Product p`: Selects only name and price properties from `Product` entities.

3. Filtering with WHERE Clause:

- Use comparison operators and entity properties to create conditions:
    - `SELECT p FROM Product p WHERE p.id = 10`: Finds products with ID 10.
    - `SELECT c FROM Customer c WHERE c.name LIKE '%John%'`: Finds customers with names containing "John".

4. Joining Entities:

- JPQL supports various join types (INNER JOIN, LEFT JOIN, etc.) to retrieve data from related entities:
    - `SELECT o FROM Order o JOIN o.customer c`: Joins `Order` and `Customer` entities based on the one-to-many relationship.

5. Sorting Results:

- Use the `ORDER BY` clause with entity properties and optional ascending/descending order:
    - `SELECT p FROM Product p ORDER BY p.price DESC`: Sorts products by price in descending order.

Join Examples:

1. Inner Join (Fetching All Related Entities):

This query retrieves all `Order` entities and eagerly fetches their associated `Customer`:

```
SELECT o FROM Order o JOIN FETCH o.customer c
```

2. Left Join (Including Orders Without Customers):

```
SELECT o FROM Order o LEFT JOIN o.customer c
```

3. Join with Conditions:

This query finds `Order` entities where the product name contains "Laptop" and joins with the `Customer`:

```
SELECT o FROM Order o JOIN o.customer c WHERE o.productName LIKE '%
```

Criteria API

The Criteria API in JPA offers a programmatic way to construct database queries.

provides a type-safe and flexible alternative to JPQL (Java Persistence Query Language).

1. Building Blocks:

The Criteria API provides several key components for building queries:

- **CriteriaBuilder:** This object helps you construct the criteria query itself. You can obtain it from the `EntityManager`.
- **CriteriaQuery:** This represents the overall query you're building, specifying the selection clause, root entity, and optional filtering criteria.

- **Root:** This defines the starting point of the query, typically the entity you're querying for.
- **Criteria:** These represent restrictions on the results, such as predicates and conjunctions.
- **Predicate:** This defines a condition that must be true for a result to be included.

2. Constructing a Criteria Query:

Here's a basic structure for building a Criteria query to find all `Product` entities:

```
EntityManager em = ...; // Get the entity manager
CriteriaBuilder cb = em.getCriteriaBuilder();
CriteriaQuery<Product> cq = cb.createQuery(Product.class);

Root<Product> root = cq.from(Product.class); // Set the root entity

// Select all fields (optional)
cq.select(root);

// Build and execute the query
List<Product> products = em.createQuery(cq).getResultList();
```

3. Adding Filtering Criteria (Predicates):

You can use various criteria builders like `cb.equal`, `cb.like`, and `cb.gt` to create predicates based on different comparison operators. Here's an example to find products with a price greater than 100:

```
Predicate priceGreaterThan100 = cb.gt(root.get("price"), 100.0);
cq.where(priceGreaterThan100);
```

4. Combining Predicates:

You can combine multiple predicates using `and` and `or` methods from the `CriteriaBuilder`:

```
Predicate nameStartsWithA = cb.like(root.get("name"), "A%");
Predicate priceLessThan50 = cb.lt(root.get("price"), 50.0);
```

```
cq.where(cb.and(nameStartsWithA, priceLessThan50));
```

5. Sorting:

The Criteria API allows sorting results using the `orderBy` method on the `CriteriaQuery`:

```
cq.orderBy(cb.asc(root.get("price"))); // Sort by price in ascendin
```

6. Advantages of Criteria API:

- **Type Safety:** Eliminates syntax errors common with JPQL strings.
- **Flexibility:** Allows for complex query construction with various criteria.
- **Integration with Metamodel API:** Provides compile-time type checking for field names (optional).

When to Use Criteria API:

Consider using the Criteria API when:

- You need complex queries with dynamic filtering criteria.
- You want type safety and compile-time validation.

Transaction Management in JPA

1. Understanding Transactions:

- A transaction is a unit of work that ensures data consistency in your database.
- All database operations within a transaction are treated as a whole.
- If any operation fails, the entire transaction is rolled back, reverting all changes.

2. Using `@Transactional` Annotation:

The `@Transactional` annotation is applied at the method or class level in your service or repository classes. It tells Spring to manage the transaction automatically.

```
@Service
public class ProductService {

  @Autowired
  private ProductRepository productRepository;

  @Transactional
  public Product saveProduct(Product product) {
    Product savedProduct = productRepository.save(product);
    // Other logic that modifies data (e.g., updating stock)
    return savedProduct;
  }
}
```

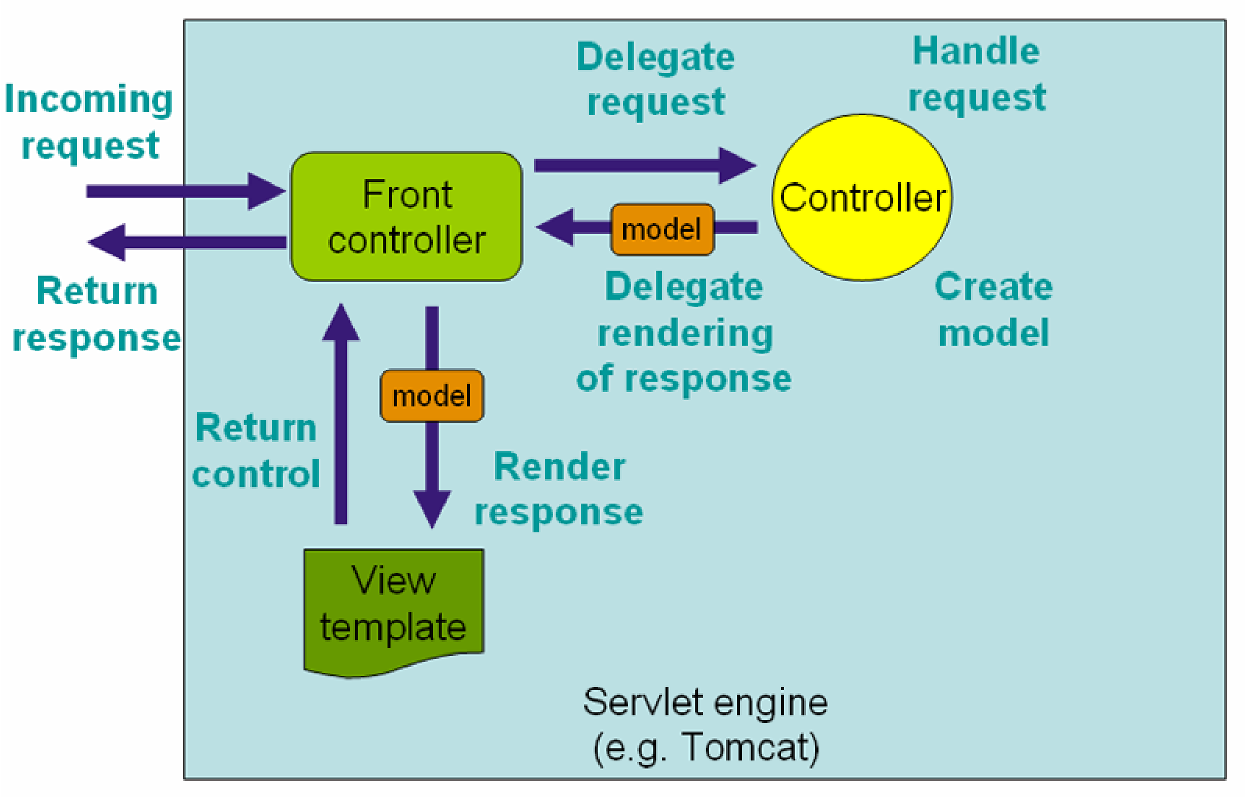
Spring MVC

The MVC Design Pattern

- **MVC** is a design pattern that divides an application into three interconnected components:
  - **Model**: Represents the data and the business logic of the application. It interacts with the database and other data sources.
  - **View**: Represents the presentation layer. It's responsible for displaying the data provided by the model to the user.
  - **Controller**: Acts as an intermediary between the Model and the View. It handles user input, processes it, and updates the Model.

