



Building modern Web Apps with Spring Boot and Vaadin

A practical introduction to
web application development
using Java.



Table of Contents

Introduction: Building modern web apps with Spring Boot and Vaadin.....	1
What you'll learn	1
Tools and frameworks	2
Why use Vaadin instead of Spring MVC and Thymeleaf, JSP or Freemarker?	3
Why use Vaadin instead of REST and React or Angular?	3
Source code	4
Video tutorials	4
Setting up a Java development environment.....	5
Which Java version should you install?	5
Setting up on Windows	5
Setting up on macOS	11
Setting up on Linux	13
Importing, running, and debugging a Maven-base Java project in IntelliJ IDEA.....	16
Importing a Maven project into IntelliJ	16
Running a Spring Boot project	20
Debugging with IntelliJ	21
Enabling live browser reload	24
Enabling auto import	27
Vaadin basics: building UIs with components and layouts.....	29
Quick introduction to Vaadin	29
Preparing the project	31
Creating a Spring Boot backend: database, JPA repositories, and services.....	35
Installing the database dependencies	35
Defining the data model	36
Creating repositories to access the database	41
Creating service classes for business logic	42
Populating with test data	44
Finalizing the back end	46
Adding data and configuring columns in Vaadin Grid.....	47
Creating and configuring the Grid	47
Populating the Grid with data from the backend	48
Adding a custom column to the grid	50
Defining column widths	52
Filtering rows in Vaadin Grid	54
Adding a text field for filtering	54
Implementing filtering in the back end	55
Creating your own reusable components in Vaadin	58
Creating a form component	58
Adding the form to main view	60
Making the layout responsive	61

Importing CSS styles into main the view	62
Vaadin form data binding and validation.....	64
Binding object properties to input fields	64
Creating the binder	64
Decoupling components	65
Defining the form component API	65
Setting the company and contact status	66
Updating the contact	67
Setting up events	67
Saving, deleting, and closing the form	68
Communicating between components using events and properties	70
Showing selected contacts in the form	70
Adding new contacts	74
Navigating between views in Vaadin	78
Defining routes	78
Creating the parent list and child view	78
Creating the dashboard view	83
Adding a login screen to a Vaadin app with Spring Security	89
Creating a login view	89
Setting up Spring Security to handle logins	91
Adding a logout link	98
Turning a Vaadin app into an installable PWA	101
What is a PWA?	101
Generating PWA resources	101
Customizing the offline page	103
Testing the offline page	105
Testing Spring Boot apps with unit and integration tests.....	107
Creating and running unit tests for simple UI logic	107
Creating and running integration tests for more advanced UI logic	111
Testing Vaadin apps in the browser with end-to-end tests.....	115
Configuring Maven to start the server	115
Setting up Chrome and its webdriver to control the browser	118
Creating the base test class	118
Testing the login view	121
Creating a view object	122
Deploying a Spring Boot app on AWS Elastic Beanstalk.....	125
Preparing the application for production	125
Creating an AWS account	126
Setting up a Java application on Elastic Beanstalk	127
Deploying the Elastic Beanstalk app	130
Next steps	134
Share your experience	134

Introduction: Building modern web apps with Spring Boot and Vaadin

This guide is specifically designed as a practical introduction to web application development with Spring Boot and Vaadin.

It covers the entire development process, from setup to deployment, following a step-by-step approach. You can replicate each section at your own pace as you follow along.

The content is suitable for anyone familiar with Java who wants to build a web application. To make sure your development experience is enjoyable and productive, we start right from the beginning with setting up your development environment.

What you'll learn

This guide teaches you how to build a functional, full-stack web app using modern Java. It focuses on real-world developer needs, without diving deeply into theory or academics. Links to relevant further reading are provided for those who are interested.

The application is a customer relationship management (CRM) system for managing contacts. It features:

- A login screen to restrict access.
- A responsive layout with side navigation that works on desktop and mobile.
- A database for persistent data storage.
- A list view that can be sorted and filtered.
- A form to edit and add contacts.
- Data import from a REST API.
- A dashboard view.
- Cloud deployment.
- User installation.

The screenshot shows a Vaadin CRM application interface. At the top, there are three red dots, the text "Vaadin CRM", and a "Log out" button. Below this is a navigation bar with "List" and "Dashboard" tabs, and a search bar labeled "Filter by name...". A blue "Add contact" button is also present.

The main area displays a table of contacts with columns: First Name, Last Name, Email, Status, and a detailed view section. The contacts listed include Gabrielle Patel, Brian Robinson, Eduardo Haugen, Koen Johansen, Alejandro Macdonald, Angel Karlsson, Yahir Gustavsson, Haiden Svensson, Emily Stewart, Corinne Davis, Ryann Davis, Yurem Jackson, Kelly Gustavsson, Eileen Walker, Katelyn Martin, Israel Carlsson, and Quinn Hansson. The status column includes entries like "Customer", "Contact", "Not Contact", and "Closed".

A modal dialog is open for the contact "Alejandro Macdonald". It contains fields for "First name" (Alejandro), "Last name" (Macdonald), "Email" (alejandro.macdonald@pathwayelectronics.com), and a "Company" dropdown set to "Path-Way Electronics". There is also a "Status" dropdown set to "ClosedLost". At the bottom of the modal are "Save", "Delete", and "Cancel" buttons.

Tools and frameworks

The frameworks and tools used in the guide were chosen for two reasons: they are easy to use, and they are suitable for both learning and production use.

On the **back end**, the application uses [Spring Boot](#). This eliminates most of the hassle of setting up and running a Spring-based app and lets you focus on your own code. The main features you'll use are:

- [Dependency injection](#) to decouple components.
- [Spring Data JPA](#) repositories to work with the database.
- [Spring Security](#) to handle access control.
- An embedded [Tomcat](#) server to serve the application.
- [Spring Boot Developer Tools](#) to provide a smoother development experience.

