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THOUGHTS ON SOFTWARE ENGINEERING

Creating a Blog System with Spring MVC, Thymeleaf, JPA and MySQL

AUGUST 5, 2016

Recently, I created a detailed **Spring MVC tutorial** for my students at the Software University (SoftUni), as part of their training course "Software Technologies", so I want to share it with anyone interested to learn how to integrate Java, Spring Framework, Spring MVC, Spring Boot, Spring services, repositories, controllers, models, Thymeleaf views, Spring form validation, JPA, entity classes, Spring Data, Spring Data JPA, Hibernate, JPQL, MySQL, HTML, CSS, JavaScript and jQuery into a single working project – a server-side Web application for simple blogging.

In this tutorial we shall create a fully-functional **Blog system** from scratch using **Spring MVC** and **MySQL** database. The blog holds posts (visible for everyone). Registered users (after login) can create / edit / delete posts. The blog will use Java, Spring Framework, Spring MVC, Thymeleaf template engine, Spring Data JPA, JPA, Hibernate and MySQL.

First, download the project resources (images, JS code, database sample data, etc.): **Spring-MVC-Blog-resources.zip**.

What We Are Building?

We are building a **Blog system** where users can **view posts** and **create** / **edit** / **delete posts** after **registration** / **login**.

Blog System – Project Specification

Design and implement a **"Blog" Web application** in Spring MVC + MySQL. Implement the following functionality:

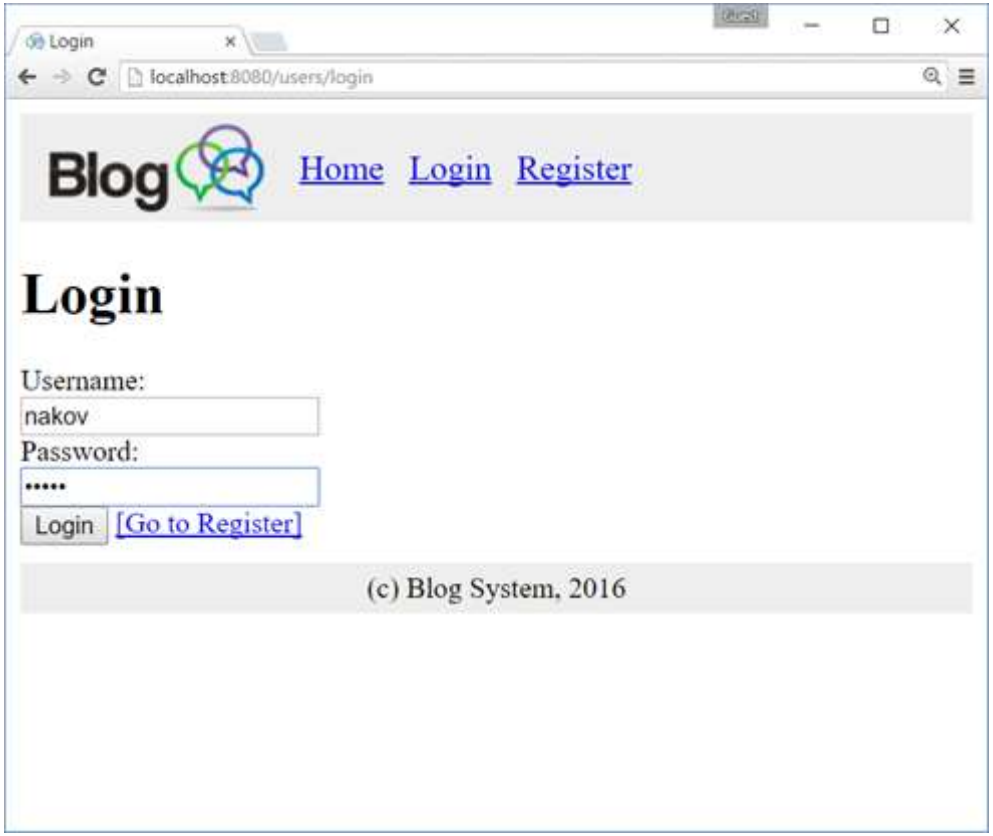
- **Home**
  - Show the **last 3 posts** at the home page, ordered by date (from the most recent).
  - Show also the **last 5 post titles** at the home page (as a **sidebar**) with a link to the post.
  - Show **[Login]** and **[Register]** buttons (when no user is logged in).
- **Login**
  - Login in the blog with existing account (username + password).
  - Show a success message after login or error message in case of problem.
- **Register**
  - Register a new user in the MySQL database (by username + password + full name).
  - Show a success message after registration or error message in case of problem.
- **Logout**
  - Logout the current user.
  - This [Logout] button is available after successful login only.
- **View / Create / Edit / Delete Posts (CRUD Operations)**
  - Logged in users should be able to **view** all posts, **create** new post (by title + content) / **edit** / **delete** their own posts.
  - Posts are **displayed in a table** (one row for each post). At each row a link **[Edit]** and **[Delete]** should be displayed.

    - **Create post** shows a **form** to enter the post data (title + content). After the form submission, the post is created in the database. Implement field validation (non-empty fields are required).
    - **Edit post** fills an existing post data in a form and allows it to be edited. After successful form submission, the post is edited. Implement field validation.
    - **Delete post** shows the post to be deleted and asks for confirmation.

- **View All Users**
    - Logged in users should be able to **view** all users (username + full name) in a table.

Blog System – Screenshots

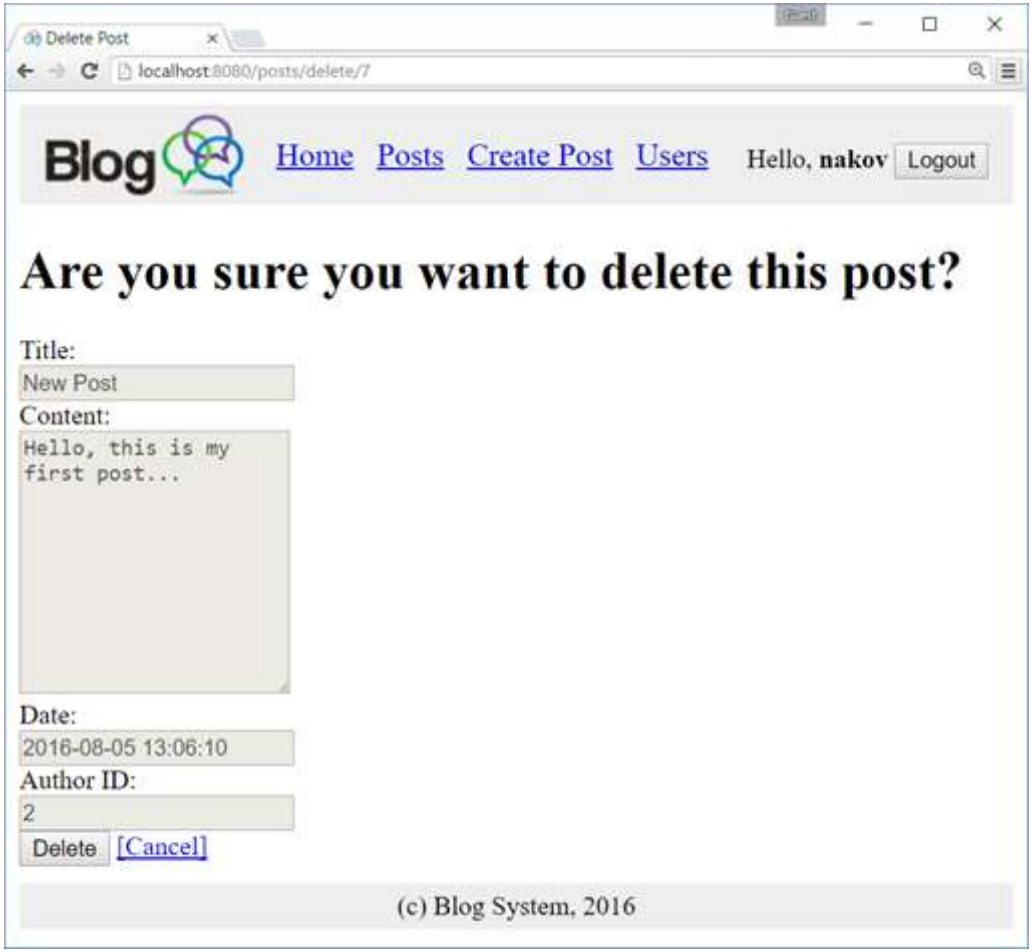

Welcome to My Blog
localhost:8080
Blog
Home Login Register
Welcome to My Blog
Work Begins on HTML5.1
Posted on 22-May-2016 by Svetlin Nakov
The World Wide Web Consortium (W3C) has begun work on HTML5.1, and this time it is handling the creation of the standard a little differently. The specification has its own GitHub project where anyone can see what is happening and propose changes.
Recent Posts
Work Begins on HTML5.1
Windows 10 Preview with Bash Support Now Available
Atom Text Editor GetsNew Windows Features
SoftUni 3.0 Launched
Git 2.8 Adds Security and Productivity Features


Login
localhost:8080/users/login
Blog
Home Login Register
Login
Username:
nakov
Password:
Login [Go to Register]
(c) Blog System, 2016


Posts
localhost:8080/posts
Blog
Home Posts Create Post Users
Hello, nakov Logout
Login successful.
Posts
ID Title Content Date Author ID Action
1 Work Begins on HTML5.1 <p>The World Wide Web Consortium (W3C) has begun work on HTML5.1, and this time it is handling the creation of the standard a little differently. The specification has its <a href="https://w… 2016-05-22 10:13:37 2 [Edit] [Delete]

2	Windows 10 Preview with Bash Support Now Available	<p>Microsoft has released a new Windows 10 Insider Preview that includes native support for Bash running on Ubuntu Linux. The company first announced the new feature at last week's Build…	2016-05-20 11:18:26	8	[Edit] [Delete]
3	Atom Text Editor GetsNew	<p>GitHub has released Atom 1.7, and the updated version of the text editor offers improvements for Windows developers.	2016-05-07	3	[Edit]


Posts
localhost:8080/posts
Blog
Home
Posts
Create Post
Users
Hello, nakov
Logout
Post created.
Posts
ID
Title
Content
Date
Author ID
Action
7
New Post
Hello, this is my first post...
2016-08-05 13:06:10
2
[Edit] [Delete]
1
Work Begins on HTML5.1
<p>The World Wide Web Consortium (W3C) has begun work on HTML5.1, and this time it is handling the creation of the standard a little differently. The specification has its <a href="https://w…
2016-05-22 10:13:37
2
[Edit] [Delete]
Windows 10
<p>Microsoft has released a new


Delete Post
localhost:8080/posts/delete/7
Blog
Home Posts Create Post Users
Hello, nakov
Logout
Are you sure you want to delete this post?
Title:
New Post
Content:
Hello, this is my first post...
Date:
2016-08-05 13:06:10
Author ID:
2
Delete
[Cancel]
(c) Blog System, 2016


Users
localhost:8080/users
Blog
Home Posts Create Post Users
Hello, nakov
Logout
Users
ID Username Full Name
1 admin
4 ani Ani Kirova
7 it's security "test"
 it's security "test"
5 joe Joe Green
3 maria Maria Ivanova
2 nakov Svetlin Nakov
6 test
8 vikash Vikash Jain
(c) Blog System, 2016

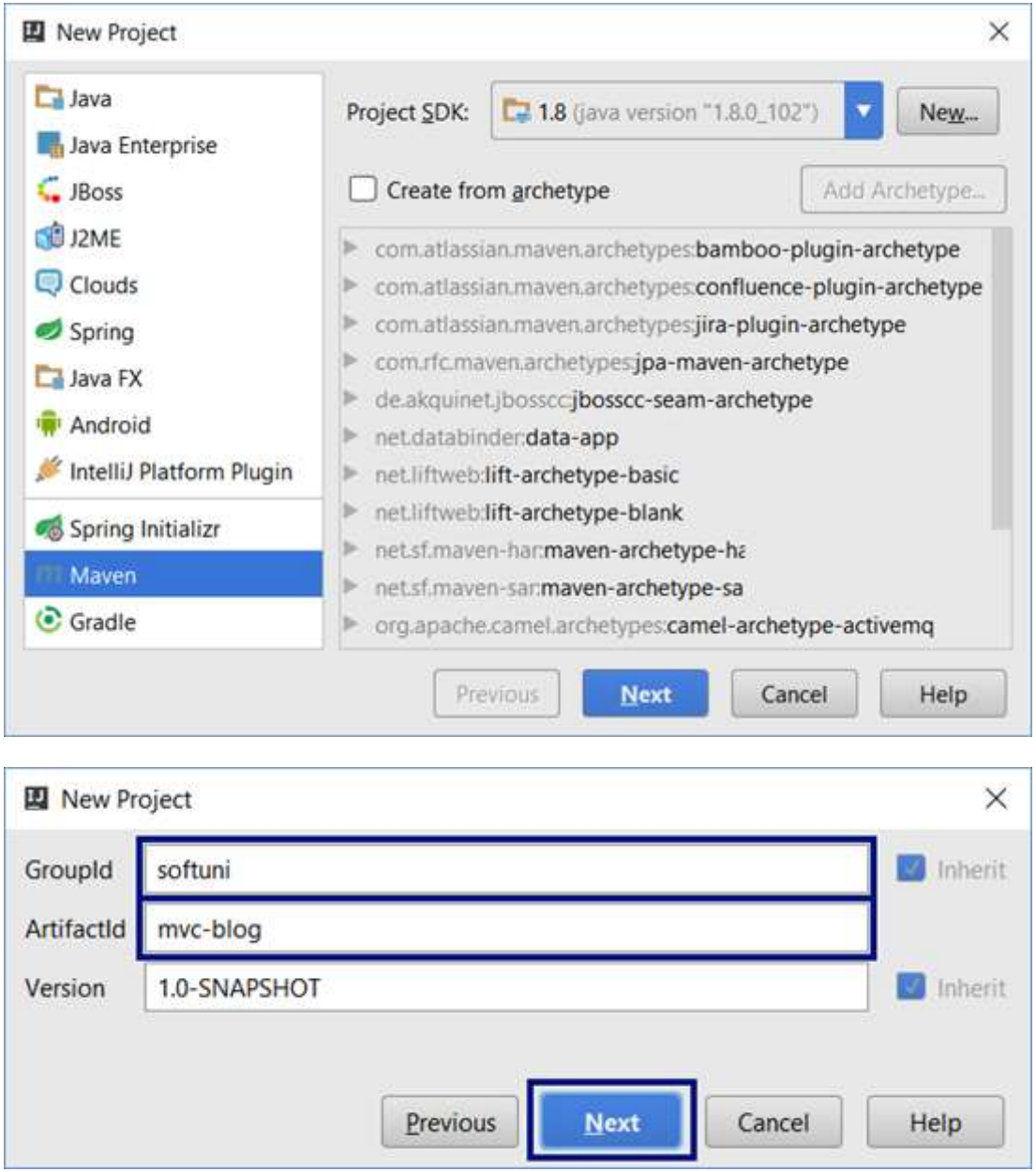
Part I: Setup a Spring Boot Project

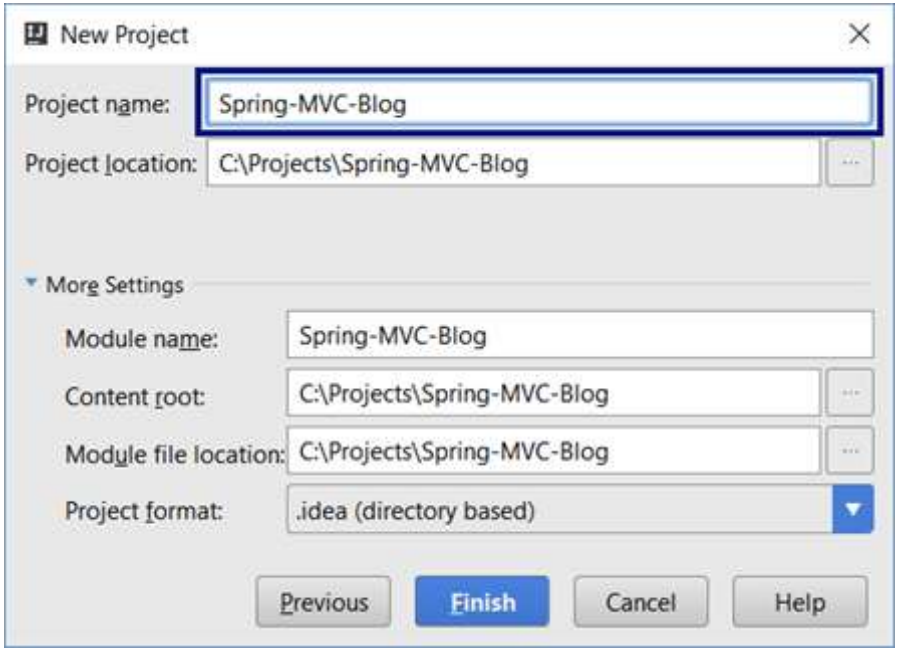
In this section we shall create an empty **Spring MVC application** based on **Spring Boot** using **Maven**.

We shall use **IntelliJ IDEA** as development environment, but Eclipse or any other Java IDE could work as well.