Role of `DispatcherServlet` in Spring MVC

The `DispatcherServlet` is a crucial component in the Spring MVC framework, acting as the front controller in the MVC architecture. It is responsible for handling all incoming HTTP requests and dispatching them to the appropriate components within the Spring MVC framework.



Step-by-Step Guide to Creating a Spring MVC Project with Manual Configuration

This guide will walk you through setting up a Spring MVC project from scratch using manual configurations (without Spring Boot). We'll start by setting up the project, configuring the necessary components, and creating a simple request handling mechanism.

1. Setting Up the Project

a. Create a Maven Project:

1. Open your IDE (like IntelliJ IDEA, Eclipse, or STS) and create a new Maven project.
2. Set the Group ID (e.g., `com.example`) and Artifact ID (e.g., `SpringMVCDemo`).
3. Choose the Maven project template if prompted.

b. Update the `pom.xml` File:

Add the necessary dependencies for Spring MVC:

```
xmlCopy code
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/maven-v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

    <groupId>com.example</groupId>
    <artifactId>SpringMVCDemo</artifactId>
    <version>1.0-SNAPSHOT</version>

    <dependencies>
        <!-- Spring MVC -->
        <dependency>
            <groupId>org.springframework</groupId>
            <artifactId>spring-webmvc</artifactId>
            <version>5.3.13</version>
        </dependency>

        <!-- Servlet API -->
        <dependency>
            <groupId>javax.servlet</groupId>
            <artifactId>javax.servlet-api</artifactId>
            <version>4.0.1</version>
            <scope>provided</scope>
        </dependency>

        <!-- JSP support -->
        <dependency>
            <groupId>javax.servlet.jsp</groupId>
            <artifactId>javax.servlet.jsp-api</artifactId>
            <version>2.3.3</version>
            <scope>provided</scope>
        </dependency>
    </dependencies>
    <build>
        <plugins>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-war-plugin</artifactId>
                <version>3.2.3</version>
                <configuration>
                    <failOnMissingWebXml>false</failOnMissingWebXml>
                </configuration>
            </plugin>
        </plugins>
    </build>
</project>
```

- **Explanation:**
    - We include `spring-webmvc` for Spring MVC.
    - The `javax.servlet-api` and `javax.servlet.jsp-api` dependencies are added to support servlets and JSPs, respectively.

c. Directory Structure:

Ensure your project directory structure looks like this:

```
bashCopy code
src/
├── main/
│   ├── java/
│   │   └── com/example/SpringMVCDemo/
│   │       └── config/
│   │       └── controller/
│   ├── resources/
│   └── webapp/
│       ├── WEB-INF/
│       │   └── web.xml
│       │   └── views/
│       │       └── hello.jsp
└── test/
```

2. Configure `web.xml`

`web.xml` is the deployment descriptor for your application. Here we configure the `DispatcherServlet`.

```
xmlCopy code
<web-app xmlns="http://xmlns.jcp.org/xml/ns/javaee"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/javaee
             http://xmlns.jcp.org/xml/ns/javaee/web-app_3_1.xsd"
         version="3.1">

    <display-name>SpringMVCDemo</display-name>

    <!-- DispatcherServlet Configuration -->
    <servlet>
        <servlet-name>dispatcher</servlet-name>
        <servlet-class>org.springframework.web.servlet.Dispatcher
Servlet</servlet-class>
        <init-param>
            <param-name>contextConfigLocation</param-name>
            <param-value>/WEB-INF/spring-servlet.xml</param-value
>
        </init-param>
        <load-on-startup>1</load-on-startup>
    </servlet>

    <servlet-mapping>
        <servlet-name>dispatcher</servlet-name>
        <url-pattern>/</url-pattern>
    </servlet-mapping>

    <!-- Character Encoding Filter -->
    <filter>
```

```
        <filter-name>encodingFilter</filter-name>
        <filter-class>org.springframework.web.filter.CharacterEnc
odingFilter</filter-class>
        <init-param>
            <param-name>encoding</param-name>
            <param-value>UTF-8</param-value>
        </init-param>
        <init-param>
            <param-name>forceEncoding</param-name>
            <param-value>true</param-value>
        </init-param>
    </filter>

    <filter-mapping>
        <filter-name>encodingFilter</filter-name>
        <url-pattern>/*</url-pattern>
    </filter-mapping>
</web-app>
```

- **Explanation:**
    - The `DispatcherServlet` is configured with the name `dispatcher`.
    - The `contextConfigLocation` parameter points to the `spring-servlet.xml` file for Spring configuration.
    - The URL pattern `/` maps all requests to the `DispatcherServlet`.
    - A `CharacterEncodingFilter` is added to ensure UTF-8 encoding for all requests and responses.

3. Create Spring Configuration File: `spring-servlet.xml`

This file configures Spring MVC components such as view resolvers and component scanning.

```
xmlCopy code
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:context="http://www.springframework.org/schema/conte
```

```
xt"
       xmlns:mvc="http://www.springframework.org/schema/mvc"
       xsi:schemaLocation="
           http://www.springframework.org/schema/beans
           http://www.springframework.org/schema/beans/spring-bea
ns.xsd
           http://www.springframework.org/schema/context
           http://www.springframework.org/schema/context/spring-c
ontext.xsd
           http://www.springframework.org/schema/mvc
           http://www.springframework.org/schema/mvc/spring-mvc.x
sd">

    <!-- Enable annotation-driven configuration -->
    <mvc:annotation-driven/>

    <!-- Scan for components (controllers, services, etc.) -->
    <context:component-scan base-package="com.example.SpringMVCDe
mo"/>

    <!-- View Resolver to map view names to JSP files in the WEB-
INF/views directory -->
    <bean class="org.springframework.web.servlet.view.InternalRes
ourceViewResolver">
        <property name="prefix" value="/WEB-INF/views/"/>
        <property name="suffix" value=".jsp"/>
    </bean>

</beans>
```

- **Explanation:**
  - `mvc:annotation-driven` enables Spring MVC annotations such as `@Controller` and `@RequestMapping`.
  - `context:component-scan` tells Spring to scan the specified package for components (like controllers).

    - `InternalResourceViewResolver` maps view names returned by controllers to JSP files in the `WEB-INF/views` directory.

4. Create a Simple Controller

Create a controller to handle requests and return a view.

a. Create the Controller Class:

```
javaCopy code
package com.example.SpringMVCDemo.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestParam;

@Controller
public class HelloController {

    @GetMapping("/hello")
    public String sayHello(@RequestParam(name="name", required=fa
lse, defaultValue="World") String name, Model model) {
        model.addAttribute("name", name);
        return "hello"; // Logical view name
    }
}
```

- **Explanation:**
    - The `HelloController` class is annotated with `@Controller`, making it a Spring MVC controller.
    - The `@GetMapping("/hello")` annotation maps HTTP GET requests to `/hello` to this method.
    - The method takes a `name` parameter from the request and adds it to the model, which is passed to the view.
    - It returns `"hello"`, which is the logical name of the view.

b. Create the View (JSP):

Create a JSP file `hello.jsp` under `src/main/webapp/WEB-INF/views/`.

```
jspCopy code
<%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="c" %>
<!DOCTYPE html>
<html>
<head>
    <title>Hello Page</title>
</head>
<body>
    <h1>Hello, ${name}!</h1>
</body>
</html>
```

- **Explanation:**
    - This JSP file displays a simple message using the `name` attribute passed from the controller.