Don't worry if you don't know what all of these are, we cover each individually as we go.

On the **front end**, the application uses [Vaadin](#). This is an open-source Java web app framework that comes with:

- [A large library of UI components](#). Each component has a Java API and you can customize the look and feel.
- A router for navigating between views.
- A powerful data-binding system for forms and lists.

Why use Vaadin instead of Spring MVC and Thymeleaf, JSP or Freemarker?

Vaadin is an alternative to using Spring MVC and Thymeleaf, JSP or Freemarker when building web applications with Spring Boot.

The main advantage of Vaadin are:

- Vaadin is designed for building interactive single-page apps (SPA). Spring MVC and templates are better suited for more static content.
- Vaadin offers a Java component API, allowing you to build the entire application in Java.
- Vaadin comes with a large [library of customizable UI components](#).
- Vaadin handles the communication between the server and the browser automatically, you don't need to write any JavaScript to update content dynamically.

Why use Vaadin instead of REST and React or Angular?

Combining a Spring Boot based REST backend with a frontend framework like React or Angular is a popular way of building SPAs. Vaadin allows you to build similar app experiences with less effort.

Advantages of using Vaadin:

- Faster development: you do not need to develop the backend and frontend separately.
- The entire application can be written in typesafe Java.
- Vaadin comes with a large [library of customizable UI components](#).
- Vaadin handles the communication between the server and the browser automatically, you don't need to write any JavaScript to update content dynamically.
- More secure: the Vaadin app runs on the server and doesn't expose application code or extra endpoints to the browser.

Source code

You can find the full source code for this guide on [GitHub](#). Each chapter is in a separate branch. In addition, the individual chapters include links to download the code both before and after the changes in the chapter, so you can easily get your project working again, if something does go wrong. You can also jump straight to a specific chapter by downloading the full project when starting the guide.

Video tutorials

You can find video tutorials of each chapter on the [Vaadin YouTube Channel](#).

Setting up a Java development environment

Before you can start developing your Java app, you need to install the necessary development tools and set up your development environment.

For web app development in Java, you need a:

- Java Development Kit (JDK)
- Build tool (Maven)
- Version control system (Git)
- Front-end build tool (Node.js)
- Integrated development environment (IDE).

You can complete this guide using any IDE, but for the sake of simplicity, we use [IntelliJ Idea](#) throughout. The IntelliJ Community Edition is free to use and a great choice if you don't already have an IDE setup.

If you have the necessary tools installed on your computer, you're ready to start the tutorial, and can skip ahead to the next chapter. If not, follow the instructions for your operating system to get ready to start coding.

Which Java version should you install?

If you're new to Java or haven't used it in a while, you may be surprised by the number of Java runtimes available. A while ago, [Oracle changed their release model](#) and made the official Oracle JDK a paid product for commercial projects. Instead of one major release every few years, they now release new major versions every 6 months, and designate a long-term support (LTS) version every 3 years. [We recommend you use the current LTS version, Java SE 11](#), if you prefer to use Oracle.

When the Oracle JDK became a commercial product, many developers chose to switch to alternative JDKs. There are many available drop-in replacements that are free to use and come with long-term-support releases. [We recommend you use either Amazon Corretto or OpenJDK](#).

Setting up on Windows

To set up your development environment on Windows:

1. Install Java:

- a. Go to the Amazon Corretto 11 download page.
- b. Download and run the Windows installer ([.msi](#)).
- c. Follow the prompts in the wizard.

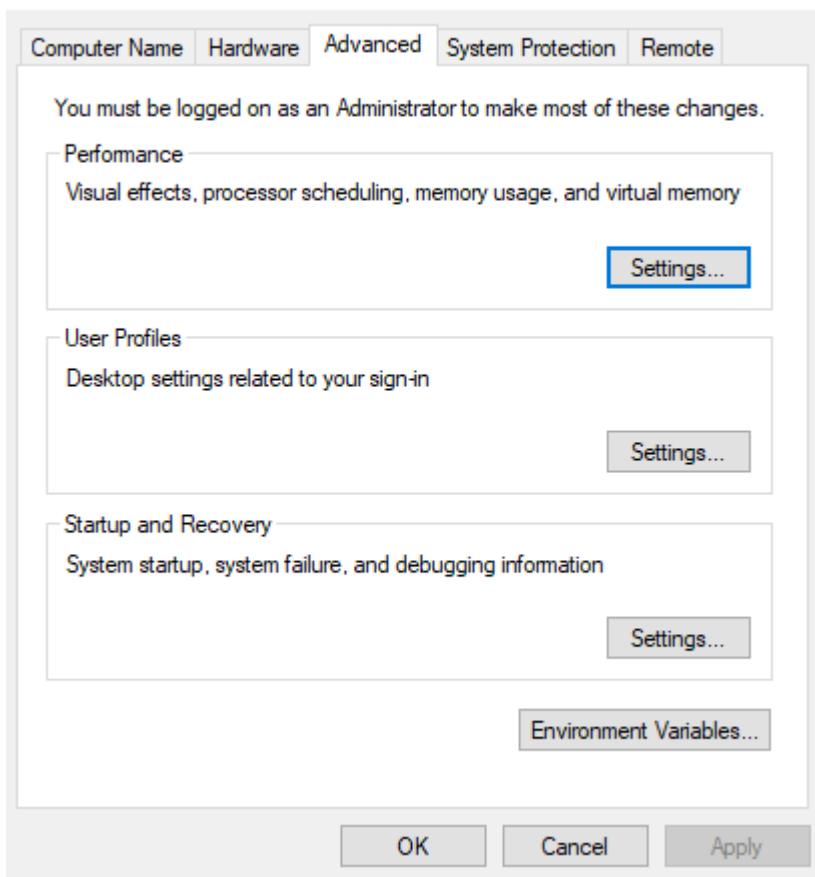


2. Install Maven:

- a. Go to the Maven [download](#) page.
- b. Download the Binary zip archive in the Files section.
- c. Extract the archive to `C:\Program Files`.
- d. In Windows, go to Control Panel > Systems and Security > System > Advanced system settings.
- e. Select Environment Variables.