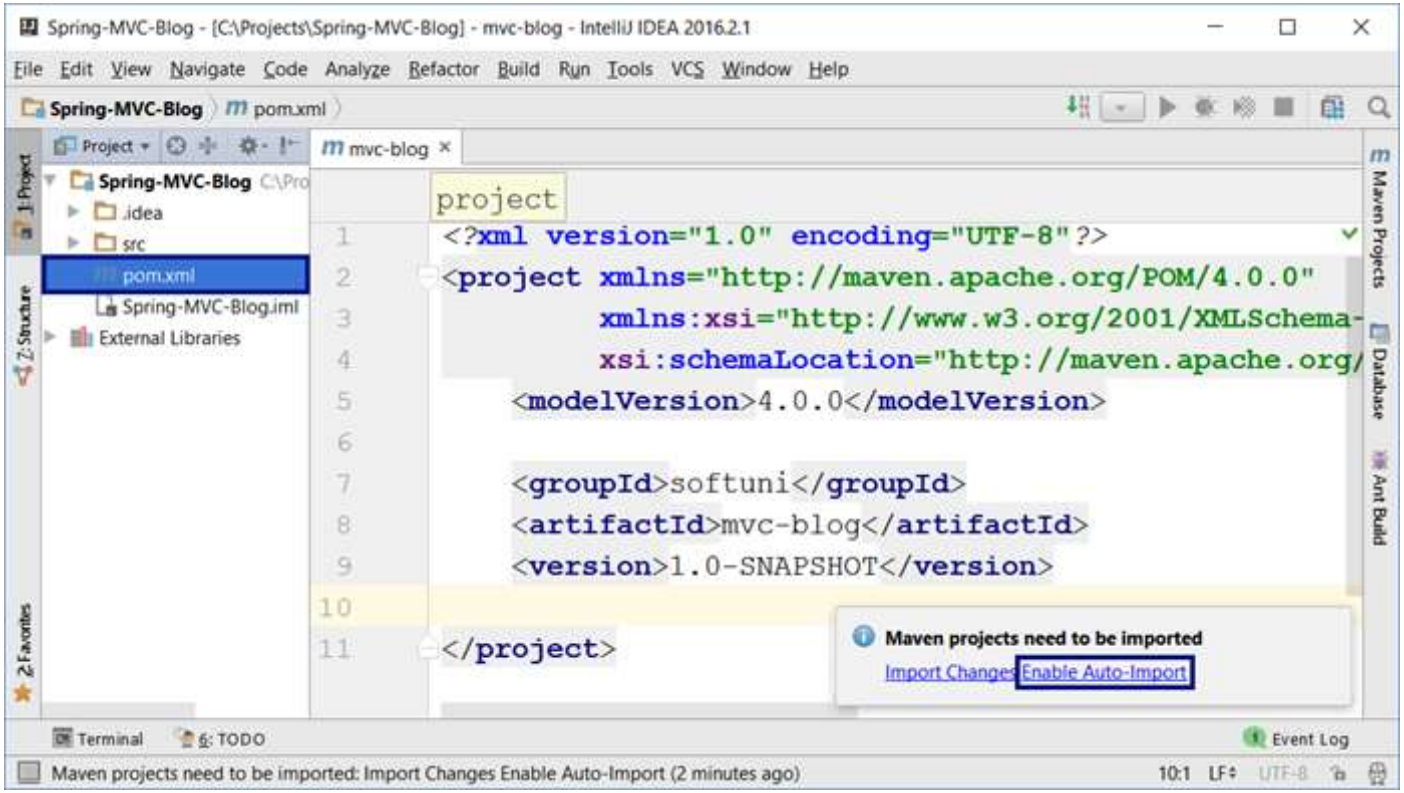
Create a New Maven Project

Create a new **Maven project** for the Blog system:





The IDE will create for you a Maven configuration file **`pom.xml`** in the project root folder. In IntelliJ IDEA enable the "auto-import" for the Maven dependencies.



Add the Spring Boot Dependencies in Maven

Inside the **<project>** element in the **pom.xml** add the **spring-boot-starter-parent** dependency:

pom.xml

```
<parent>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-parent</artifactId>
<version>1.4.0.RELEASE</version>
</parent>
```

The above declaration inherits all **Spring Boot** libraries and project settings from **spring-boot-starter-parent**. We will assign the Spring Framework **version** only once at this place. We shall use version **1.4.0 –** the latest stable release as of August 2016. All other Maven dependencies will be without an explicitly specified version, so Maven will detect the required version automatically.

Add also a dependency to **spring-boot-starter-thymeleaf**:

pom.xml

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-thymeleaf</artifactId>
  </dependency>
</dependencies>
```

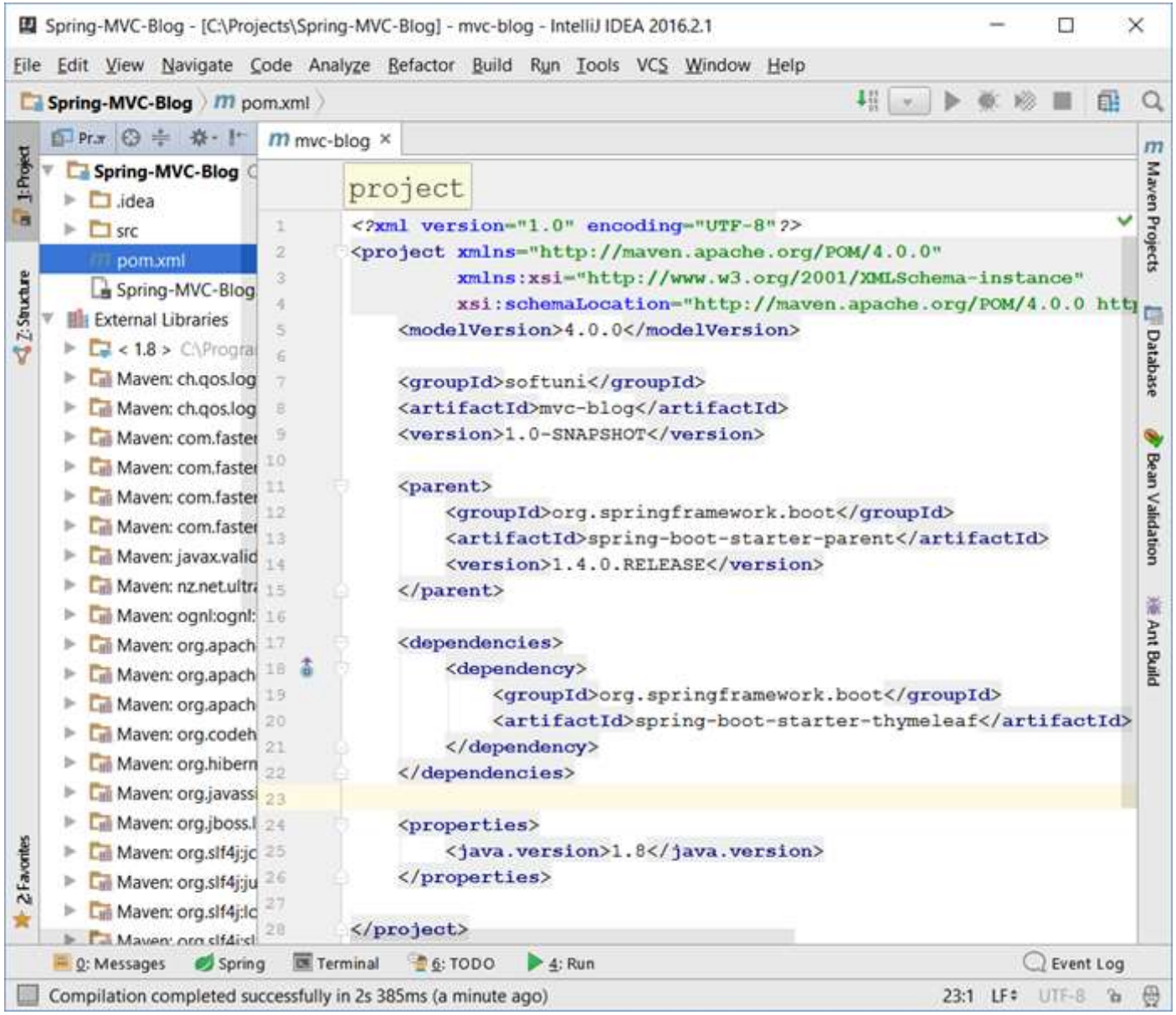
The above code will configure the **Thymeleaf templating engine** that will be used for the views

Set the **Java version** to **1.8**. Otherwise the project will use old Java version and some functionality will not compile:

pom.xml

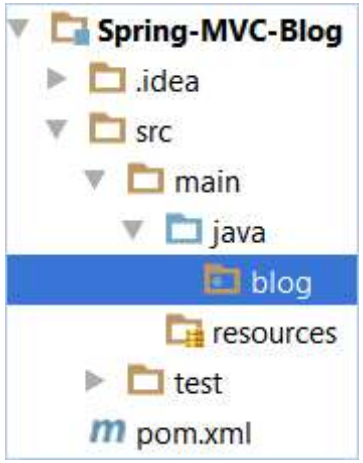
```
<properties>
  <java.version>1.8</java.version>
</properties>
```

This is how your Maven configuration file **pom.xml** might look like. Note that if everything is OK, the project libraries will include all **Spring Core**, **Spring Boot**, **Spring MVC** and **Thymeleaf** libraries (**jar** files, shown on the left):



Create the Project Structure: Directories

Create a package "**`blog`**" in the source code root of your Java project: **`src/main/java`**:



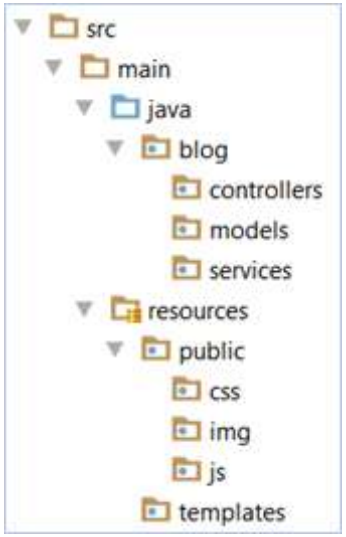
Create the following **packages** (directories) in **`src/main/java/blog`**:

- **`models`** – will hold the project **MVC models** (entity classes) like **`User`** and **`Post`**.
- **`controllers`** – will hold the project **MVC controllers** that will serve the blog functionality.
- **`services`** – will hold the **business logic** of the project, invoked by the controllers.

Create the following **folders** in **`src/main/resources`**:

- **`templates`** – will hold the application **views** (the Thymeleaf HTML templates and template fragments).
- **`public`** – will hold static HTML content like **CSS**, **images** and **JavaScript** code.
- **`public/img`** – will hold the site **images** (e.g. site logo).
- **`public/css`** – will hold the site **CSS** styles.
- **`public/js`** – will hold the site **JavaScript** files (e.g. jQuery, Bootstrap and custom JS code).

Your **project directory structure** should look like this:

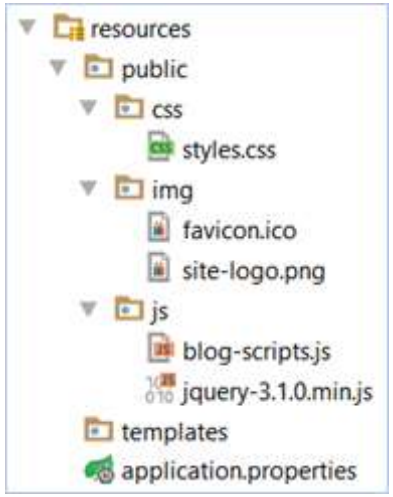


Create the Project Structure: Files

Create a few important **project files** in `src/main/resources`:

- `public/css/styles.css` – the main **CSS styles** for the application. You shall put some style in this file later, so leave it empty now.
- `public/img/site-logo.png` – the site **logo**. Copy it from the resources coming with this tutorial.
- `public/img/favico.ico` – the browser **icon** for the site. Copy it from the resources for this tutorial.
- `public/js/blog-scripts.js` – the **JavaScript code** that will be used in our blog. You shall put some JS code in this file later, so leave it empty now.
- `public/js/jquery-3.1.0.min.js` – the **jQuery** library that will simplify your JS code. Copy it from the resources for this tutorial or from Internet: https://jquery.com/download/.
- `application.properties` – the Spring **application settings** (like logging configuration and database connection settings). Initially, leave this file empty.

After completing all the above steps, your **project resources file structure** should look like this:



Create the Spring Boot Application Startup Class

Create the **Spring Boot application startup class** in the package "**blog**" in your **src/main/java** directory:

src/main/java/blog/**BlogMvcApplication.java**

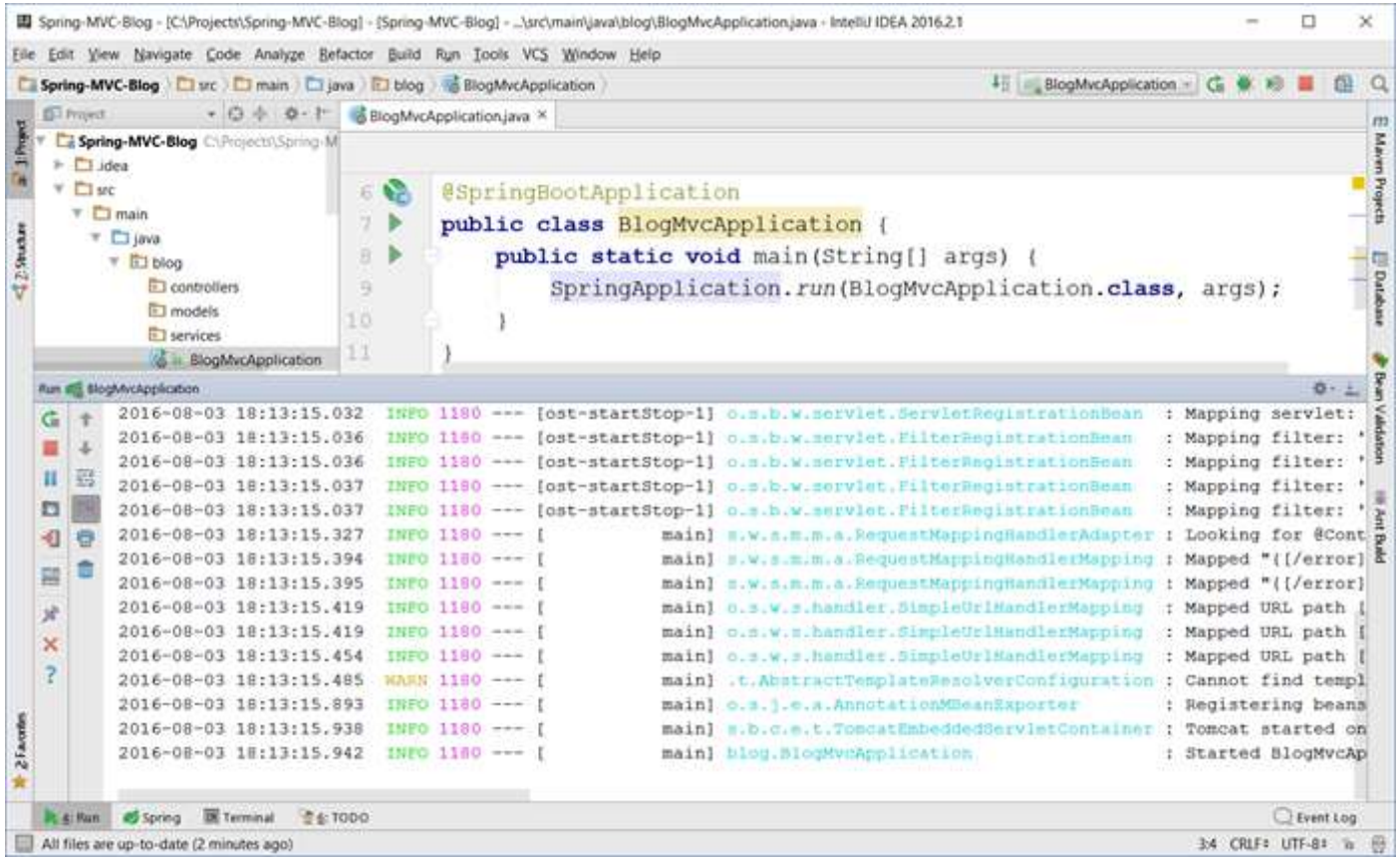
```
package blog;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

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

This class configures and starts your Spring Boot application, which is still empty. The **@SpringBootApplication** annotation applies the default configuration settings for our Spring Boot application (finds and loads all entities, controllers, UI templates and other application

assets). Calling **`SpringApplication.run(…)`** will start an embedded **Tomcat Web application server** at http://localhost:8080 to serve the HTTP requests to your Spring MVC Web application.

Run the Empty Web Application

Now you are ready to **run your Web application** for the first time. Run the **`BlogMvcApplication`** class, just like any other Java program. It should show a long sequence of **logs** (informational messages) at its startup:



Open project URL at **http://localhost:8080** in your browser to check **whether Tomcat and Spring MVC are running**. You should see a Web page like the shown below. Note the **green site icon** of the top left angle of the browser. This is the Spring Framework's icon. If you see it, your browser shows a Spring MVC application.

It is quite normal to see this **error message**. It says that the Embedded Tomcat server with Spring MVC is running, but you have **no registered controller action** to handle HTTP GET requests for your home page URL "**/**".