5. Deploy and Run the Application

Step-by-Step Guide to Creating a Spring MVC Project with Java Configuration

This guide will walk you through setting up a Spring MVC project from scratch using Java-based configuration, without any XML configuration.

1. Setting Up the Project

a. Create a Maven Project:

1. Open your IDE (like IntelliJ IDEA, Eclipse, or STS) and create a new Maven project.
2. Set the Group ID (e.g., `com.example`) and Artifact ID (e.g., `SpringMVCJavaConfigDemo`).

3. Choose the Maven project template if prompted.

b. Update the `pom.xml` File:

Add the necessary dependencies for Spring MVC:

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 ht
tp://maven.apache.org/maven-v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>

    <groupId>com.example</groupId>
    <artifactId>SpringMVCJavaConfigDemo</artifactId>
    <version>1.0-SNAPSHOT</version>

    <dependencies>
        <!-- Spring MVC -->
        <dependency>
            <groupId>org.springframework</groupId>
            <artifactId>spring-webmvc</artifactId>
            <version>5.3.13</version>
        </dependency>

        <!-- Servlet API -->
        <dependency>
            <groupId>javax.servlet</groupId>
            <artifactId>javax.servlet-api</artifactId>
            <version>4.0.1</version>
            <scope>provided</scope>
        </dependency>

        <!-- JSP support -->
        <dependency>
            <groupId>javax.servlet.jsp</groupId>
            <artifactId>javax.servlet.jsp-api</artifactId>
            <version>2.3.3</version>
            <scope>provided</scope>
        </dependency>
    </dependencies>

    <build>
        <plugins>
            <plugin>
                <groupId>org.apache.maven.plugins</groupId>
                <artifactId>maven-war-plugin</artifactId>
                <version>3.2.3</version>
                <configuration>
                    <failOnMissingWebXml>false</failOnMissingWebX
ml>
                </configuration>
            </plugin>
        </plugins>
    </build>
</project>
```

- **Explanation:**
  - We include `spring-webmvc` for Spring MVC.
  - The `javax.servlet-api` and `javax.servlet.jsp-api` dependencies are added to support servlets and JSPs, respectively.

c. Directory Structure:

Ensure your project directory structure looks like this:

```
bashCopy code
src/
├── main/
│   ├── java/
│   │   └── com/example/SpringMVCJavaConfigDemo/
│   │       └── config/
│   │       └── controller/
│   ├── resources/
│   └── webapp/
│       ├── WEB-INF/
```

```
|       |    └── views/
|       |        └── hello.jsp
└── test/
```

2. Java-Based Configuration

a. Create the `WebInitializer` Class:

This class will replace the `web.xml` and configure the `DispatcherServlet`.

```
javaCopy code
package com.example.SpringMVCJavaConfigDemo.config;

import org.springframework.web.servlet.support.AbstractAnnotationConfigDispatcherServletInitializer;

public class WebInitializer extends AbstractAnnotationConfigDispatcherServletInitializer {

    @Override
    protected Class<?>[] getRootConfigClasses() {
        return null; // No root configuration in this case
    }

    @Override
    protected Class<?>[] getServletConfigClasses() {
        return new Class[] { WebConfig.class };
    }

    @Override
    protected String[] getServletMappings() {
        return new String[] { "/" };
    }
}
```

- **Explanation:**

- `WebInitializer` extends `AbstractAnnotationConfigDispatcherServletInitializer`, which helps register the `DispatcherServlet`.
- `getRootConfigClasses()` is for root application context (e.g., services, repositories), which we don't use here.
- `getServletConfigClasses()` returns the configuration class (`WebConfig`), which will contain our Spring MVC configuration.
- `getServletMappings()` maps the `DispatcherServlet` to the root URL (`/`).

b. Create the `WebConfig` Class:

This class will replace `spring-servlet.xml` and configure Spring MVC.

```
javaCopy code
package com.example.SpringMVCJavaConfigDemo.config;

import org.springframework.context.annotation.ComponentScan;
import org.springframework.context.annotation.Configuration;
import org.springframework.web.servlet.config.annotation.EnableWe
bMvc;
import org.springframework.web.servlet.config.annotation.ViewReso
lverRegistry;
import org.springframework.web.servlet.config.annotation.WebMvcCo
nfigurer;

@Configuration
@EnableWebMvc
@ComponentScan(basePackages = "com.example.SpringMVCJavaConfigDem
o")
public class WebConfig implements WebMvcConfigurer {

    @Override
    public void configureViewResolvers(ViewResolverRegistry regis
try) {
        registry.jsp("/WEB-INF/views/", ".jsp");
    }
}
```

- **Explanation:**
    - `@Configuration` indicates that this class is a configuration class.
    - `@EnableWebMvc` enables Spring MVC features like `@Controller` annotations.
    - `@ComponentScan` scans the specified base package for Spring components (controllers, etc.).
    - `WebMvcConfigurer` provides callback methods to customize the default configuration.
    - `configureViewResolvers` configures the view resolver to map view names to JSP files in the `WEB-INF/views` directory.

3. Create a Simple Controller

Create a controller to handle requests and return a view.

a. Create the Controller Class:

```
javaCopy code
package com.example.SpringMVCJavaConfigDemo.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestParam;

@Controller
public class HelloController {

    @GetMapping("/hello")
    public String sayHello(@RequestParam(name="name", required=fa
lse, defaultValue="World") String name, Model model) {
        model.addAttribute("name", name);
        return "hello"; // Logical view name
    }
}
```

- **Explanation:**

  - The `HelloController` class is annotated with `@Controller`, making it a Spring MVC controller.
  - The `@GetMapping("/hello")` annotation maps HTTP GET requests to `/hello` to this method.
  - The method takes a `name` parameter from the request and adds it to the model, which is passed to the view.
  - It returns `"hello"`, which is the logical name of the view.

b. Create the View (JSP):

Create a JSP file `hello.jsp` under `src/main/webapp/WEB-INF/views/`.

```
jspCopy code
<%@ taglib uri="http://java.sun.com/jsp/jstl/core" prefix="c" %>
<!DOCTYPE html>
<html>
<head>
    <title>Hello Page</title>
</head>
<body>
    <h1>Hello, ${name}!</h1>
</body>
</html>
```

- **Explanation:**
  - This JSP file displays a simple message using the `name` attribute passed from the controller.

4. Deploy and Run the Application

a. Build the Project:

- Use Maven to build the project by running `mvn clean install`.

b. Deploy the WAR file:

- Deploy the generated WAR file (`SpringMVCJavaConfigDemo.war`) to a servlet container like Apache Tomcat.

c. Access the Application:

- Start your servlet container and navigate to `http://localhost:8080/SpringMVCJavaConfigDemo/hello?name=YourName` in your browser.
- You should see a message like "Hello, YourName!" displayed on the page.

How Spring Boot Configure Spring MVC Automatically

Spring Boot automates the process of setting up a Spring MVC application by providing a set of conventions and auto-configurations that eliminate the need for most of the manual configurations. Here's how Spring Boot simplifies and automates the setup process:

1. No `web.xml` Required

- **Spring Boot Auto-Configuration**: Spring Boot automatically sets up the `DispatcherServlet` and maps it to the root URL (`/`) without requiring a `web.xml` file or a `WebInitializer` class.
- **Embedded Server**: Spring Boot includes an embedded servlet container (like Tomcat, Jetty, or Undertow), so you don't need to deploy the application to an external server. You can run your application as a simple Java application.

2. No XML Configuration Files

- **Java-Based Configuration by Default**: Spring Boot uses Java-based configuration by default. The `@SpringBootApplication` annotation is a convenience annotation that combines `@Configuration`, `@EnableAutoConfiguration`, and `@ComponentScan`.