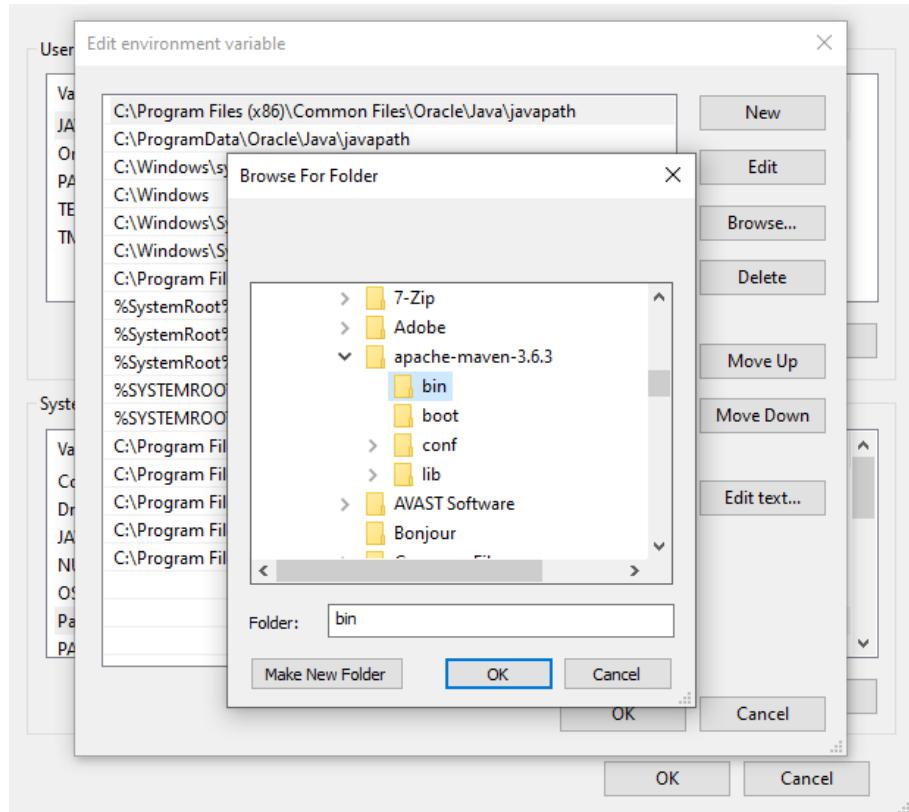
System Properties

X



- f. In Environment Variables, select the Path systems variable (in the bottom box) and then select Edit.
- g. Select Browse in the edit dialog.
- h. Navigate to and select `C:\Program Files\apache-maven-3.6.3\bin` (substitute the version number you downloaded) and then select OK.

Environment Variables



- Select OK in all open dialogs to close them and save the environment variable.

3. Install Node:

- Go to the Node.js [download](#) page.
- Download and run the Windows Installer ([.msi](#)) for your system.
- Follow the prompts in the wizard.



Welcome to the Node.js Setup Wizard



The Setup Wizard will install Node.js on your computer.

Back

Next

Cancel

4. Install Git:
- Go to the Git [download](#) page.
 - Download and run the Windows installer ([.exe](#)) for your system.
 - Follow the prompts in the wizard. If you are unsure about any option, use the defaults.

Information

Please read the following important information before continuing.



When you are ready to continue with Setup, click Next.

GNU General Public License

Version 2, June 1991

Copyright (C) 1989, 1991 Free Software Foundation, Inc.
59 Temple Place - Suite 330, Boston, MA 02111-1307, USA

Everyone is permitted to copy and distribute verbatim copies
of this license document, but changing it is not allowed.

Preamble

The licenses for most software are designed to take away your
freedom to share and change it. By contrast, the GNU General Public
License is intended to guarantee your freedom to share and change

<https://gitforwindows.org/>

Next >

Cancel

5. Install IntelliJ:

- Go to the IntelliJ Windows [download](#) page.
- Download and run the Community Edition installer ([.exe](#)).
- Follow the prompts in the wizard.



Welcome to IntelliJ IDEA Community Edition Setup

Setup will guide you through the installation of IntelliJ IDEA Community Edition.

It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.

Click Next to continue.

[Next >](#)

[Cancel](#)

- d. Reboot your computer to finish the setup.
- e. Start IntelliJ and set up your preferences. You can use the defaults, unless you have reason not to.

Setting up on macOS

To set up your developer environment on macOS:

1. Install Java:
 - a. Go to the Amazon Corretto 11 [download](#) page.
 - b. Download and run the macOS installer ([.pkg](#)).
 - c. Follow the prompts in the wizard.