If your browser shows you other Web content (e.g. different site icon), or fails to open **`localhost:8080`**, check for errors in your Java application output and also who is listening at port **8080** on your localhost loopback interface.

Create the Home Controller + View

To ensure your **Spring MVC application** and the **Thymeleaf** templating engine are properly configured, create your first **controller** + **Thymeleaf view** and invoke it from your browser.

Create a Java class **`HomeController.java`** in your **`src/main/java/blog/controllers`** directory:

```
src/main/java/blog/controllers/HomeController.java
```

```
package blog.controllers;

import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.RequestMapping;

@Controller
public class HomeController {
@RequestMapping("/")
    public String index() {
        return "index";
    }
}
```

The above code defines a **Spring Web MVC controller** and defines an **action** that handles HTTP GET requests for the root URL of the project "**/**". When someone opens http://localhost:8080/ form a Web browser, the above action will be called. It returns the "**index**" view and this means to render a Thymeleaf template "**index.html**" located in the file **src/main/resources/templates/index.html**.

Create a **Thymeleaf view** "**index.html**" in your **src/main/resources/templates** directory:

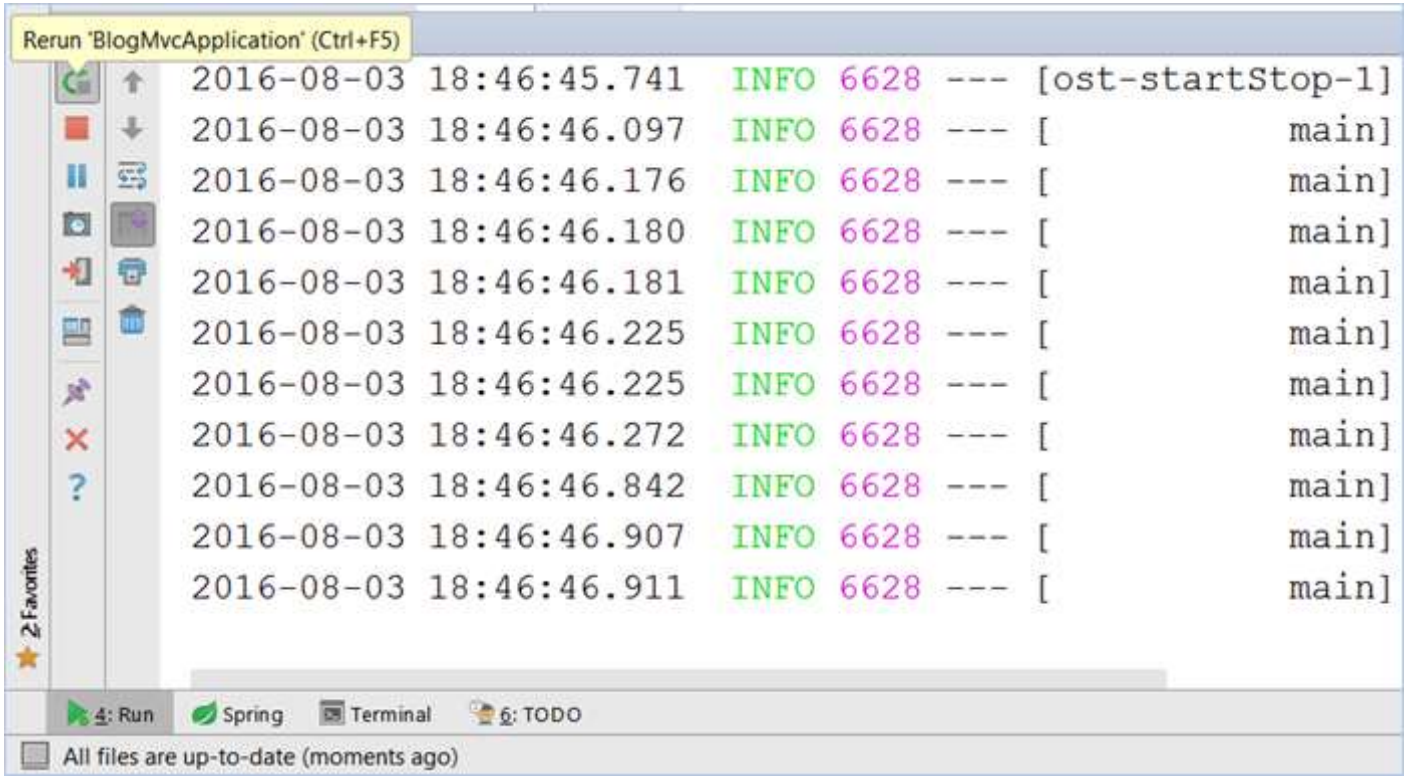
src/main/resources/templates/**index.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">

<head>
    <meta charset="UTF-8" />
    <title>Blog</title>
</head>

<body>
<h1>Welcome to Spring MVC</h1>
    Now is: <b th:text="${execInfo.now.time}"></b>
</body>

</html>
```

The above code is a sample **HTML page** that uses the **Thymeleaf view engine** to display the **current date and time**. The namespace `xmlns:th="http://www.thymeleaf.org"` indicates that this file is not pure HTML, but is a **Thymeleaf template** that should be processed at the server side to produce a HTML page.

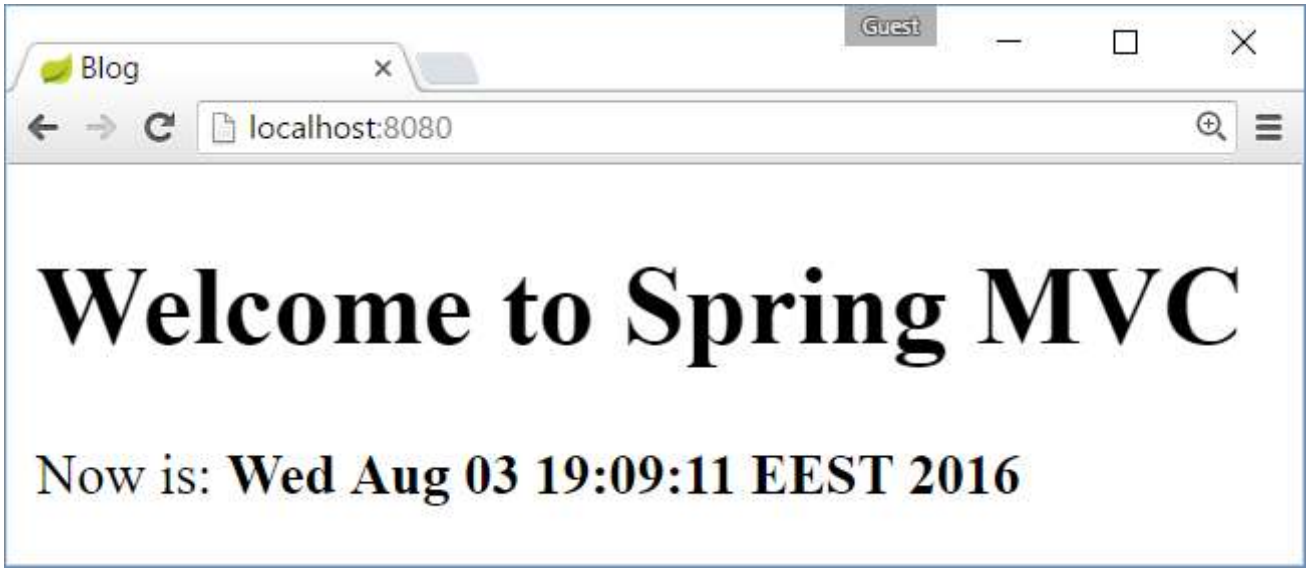
Restart the Web Server to See the Changes

Compile and **make your project** (press [Ctrl+F9] in IDEA) and **restart the Spring Boot Web server** to be able to see the changes in your code (the new controller + view). Stop and start again (or re-run) your Spring MVC application (the **`BlogMvcApplication`** class). In IntelliJ IDEA you have a special button to do this in the [Run] panel:



See the Output from Your First Controller + View

Now refresh your Web browser or open again http://localhost:8080. You should see the **HTML output** from your first MVC **controller action** + Thymeleaf **view**. It should look like this:



Configure Auto-Reload after Change in the Source Code

It is quite ugly to **rebuild** your project and **restart** your Web server manually each time you change the source code in order to see the changes. Let's automate this process.

First, disable the Thymeleaf **template caching** in your **`application.properties`** settings file:

src/main/resources/**application.properties**

```
spring.thymeleaf.cache = false
```

Second, install **Spring Boot Development Tools** in your Maven configuration. Just **add this dependency**:

pom.xml

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-devtools</artifactId>
</dependency>
```

Don't remove the other dependencies when you add this new dependency. Your **<dependencies>** section in **pom.xml** should look like this:

```
<dependencies>
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-thymeleaf</artifactId>
    </dependency>

    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-devtools</artifactId>
    </dependency>
</dependencies>
```

Now **rebuild** the project and **restart** the server. You will not need to do this more after changing the project. The Spring Boot server will restart automatically after a project change. Make sure to press **[Ctrl+F9] in IntelliJ IDEA** when you want to see the changes in the source code or view templates.

Create the Site Layout (Header, Menu, Footer, CSS)

Now, let's build the **site layout** (also known as master page template). The site layout includes the parts of the site, which should be **shared between all site pages**:

- **Head** section – holds the site **<head>** section with the CSS and scripts references.
- Site **header** section – holds the site header and top menu.
- Site **footer** section – holds the site footer area.

Create a new HTML file "**layout.html**" in **src/main/resources/templates**. It will hold the site layout:

src/main/resources/templates/**layout.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org"><head th:fragment="site-head">
<meta charset="UTF-8" />
<link rel="stylesheet" href="../public/css/styles.css" th:href="@{/css/styles.css}" />
<link rel="icon" href="../public/img/favicon.ico" th:href="@{/img/favicon.ico}" />
<script src="../public/js/jquery-3.1.0.min.js" th:src="@{/js/jquery-3.1.0.min.js}"></script>
<script src="../public/js/blog-scripts.js" th:src="@{/js/blog-scripts.js}"></script>
<meta th:include="this :: head" th:remove="tag"/>
</head><body><header th:fragment="site-header">
<a href="index.html" th:href="@{/}"><img src="../public/img/site-logo.png" th:src="@{/img/site-
logo.png}" /></a>
<a href="index.html" th:href="@{/}">Home</a>
<a href="users/login.html" th:href="@{/users/login}">Login</a>
<a href="users/register.html" th:href="@{/users/register}">Register</a>
<a href="posts/index.html" th:href="@{/posts}">Posts</a>
<a href="posts/create.html" th:href="@{/posts/create}">Create Post</a>
<a href="users/index.html" th:href="@{/users}">Users</a>
<div id="logged-in-info"> <span>Hello, <b>(user)</b></span>
<form method="post" th:action="@{/users/logout}">
<input type="submit" value="Logout"/>
</form>
</div>
</header> <h1>Welcome</h1>
<p>Welcome to the Spring MVC Blog.</p> <footer th:fragment="site-footer">
&copy; Spring MVC Blog System, 2016
</footer></body></html>
```

The above file "**layout.html**" holds several **Thymeleaf fragments** that will be included in all site pages:

- The "**site-head**" fragment holds the **<head>** section. It includes the site CSS, JavaScript code, etc. It appends to the page **<head>** section the **<head>** section of the invoking page, e.g. **index.html**.

- The "`site-header`" fragment holds the **site header**: site **logo** + top navigation **links** to the other site pages. It also holds the "**Logout**" form. The header now holds links to all pages, but once the login / logout functionality is implemented, it will **show / hide some of the links** for anonymous site **visitors** and for the **authenticated users**.
- The "`site-footer`" fragment is very simple. It holds some static text for the **site footer**.

Note that the links in the above code look like **duplicated**, because there are two attributes that specify the resource address: **`href="..."`** and **`th:href="..."`**. This is because Thymeleaf uses **natural templates**. "Natural templates" means that the template is a document as valid as the final result and the view engine syntax doesn't break the document's structure. The **`href`** value specifies the relative resource location **in the system** (provided by the Web site designer, e.g. "`../public/css/styles.css`"). The **`th:href`** value specifies the resource runtime **location at the Web server** (which is relative to the site root, e.g. "`/css/styles.css`").

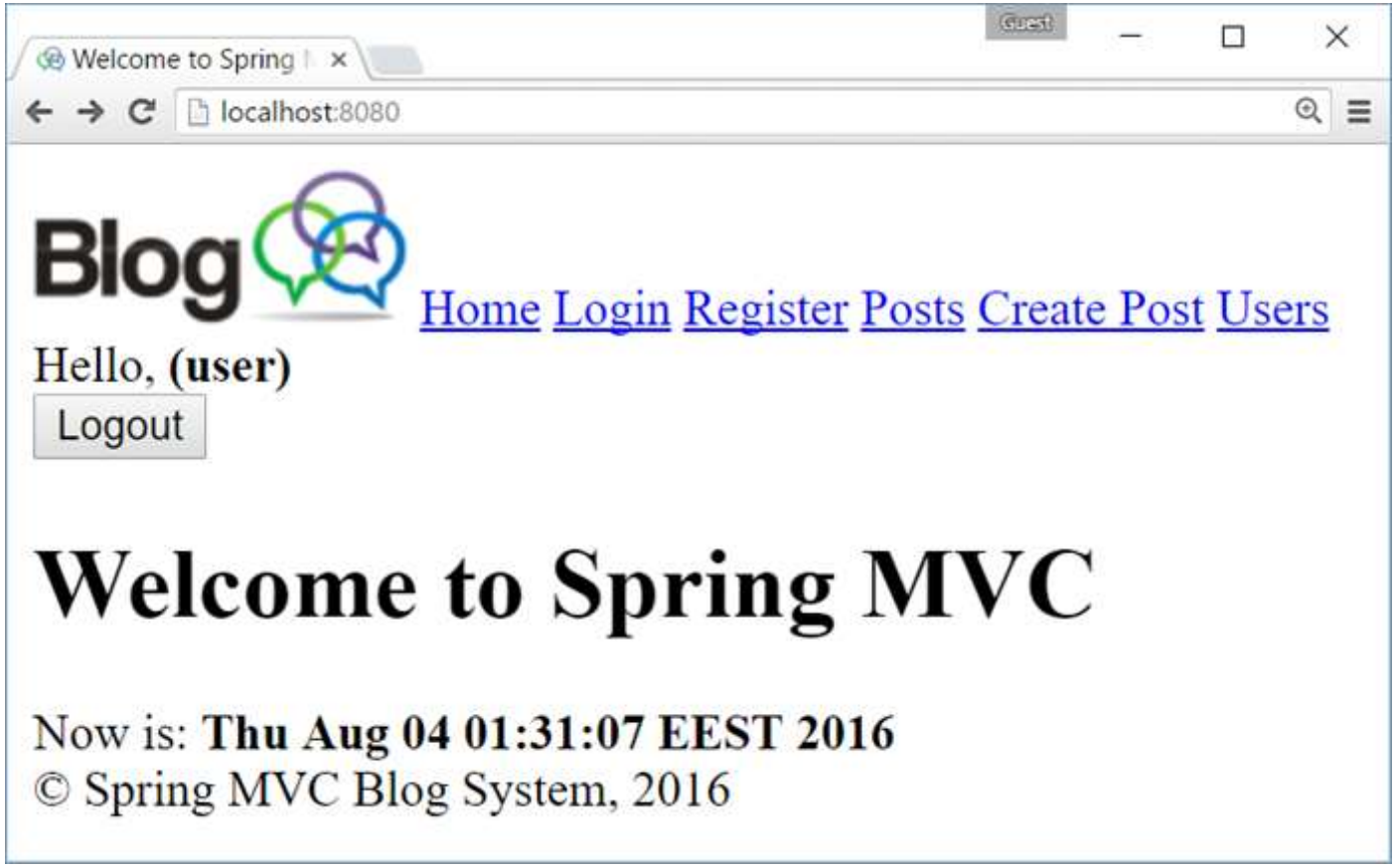
Once you have created the site layout template, it is time to modify the home view "**`index.html`**" to use this site layout by including its **`site-head`**, **`site-header`** and **`site-footer`** fragments using the Thymeleaf **`th:replace`** attributes as it is shown below:

src/main/resources/templates/**index.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">

<head th:replace="layout :: site-head">
<title>Welcome to Spring MVC Blog</title>
</head>

<body>

<header th:replace="layout :: site-header" />

<h1>Welcome to Spring MVC</h1>
Now is: <b th:text="${execInfo.now.time}">date and time</b>

<footer th:replace="layout :: site-footer" />

</body>

</html>
```

The concept of "**natural templates**" is simple: if you **open directly** in a Web browser the above HTML files (by double-clicking on **`layout.html`** or **`index.html`**), without rendering them through the Thymeleaf view engine, their HTML content will be displayed correctly and will look meaningful.

Now **make the project** ([Ctrl+F9] in IntelliJ IDEA) and **refresh the browser** to see the changes:



The site **header** and **footer** should be shown correctly but look a little bit ugly, because **there is no CSS** styles. The site browser icon (at the top left corner) is also change (by the **`favico.ico`** file in the site header).