```
javaCopy code
@SpringBootApplication
public class SpringBootMvcApplication {
    public static void main(String[] args) {
        SpringApplication.run(SpringBootMvcApplication.class,
args);
    }
}
```

  - `@EnableAutoConfiguration`: This annotation tells Spring Boot to automatically configure your application based on the dependencies you have added. For example, if `spring-webmvc` is on the classpath, Spring Boot automatically configures Spring MVC.
  - `@ComponentScan`: This annotation enables component scanning, which automatically detects and registers beans, including `@Controller` classes.

3. Auto-Configuration of Spring MVC Components

- **DispatcherServlet**: Spring Boot automatically registers a `DispatcherServlet` with the default URL mapping (`/`).
- **View Resolvers**: If you have JSPs, Thymeleaf, or other view templates in your project, Spring Boot automatically configures the necessary view resolvers.
- **Static Resources**: Spring Boot automatically serves static resources like HTML, CSS, and JavaScript from the `/static`, `/public`, `/resources`, or `/META-INF/resources` directories without additional configuration.

4. Embedded Server and Simplified Deployment

- **Run as a Standalone Application**: Spring Boot packages your application as an executable JAR with an embedded server, allowing you to run it directly with `java -jar`.

```
bashCopy code
java -jar target/myapp.jar
```

- **No External Server Setup**: There's no need to set up an external server like Tomcat. Spring Boot handles that internally, making the deployment process much simpler.

5. Simplified Dependency Management

- **Starters**: Spring Boot provides "starter" dependencies that aggregate commonly used libraries, reducing the need to manually manage dependencies. For example, adding `spring-boot-starter-web` brings in all dependencies needed for a Spring MVC web application, including Spring MVC itself, an embedded Tomcat server, and Jackson for JSON processing.

```
xmlCopy code
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>
```

6. Integrated Development Features

- **Spring Boot DevTools**: Provides additional features to enhance the development experience, such as automatic restart, live reload, and configuration for faster development.

```
xmlCopy code
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
    <scope>runtime</scope>
</dependency>
```

7. Automatic Configuration of Common Use Cases

- **Error Handling**: Spring Boot provides default error pages and JSON error responses for REST APIs.
- **Embedded Database Support**: If you include an embedded database dependency like H2, Spring Boot will automatically configure it.
- **Security**: If `spring-boot-starter-security` is added, Spring Boot configures basic authentication by default.

8. Production-Ready Features

- **Monitoring and Management**: Spring Boot provides production-ready features out of the box, such as health checks, metrics, and application monitoring via the `spring-boot-starter-actuator`.

- **Configuration Management**: Spring Boot supports various ways to configure your application, such as via `application.properties` or `application.yml` files, environment variables, and command-line arguments.

Example of a Simple Spring Boot MVC Application

1. Create a Spring Boot Project:

You can use Spring Initializr (https://start.spring.io) to generate a Spring Boot project with the necessary dependencies:

- **Dependencies**: `Spring Web` (which includes Spring MVC).

2. The Main Application Class:

```
javaCopy code
package com.example;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplicati
on;

@SpringBootApplication
public class SpringBootMvcApplication {
    public static void main(String[] args) {
        SpringApplication.run(SpringBootMvcApplication.class, arg
s);
    }
}
```

3. A Simple Controller:

```
javaCopy code
package com.example.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestParam;

@Controller
public class HelloController {

    @GetMapping("/hello")
    public String sayHello(@RequestParam(name="name", required=fa
lse, defaultValue="World") String name, Model model) {
        model.addAttribute("name", name);
        return "hello";
    }
}
```

4. Create the View (JSP or Thymeleaf):

- **JSP**: `src/main/webapp/WEB-INF/jsp/hello.jsp`

  ```
  jspCopy code
  <html>
  <body>
      <h1>Hello, ${name}!</h1>
  </body>
  </html>
  ```

5. Run the Application:

Simply run the `SpringBootMvcApplication` class as a Java application. The application will start on `http://localhost:8080`, and you can access the hello endpoint at `http://localhost:8080/hello?name=YourName`.

---

1. `@Controller`

- **Purpose**:

  - The `@Controller` annotation is used to define a controller in Spring MVC. It is a specialization of the `@Component` annotation and indicates that the class serves the role of a controller in the MVC pattern.
  - The controller processes incoming web requests, prepares a model, and returns a view.
- **Example**:

```
javaCopy code
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;

@Controller
public class MyController {

    @GetMapping("/welcome")
    public String welcome(Model model) {
        model.addAttribute("message", "Welcome to Spring MV
C!");
        return "welcome"; // This refers to a view named "welc
ome"
    }
}
```

  - Here, `MyController` is a Spring MVC controller, and the `welcome` method handles GET requests to `/welcome`.

2. `@RequestMapping`

- **Purpose**:
  - The `@RequestMapping` annotation is used to map web requests to specific handler methods in a controller class.
  - It can be applied at both the class and method levels to specify the URL patterns and HTTP methods.
- **Example**:

```
javaCopy code
import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;

@Controller
@RequestMapping("/api")
public class ApiController {

    @RequestMapping(value = "/greet", method = RequestMethod.G
ET)
    public String greet() {
        return "greeting"; // This refers to a view named "gre
eting"
    }
}
```

  - `@RequestMapping("/api")` at the class level defines a base URL for all methods in the class.
  - `@RequestMapping(value = "/greet", method = RequestMethod.GET)` maps GET requests to `/api/greet`.

3. `@GetMapping`, `@PostMapping`, `@PutMapping`, `@DeleteMapping`

- **Purpose**:
  - These are specialized variants of `@RequestMapping` for specific HTTP methods: GET, POST, PUT, DELETE. They simplify the declaration of request mappings.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RestController;

@RestController
```

```
@RequestMapping("/users")
public class UserController {

    @GetMapping("/{id}")
    public String getUser(@PathVariable("id") Long id) {
        return "Fetching user with ID: " + id;
    }

    @PostMapping
    public String createUser() {
        return "Creating a new user";
    }
}
```

  - `@GetMapping("/{id}")` maps GET requests to `/users/{id}`.
  - `@PostMapping` maps POST requests to `/users`.

4. `@PathVariable`

- **Purpose**:
  - `@PathVariable` is used to extract values from the URI. It binds a method parameter to a URI template variable.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RestController;

@RestController
@RequestMapping("/orders")
public class OrderController {

    @GetMapping("/{orderId}")
    public String getOrder(@PathVariable("orderId") String ord
erId) {
        return "Order ID: " + orderId;
    }
}
```

  - In this example, `@PathVariable("orderId")` binds the `orderId` parameter to the value of `{orderId}` in the URI.

5. `@RequestParam`

- **Purpose**:
  - `@RequestParam` is used to bind a method parameter to a query parameter in the request.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

@RestController
@RequestMapping("/search")
public class SearchController {

    @GetMapping
    public String search(@RequestParam("q") String query) {
        return "Searching for: " + query;
    }
}
```

  - Here, `@RequestParam("q")` binds the query parameter `q` to the `query` method parameter.
  - If you access `/search?q=Spring`, the method will return `Searching for: Spring`.

6. `@RequestBody`

- **Purpose**:

- `@RequestBody` is used to bind the HTTP request body to a method parameter. It is typically used in POST, PUT, or DELETE methods.

- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RestController;

@RestController
@RequestMapping("/products")
public class ProductController {

    @PostMapping
    public String addProduct(@RequestBody Product product) {
        return "Product added: " + product.getName();
    }
}
```

  - In this example, the JSON body of a POST request is bound to the `Product` object using `@RequestBody`.

7. `@ResponseBody`

- **Purpose**:
  - `@ResponseBody` is used to indicate that the return value of a method should be bound to the web response body. It is commonly used in RESTful web services.

- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ResponseBody;
import org.springframework.web.bind.annotation.RestController;

@RestController
```

```
@RequestMapping("/status")
public class StatusController {

    @GetMapping
    @ResponseBody
    public String status() {
        return "Application is running";
    }
}
```

  - `@ResponseBody` indicates that the method's return value will be written directly to the HTTP response body as plain text or JSON.

8. `@RestController`

- **Purpose**:
  - `@RestController` is a convenience annotation that combines `@Controller` and `@ResponseBody`. It is used for building RESTful web services.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RestController;

@RestController
@RequestMapping("/api")
public class ApiRestController {

    @GetMapping("/hello")
    public String sayHello() {
        return "Hello from REST API";
    }
}
```

    - With `@RestController`, there's no need to annotate each method with `@ResponseBody`; it's implied for all methods in the class.

9. `@RequestHeader`

- **Purpose**:
    - `@RequestHeader` is used to bind a method parameter to a request header value.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestHeader;
import org.springframework.web.bind.annotation.RestController;

@RestController
@RequestMapping("/headers")
public class HeaderController {

    @GetMapping
    public String getHeader(@RequestHeader("User-Agent") Strin
g userAgent) {
        return "User-Agent: " + userAgent;
    }
}
```

    - In this example, `@RequestHeader("User-Agent")` binds the `User-Agent` header value to the `userAgent` method parameter.

10. `@ModelAttribute`

- **Purpose**:
    - `@ModelAttribute` is used to bind a method parameter or method return value to a named model attribute and then expose it to a web view.
- **Example**:

```
javaCopy code
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PostMapping;

@Controller
@RequestMapping("/user")
public class UserController {

    @GetMapping("/form")
    public String userForm(Model model) {
        model.addAttribute("user", new User());
        return "userForm";
    }

    @PostMapping("/save")
    public String saveUser(@ModelAttribute User user) {
        // Save user to database
        return "redirect:/user/success";
    }
}
```

  - In this example, `@ModelAttribute` binds the form data to a `User` object and adds it to the model.

11. `@SessionAttributes`

- **Purpose**:
  - `@SessionAttributes` is used to store model attributes in the session. This is typically used to maintain the state of form-backing objects across multiple requests.
- **Example**:

```
javaCopy code
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.SessionAttribut
es;

@Controller
@RequestMapping("/checkout")
@SessionAttributes("cart")
public class CheckoutController {

    @ModelAttribute("cart")
    public Cart setupCart() {
        return new Cart();
    }

    @RequestMapping("/review")
    public String reviewCart(@ModelAttribute("cart") Cart car
t, Model model) {
        // Process cart
        return "reviewCart";
    }
}
```

  - `@SessionAttributes("cart")` indicates that the `cart` attribute should be stored in the session and remain available across multiple requests.

12. `@ExceptionHandler`

- **Purpose**:
  - `@ExceptionHandler` is used to define a method that handles exceptions thrown by request-handling methods in the same controller or across the application if used in a `@ControllerAdvice`.
- **Example**:

```
javaCopy code
import org.springframework.web.bind.annotation.ControllerAdvic
e;
import org.springframework.web.bind.annotation.ExceptionHandle
r;
import org.springframework.web.bind.annotation.ResponseStatus;
import org.springframework.http.HttpStatus;

@ControllerAdvice
public class GlobalExceptionHandler {

    @ExceptionHandler(ResourceNotFoundException.class)
    @ResponseStatus(HttpStatus.NOT_FOUND)
    public String handleResourceNotFoundException() {
        return "error/404";
    }
}
```

- In this example, if a `ResourceNotFoundException` is thrown, the method returns a view called `error/404` and sets the HTTP status to `404`.

Data Binding and Validation

For validation add `validation` dependency .

Data binding is the process of binding the incoming JSON (or other formats) data from HTTP requests to Java objects. This is typically done using the `@RequestBody` annotation.

Model Class with Jakarta Validation Annotations

Here's how to define a model class using `jakarta.validation` annotations:

```
package com.example.demo.model;

import jakarta.validation.constraints.Email;
import jakarta.validation.constraints.NotEmpty;
import jakarta.validation.constraints.Size;

public class User {

    @NotEmpty(message = "Name is required")
    @Size(min = 2, max = 30, message = "Name must be between 2 and 30 characters")
    private String name;

    @NotEmpty(message = "Email is required")
    @Email(message = "Email should be valid")
    private String email;

    @NotEmpty(message = "Password is required")
    @Size(min = 8, message = "Password must be at least 8 characters")
    private String password;

    // Getters and Setters
    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getEmail() {
        return email;
    }

    public void setEmail(String email) {
        this.email = email;
    }

    public String getPassword() {
        return password;
    }

    public void setPassword(String password) {
        this.password = password;
    }
}
```

- **Explanation**:
    - The model class `User` uses annotations from `jakarta.validation.constraints` for data validation.
    - The fields are validated to ensure that they meet specific constraints, such as not being empty, having a valid email format, and adhering to specific size limits.

Controller Class with Validation

Here's how to create a controller that uses Jakarta Validation to validate incoming data:

```
javaCopy code
package com.example.demo.controller;

import com.example.demo.model.User;
import jakarta.validation.Valid;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.validation.BindingResult;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RestController;

import java.util.HashMap;
import java.util.Map;

@RestController
public class UserController {
    @PostMapping("/users")
    public ResponseEntity<Object> createUser(@Valid @RequestBody User user, BindingResult result) {
        if (result.hasErrors()) {
            Map<String, String> errors = new HashMap<>();
            result.getFieldErrors().forEach(error -> errors.put(error.getField(), error.getDefaultMessage()));
            return new ResponseEntity<>(errors, HttpStatus.BAD_REQUEST);
        }

        // Logic to save the user to the database

        return new ResponseEntity<>("User created successfully", HttpStatus.OK);
    }
}
```

- **Explanation**:
    - `@Valid` is from `jakarta.validation` and is used to trigger validation on the `User` object.
    - `@RequestBody` binds the incoming JSON data to the `User` object.
    - If validation fails, the errors are captured and returned as a `BAD_REQUEST` response.

Global Exception Handling with Jakarta Validation

Create a global exception handler that will handle validation errors and other exceptions using Jakarta Validation:

```
javaCopy code
package com.example.demo.exception;

import jakarta.validation.ConstraintViolationException;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.validation.FieldError;
import org.springframework.web.bind.MethodArgumentNotValidException;
import org.springframework.web.bind.annotation.ControllerAdvice;
import org.springframework.web.bind.annotation.ExceptionHandler;
import org.springframework.web.bind.annotation.ResponseStatus;

import java.util.HashMap;
import java.util.Map;

@ControllerAdvice
public class GlobalExceptionHandler {

    @ExceptionHandler(MethodArgumentNotValidException.class)
    @ResponseStatus(HttpStatus.BAD_REQUEST)
    public ResponseEntity<Map<String, String>> handleValidationExceptions(MethodArgumentNotValidException ex) {
        Map<String, String> errors = new HashMap<>();
        ex.getBindingResult().getAllErrors().forEach((error) -> {
            String fieldName = ((FieldError) error).getField();
            String errorMessage = error.getDefaultMessage();
            errors.put(fieldName, errorMessage);
        });
        return new ResponseEntity<>(errors, HttpStatus.BAD_REQUEST);
    }

    @ExceptionHandler(ConstraintViolationException.class)
    @ResponseStatus(HttpStatus.BAD_REQUEST)
    public ResponseEntity<Map<String, String>> handleConstraintViolationExceptions(ConstraintViolationException ex) {
        Map<String, String> errors = new HashMap<>();
        ex.getConstraintViolations().forEach(violation -> {
            String fieldName = violation.getPropertyPath().toString();
            String errorMessage = violation.getMessage();
            errors.put(fieldName, errorMessage);
        });
        return new ResponseEntity<>(errors, HttpStatus.BAD_REQUEST);
    }

    // Additional exception handlers can be added here for other exception types
}
```

- **Explanation**:
    - The global exception handler now uses `MethodArgumentNotValidException` to handle validation errors when using `@Valid`.
    - `ConstraintViolationException` handles cases where individual constraint violations are caught (such as when validating a single field).