2. Install Homebrew:

[Homebrew](#), is a package manager, and is the easiest way to install both Maven and Node on macOS. To install Homebrew, paste the following into your terminal:

```
/usr/bin/ruby -e "$(curl -fsSL  
https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

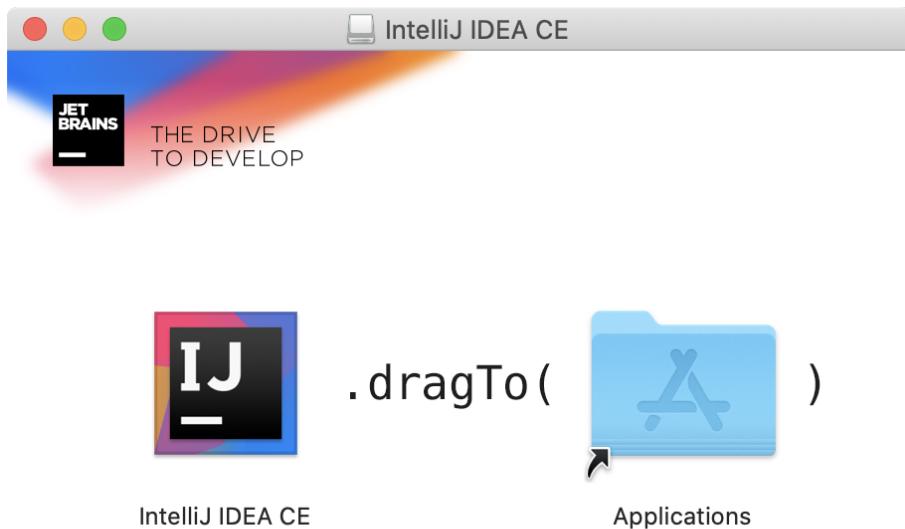
3. Install Maven and Node:

Use this command to install both Maven and Node in Homebrew:

```
brew install node maven
```

4. Install IntelliJ:

- Go to the IntelliJ Mac [download](#) page.
- Download the Community Edition installer .
- Copy the app to your Applications folder in Finder.



Setting up on Linux

This section contains instructions for Debian and RPM-based distros. Installation on other distributions should be very similar and you can adapt these instructions, if necessary. On Linux, it's easiest to use OpenJDK, as it's available in the package repositories.

1. Install Node.js:

NOTE

You need to install the latest Node.js LTS repository to your package manager. The version available in most distributions is not sufficiently new for our purposes. [Nodesource](#) offers packages for all major distros.

a. Debian-based systems:

i. For Ubuntu and distributions using sudo, run:

```
curl -sL https://deb.nodesource.com/setup_12.x | sudo -E bash -  
sudo apt-get install -y openjdk-11-jdk maven git nodejs
```

ii. For Debian, or if you are not using sudo, run the following as root:

```
curl -sL https://deb.nodesource.com/setup_12.x | bash -  
apt-get install -y openjdk-11-jdk maven git nodejs
```

b. RPM-based distributions, run:

```
curl -sL https://rpm.nodesource.com/setup_12.x | sudo -E bash -  
sudo yum install -y java-11-openjdk-devel.x86_64 maven git nodejs
```

i. Check the Java version:

- To ensure that you are running Java 11, run `java -version`.
- To change to change to Java 11, if necessary, use:

```
sudo alternatives --config java
```

NOTE

If you are on a different distro, or aren't comfortable with the automatic repo setup script, you can find a full set of instructions on the [NodeSource GitHub repository](#).

2. Install IntelliJ:

TIP

The easiest way to install IntelliJ on Linux is to use the [Snap package manager](#). If you use Ubuntu or a derivative, it is already installed.

a. To install IntelliJ using snap, run:

```
sudo snap install intellij-idea-community --classic
```

b. To install IntelliJ manually:

- Go to the IntelliJ Linux [download](#) page.
- Download the Community Edition [.tar.gz](#).
- Extract the archive:

```
sudo mkdir /opt/intellij  
sudo tar zxfv ideaIC*.tar.gz -C /opt/intellij --strip-components=1
```

c. Run the IDE (the start wizard gives you the option to create a desktop shortcut):