Add CSS Styles for the Site Layout

Let's style the header, footer and the main page content. Add these **style definitions** in the site **CSS** file:

src/main/resources/public/css/**styles.css**

```
body>header {
background: #eee;
padding: 5px;
}

body>header>a>img, body>header a {
display: inline-block;
vertical-align: middle;
padding: 0px 5px;
font-size: 1.2em;
}

body>footer {
background: #eee;
padding: 5px;
margin: 10px 0;
text-align: center;
}

#logged-in-info {
float: right;
margin-top: 18px;
}

#logged-in-info form {
display: inline-block;
margin-right: 10px;
}
```

Now **save** the changes, **make** the project and **refresh** the Web browser to see how the site looks after the styling:

Congratulations, you have successfully created the **site layout** (the shared head, header, footer and CSS).

Part II: Build the Application UI (Spring MVC)

In this section we shall build the application **user interface (UI)** without connecting it to the database. We shall build **controllers** and **views** to implement the user interface of the project. Instead of connecting to the database, we shall use stub **service** implementations that provide **sample data** for visualization in the view templates.

Create Entity Classes: "User" and "Post"

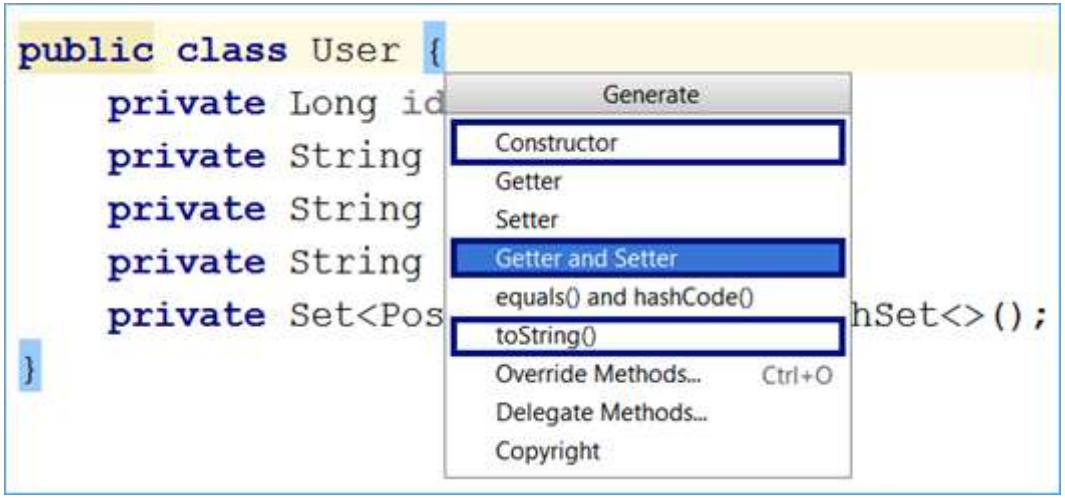
In order to create the controllers and views of the Blog system, we will need the **entity classes** (data models) to hold **users** and **posts**. Let's create these classes.

First, create a class `User` in the package `blog.models` to hold information about blog users. **Users** have `id`, `username`, `passwordHash` (encrypted password), `fullName` and a **set of posts**:

src/main/java/blog/models/**User.java**

```
package blog.models;

import java.util.HashSet;
import java.util.Set;

public class User {
private Long id;
private String username;
private String passwordHash;
private String fullName;
private Set<Post> posts = new HashSet<>();
}
```

Now generate **getters and setters** (for all fields), **constructors** (empty and by **`id`** + **`username`** + **`fullName`**) and **`toString()`** method (don't print the set of posts in the **`toString()`** to avoid endless recursion) in the **`User`** class:



The **generated code** might look as follows:

src/main/java/blog/models/**User.java**

```
public class User {
    …
    public Long getId() { return id; }
    public void setId(Long id) { this.id = id; }
    public String getUsername() { return username; }
    public void setUsername(String username) { this.username = username; }
    public String getPasswordHash() { return passwordHash; }
    public void setPasswordHash(String passHash) { this.passwordHash = passHash; }
    public String getFullName() { return fullName; }
    public void setFullName(String fullName) { this.fullName = fullName; }
    public Set<Post> getPosts() { return posts; }
    public void setPosts(Set<Post> posts) { this.posts = posts; }
    public User() { }

    public User(Long id, String username, String fullName) {
         this.id = id; this.username = username; this.fullName = fullName;
    }

    @Override
    public String toString() {
        return "User{" + "id=" + id + ", username='" + username + '\'' +
            ", passwordHash='" + passwordHash + '\'' +
            ", fullName='" + fullName + '\'' + '}';
    }
}
```

Next, create a class **Post** in the package **blog.models** to hold information about blog posts. **Posts** have **id**, **title**, **body**, **date** of publishing (defaults to the current date and time) and an **author** (which is **User**):

src/main/java/blog/models/**Post.java**

```
package blog.models;

import java.util.Date;

public class Post {
```

```
    private Long id;
    private String title;
    private String body;
    private User author;
    private Date date = new Date();

}
```

Generate **getters and setters** (for all fields), **empty constructor**, **constructors** by **`id`** + **`title`** + **`body`** + **`author`** and **`toString()`** method for the **`Post`** class. Your code might look like the shown below (it is intentionally shown as image to avoid copy / paste):

src/main/java/blog/models/**Post.java**

```
public Long getId() { return id; }
public void setId(Long id) { this.id = id; }
public String getTitle() { return title; }
public void setTitle(String title) { this.title = title; }
public String getBody() { return body; }
public void setBody(String body) { this.body = body; }
public User getAuthor() { return author; }
public void setAuthor(User author) { this.author = author; }
public Date getDate() { return date; }
public void setDate(Date date) { this.date = date; }
public Post() {...}
public Post(Long id, String title, String body, User author) {...}
@Override
public String toString() {...}
```

Create Service Interface “PostService”

In Spring MVC uses a layered architecture: **controllers →** **services →** **repositories →** **models →** **database**.

- **Controllers –** hold the **presentation (UI) logic –** process user request (GET / POST / other), prepare data for the view and render the view (or redirect to another URL). Example: prepare and show the home page.
- **Services –** hold the **business logic**. Often just call some repository method. Example: create new post / show a post for deleting / delete post. Services may have several **implementations**: DB based or stub based.
- **Repositories –** implement the **database CRUD operations** (create / read / edit / delete) in the database for certain entity class (model). Examples: find post by id / delete post by id. Often provided by the framework (not written by hand).
- **Models (entity classes) –** holds the data about the **application data**. Examples: user, post, tag, …

Now, create the **service interface** that will provide the business logic for working with posts in the blog system:

src/main/java/blog/services/**PostService.java**

```
package blog.services;

import blog.models.Post;

import java.util.List;

public interface PostService {
    List<Post> findAll();
    List<Post> findLatest5();
    Post findById(Long id);
    Post create(Post post);
    Post edit(Post post);
    void deleteById(Long id);
}
```

The **`PostService`** interface provides all the functionality about posts that is needed for the blog system.

Create Stub Service Implementation "PostServiceStubImpl"

To **reduce the complexity**, the blog application will be created **step by step**. First, the blog will be implemented to work **without a database**: users and posts will be stored in the server memory. Later, the database persistence will be implemented to replace the in-

memory object storing.

Let's implement a **stub** (sample data, stored in the memory) for the **PostService**. It will be a Java class called **PostServiceStubImpl**. It will hold the **posts** in a **List<Post>** collection and the service methods will be easy to be implemented:

src/main/java/blog/services/**PostServiceStubImpl.java**

```
package blog.services;

import blog.models.Post;
import blog.models.User;
import org.springframework.stereotype.Service;

import java.util.*;
import java.util.stream.Collectors;

@Service
public class PostServiceStubImpl implements PostService {
    private List<Post> posts = new ArrayList<Post>() {{
        add(new Post(1L, "First Post", "<p>Line #1.</p><p>Line #2</p>", null));
        add(new Post(2L, "Second Post",
        "Second post content:<ul><li>line 1</li><li>line 2</li></p>",
        new User(10L, "pesho10", "Peter Ivanov")));
        add(new Post(3L, "Post #3", "<p>The post number 3 nice</p>",
        new User(10L, "merry", null)));
        add(new Post(4L, "Forth Post", "<p>Not interesting post</p>", null));
        add(new Post(5L, "Post Number 5", "<p>Just posting</p>", null));
        add(new Post(6L, "Sixth Post", "<p>Another interesting post</p>", null));
    }};

    @Override
    public List<Post> findAll() {
        return this.posts;
    }

    @Override
    public List<Post> findLatest5() {
        return this.posts.stream()
                .sorted((a, b) -> b.getDate().compareTo(a.getDate()))
                .limit(5)
```

```
                .collect(Collectors.toList());
    }

    @Override
    public Post findById(Long id) {
        return this.posts.stream()
                .filter(p -> Objects.equals(p.getId(), id))
                .findFirst()
                .orElse(null);
    }

    @Override
    public Post create(Post post) {
        post.setId(this.posts.stream().mapToLong(
                p -> p.getId()).max().getAsLong() + 1);
        this.posts.add(post);
        return post;
    }

    @Override
    public Post edit(Post post) {
        for (int i = 0; i < this.posts.size(); i++) {
            if (Objects.equals(this.posts.get(i).getId(), post.getId())) {
                this.posts.set(i, post);
                return post;
            }
        }
        throw new RuntimeException("Post not found: " + post.getId());
    }

    @Override
    public void deleteById(Long id) {
        for (int i = 0; i < this.posts.size(); i++) {
            if (Objects.equals(this.posts.get(i).getId(), id)) {
                this.posts.remove(i);
                return;
            }
        }
        throw new RuntimeException("Post not found: " + id);
    }
}
```

The above service implementation is just **for testing**. It will allow us to develop the application frond-end UI (controllers and views) without carrying about the complexity of the database access. It will also make the application services testable without the need of database. Let's update the home page controller.

Note: the annotation **`@Service`** for the service implementation class is important here. It tells the Spring Framework that this class will be used by the application controllers as a **service** and Spring Framework will **automatically instantiate** and **inject** it in the controllers (through the **`@Autowired`** annotation).

Invoke the "PostService" from the Home Page Controller

Now, let's **update the home page controller** to use the **`PostService`** and its testing stub implementation **`PostServiceStubImpl`**. Now the **`HomeController.index()`** method should **prepare** for the view the **latest 3 blog posts** (to be shown at the home page) + **the latest 5 blog posts** (to be shown at the sidebar).

src/main/java/blog/controllers/**HomeController.java**

```
@Controller
public class HomeController {
@Autowired
private PostService postService;

@RequestMapping("/")
public String index(Model model) {
List<Post> latest5Posts = postService.findLatest5();
model.addAttribute("latest5posts", latest5Posts);

List<Post> latest3Posts = latest5Posts.stream()
.limit(3).collect(Collectors.toList());
model.addAttribute("latest3posts", latest3Posts);

return "index";
}
}
```

Note the **@Autowired** annotation before the **postService** field. This is **the "magic" of Spring Framework**. It automatically **injects** the correct implementation for your services at the places where they are needed. Developers just type "**@Autowired**". Spring scans the project and finds all classes that implement the service interface. If only one such class is found, it is instantiated and its instance is **auto-wired (injected)** in the field or method parameter where it is requested.

The above controller action puts in the **view model** the latest 5 posts as object named "**latest5posts**" and the latest 3 posts as object named "**latest3posts**" to be shown at the home page by the view. Now it is time to write the **home page view** to process these posts.

Implement "List Latest 3 Posts" at the Home Page Main Area

Let's modify the **home page view** to display the latest 3 posts:

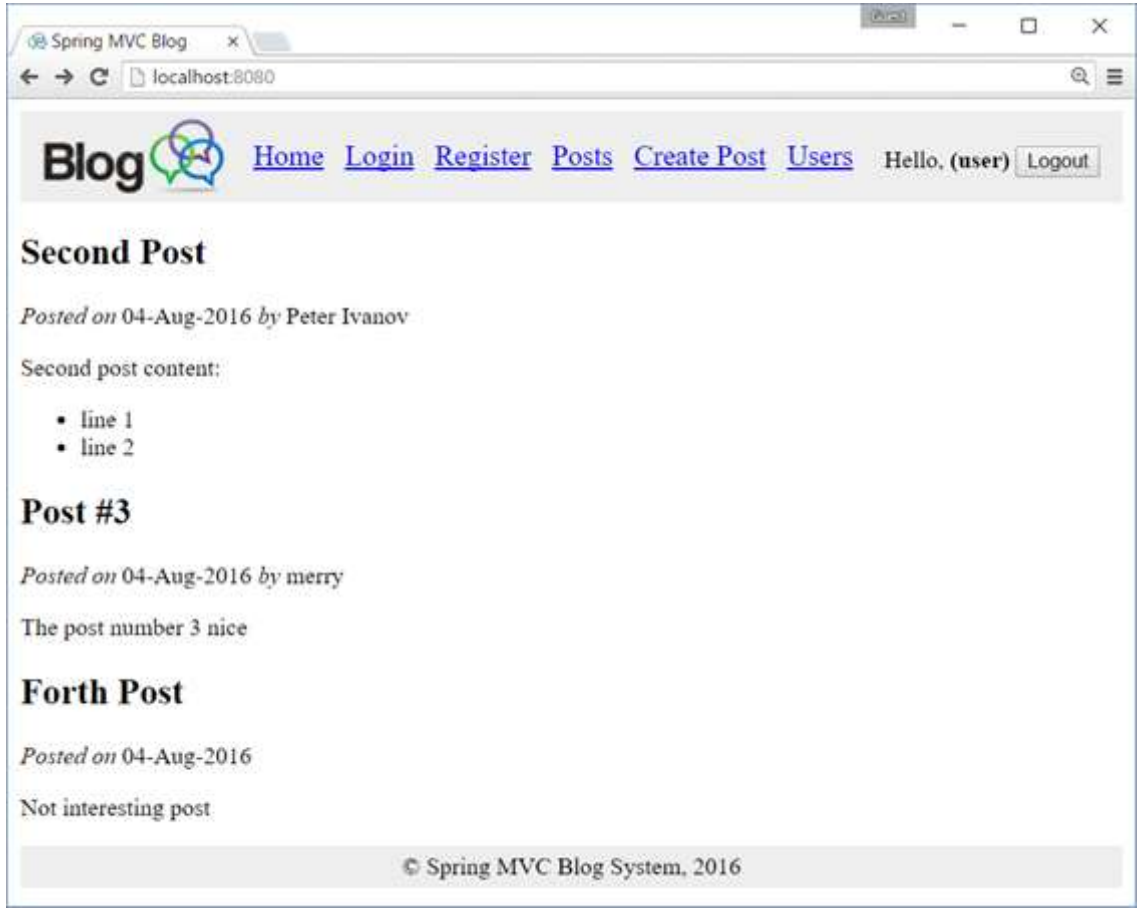
src/main/resources/templates/**index.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">

<head th:replace="layout :: site-head">
    <title>Spring MVC Blog</title>
</head>

<body>

<header th:replace="layout :: site-header" />

<main id="posts">
    <article th:each="p : ${latest3posts}">
      <h2 class="title" th:text="${p.title}">Post Title</h2>
      <div class="date">
        <i>Posted on</i>
        <span th:text="${#dates.format(p.date, 'dd-MMM-yyyy')}">22-May-2016</span>
        <span th:if="${p.author}" th:remove="tag">
          <i>by</i>
          <span th:text="${p.author.fullName != null ?
```

```
                        p.author.fullName : p.author.username}">Svetlin Nakov</span>
          </span>
        </div>
        <p class="content" th:utext="${p.body}">Post content</p>
      </article>
</main>

<footer th:replace="layout :: site-footer" />
</body>

</html>
```

The view iterates over the "**latest3posts**" collection and for each post in it shows the post details: **title**, **date** (in format **dd-MMM-yyyy**, e.g. 22-May-2016), **author** (when available, print its **full name** or just its **username** when the full name is missing) and post **body**.

Make the project and **open the home page** from your Web browser. It should look like this:



Implement the "List latest 5 Posts" at the Home Page Sidebar

Now implement the **sidebar at the home page** that holds the titles of the last 5 posts in hyperlinks to these posts. Add the following code just **after the header** in the **`index.html`** home page template:

src/main/resources/templates/**index.html**