Custom Validator with Jakarta Validation

Here's how to create and use a custom validator with Jakarta Validation:

a. Define the Custom Annotation

```
javaCopy code
package com.example.demo.validation;

import jakarta.validation.Constraint;
import jakarta.validation.Payload;

import java.lang.annotation.ElementType;
import java.lang.annotation.Retention;
import java.lang.annotation.RetentionPolicy;
import java.lang.annotation.Target;

@Target({ ElementType.FIELD })
@Retention(RetentionPolicy.RUNTIME)
@Constraint(validatedBy = PasswordValidator.class)
public @interface ValidPassword {
    String message() default "Password must contain at least one uppercase letter, one lowercase letter, and one digit";

    Class<?>[] groups() default {};

    Class<? extends Payload>[] payload() default {};
}
```

b. Create the Validator Implementation

```
package com.example.demo.validation;

import jakarta.validation.ConstraintValidator;
import jakarta.validation.ConstraintValidatorContext;

public class PasswordValidator implements ConstraintValidator<ValidPassword, String> {

    @Override
    public boolean isValid(String value, ConstraintValidatorContext context) {
        if (value == null) {
            return false;
        }
        return value.matches("^(?=.*[a-z])(?=.*[A-Z])(?=.*\\d).+$");
    }
}
```

```
package com.example.demo.validation;

import jakarta.validation.ConstraintValidator;
import jakarta.validation.ConstraintValidatorContext;
```

```
public class PasswordValidator implements ConstraintValidator<Valid

    private String message;

    @Override
    public void initialize(ValidPassword constraintAnnotation) {
        // Access the message from the annotation
        this.message = constraintAnnotation.message();
    }

    @Override
    public boolean isValid(String value, ConstraintValidatorContext
        if (value == null || !value.matches("^(?=.*[a-z])(?=.*[A-Z]
            // Customize the error message in the validation contex
            context.disableDefaultConstraintViolation();
            context.buildConstraintViolationWithTemplate(message)
                   .addConstraintViolation();
            return false;
        }
        return true;
    }
}
```

c. Apply the Custom Validator

```
javaCopy code
package com.example.demo.model;

import com.example.demo.validation.ValidPassword;
import jakarta.validation.constraints.Email;
import jakarta.validation.constraints.NotEmpty;
import jakarta.validation.constraints.Size;

public class User {

    @NotEmpty(message = "Name is required")
    @Size(min = 2, max = 30, message = "Name must be between 2 and 30 characters")
    private String name;

    @NotEmpty(message = "Email is required")
    @Email(message = "Email should be valid")
    private String email;

    @ValidPassword
    private String password;

    // Getters and Setters
    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public String getEmail() {
        return email;
    }

    public void setEmail(String email) {
        this.email = email;
    }

    public String getPassword() {
        return password;
    }

    public void setPassword(String password) {
        this.password = password;
    }
}
```

How to create custom image validator.

Define the Custom Annotation

First, we'll create a custom annotation named `ValidImage`:

```
javaCopy code
package com.example.demo.validation;

import jakarta.validation.Constraint;
import jakarta.validation.Payload;

    import java.lang.annotation.ElementType;
import java.lang.annotation.Retention;
import java.lang.annotation.RetentionPolicy;
import java.lang.annotation.Target;

@Target({ ElementType.FIELD, ElementType.PARAMETER })
@Retention(RetentionPolicy.RUNTIME)
@Constraint(validatedBy = ImageValidator.class)
public @interface ValidImage {

    String message() default "Invalid image file";

    Class<?>[] groups() default {};

    Class<? extends Payload>[] payload() default {};
}
```

- **Explanation**:
  - `@Target({ ElementType.FIELD, ElementType.PARAMETER })`: This annotation can be applied to fields or method parameters.
  - `@Retention(RetentionPolicy.RUNTIME)`: The annotation will be available at runtime.
  - `@Constraint(validatedBy = ImageValidator.class)`: Specifies that the validation logic is implemented in the `ImageValidator` class.
  - `message`: The default error message that will be returned if validation fails.

2. Implement the `ConstraintValidator`

Next, we implement the `ConstraintValidator` to define the logic for validating an image file.

```
javaCopy code
package com.example.demo.validation;

import jakarta.validation.ConstraintValidator;
import jakarta.validation.ConstraintValidatorContext;
import org.springframework.web.multipart.MultipartFile;

import java.util.Arrays;
import java.util.List;

public class ImageValidator implements ConstraintValidator<ValidImage, MultipartFile> {

    private static final List<String> ALLOWED_CONTENT_TYPES = Arrays.asList("image/jpeg", "image/png", "image/gif");

    @Override
    public boolean isValid(MultipartFile value, ConstraintValidatorContext context) {
        if (value == null || value.isEmpty()) {
            return true; // Consider null or empty file as valid. Handle required validation separately.
        }

        // Check if the file's content type is in the list of allowed image content types
        return ALLOWED_CONTENT_TYPES.contains(value.getContentType());
    }
}
```

- **Explanation**:

  - The `ImageValidator` implements `ConstraintValidator<ValidImage, MultipartFile>`, where `MultipartFile` is the type of the file being validated.
  - `ALLOWED_CONTENT_TYPES` contains the MIME types that are considered valid images (`image/jpeg`, `image/png`, `image/gif`).
  - The `isValid` method checks whether the uploaded file's content type matches one of the allowed types.

3. Apply the Custom Annotation to a Model Class

Now, you can use the `@ValidImage` annotation in your model class to validate image uploads.

```
javaCopy code
package com.example.demo.model;

import com.example.demo.validation.ValidImage;
import org.springframework.web.multipart.MultipartFile;

public class ImageUploadRequest {

    @ValidImage(message = "Please upload a valid image file (JPEG, PNG, GIF)")
    private MultipartFile image;

    // Getters and Setters
    public MultipartFile getImage() {
        return image;
    }

    public void setImage(MultipartFile image) {
        this.image = image;
    }
}
```

- **Explanation**:

  - `@ValidImage` is applied to the `MultipartFile` field to validate that the uploaded file is a valid image.
  - The `message` attribute allows customization of the error message.

4. Create a Controller to Handle Image Uploads

Here's an example of a controller that handles image uploads and uses the `ImageUploadRequest` model:

```
javaCopy code
package com.example.demo.controller;

import com.example.demo.model.ImageUploadRequest;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.validation.BindingResult;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RestController;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.multipart.MultipartFile;

import jakarta.validation.Valid;
import java.util.HashMap;
import java.util.Map;

@RestController
public class ImageUploadController {

    @PostMapping("/uploadImage")
    public ResponseEntity<Object> uploadImage(@Valid @ModelAttrib
ute ImageUploadRequest request, BindingResult result) {
        if (result.hasErrors()) {
            Map<String, String> errors = new HashMap<>();
            result.getFieldErrors().forEach(error -> errors.put(e
rror.getField(), error.getDefaultMessage()));
            return new ResponseEntity<>(errors, HttpStatus.BAD_RE
QUEST);
```

```
        }

        // Process the valid image file (e.g., save to disk or database)
        MultipartFile image = request.getImage();

        return new ResponseEntity<>("Image uploaded successfully", HttpStatus.OK);
    }
}
```

Interceptors in Spring MVC

Interceptors in Spring MVC are used to perform operations before and after the execution of a controller action. They can be used for various cross-cutting concerns like logging, authentication, and request processing. Interceptors in Spring MVC are similar to filters in the servlet specification but are more powerful and flexible.