```
sh /opt/intellij/bin/idea.sh
```

You now have everything you need to start coding Java. The next tutorial will show you how to import and run a Maven-based Java project in IntelliJ.

Importing, running, and debugging a Maven-base Java project in IntelliJ IDEA

The first step in any project is to set up the project and get a base app running.

In this section, you'll learn:

- How to import a project starter into your IDE.
- How to set up your browser to automatically show updates as you build your application.

Importing a Maven project into IntelliJ

[Maven](#) is the most popular project management tool for Java. It takes care of managing your project structure and dependencies, and builds runnable artifacts.

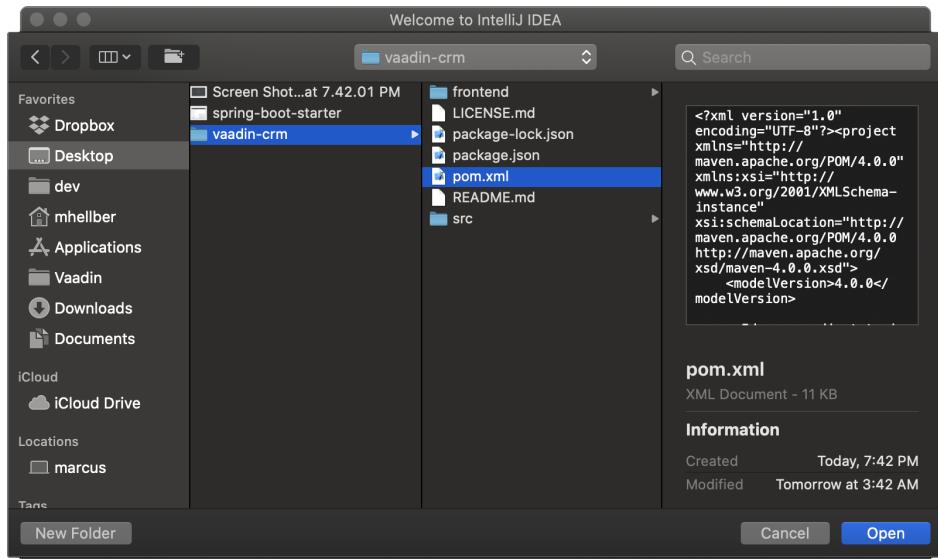
1. To start, download a Spring Boot-based Vaadin starter project:
 - a. Go to <https://vaadin.com/start>.
 - b. Select the **Spring Boot** technology stack.
 - c. Change the group name to com.vaadin.tutorial.crm.
 - d. Change the project name to Vaadin CRM.
 - e. Click **Download**.

The screenshot shows a browser window with the title 'Get Started | Vaadin'. The URL in the address bar is 'vaadin.com/start/latest'. The page header includes the 'vaadin}' logo, navigation links for 'Build', 'Learn', 'Community', 'Services', 'Pricing', a search bar, and user account links for 'Login' and 'Sign up'. The main content area features the heading 'Get started with Vaadin' and a sub-section titled 'Create a new project'. A dropdown menu for 'Choose Vaadin version' is set to 'Vaadin 14 (Latest LTS)'. Below this are tabs for 'Download', 'Maven archetype', and 'Eclipse', with 'Download' being the active tab. On the left, there's a section for 'Technology stack' with three options: 'Spring Boot' (selected), 'CDI and Java EE', and 'Plain Java Servlet'. Underneath are fields for 'Maven Group ID' (set to 'com.vaadin.tutorial.crm') and 'Project Name' (set to 'Vaadin CRM'). At the bottom are two buttons: 'DOWNLOAD' and 'CUSTOMIZE APP'. To the right, under 'Instructions', there are five numbered steps with links to further documentation. A blue circular icon with a white square containing a dot is located at the bottom right of the main content area.

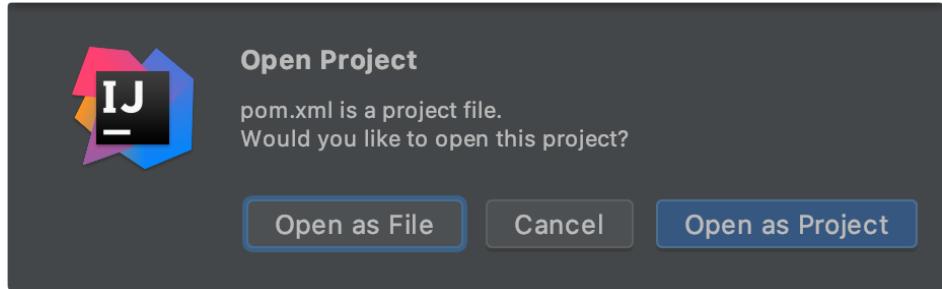
- 2 Unzip the downloaded archive to a file location of your choice. TIP: Avoid unzipping to the download folder, as you could unintentionally delete your project when clearing out old downloads.
- 3 In IntelliJ, select **Open** in the Welcome screen or **File** menu.



- Find the extracted folder, and select the pom.xml file.



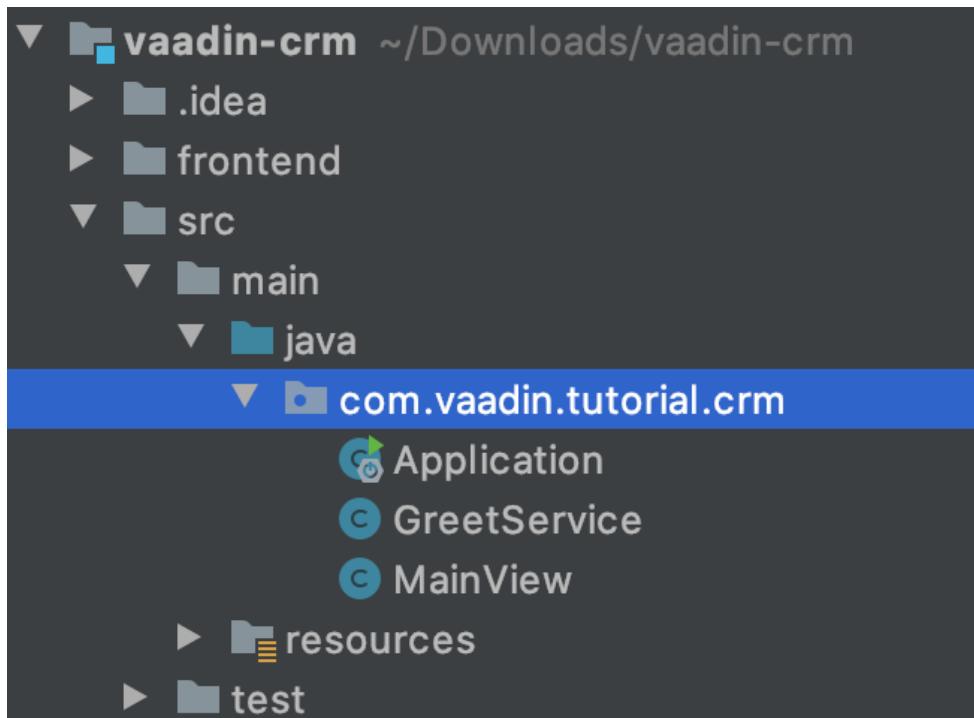
- Select **Open as Project**. This imports a project based on the POM file.



6. IntelliJ imports the project and downloads all necessary dependencies. This can take several minutes, depending on your internet connection speed.

When the import is complete, your project structure will be similar to this:

- Java source files are in the `src/main/java` folder.
- Test files are in the `src/test` folder (we'll refer to these later).



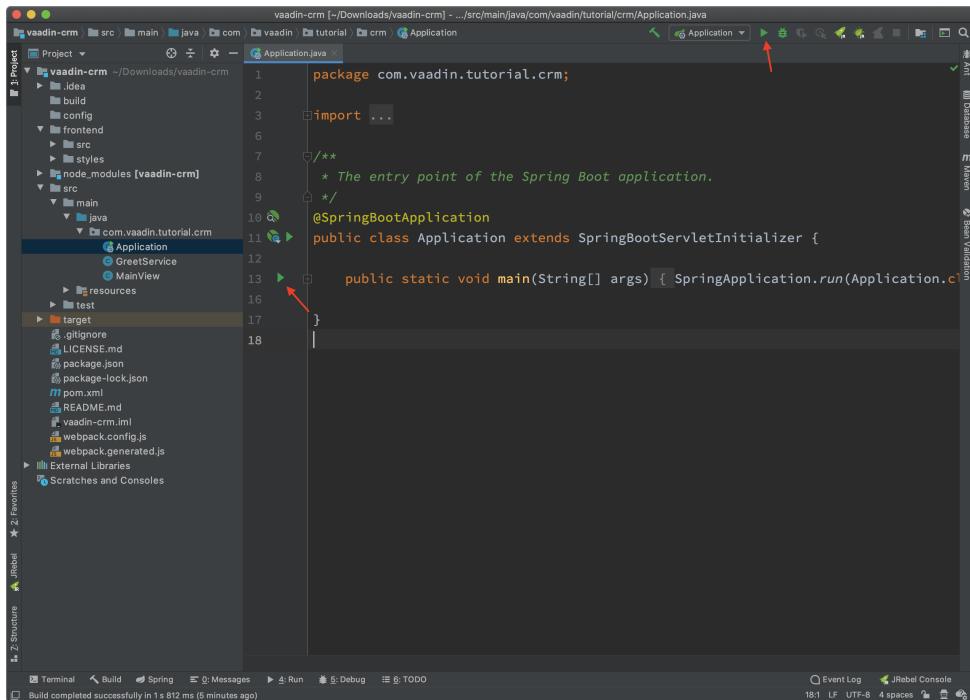
Running a Spring Boot project

Spring Boot makes it easier to run a Java web application, because it takes care of starting and configuring the server.

To run your application, all you need to do is to run the Application class that contains the main method that starts Spring Boot. IntelliJ automatically detects that you have a class with a main method and displays it in the run configurations dropdown.

To start your application:

- Click the play button next to the run configurations dropdown.
- Alternatively, open Application.java and click the play button next to the code line containing the main method.



The screenshot shows the IntelliJ IDEA interface with the 'vaadin-crm' project open. The 'Application.java' file is selected in the editor. The code is as follows:

```
package com.vaadin.tutorial.crm;
import ...
/**
 * The entry point of the Spring Boot application.
 */
@SpringBootApplication
public class Application extends SpringBootServletInitializer {
    public static void main(String[] args) { SpringApplication.run(Application.class, args); }
}
```

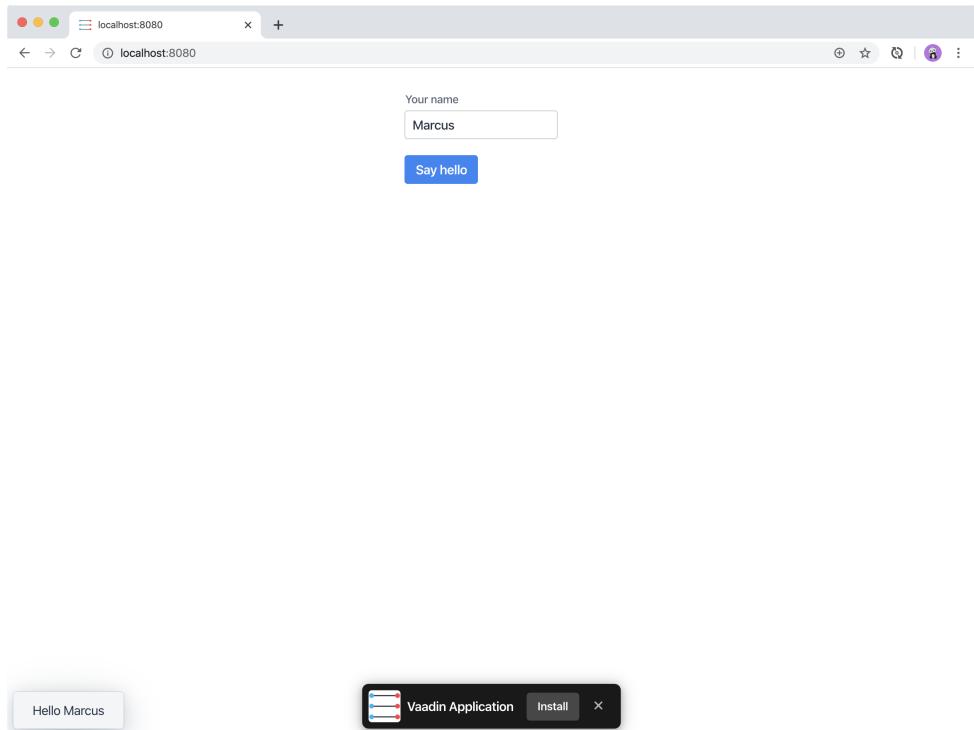
A red arrow points to the play button icon in the top right corner of the editor window. Another red arrow points to the play button icon located to the left of the line number 13, which contains the main method declaration.

The first time you start a Vaadin application, it downloads front-end dependencies and builds a JavaScript bundle. This can take several minutes, depending on your computer and internet speed.

You'll know that your application has started when you see the following output in the console:

```
Tomcat started on port(s): 8080 (http) with context path ''
Started Application in 80.189 seconds (JVM running for 83.42)
```

You can now open localhost:8080 in your browser. You'll see a **Say hello** button and **Your name** field on the screen. Enter your name and click the button to see the notification that displays.



Debugging with IntelliJ

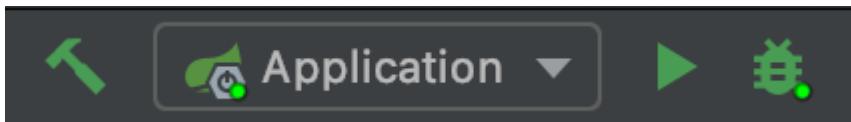
The debugger is a useful tool to understand what's happening in your code when things are not working as expected. Knowing how to use the debugger saves you from having to use a lot of `System.out.println's.

To use the debugger in IntelliJ:

1. If your application is still running from the previous step, click the red stop-button to terminate it.



2. Start your application in debug mode, by clicking the bug icon next to the play button. You can now insert a debug point. This tells the debugger to pause the app whenever it gets to the line marked in the code.



You can now insert a debug point. This tells the debugger to pause the app whenever it gets to the line marked in the code.

3. In MainView.java, on the line containing `Notification.show`, click next to the line number to add a breakpoint (debug point). When you click, the code line is highlighted and a red dot displays.