```
<aside>
<h2>Recent Posts</h2>
```

```
<a href="#" th:each="p : ${latest5posts}" th:text="${p.title}"
th:href="@{/posts/view/{id}/(id=${p.id})}">Work Begins on HTML5.1</a>
</aside>
```

Now **test the application**. It should display **5 links at the home page**, just after the page header:

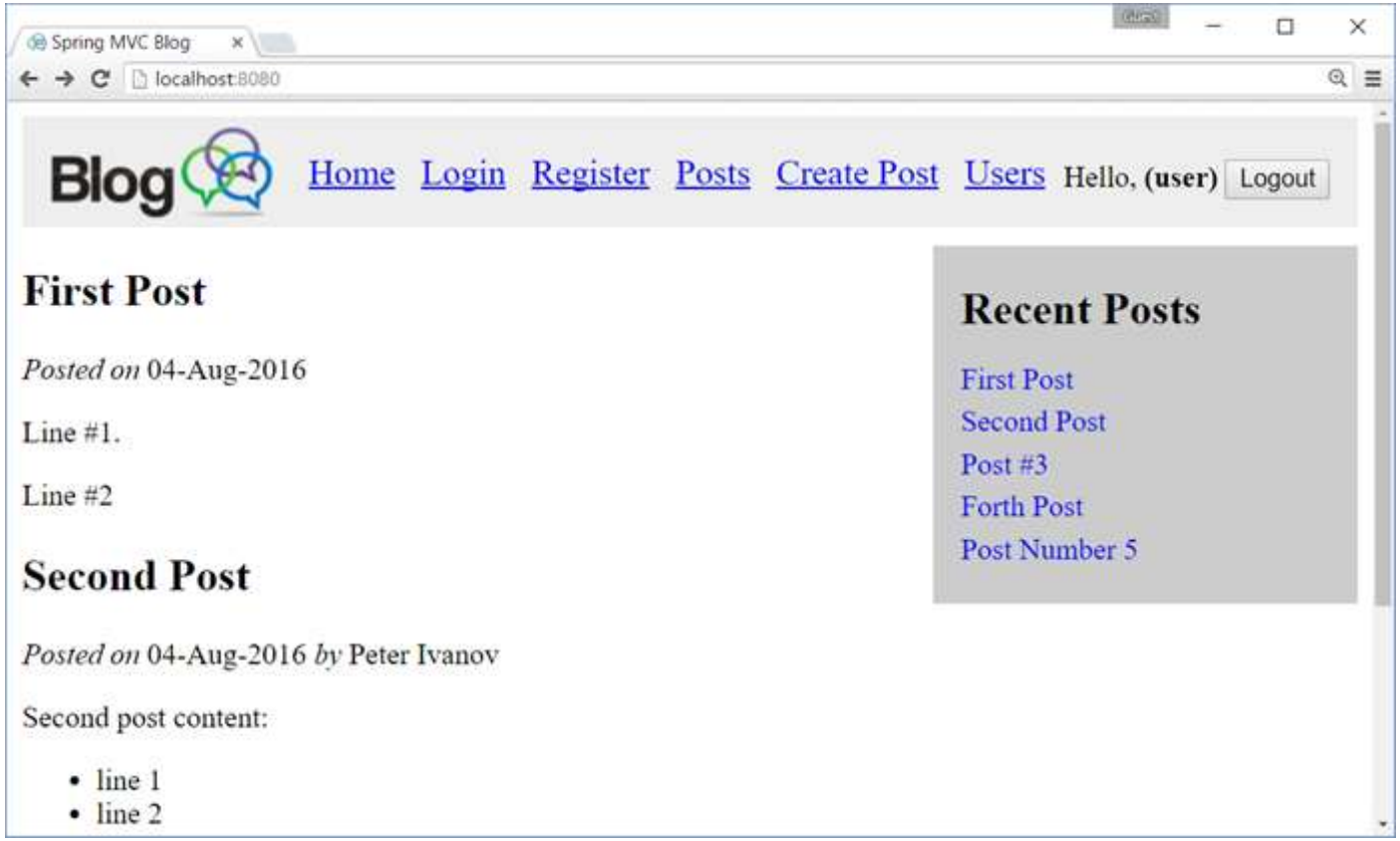
Now add some **CSS styles** to make these links display correctly at the **sidebar on the right** side of the home page. Append the following code in your **styles.css** file:

src/main/resources/public/css/**styles.css**

```
body>aside {
  float: right;
  width: 200px;
  background: #CCC;
  padding: 15px;
```

```
  margin-left: 20px;
  margin-top: 10px;
}

body>aside h2 {
  margin: 5px 0px 15px 0px;
}

body>aside a {
  display: block;
  margin: 5px 0px;
  text-decoration: none;
}

body>main:after {
  content: '';
  display: block;
  clear: both;
}
```

Now the sidebar looks better:



Create the "Post Details" Page

Now create the **"Post Details" page**, which will display a single post by **id**. It will be invoked when user clicks on the links in the Sidebar. It will be mapped to URL **`/posts/view/{id}/`**, e.g. http://localhost:8080/posts/view/3/.

Create "Post Details" Action in PostsController

Create the **`PostsController`** and its action **`view(id)`**:

src/main/java/blog/controllers/**PostsController.java**

```
@Controller
public class PostsController {
    @Autowired
    private PostService postService;

    @RequestMapping("/posts/view/{id}")
    public String view(@PathVariable("id") Long id, Model model) {
        Post post = postService.findById(id);
        model.addAttribute("post", post);
        return "posts/view";
    }
}
```

The **PostsController** works like the **HomeController**. It handles URLs like **/posts/view/{id}/** and finds the requested post using the **@Autowired** implementation of the **PostService** and renders the view "**posts/view**", which corresponds to the file "**view.html**" in directory **src/main/resources/templates/posts**. For cleaner organization, all post-related views are placed in a subdirectory "**posts**" under "**templates**".

Create "Post Details" View

Create the **posts/view.html** template (view) to display the post loaded by the **PostsController**:

src/main/resources/templates/**posts/view.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">

<head th:replace="layout :: site-head">
    <title th:text="${post.title}">View Post</title>
</head>

<body>

<header th:replace="layout :: site-header" />

<main id="posts">
  <article>
    <h2 class="title" th:text="${post.title}">Post Title</h2>
```

```
    <div class="date">
    <i>Posted on</i>
    <span th:text="${#dates.format(post.date, 'dd-MMM-yyyy')}">22-May-2016</span>
         <span th:if="${post.author}" th:remove="tag">
         <i>by</i>
         <span th:text="${post.author.fullName != null ?
                         post.author.fullName : post.author.username}">Svetlin Nakov</span>
         </span>
    </div>
    <p class="content" th:utext="${post.body}">Post content</p>
  </article>
</main>

<footer th:replace="layout :: site-footer" />

</body>

</html>
```

The view "**posts/view.html**" works exactly like the home view "**index.html**". It shows the post details: **title**, formatted **date**, **author** (when available, print its **full name** or **username** when the full name is missing) and post **body**. Like any other view, it re-uses the "**head**", "**site-header**" and "**site-footer**" fragments from "**layout.html**". Additionally, it changes the **page title** to hold the **post title**.

Test the "Post Details" View

Run the project (just recompile it and refresh the browser) to see how the new page works:

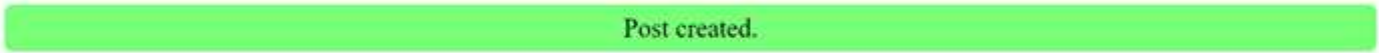
Test the "Post Details" View for Invalid Post

Looks good, but what will happen, if a wrong post is open, e.g. **`/posts/view/150`**? Let's see:

It would be better if the application says something like "Sorry, the post #150 is not found" in a good-looking form. You might change the error page following the Spring Boot documentation: http://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#boot-features-error-handling-custom-error-pages.

Implement Notifications System

Let's implement a "**notification system**" that allows us to display **success** / **error messages**, like these:



A good approach is to create a **`NotificationService`**, which will encapsulate the logic related to adding and storing the info / error messages + add some code in the site **layout template** to show the messages (when available). Let's create a **notification service**, **implementation** of this service and **notifications view template**.

Notification Service Interface

Create a new Java interface called "**`NotificationService.java`**" in **`src/main/java/blog/services`**:

src/main/java/blog/services/**NotificationService.java**

```
package blog.services;

public interface NotificationService {
```

```
    void addInfoMessage(String msg);
    void addErrorMessage(String msg);
}
```

This service interface provides methods for adding **error** and **information messages** for displaying later in the view.

Notification Service Implementation

Implement the **`NotificationService`** interface in a new Java class called **`NotificationServiceImpl`**. It stores the info and error messages in a **`List<NotificationMessage>`** in the HTTP session. The **HTTP session** is a special place where you can **store objects** (key → value) and they persist **for long time**. HTTP session objects survive request redirections and may be accessed long time later after they are created. The notification messages will be displayed later in the **site header** (in **`layout.html`**). To implement the notification service, just create the class:

src/main/java/blog/services/**NotificationServiceImpl.java**

```
package blog.services;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Service;

import javax.servlet.http.HttpSession;
import java.util.ArrayList;
import java.util.List;

@Service()
public class NotificationServiceImpl implements NotificationService {

    public static final String NOTIFY_MSG_SESSION_KEY = "siteNotificationMessages";

    @Autowired
    private HttpSession httpSession;

    @Override
    public void addInfoMessage(String msg) {
        addNotificationMessage(NotificationMessageType.INFO, msg);
    }
```

```
    @Override
    public void addErrorMessage(String msg) {
        addNotificationMessage(NotificationMessageType.ERROR, msg);
    }

    private void addNotificationMessage(NotificationMessageType type, String msg) {
        List<NotificationMessage> notifyMessages = (List<NotificationMessage>)
        httpSession.getAttribute(NOTIFY_MSG_SESSION_KEY);
        if (notifyMessages == null) {
            notifyMessages = new ArrayList<NotificationMessage>();
        }
        notifyMessages.add(new NotificationMessage(type, msg));
        httpSession.setAttribute(NOTIFY_MSG_SESSION_KEY, notifyMessages);
    }

    public enum NotificationMessageType {
        INFO,
        ERROR
    }

    public class NotificationMessage {
        NotificationMessageType type;
        String text;

        public NotificationMessage(NotificationMessageType type, String text) {
            this.type = type;
            this.text = text;
        }

        public NotificationMessageType getType() {
            return type;
        }

        public String getText() {
            return text;
        }
    }
}
```

Modify the Layout View Template to Show Notifications

Now the messages are available in the **HTTP session**. It is time to **display them** after the site header and remove them from the session (after they have been successfully shown to the user). **Replace** the "**site-header**" fragment in the layout view "**layout.html**" with the following:

src/main/resources/templates/**layout.html**

```
...

<header th:fragment="site-header" th:remove="tag">
    <header>
      <a href="index.html" th:href="@{/}"><img
                        src="../public/img/site-logo.png" th:src="@{/img/site-logo.png}" /></a>
      <a href="index.html" th:href="@{/}">Home</a>
      <a href="users/login.html" th:href="@{/users/login}">Login</a>
      <a href="users/register.html" th:href="@{/users/register}">Register</a>
      <a href="posts/index.html" th:href="@{/posts}">Posts</a>
      <a href="posts/create.html" th:href="@{/posts/create}">Create Post</a>
      <a href="users/index.html" th:href="@{/users}">Users</a>
      <div id="logged-in-info">
          <span>Hello, <b>(user)</b></span>
          <form method="post" th:action="@{/users/logout}">
              <input type="submit" value="Logout"/>
          </form>
      </div>
    </header>

    <ul id="messages" th:with="notifyMessages=${session[T(blog.services
          .NotificationServiceImpl).NOTIFY_MSG_SESSION_KEY]}">
      <li th:each="msg : ${notifyMessages}" th:text="${msg.text}"
           th:class="${#strings.toLowerCase(msg.type)}">
      </li>
      <span th:if="${notifyMessages}" th:remove="all" th:text="${session.remove(

          T(blog.services.NotificationServiceImpl).NOTIFY_MSG_SESSION_KEY)}"></span>

    </ul>
</header>
```

```
...
```

The above code **first replaces the site header** with two elements:

- The original **`<header>`** element which holds the site logo and top navigation.
- A new element **`<ul id="messages">`** to hold the notification messages

The code to show the notification messages is complex to be explained, but in brief: it iterates over the list of notification messages, **displays each message** in a **`<li>`** and finally **removes all messages** from the HTTP session.

Modify the PostsController to Add Error Messages

Now add an error message notification in the **`PostsController`**, when an **invalid post `id`** is requested:

src/main/java/blog/controllers/**PostsController.java**

```
@Controller
public class PostsController {
        @Autowired
        private PostService postService;

        @Autowired
        private NotificationService notifyService;

        @RequestMapping("/posts/view/{id}")
        public String view(@PathVariable("id") Long id, Model model) {
            Post post = postService.findById(id);
            if (post == null) {
                notifyService.addErrorMessage("Cannot find post #" + id);
                return "redirect:/";
            }
            model.addAttribute("post", post);
            return "posts/view";
        }
}
```

The above code first **injects the notification service** by "`@Autowired`" annotation. It adds a **check** in the `view(id)` action and in case of invalid post `id`, it **adds an error message** though the notification service and **redirects to the home page**, where this message well be shown.

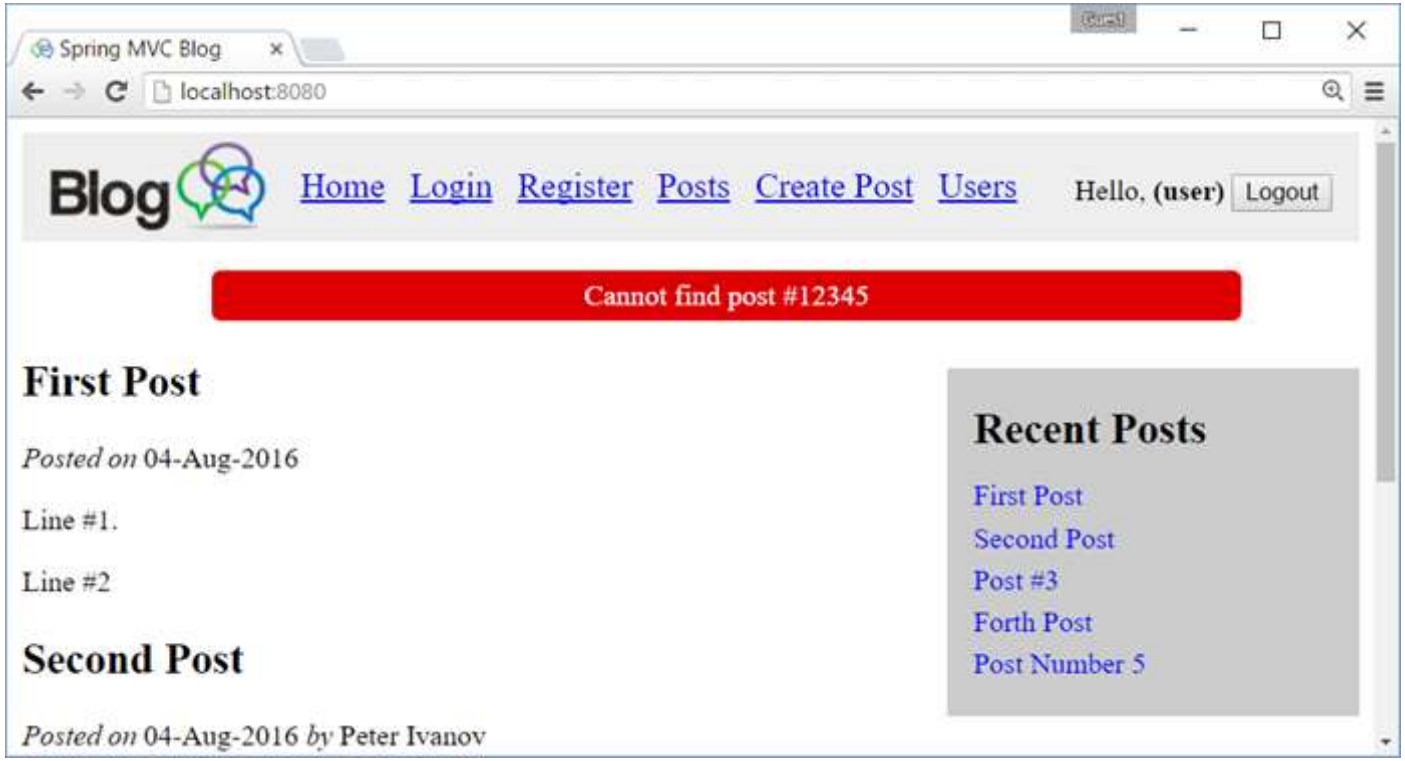
Add CSS Styles for the Notification Messages

src/main/resources/public/css/**styles.css**

```
ul#messages li {
display: block;
width: 80%;
margin: 5px auto;
text-align: center;
padding: 5px;
border-radius: 5px;
}

ul#messages li.info {
background: #7f7;
}

ul#messages li.error {
background: #d00;
color: white;
}
```

Test the Notification Messages

To test the notification messages, open an invalid post, e.g. http://localhost:8080/posts/view/12345. The result should be like this:



Add JavaScript to Animate the Notification Messages

Now, let's make the notification messages more fancy. Add **JavaScript code** that will hide automatically all notification messages after 3 seconds and will **hide all notification messages on mouse click**. Add the following code in the main file, holding the site JavaScript code "**blog-scripts.js**":

src/main/resources/public/js/**blog-scripts.js**

```
$(function() {
    $('#messages li').click(function() {
        $(this).fadeOut();
    });
    setTimeout(function() {
        $('#messages li.info').fadeOut();
```

```
    }, 3000);
});
```

The above **JS code** is loaded by the layout template (in the "**site-head**" fragment), just after the **jQuery** library and the function in it is executed when the page is completely loaded. The code finds all **<li class="message">** elements with jQuery and attaches **event handlers** to hide them (with pleasant fade-out effect) on mouse click or at 3000 milliseconds timeout (for **.info** messages).

Create the "Login" Page

Forms are a bit more complicated. Let's create the **login page** and its functionality.