1. What is a Spring MVC Interceptor?

A Spring MVC Interceptor is a component that allows you to intercept HTTP requests before they reach the controller and/or after the controller has processed them but before the response is sent to the client. Interceptors can also intercept the execution of view rendering.

Interceptors in Spring MVC are typically implemented by creating a class that implements the `HandlerInterceptor` interface.

2. Key Methods in `HandlerInterceptor`

The `HandlerInterceptor` interface has three key methods:

1. **`preHandle(HttpServletRequest request, HttpServletResponse response, Object handler)`**:
    - Called before the actual controller method is invoked.
    - Returns `true` to continue the execution chain, or `false` to stop it.
2. **`postHandle(HttpServletRequest request, HttpServletResponse response, Object handler, ModelAndView modelAndView)`**:

    - Called after the controller method has been invoked but before the view is rendered.
    - Allows modification of the `ModelAndView` object or adding additional data to the model.
3. `afterCompletion(HttpServletRequest request, HttpServletResponse response, Object handler, Exception ex)`:
    - Called after the view has been rendered and the request is complete.
    - Useful for resource cleanup or logging after request processing is finished.

3. Creating an Interceptor

Let's create a simple logging interceptor that logs request details before and after a controller is executed.

a. Implement the Interceptor

```
javaCopy code
package com.example.demo.interceptor;

import jakarta.servlet.http.HttpServletRequest;
import jakarta.servlet.http.HttpServletResponse;
import org.springframework.web.servlet.HandlerInterceptor;
import org.springframework.web.servlet.ModelAndView;

public class LoggingInterceptor implements HandlerInterceptor {

    @Override
    public boolean preHandle(HttpServletRequest request, HttpServletResponse response, Object handler) throws Exception {
        System.out.println("Pre Handle method is Calling: " + request.getRequestURI());
        return true;  // Continue with the next interceptor or the controller method
    }

    @Override
    public void postHandle(HttpServletRequest request, HttpServle
tResponse response, Object handler, ModelAndView modelAndView) th
rows Exception {
        System.out.println("Post Handle method is Calling: " + re
quest.getRequestURI());
    }

    @Override
    public void afterCompletion(HttpServletRequest request, HttpS
ervletResponse response, Object handler, Exception ex) throws Exc
eption {
        System.out.println("Request and Response is completed: "
+ request.getRequestURI());
    }
}
```

- **Explanation**:
    - `preHandle`: Logs the request URI before the controller method is executed.
    - `postHandle`: Logs after the controller method has executed but before the view is rendered.
    - `afterCompletion`: Logs after the request has been fully processed and the response is completed.

b. Register the Interceptor

You need to register the interceptor with Spring MVC so that it can be invoked for incoming requests. This is done by implementing `WebMvcConfigurer` and overriding the `addInterceptors` method.

```
javaCopy code
package com.example.demo.config;

import com.example.demo.interceptor.LoggingInterceptor;
import org.springframework.context.annotation.Configuration;
import org.springframework.web.servlet.config.annotation.Intercep
torRegistry;
import org.springframework.web.servlet.config.annotation.WebMvcCo
```

```
nfigurer;

@Configuration
public class WebConfig implements WebMvcConfigurer {

    @Override
    public void addInterceptors(InterceptorRegistry registry) {
        registry.addInterceptor(new LoggingInterceptor())
                .addPathPatterns("/**")  // Intercept all request
s
                .excludePathPatterns("/api/ignore/**");  // Exclu
de certain paths
    }
}
```

- **Explanation**:
    - `addInterceptor(new LoggingInterceptor())`: Registers the `LoggingInterceptor` with the application.
    - `addPathPatterns("/**")`: Specifies that the interceptor should apply to all incoming requests.
    - `excludePathPatterns("/api/ignore/**")`: Excludes specific paths from being intercepted.

4. Common Use Cases for Interceptors

Interceptors are useful for implementing common cross-cutting concerns:

1. **Logging**: Log request and response data for debugging or auditing purposes.
2. **Authentication/Authorization**: Check if a user is authenticated or authorized to access a specific resource.
3. **Performance Monitoring**: Measure the time taken to process a request.
4. **Request Modification**: Modify the request or response before it reaches the controller or after it leaves the controller.
5. **Resource Management**: Open and close resources

4o

how to register in lasted spring boot usign filterchain

ChatGPT

In the latest versions of Spring Boot (particularly with Spring Security and Spring Web), the registration of interceptors and filters has evolved, particularly with the introduction of `SecurityFilterChain` and the use of `Filter` for handling security-related tasks. However, if you want to register a custom interceptor in the context of a Spring Boot application, the approach remains straightforward.

Registering an Interceptor with Spring Boot using `WebMvcConfigurer`

If you are looking to register an interceptor (not a security filter), you would typically do this using `WebMvcConfigurer`, as shown earlier. This approach remains valid even in the latest versions of Spring Boot.

Registering Filters in Spring Boot with `SecurityFilterChain`

If you want to work with security filters or modify the security filter chain, you can use `SecurityFilterChain` introduced with Spring Security.

1. Registering an Interceptor Using `WebMvcConfigurer`

This approach is used to handle HTTP requests at the MVC level, allowing you to add custom interceptors:

1. **Create the Interceptor**: (same as before)
2. **Register the Interceptor**:
    - In the latest Spring Boot, you still use `WebMvcConfigurer` to register your interceptors.

```
javaCopy code
package com.example.demo.config;

import com.example.demo.interceptor.LoggingInterceptor;
import org.springframework.context.annotation.Configuration;
import org.springframework.web.servlet.config.annotation.Intercep
torRegistry;
import org.springframework.web.servlet.config.annotation.WebMvcCo
nfigurer;
```

```
@Configuration
public class WebConfig implements WebMvcConfigurer {

    @Override
    public void addInterceptors(InterceptorRegistry registry) {
        registry.addInterceptor(new LoggingInterceptor())
                .addPathPatterns("/**")
                .excludePathPatterns("/api/ignore/**");
    }
}
```

This approach is still valid in the latest Spring Boot versions.

2. Registering a Custom Filter Using `SecurityFilterChain`

If you are specifically dealing with security filters (e.g., for authentication or authorization), Spring Security uses the `SecurityFilterChain` configuration.