```
42     public MainView(@Autowired GreetService service) {  
43  
44         // Use TextField for standard text input  
45         TextField textField = new TextField(label: "Your name");  
46  
47         // Button click listeners can be defined as lambda expressions  
48         Button button = new Button(text: "Say hello",  
49             e -> Notification.show(service.greet(textField.getValue())));  
50     }
```

If you now open <http://localhost:8080> in your browser, and click the Say hello button, nothing happens. This is because the application stops on the line indicated in the IDE.

4. In IntelliJ, have a look at the highlighted code line and the debug panel in the lower part of the screen.

The screenshot shows the IntelliJ IDEA interface with the following details:

- Project Tree:** Shows the project structure under "vaadin-crm".
- MainView.java:** The current file being edited, containing Java code for a Vaadin application.
- Code Editor:** Displays the following code snippet:

```
// Use TextField for standard text input
TextField textField = new TextField(label: "Your name"); textField;

// Button click listeners can be defined as lambda expressions
Button button = new Button(text: "Say hello",
    e -> Notification.show(service.greet(textField.getValue())));

// Theme variants give you predefined extra styles for components.
// Example: Primary button is more prominent look.
button.addThemeVariants(ButtonVariant.LUMO_PRIMARY);

// You can specify keyboard shortcuts for buttons.
// Example: Pressing enter in this view clicks the Button.
button.addClickShortcut(Key.ENTER);

// Use custom CSS classes to apply styling. This is defined in shared-style.css

```

The code editor has syntax highlighting and a gutter with error markers. The bottom status bar shows "Build completed successfully in 2 s 121 ms (3 minutes ago)".

Toolbars and Panels:

- Top toolbar: Application, Run, Stop, Refresh, Help.
- Bottom toolbar: Terminal, Build, Spring, Messages, Run, Debug, TODO.
- Left sidebar: Project, Packages, Structure, Favorites, Settings.
- Bottom right panel: Event Log, JRE Console.

In the debug panel, you can see values for all variables. There are also controls that allow you to run the app one step at a time, to better understand what's happening. The most important controls are:

- **Step over:** Continue to the next line in the same file.



- **Step into:** Drill into a method call (for instance, if you wanted to see what's going on inside `service.greet()`).



- **Step out:** Go back to the line of code that called the method you're currently in.



Play around with the debugger to familiarize yourself with it. If you want to learn more, JetBrains has an [excellent resource on using the debugger](#).

5. Click Resume Program when you are done.

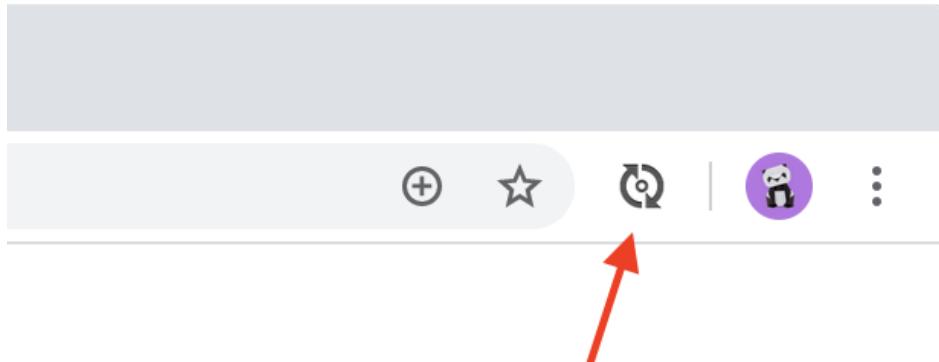


Your code will now run normally and you'll see the notification in your browser.

Enabling live browser reload

One final thing to do before starting to program is to enable live reloading of changes. This provides a far better development experience. All code changes you make are automatically displayed in the browser, without the need to refresh the page manually.

1. Start by downloading the LiveReload plugin for your browser:
 - [LiveReload plugin for Chrome and Chromium Edge](#)
 - [LiveReload plugin for Firefox](#)
 - [LiveReload plugin for Safari](#)
2. Install the plugin, reload your browser window, and click on the LiveReload icon in the top bar of your browser. (Make sure your app is running when you do this.)



The middle of the icon should turn solid to indicate that LiveReload is working and has connected to your app. If it doesn't, try refreshing the page or reloading the browser.

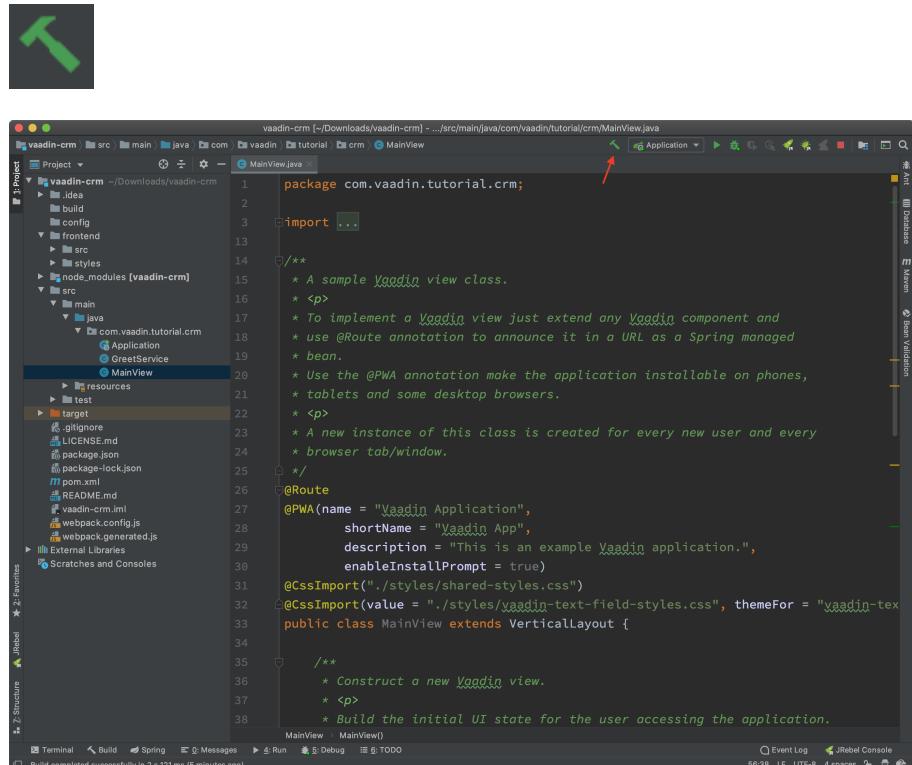
3. When LiveReload is running, verify that it works by making a change in the code:

- Create a new H1 heading and add it as the first argument in the add() method on the last line in MainView.

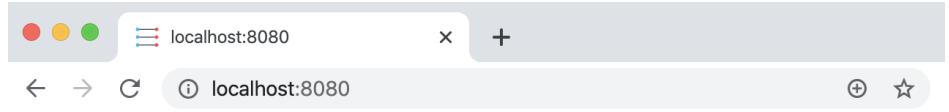
MainView.java