Create LoginForm Model Class

First, create the **login form model**. It holds the validation rules for the form fields:

src/main/java/blog/forms/**LoginForm.java**

```
package blog.forms;

import javax.validation.constraints.NotNull;
import javax.validation.constraints.Size;

public class LoginForm {
    @Size(min=2, max=30, message = "Username size should be in the range [2...30]")
    private String username;

    @NotNull
    @Size(min=1, max=50)
    private String password;

    public String getUsername() {
        return username;
    }

    public void setUsername(String username) {
        this.username = username;
```

```
    }

    public String getPassword() {
        return password;
    }

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

Create UserService

Next, create the **user service interface** that implements the login **authentication functionality**:

src/main/java/blog/services/**UserService.java**

```
package blog.services;

public interface UserService {
    boolean authenticate(String username, String password);
}
```

Create UserServiceStubImpl

Next, create the **user service stub implementation** (we shall have real implementation later):

src/main/java/blog/services/**UserServiceStubImpl.java**

```
package blog.services;

import org.springframework.stereotype.Service;

import java.util.Objects;
```

```
@Service
public class UserServiceStubImpl implements UserService {
    @Override
    public boolean authenticate(String username, String password) {
        // Provide a sample password check: username == password
        return Objects.equals(username, password);
    }
}
```

Create the LoginController

Next, create the **login controller**:

src/main/java/blog/controllers/**LoginController.java**

```
package blog.controllers;

import blog.forms.LoginForm;
import blog.services.NotificationService;
import blog.services.UserService;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Controller;
import org.springframework.validation.BindingResult;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;

import javax.validation.Valid;

@Controller
public class LoginController {

    @Autowired
    private UserService userService;

    @Autowired
    private NotificationService notifyService;

    @RequestMapping("/users/login")
    public String login(LoginForm loginForm) {
        return "users/login";
```

```
    }

    @RequestMapping(value = "/users/login", method = RequestMethod.POST)
    public String loginPage(@Valid LoginForm loginForm, BindingResult bindingResult) {
        if (bindingResult.hasErrors()) {
            notifyService.addErrorMessage("Please fill the form correctly!");
            return "users/login";
        }

        if (!userService.authenticate(

            loginForm.getUsername(), loginForm.getPassword())) {
            notifyService.addErrorMessage("Invalid login!");
            return "users/login";
        }

        notifyService.addInfoMessage("Login successful");
        return "redirect:/";
    }
}
```

Create the Login View

Finally, create the **login view**:

src/main/resources/templates/users/**login.html**

```
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">

<head th:replace="layout :: site-head">
  <title>Login</title>
</head>

<body>

<header th:replace="layout :: site-header" />

<h1>Login in the Blog</h1>
```

```
<form method="post" th:object="${loginForm}">
  <div><label for="username">Username:</label></div>
  <input id="username" type="text" name="username" th:value="*{username}" />
  <span class="formError" th:if="${#fields.hasErrors('username')}"
                          th:errors="*{username}">Invalid username</span>

  <div><label for="password" th:value="*{username}">Password:</label></div>
  <input id="password" type="password" name="password" th:value="*{password}" />
  <span class="formError" th:if="${#fields.hasErrors('password')}"
                          th:errors="*{password}">Invalid password</span>

  <div><input type="submit" value="Login"/>
  <a href="register.html" th:href="@{/users/register}">[Go to Register]</a></div>
</form>

<footer th:replace="layout :: site-footer" />

</body>

</html>
```

Add CSS for the Form Validation

Add some **CSS** for the form validation:

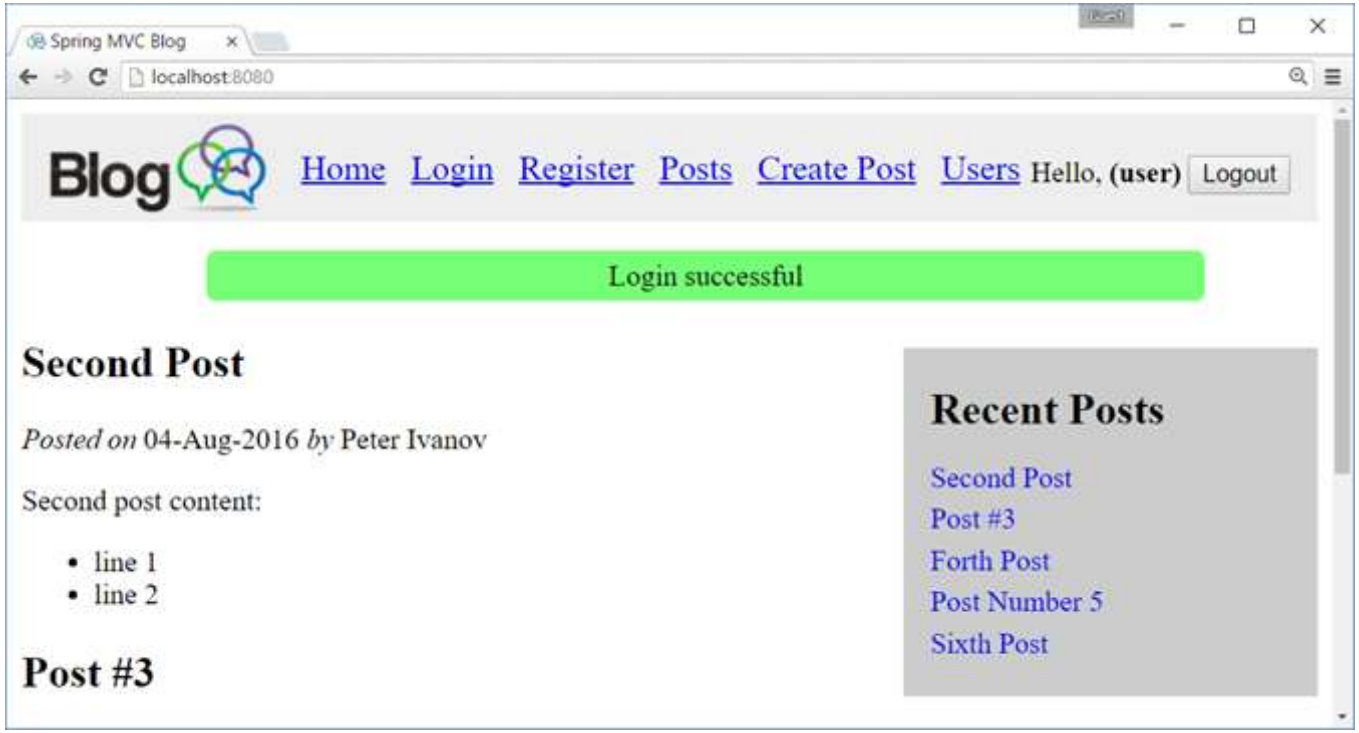
src/main/resources/public/css/**styles.css**

```
.formError {
    color: red;
    font-style: italic;
}
```

Test the Login Form Functionality

Now **run** the login form and **test** it:


Login
localhost:8080/users/login
Blog
Home Login Register Posts Create Post Users
Hello, (user) Logout
Invalid login!
Login in the Blog
Username:
test
Password:
Login [Go to Register]
© Spring MVC Blog System, 2016



Create the “User Registration” Page

Create the page like the previous one. It is very similar.

The next few steps are still unfinished, so you could implement them yourself.

Create the “List Posts” Page

Create the “Create New Post” Page

Create the “Delete Post” Page

Create the “Edit Existing Post” Page

Create the “List Users” Page

Part III: Connect the Application to the DB (Spring Data JPA)

In this section we shall connect the application to the **database** and implement data access logic with **Spring Data JPA**, **JPA**, **Hibernate** and **MySQL**.

Add Spring Data Maven Dependencies

Add **Spring Data JPA** and **MySQL** dependencies in the **Maven** project settings:

pom.xml

```
<dependency>
<groupId>org.springframework.data</groupId>
<artifactId>spring-data-jpa</artifactId>
</dependency>

<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
```

```
<dependency>
<groupId>mysql</groupId>
<artifactId>mysql-connector-java</artifactId>
<version>6.0.3</version>
</dependency>
```

Define MySQL Connection Settings (application.properties)

Define the JPA settings to connect to your MySQL database. Ensure your MySQL server is running and the database "**blog_db**" exists inside it. Use the following database configuration settings:

src/main/resources/**application.properties**

```
spring.thymeleaf.cache = false

spring.datasource.driver-class-name = com.mysql.cj.jdbc.Driver
spring.datasource.url = jdbc:mysql://localhost/blog_db?characterEncoding=utf8
spring.datasource.username = root
spring.datasource.password =

# Configure Hibernate DDL mode: create / update
spring.jpa.properties.hibernate.hbm2ddl.auto = create

# Disable the default loggers
#logging.level.org = WARN
#logging.level.blog = WARN

### Show SQL executed with parameter bindings
#logging.level.org.hibernate.SQL = DEBUG
#logging.level.org.hibernate.type.descriptor = TRACE
#spring.jpa.properties.hibernate.format_sql = TRUE
```

Annotate the Entity Classes: User and Post

Put **JPA annotations** (table and column mappings + relationship mappings) to the entity classes in order to make then ready for **persistence** in the database through the **JPA** / **`Hibernate`** technology. Start with the **`User`** class:

src/main/java/blog/models/**User.java**

```
package blog.models;

import javax.persistence.*;
import java.util.HashSet;
import java.util.Set;

@Entity
@Table(name = "users")
public class User {

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;

    @Column(nullable = false, length = 30, unique = true)
    private String username;

    @Column(length = 60)
    private String passwordHash;

    @Column(length = 100)
    private String fullName;

    @OneToMany(mappedBy = "author")
    private Set<Post> posts = new HashSet<Post>();
```

```
public Long getId() {
return id;
}

public void setId(Long id) {
this.id = id;
}

public String getUsername() {
return username;
}

public void setUsername(String username) {
this.username = username;
}

public String getPasswordHash() {
return passwordHash;
}

public void setPasswordHash(String passwordHash) {
this.passwordHash = passwordHash;
}

public String getFullName() {
return fullName;
}

public void setFullName(String fullName) {
this.fullName = fullName;
}

public Set<Post> getPosts() {
return posts;
}
```

```
    public void setPosts(Set<Post> posts) {
    this.posts = posts;
    }

    public User() {
    }

    public User(String username, String fullName) {
    this.username = username;
    this.fullName = fullName;
    }

    public User(Long id, String username, String fullName) {
    this.id = id;
    this.username = username;
    this.fullName = fullName;
    }

    @Override
    public String toString() {
    return "User{" +
    "id=" + id +
    ", username='" + username + '\'' +
    ", passwordHash='" + passwordHash + '\'' +
    ", fullName='" + fullName + '\'' +
    '}';
    }

}
```

Annotate in the same way the **Post** class:

src/main/java/blog/models/**Post.java**

```
package blog.models;

import javax.persistence.*;
import java.util.Date;

@Entity
@Table(name = "posts")
public class Post {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;

    @Column(nullable = false, length = 300)
    private String title;

    @Lob @Column(nullable = false)
    private String body;

    @ManyToOne(optional = false, fetch = FetchType.LAZY)
    private User author;

    @Column(nullable = false)
    private Date date = new Date();

    public Long getId() {
        return id;
    }

    public void setId(Long id) {
        this.id = id;
    }

    public String getTitle() {
        return title;
    }

    public void setTitle(String title) {
        this.title = title;
    }

    public String getBody() {
        return body;
```

```
    }

    public void setBody(String body) {
        this.body = body;
    }

    public User getAuthor() {
        return author;
    }

    public void setAuthor(User author) {
        this.author = author;
    }

    public Date getDate() {
        return date;
    }

    public void setDate(Date date) {
        this.date = date;
    }

     public Post() {}

     public Post(Long id, String title, String body, User author) {
         this.id = id;
         this.title = title;
         this.body = body;
         this.author = author;
    }

     @Override
     public String toString() {
        return "Post{" +
           "id=" + id +
           ", title='" + title + '\'' +
           ", body='" + body + '\'' +
           ", author=" + author +
           ", date=" + date +
           '}';
    }
}
```

Create UserRepository and PostRepository (Spring Data JPA)

Create the interface **`UserRepository`**. Note that you **will not provide any implementation for it**. Spring Data JPA will implement it for you. This is part of **the "magic"** behind the "**Spring Data**" framework:

src/main/java/blog/repositories/**UserReposiory.java**

```
package blog.repositories;

import blog.models.User;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.stereotype.Repository;

@Repository
public interface UserRepository extends JpaRepository<User, Long> {
}
```

Create the interface **`PostRepository`** in similar way. **Don't implement this interface**. Spring Data will create an implementation of it. This is **the "magic"** of the **`@Repository`** annotation.

src/main/java/blog/repositories/**PostReposiory.java**

```
package blog.repositories;

import blog.models.Post;
import org.springframework.data.domain.Pageable;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.data.jpa.repository.Query;
import org.springframework.stereotype.Repository;

import java.util.List;
```

```
@Repository
public interface PostRepository extends JpaRepository<Post, Long> {
@Query("SELECT p FROM Post p LEFT JOIN FETCH p.author ORDER BY p.date DESC")
List<Post> findLatest5Posts(Pageable pageable);
}
```

Not that the above **JPQL query** will be automatically implemented and mapped to the method **`findLatest5Posts()`** in the service implementation provided by Spring Data.

Implement the PostService and UserService to Use the DB

Just add new implementations for the **`UserService`** and **`PostService`**, annotated with **`@Primary`**. This will tell the Spring Framework to use these implementations instead of the old stubs.

src/main/java/blog/services/**PostServiceJpaImpl.java**

```
package blog.services;

import blog.models.Post;
import blog.repositories.PostRepository;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Primary;
import org.springframework.data.domain.PageRequest;
import org.springframework.stereotype.Service;

import java.util.List;

@Service
@Primary
public class PostServiceJpaImpl implements PostService {

    @Autowired
    private PostRepository postRepo;
```

```
    @Override
    public List<Post> findAll() {
    return this.postRepo.findAll();
    }

    @Override
    public List<Post> findLatest5() {
    return this.postRepo.findLatest5Posts(new PageRequest(0, 5));
    }

    @Override
    public Post findById(Long id) {
    return this.postRepo.findOne(id);
    }

    @Override
    public Post create(Post post) {
    return this.postRepo.save(post);
    }

    @Override
    public Post edit(Post post) {
    return this.postRepo.save(post);
    }

    @Override
    public void deleteById(Long id) {
    this.postRepo.delete(id);
    }

}
```

The **`UserService`** and its **implementation** are similar to **`PostService`** and its **implementation**.

src/main/java/blog/services/**UserService.java**

```
package blog.services;

import blog.models.User;

import java.util.List;

public interface UserService {

    List<User> findAll();
    User findById(Long id);
    User create(User user);
    User edit(User user);
    void deleteById(Long id);

}
```

The **`UserServiceJpaImpl`** class just invokes the repository methods to do its job. It is annotated with the **`@Service`** and **`@Primary`** annotations to tell the Spring Framework to make it available for **`@Autowire`** injection in the controllers:

src/main/java/blog/services/**UserServiceJpaImpl.java**

```
package blog.services;

import blog.models.User;
import blog.repositories.UserRepository;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Primary;
import org.springframework.stereotype.Service;

import java.util.List;

@Service
@Primary
```

```
public class UserServiceJpaImpl implements UserService {

    @Autowired
    private UserRepository userRepo;

    @Override
    public List<User> findAll() {
    return this.userRepo.findAll();
    }

    @Override
    public User findById(Long id) {
    return this.userRepo.findOne(id);
    }

    @Override
    public User create(User user) {
    return this.userRepo.save(user);
    }

    @Override
    public User edit(User user) {
    return this.userRepo.save(user);
    }

    @Override
    public void deleteById(Long id) {
    this.userRepo.delete(id);
    }

}
```

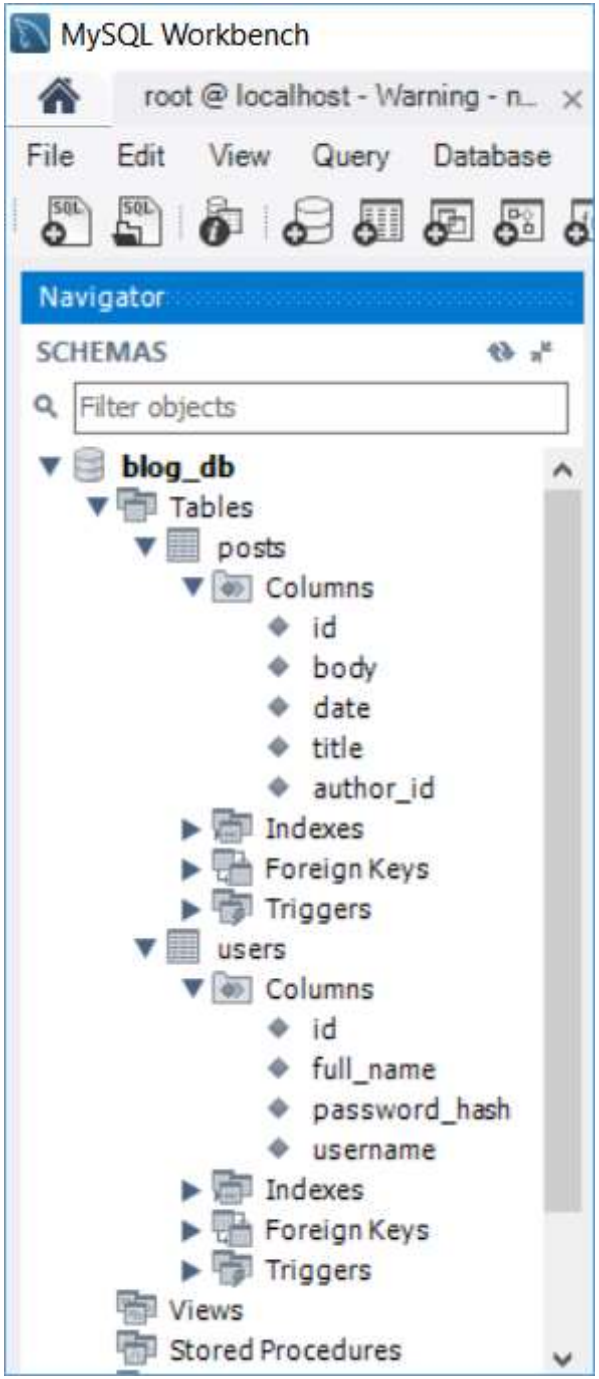
Create the Database with hbm2ddl.auto

Ensure the **hbm2ddl** is enabled (value "**create**"). This will **drop the database** at application startup and will re-**create the database tables** according to the entity classes found in the project.

src/main/resources/**application.properties**