1. **Create a Custom Filter**:
    - A custom filter can be created by implementing the `Filter` interface.

```
javaCopy code
package com.example.demo.filter;

import jakarta.servlet.Filter;
import jakarta.servlet.FilterChain;
import jakarta.servlet.FilterConfig;
import jakarta.servlet.ServletException;
import jakarta.servlet.ServletRequest;
import jakarta.servlet.ServletResponse;
import jakarta.servlet.http.HttpServletRequest;
import jakarta.servlet.http.HttpServletResponse;

import java.io.IOException;

public class CustomSecurityFilter implements Filter {
    @Override
    public void init(FilterConfig filterConfig) throws ServletExc
eption {
        // Initialization logic if needed
    }

    @Override
    public void doFilter(ServletRequest request, ServletResponse
response, FilterChain chain)
            throws IOException, ServletException {
        HttpServletRequest httpRequest = (HttpServletRequest) req
uest;
        HttpServletResponse httpResponse = (HttpServletResponse)
response;

        // Custom security logic here (e.g., logging, authenticat
ion checks)
        System.out.println("Custom Security Filter is applied on
URI: " + httpRequest.getRequestURI());

        // Continue the filter chain
        chain.doFilter(request, response);
    }

    @Override
    public void destroy() {
        // Cleanup logic if needed
    }
}
```

1. **Register the Custom Filter Using `SecurityFilterChain`:**
    - The `SecurityFilterChain` bean allows you to customize the security filter chain.

```
javaCopy code
package com.example.demo.config;
```

```
import com.example.demo.filter.CustomSecurityFilter;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.security.config.annotation.web.builders.HttpSecurity;
import org.springframework.security.web.SecurityFilterChain;

import org.springframework.security.web.authentication.UsernamePasswordAuthenticationFilter;

@Configuration
public class SecurityConfig {

    @Bean
    public SecurityFilterChain securityFilterChain(HttpSecurity http) throws Exception {
        http
            // Add your custom filter before/after specific filters
            .addFilterBefore(new CustomSecurityFilter(), UsernamePasswordAuthenticationFilter.class)
            // Add your security configurations
            .authorizeHttpRequests(authorizeRequests ->
                authorizeRequests
                    .requestMatchers("/public/**").permitAll()
                    .anyRequest().authenticated()
            )
            .formLogin()
            .and()
            .httpBasic();

        return http.build();
    }
}
```

- **Explanation**:

  - `SecurityFilterChain` configures the security filter chain for your application.
  - `addFilterBefore` or `addFilterAfter` allows you to insert your custom filter into the security filter chain at the desired position.
  - In this example, the `CustomSecurityFilter` is added before the `UsernamePasswordAuthenticationFilter`.

File Upload

File upload in Spring Boot can be handled easily using Spring MVC's `MultipartFile` interface. This allows you to upload files from clients to your server, where you can process or store them.

1. Setting Up a Spring Boot Project

Ensure your Spring Boot project includes the necessary dependencies. The `spring-boot-starter-web` dependency is usually sufficient because it includes support for file uploads.

```
xmlCopy code
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
</dependencies>
```

2. Configuring File Upload Settings

By default, Spring Boot sets up multipart support with sensible defaults. However, you can customize these settings in the `application.properties` or `application.yml` file.

Example in `application.properties`:

```
propertiesCopy code
spring.servlet.multipart.max-file-size=2MB
spring.servlet.multipart.max-request-size=2MB
```

- `spring.servlet.multipart.max-file-size`: The maximum size for a single file.
- `spring.servlet.multipart.max-request-size`: The maximum size for the entire multipart request.

3. Creating a File Upload Controller

Let's create a controller that handles file uploads.

```
javaCopy code
package com.example.demo.controller;

import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;
import org.springframework.web.multipart.MultipartFile;

import java.io.File;
import java.io.IOException;

@RestController
public class FileUploadController {

    private static final String UPLOAD_DIR = "uploads/";

    @PostMapping("/upload")
    public ResponseEntity<String> uploadFile(@RequestParam("file") MultipartFile file) {
        if (file.isEmpty()) {
            return new ResponseEntity<>("Please select a file to upload.", HttpStatus.BAD_REQUEST);
        }

        try {
            // Get the file and save it to the local filesystem
            String fileName = file.getOriginalFilename();
            File destinationFile = new File(UPLOAD_DIR + fileNam
e);
            file.transferTo(destinationFile);

            return new ResponseEntity<>("File uploaded successful
ly: " + fileName, HttpStatus.OK);
        } catch (IOException e) {
            e.printStackTrace();
            return new ResponseEntity<>("Failed to upload the fil
e: " + e.getMessage(), HttpStatus.INTERNAL_SERVER_ERROR);
        }
    }
}
```

- **Explanation**:
    - `@RequestParam("file") MultipartFile file`: Binds the uploaded file to a `MultipartFile` object.
    - `file.isEmpty()`: Checks if a file was uploaded.
    - `file.transferTo(destinationFile)`: Saves the uploaded file to the specified location on the server.

4. Creating the Upload Directory

Ensure that the directory where you want to save uploaded files exists. In this example, the directory is `uploads/` in the root of your project. You can create it manually or programmatically.

```
javaCopy code
import javax.annotation.PostConstruct;

@PostConstruct
public void init() {
    File uploadDir = new File(UPLOAD_DIR);
    if (!uploadDir.exists()) {
        uploadDir.mkdir();
    }
}
```

```
package com.example.demo.config;

import org.springframework.context.annotation.Configuration;

import javax.annotation.PostConstruct;
import java.io.File;

@Configuration
public class FileUploadConfig {

    private static final String UPLOAD_DIR = "uploads/";

    @PostConstruct
    public void init() {
        File uploadDir = new File(UPLOAD_DIR);
        if (!uploadDir.exists()) {
            boolean created = uploadDir.mkdir();
            if (created) {
                System.out.println("Upload directory created: " + U
            } else {
                System.err.println("Failed to create upload directo
            }
        }
    }

    public static String getUploadDir() {
        return UPLOAD_DIR;
    }
}
```

Handling Multiple File Uploads

To handle multiple file uploads in a single request, modify the controller method as follows:

```
javaCopy code
@PostMapping("/uploadMultiple")
public ResponseEntity<String> uploadMultipleFiles(@RequestParam
("files") MultipartFile[] files) {
    StringBuilder resultMessage = new StringBuilder();

    for (MultipartFile file : files) {
        if (file.isEmpty()) {
            resultMessage.append("Failed to upload empty fil
e.\n");
            continue;
        }

        try {
            String fileName = file.getOriginalFilename();
            File destinationFile = new File(UPLOAD_DIR + fileNam
e);
            file.transferTo(destinationFile);
            resultMessage.append("File uploaded successfully: ").
append(fileName).append("\n");
        } catch (IOException e) {
            e.printStackTrace();
            resultMessage.append("Failed to upload file: ").appen
d(file.getOriginalFilename()).append("\n");
        }
    }

    return new ResponseEntity<>(resultMessage.toString(), HttpSta
tus.OK);
}
```

- **Explanation**:

  - `@RequestParam("files") MultipartFile[] files`: Binds multiple uploaded files to an array of `MultipartFile` objects.
  - The method iterates over each file and processes them as before.

7. Handling Errors and Validation

You can add validation and error handling to ensure the uploaded files meet your requirements (e.g., file type, file size).

Example: Validating File Type and Size:

```
@PostMapping("/upload")
public ResponseEntity<String> uploadFile(@RequestParam("file") Mu
ltipartFile file) {
    if (file.isEmpty()) {
        return new ResponseEntity<>("Please select a file to uplo
ad.", HttpStatus.BAD_REQUEST);
    }

    // Validate file type
    String contentType = file.getContentType();
    if (!contentType.equals("image/jpeg") && !contentType.equals
("image/png")) {
        return new ResponseEntity<>("Only JPEG and PNG files are
allowed.", HttpStatus.BAD_REQUEST);
    }

    // Validate file size
    if (file.getSize() > 2 * 1024 * 1024) { // 2MB
        return new ResponseEntity<>("File size should be less tha
n 2MB.", HttpStatus.BAD_REQUEST);
    }

    try {
        // Save the file
        String fileName = file.getOriginalFilename();
        File destinationFile = new File(UPLOAD_DIR + fileName);
        file.transferTo(destinationFile);
        return new ResponseEntity<>("File uploaded successfully: 
" + fileName, HttpStatus.OK);
    } catch (IOException e) {
        e.printStackTrace();
        return new ResponseEntity<>("Failed to upload the file: " 
+ e.getMessage(), HttpStatus.INTERNAL_SERVER_ERROR);
    }
}
```