```
# Configure Hibernate DDL mode: create / update
spring.jpa.properties.hibernate.hbm2ddl.auto = create
```

Build and **run** the project. Ensure all **tables are created** in the MySQL. Use **MySQL Workbench** or other MySQL database administration tool to see the table structures:


MySQL Workbench
root @ localhost - Warning - n...
File
Edit
View
Query
Database
Navigator
SCHEMAS
Filter objects
blog_db
Tables
posts
Columns
id
body
date
title
author_id
Indexes
Foreign Keys
Triggers
users
Columns
id
full_name
password_hash
username
Indexes
Foreign Keys
Triggers
Views
Stored Procedures

The **database** will be **empty**: no users, no posts.

After that **disable auto-table creation**:

src/main/resources/**application.properties**

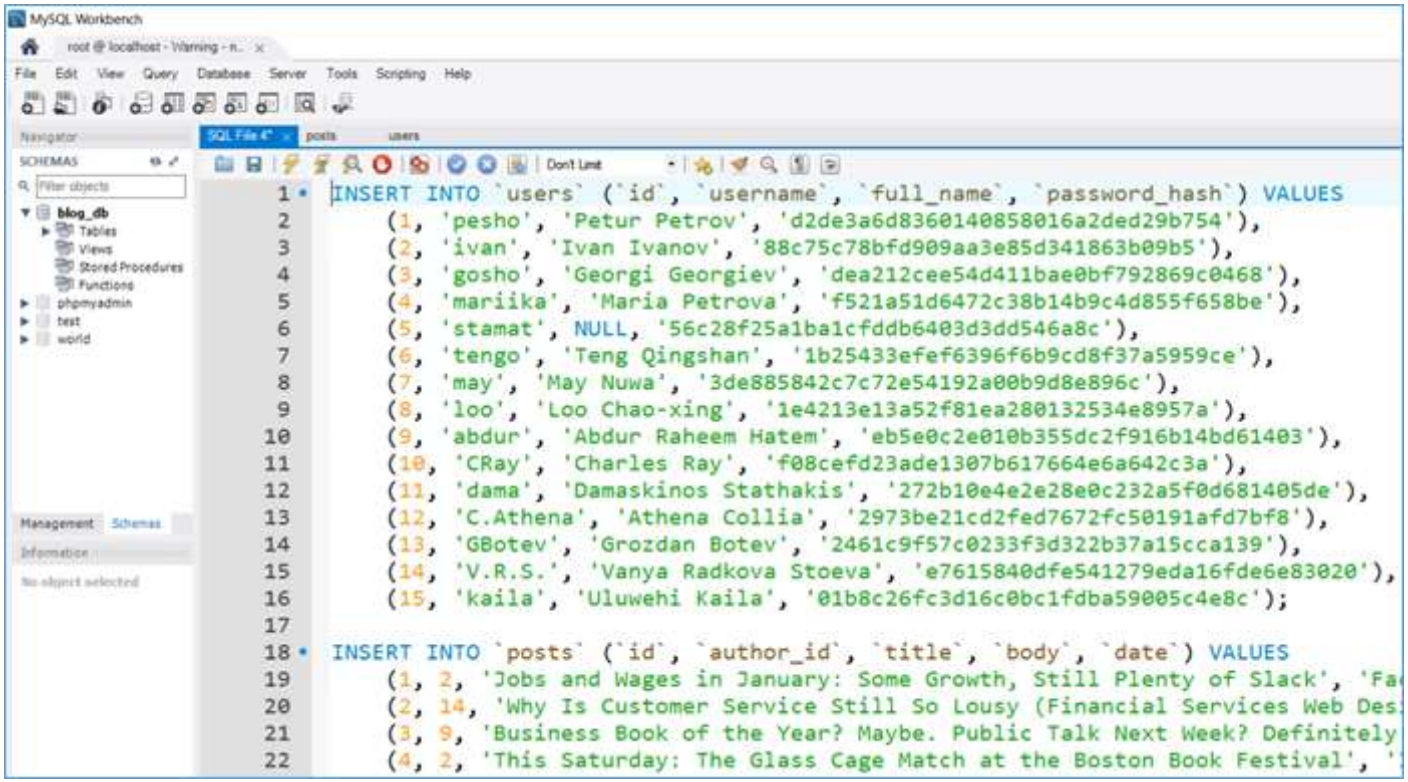
```
# Configure Hibernate DDL mode: create / update
spring.jpa.properties.hibernate.hbm2ddl.auto = update
```

Run the project again. You are ready to **fill some sample data** in the database.

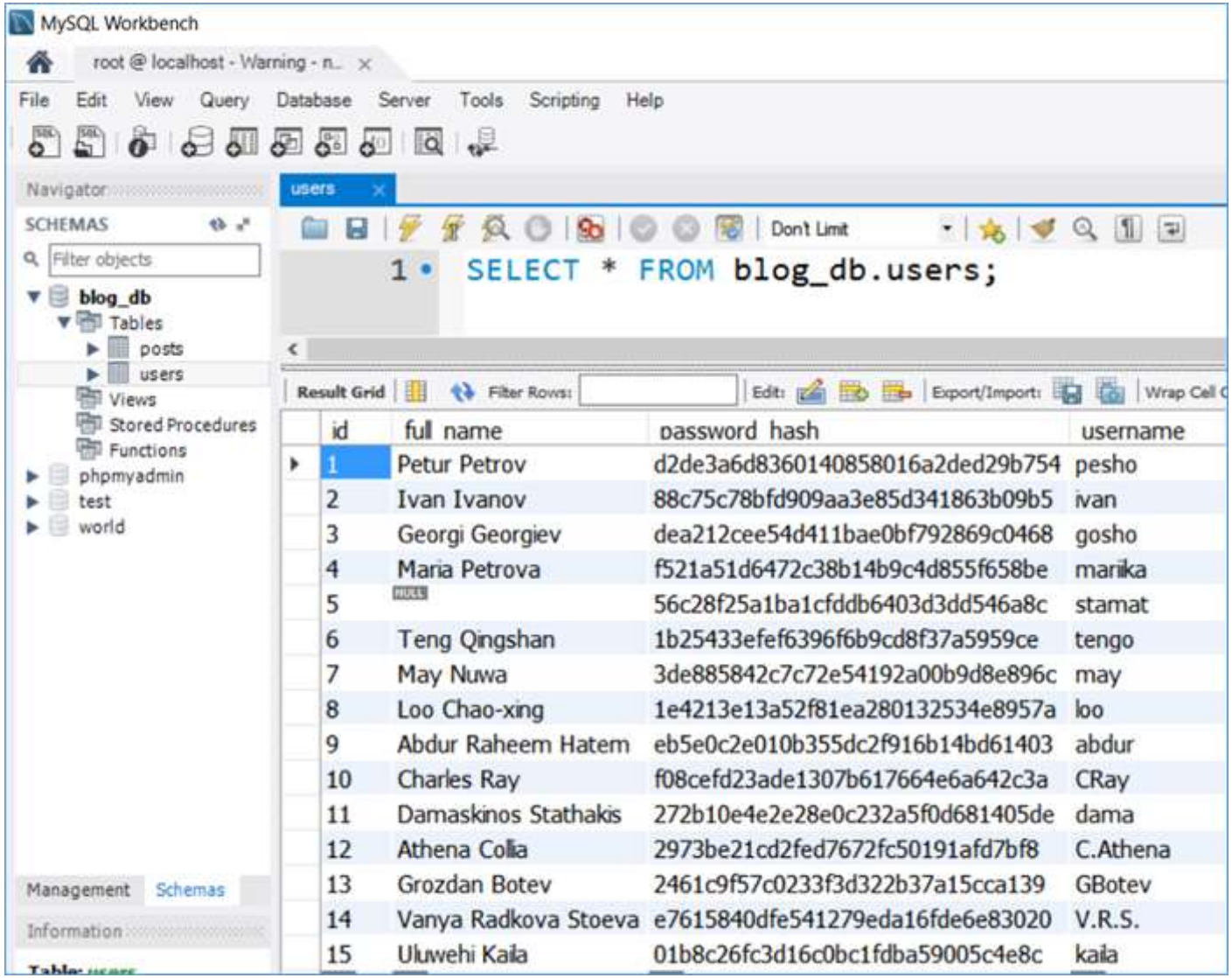
Create Some Sample Data in MySQL (Users and Posts)

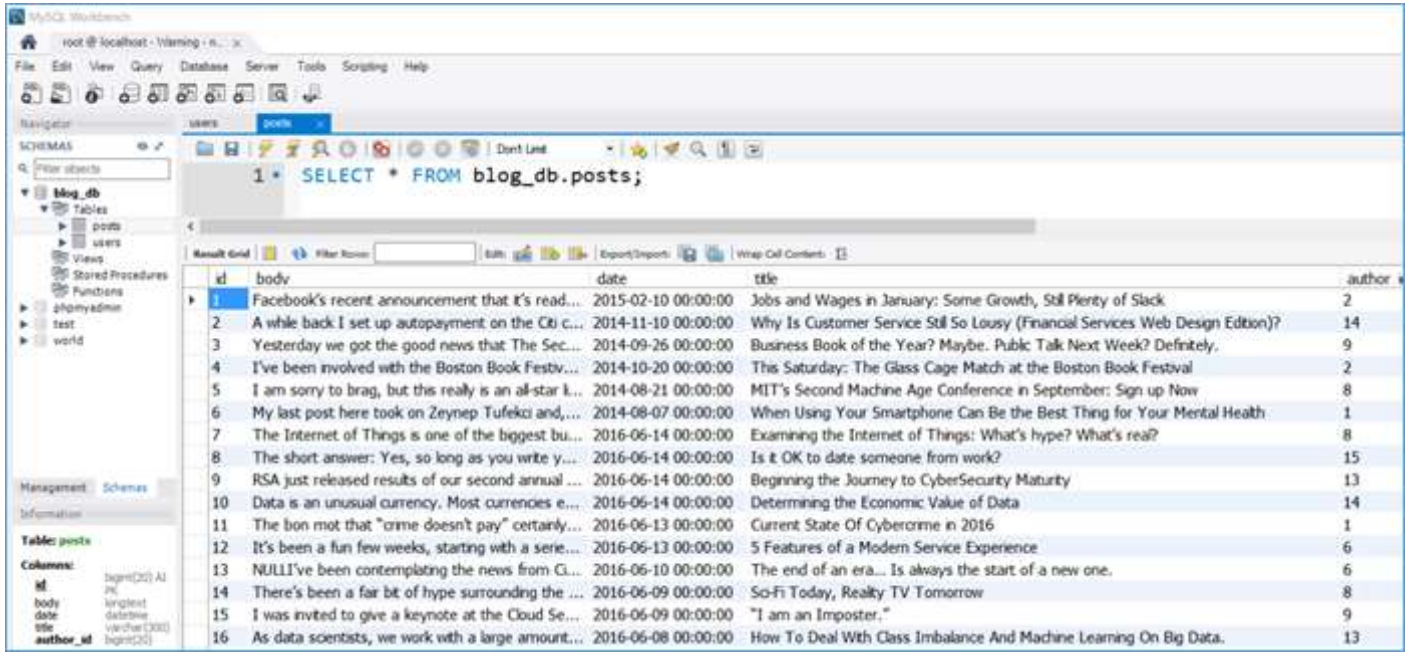
Put some data in the MySQL tables. Otherwise the home page will be empty (no blog posts).

You may use the **database script** from the resources coming with this lab. To **insert some users and** posts, execute the script **`db/Sample-data-users-posts.sql`**:



Check your database tables **`users`** and **`posts`**:

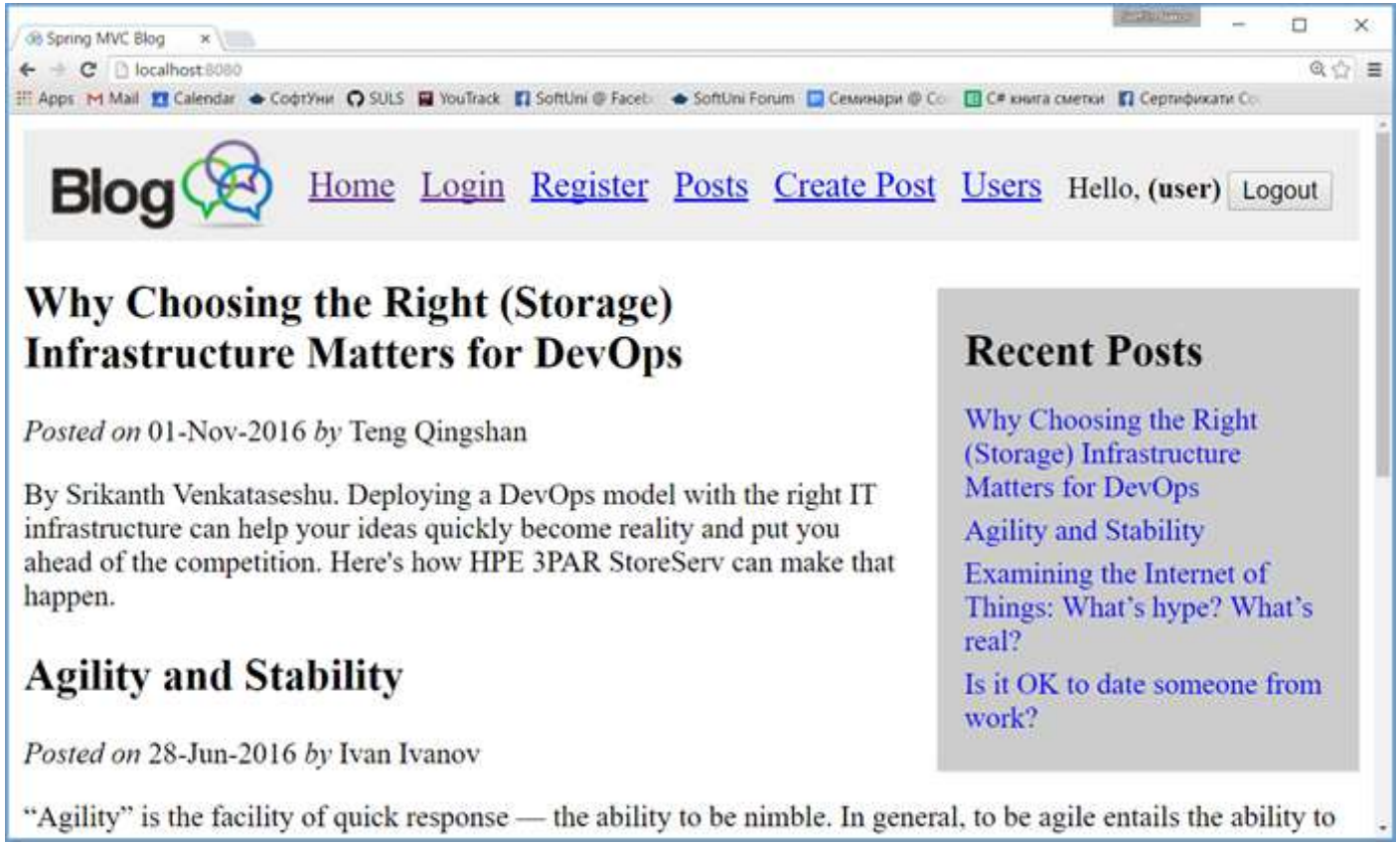

MySQL Workbench
root @ localhost - Warning - n...
File Edit View Query Database Server Tools Scripting Help
Navigator
SCHEMAS
Filter objects
blog_db
Tables
posts
users
Views
Stored Procedures
Functions
phpmyadmin
test
world
Management Schemas
Information
users
Don't Limit
1 • SELECT * FROM blog_db.users;
Result Grid Filter Rows: Edit: Export/Import: Wrap Cell
id full name password hash username
1 Petur Petrov d2de3a6d8360140858016a2ded29b754 pesho
2 Ivan Ivanov 88c75c78bfd909aa3e85d341863b09b5 ivan
3 Georgi Georgiev dea212cee54d411bae0bf792869c0468 gosho
4 Maria Petrova f521a51d6472c38b14b9c4d855f658be marika
5 NULL 56c28f25a1ba1cfddb6403d3dd546a8c stamat
6 Teng Qingshan 1b25433efef6396f6b9cd8f37a5959ce tengo
7 May Nuwa 3de885842c7c72e54192a00b9d8e896c may
8 Loo Chao-xing 1e4213e13a52f81ea280132534e8957a loo
9 Abdur Raheem Hatem eb5e0c2e010b355dc2f916b14bd61403 abdur
10 Charles Ray f08cefd23ade1307b617664e6a642c3a CRay
11 Damaskinos Stathakis 272b10e4e2e28e0c232a5f0d681405de dama
12 Athena Collia 2973be21cd2fed7672fc50191afd7bf8 C.Athena
13 Grozdan Botev 2461c9f57c0233f3d322b37a15cca139 GBotev
14 Vanya Radkova Stoeva e7615840dfe541279eda16fde6e83020 V.R.S.
15 Uluwehi Kaila 01b8c26fc3d16c0bc1fdba59005c4e8c kaila



id	body	date	title	author
1	Facebook's recent announcement that it's read...	2015-02-10 00:00:00	Jobs and Wages in January: Some Growth, Still Plenty of Slack	2
2	A while back I set up autopayment on the Citi c...	2014-11-10 00:00:00	Why Is Customer Service Still So Lousy (Financial Services Web Design Edition)?	14
3	Yesterday we got the good news that The Sec...	2014-09-26 00:00:00	Business Book of the Year? Maybe. Public Talk Next Week? Definitely.	9
4	I've been involved with the Boston Book Festiv...	2014-10-20 00:00:00	This Saturday: The Glass Cage Match at the Boston Book Festival	2
5	I am sorry to brag, but this really is an all-star l...	2014-08-21 00:00:00	MIT's Second Machine Age Conference in September: Sign up Now	8
6	My last post here took on Zeynep Tufekci and,...	2014-08-07 00:00:00	When Using Your Smartphone Can Be the Best Thing for Your Mental Health	1
7	The Internet of Things is one of the biggest bu...	2016-06-14 00:00:00	Examining the Internet of Things: What's hype? What's real?	8
8	The short answer: Yes, so long as you write y...	2016-06-14 00:00:00	Is it OK to date someone from work?	15
9	RSA just released results of our second annual ...	2016-06-14 00:00:00	Beginning the Journey to CyberSecurity Maturity	13
10	Data is an unusual currency. Most currencies e...	2016-06-14 00:00:00	Determining the Economic Value of Data	14
11	The bon mot that "crime doesn't pay" certainly...	2016-06-13 00:00:00	Current State Of Cybercrime in 2016	1
12	It's been a fun few weeks, starting with a serie...	2016-06-13 00:00:00	5 Features of a Modern Service Experience	6
13	NULLI've been contemplating the news from Ci...	2016-06-10 00:00:00	The end of an era... Is always the start of a new one.	6
14	There's been a fair bit of hype surrounding the ...	2016-06-09 00:00:00	Sci-Fi Today, Reality TV Tomorrow	8
15	I was invited to give a keynote at the Cloud Se...	2016-06-09 00:00:00	"I am an Imposter."	9
16	As data scientists, we work with a large amount...	2016-06-08 00:00:00	How To Deal With Class Imbalance And Machine Learning On Big Data.	13

Test the Sample Users and Posts Data from MySQL

Run the application again to test the sample data:



Part IV: User Accounts with Spring Security

In this section we shall implement **user accounts** and access permissions, based on the **Spring Security framework**. This includes user **registration**, user **login**, user **logout**, authentication, authorization, access control, etc.

Sorry, this part of the tutorial is still unfinished. A lot of work will come here for the login / logout to be implemented using the Spring Security framework. You might check this article as reference: https://spring.io/guides/gs/securing-web/.

Download the source code of the project up to this step (still unifinished): Spring-MVC-Blog-unfinished.zip.

Enjoy!

Tags: CSS Database entity classes Hibernate HTML Java Java Persistence API Java Web JavaScript jpa JPQL jQuery MySQL softuni software university Spring Boot Spring controllers Spring Data Spring Data JPA Spring form validation Spring Framework Spring models Spring MVC Spring repositories Spring services SQL Thymeleaf views tutorial web web development

COMMENTS (63)

63 Responses to “Creating a Blog System with Spring MVC, Thymeleaf, JPA and MySQL”

puvN says:
August 20, 2016 at 16:37

that’s awesome, thanks.
right now i am developing a website for my portfolio and this helps me so much

Reply

Max says:
August 22, 2016 at 22:45

Hi. May be you can help me. When I create layout.html file and change index.html I have this exception org.xml.sax.SAXParseException: Open quote is expected for attribute “xmlns:th” associated with an element type “html”.

Reply

nakov says:
August 23, 2016 at 00:11

Check the video. I recorded a video following this tutorial. It is in Bulgarian only, but you can see the text I type:
https://www.youtube.com/watch?v=VXRR7aTl1So

Reply

Max says:
August 23, 2016 at 08:31

Thanks, at now all works.

Reply

Mihaly says:
October 18, 2016 at 23:13

Could you please tell me how did you solve the problem? I have the same and its drives me insane.
Mail: vmisi20 [at] gmail.com

Reply

Vamshi Krishna says:
September 6, 2017 at 05:07

Hi Max,
I am also getting same error while including layout.html in index.html. Can you please tell me how you have resolved the issue.

Thanks.

Reply

Vamshi Krishna says:
September 6, 2017 at 21:11

Hi Max,
It is working fine after changing all the double quotes.
Thanks.

Anika says:

December 7, 2016 at 23:25

hi, youtube video link is not working , could you please tell me how you fixed this issue? i am also getting same error.

Reply

Alexandr says:
March 23, 2017 at 13:49

You must change quotes (because they are not standard here).

Reply

Marc says:
August 28, 2017 at 23:53

Yeah, Thymeleaf or the spring parser is very very very touchy. I had to simply retype it a couple times and then it worked fine. One of those mysteruious, wtf is the difference kind of fixes.

Reply

Max says:
August 23, 2016 at 12:19

Now I have one more problem
in file index.html when need change code to

Post Title

Posted on
22-May-2016

by
Svetlin Nakov

Post content

all functions “${...}” underlined in red. Intellij write “Cannot resolve ...”
Can you help me?

Reply

Max says:
August 23, 2016 at 12:22

My code does not copy... Maybe you can look when you write “Let’s modify the home page view to display the latest 3 posts:”

Reply

Daniel says:
September 15, 2016 at 13:49

Hi, it's really interesting this post however because i'm not a java developer I'm having some problems with the implementations of what it's missing, would it be possible to provide it?

Reply

Luke says:
September 18, 2016 at 05:37

Will you finish this tutorial ? it will be very helpful for newbie.

Reply

lucas says:
September 26, 2016 at 04:44

Pretty good. Need couple tweaks here and there but it covers the basics.

Can you explain how to publish this online thru AWS or digitalocean etc.

Reply

User says:
October 17, 2016 at 21:53

I've been attempting to follow the tutorial and I've run into some problems.
I definitely wish IntelliJ were smarter when it came to html, and especially Thymeleaf.

I'm still at the beginning, where the index is loaded with the template. I keep getting a WhiteLabel Error. Even after copying and pasting every file, it still won't vanish.

The only difference is that I used gradle instead of maven, but I absolutely have all dependencies accounted for, so, unless there's something not mentioned about maven, it must be either in my settings on IntelliJ or in the code.

The WhiteLabel is the following:
There was an unexpected error (type=Internal Server Error, status=500).
Exception parsing document: template="index", line 2 – column 16

So, given that I've copied and pasted anything, thymeleaf is enabled like normal, any clue what's going on?

Reply

nakov says:
October 21, 2016 at 01:08

See the logs at the console.

Reply

Anonymous says:
March 15, 2017 at 10:29

when you copy-paste the codes, especially the html codes, make sure that the double quotation marks are according to your computer's font

Reply

benjamin says:
October 21, 2016 at 19:08

hello
when i do the "Run the Empty Web Application" step. These are some problem when i run the BlogMvcApplication class.The console result are below:

```
. ____ _ __ _ _
/\\ / ___'_ __ _ _(_)_ __ __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
\\/ ___)| |_)| | | | | || (_| | ) ) ) )
' |____| .__|_| |_|_| |_\__, | / / / /
=========|_|==============|___/=/_/_/_/
:: Spring Boot :: (v1.4.0.RELEASE)

2016-10-22 00:01:54.408 INFO 17476 --- [ main] blog.BlogMvcApplication : Starting BlogMvcApplication on Lenovo-PC-LL with PID 17476 (C:\Users\liang\IdeaProjects\Blog\target\classes started by liang in C:\Users\liang\IdeaProjects\Blog)
2016-10-22 00:01:54.416 INFO 17476 --- [ main] blog.BlogMvcApplication : No active profile set, falling back to default profiles: default
2016-10-22 00:01:54.678 INFO 17476 --- [ main] s.c.a.AnnotationConfigApplicationContext : Refreshing org.springframework.context.annotation.AnnotationConfigApplicationContext@57c758ac: startup date [Sat Oct 22 00:01:54 CST 2016];
```

root of context hierarchy
2016-10-22 00:01:57.986 INFO 17476 — [main] o.s.j.e.a.AnnotationMBeanExporter : Registering beans for JMX exposure on startup
2016-10-22 00:01:58.009 INFO 17476 — [main] blog.BlogMvcApplication : Started BlogMvcApplication in 4.522 seconds (JVM running for 5.226)
2016-10-22 00:01:58.010 INFO 17476 — [Thread-1] s.c.a.AnnotationConfigApplicationContext : Closing org.springframework.context.annotation.AnnotationConfigApplicationContext@57c758ac: startup date [Sat Oct 22 00:01:54 CST 2016]; root of context hierarchy
2016-10-22 00:01:58.012 INFO 17476 — [Thread-1] o.s.j.e.a.AnnotationMBeanExporter : Unregistering JMX-exposed beans on shutdown

Process finished with exit code 0

I am the new guy for the IDEA. I think maybe i should configure tomcat for IDEA. Am i right,where is the problem, can you tell me how to fix the problem.Thank you very much!

Reply

benjamin says:
October 22, 2016 at 05:49

i have solve this problem when i configure the maven setting.xml

Reply

Stuart says:
November 17, 2016 at 17:15

Thanks for this great tutorial, just wondering if there's any plans to complete the missing parts?

Reply

benjamin says:
November 18, 2016 at 16:07

wo can learn the missing parts together. what is your e-mail?

Reply

David says:
January 14, 2017 at 18:42

Hi.

This post is amazing and it workssss!!!.

Just need to know how to add a link in column table to sort columns.

Anyway, thanks for your work!!

David

Reply

Zita says:
February 5, 2017 at 11:51

Hi!

The tutorial is pretty good, but was a huge disappointment to see that the part I expected the most was missing! I really only needed the Create/Edit post part, which should be the core of a blog website (even more important than user login). Could you fill that in?

Thanks!

Reply

Kerim says:
February 16, 2017 at 15:36

The best I've seen so far, thanks a lot.

Reply

Chris says:
March 2, 2017 at 02:24

I noticed that there seems to be a NotificationMessage class missing. The NotificationServiceImpl has reference to a List of objects of type NotificationMessage. Can you provide this classfile?

Reply

Chris says:
March 2, 2017 at 02:26

Nevermind. I actually found it. Great tutorial so far!

Reply

Chris Again says:
March 2, 2017 at 02:41

Nevermind. I actually found it. Great tutorial so far!

Reply

Prerak Shah says:
April 12, 2017 at 20:20

should i get direct project file for download?

Reply

nakov says:

April 13, 2017 at 10:58

This is all I have: http://www.nakov.com/wp-content/uploads/2016/08/Spring-MVC-Blog-unfinished.zip

Reply

juw says:
April 16, 2017 at 16:47

This blogpost is very complete, detail and helpful for a newcomer in spring boots. Thank you very much to putting so much effort preparing this post.

Reply

Anonymous says:
April 25, 2017 at 14:02

great article

Reply

Vishal says:
May 1, 2017 at 07:51

Great post, much appreciate your effort..Can you explain why you did th:value for password label in loginForm
See below:
Password:

Reply

Rahul Roy says:
May 20, 2017 at 21:12

Hi,
This was a great post!
When will you finish the incomplete part such as Security? Waiting in eager anticipation!

Reply

xyz says:
June 7, 2017 at 06:39

this is the best tutorial by far! please provide the unfinished part

Reply

Cahyo says:
June 7, 2017 at 09:37

hi, i got problem in index when implement p.title

title in post class is private.. how can it get called in p.title in index.html

i always get error in there..

sorry for bad english, hope you understand thanks

Reply

Cahyo says:
June 7, 2017 at 09:40

sorry its because i not yet make getter and setter in post..

my bad ☺

Reply

Dewey Banks says:
August 19, 2017 at 07:58

Awesome post.... will the Security section be forthcoming? I hope so!!

Reply

Marc says:
August 28, 2017 at 23:57

the database script you refer to and say is in the project download is not present

Reply

Michael says:
August 29, 2017 at 10:41

Hello!
Could somebody complete this amazing application?

Reply

Maxim says:
September 26, 2017 at 12:25

Hello. A greate tutorial. As I understand you didn`t do this part:
-Logged in users should be able edit / delete only their own posts.?
Can you say where can I see how to do this?)

Reply

morteza says:
October 4, 2017 at 15:46

hello,
i proceed with this tutorial and it was okay until i finished part III (Part III: Connect the Application to the DB (Spring Data JPA)) then my application crashed and this message is shown in the console : Field postRepo in blog.services.PostServiceJpaImpl required a bean named 'entityManagerFactory' that could not be found.
what should i do?
it's driving me crazy.
thank you

Reply

Java wizard says:
October 4, 2017 at 17:20

See this topic: https://stackoverflow.com/questions/45350546/entitymanagerfactory-not-found-in-springboot

Did you put @SpringBootApplication before your Spring main app class?

Reply

waqas_kamran says:
October 16, 2017 at 07:38

Nice tutorial but some improvements needed . some html tags comming back that can be escaped using utext in thymeelaf .

Reply

Rajat Kumar Chahar says:
November 7, 2017 at 04:54

when i run BlogMvcApplication.java i get lot of errors .
something like 66 frames omitted.
pls help me

Reply

bdb says:
January 25, 2018 at 20:36

My css is not working to display last 5 posts on the right side... nothing is working

Reply

asdf says:
February 8, 2018 at 10:22

Where have you created bean definition/initialized for HttpSession before autowiring it in NotificationServiceImpl ?..I am unable to autowire it .

Reply

HoaDaiKa says:
April 13, 2018 at 06:18

Hi all,
I have a problem that i don't know resolve how,
In PostServiceJpaImpl.java,
@Override
public Post findById(Long id) {
return this.postRepo.findOne(id);
}
Method findOne is not found in PostService, value return of findOne in Post Service is Post instance, while that value return of findOne is Example instance , it is not mapping right.
Can you clear me ?
Thanks

Reply

Malcolm Bouchee says:
April 26, 2018 at 01:38

It appears the library for Spring has changed for Crud Repositories since this post. I replaced findOne with Post post = this.postRepo.findById(id).get(); the ".get()" method returns an actual Post object instead of an optional if it isn't null;

Reply

Michel Blain says:
April 26, 2018 at 06:16

Very informative tutorial but I ran into one problem: the error notification messages cannot be removed with ...${session.remove... I get an exception “Cannot remove entry: map is immutable” Using thymeleaf-3.0.9.RELEASE. Any suggestion on how to resolve this problem?

Reply

Amy says:
July 5, 2018 at 13:44

I have the same problem. Were you able to fix it?

Reply

amy says:
July 5, 2018 at 14:00

I have been trying to solve this for a couple of days and I finally found the answer in section 3 of:
https://www.thymeleaf.org/doc/articles/springmvcaccessdata.html

by using ${session.remove(‘attribute’)} you are accessing the thymeleaf defined session, which I think only allows you to access the data and not modify it. Instead, you have to access the javax.servlet.http.HttpSession object. You do that by replacing ${session.remove(T(blog.services.NotificationServiceImpl).NOTIFY_MSG_SESSION_KEY)}

with

${#session.removeAttribute(T(blog.services.NotificationServiceImpl).NOTIFY_MSG_SESSION_KEY)}

Reply

Timo says:
September 13, 2018 at 12:47

Thanks for the tips, I was having the same issue! Notifications work for me now.

Reply

sam says:
February 21, 2019 at 01:33

Hey man,have you uploaded it on git ?

Reply


Ahmed says:
November 28, 2018 at 01:06

I have a problem with the notification it doesn`t apear any messages

Reply

Phan Nha says:
May 18, 2018 at 17:28

how to add images in a post?

Reply

Elysium Academy says:
November 29, 2018 at 15:15

thanks for tips

Reply

Edulite says:
December 4, 2018 at 16:01

Thanks for sharing this way of creating a blogging system using java frameworks.

Reply

dinesh says:
October 23, 2019 at 10:36

nice tutorial,where is the register.html file

Reply

Creating a Blog System with Spring MVC, Thymeleaf, JPA and MySQL - information buzzer says:
November 25, 2019 at 22:44

[...] Source [...]

Reply

Scott Macdonald says:
January 3, 2020 at 22:02

Nice article – however – you need to remove those smart quotes in some of the code examples.

Reply

piccosoft says:
February 6, 2020 at 12:54

Thanks for sharing your information. You know about piccosoft?
Piccosoft is a top India based web & mobile app development companies. Also, we offer web design services. We have experienced web and mobile app developers for hire.

Reply

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TRANSLATION

Wybierz język

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