```
add(new H1("Hello world"), textField, button);
```

- Click the build icon in IntelliJ (next to the run targets dropdown)



- If all goes well, you'll see a notification that the build was successful, and your browser will reload automatically to show the change. Magic.



Hello world

Your name

Say hello

You may sometimes see error messages like this in the browser after a reload.

```
Could not navigate to ''  
Reason: Couldn't find route for ''  
Available routes:  
This detailed message is only shown when running in development mode.
```

or

NOTE

```
There was an exception while trying to navigate to '' with the exception  
message 'Error creating bean with name 'com.vaadin.tutorial.crm.MainView':  
Unsatisfied dependency expressed through constructor parameter 0'
```

These errors are caused by a [Spring DevTools reload timing issue](#). You may be able to alleviate the issue by adding the following two properties to `src/main/resources/application.properties` and adjusting the intervals to work with your computer. Stop and restart the server after adding the properties.

application.properties

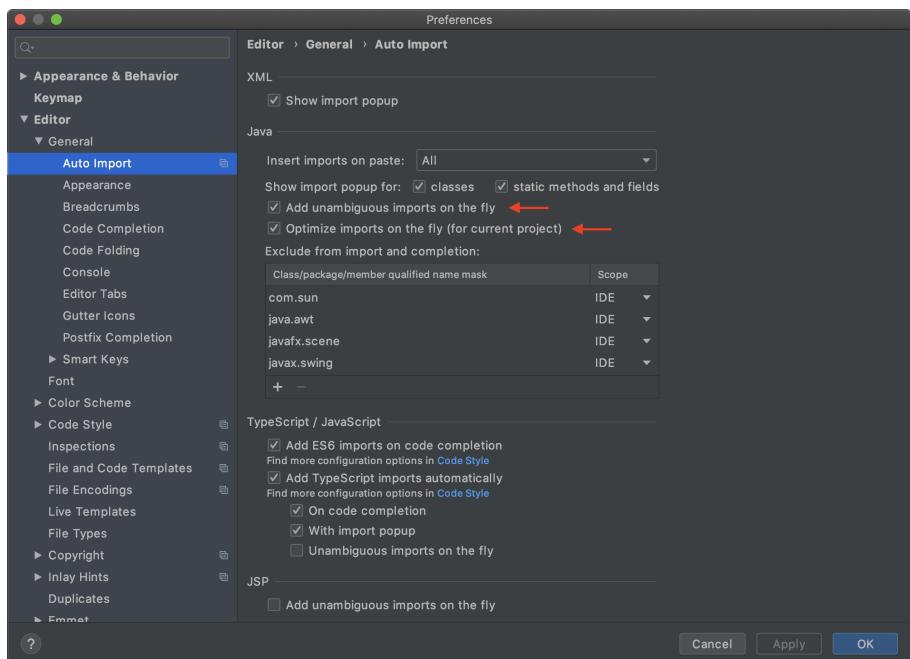
```
spring.devtools.restart.poll-interval=2s  
spring.devtools.restart.quiet-period=1s
```

Enabling auto import

You can configure IntelliJ to automatically resolve imports for Java classes. This makes it easier to copy code from this tutorial into your IDE.

To enable auto import in IntelliJ:

1. Open the Preferences/Settings window and navigate to **Editor > General > Auto Import**.
2. Enable the following two options:
 - Add unambiguous imports on the fly.
 - Optimize imports on the fly.



Vaadin shares many class names (like `Button`) with Swing, AWT, and JavaFX.

3. If you don't use Swing, AWT, or JavaFX in other projects, add the following packages to the **Exclude from import and completion** list to help IntelliJ select the correct classes automatically.
 - `com.sun`
 - `java.awt`

- javafx.scene
- javax.swing
- jdk.internal
- sun.plugin

Now that you have a working development environment, we can start building a web app.

You can find the completed source code for this tutorial on [GitHub](#).

Vaadin basics: building UIs with components and layouts

In the previous two tutorials, you learned to set up a Java development environment and to import and run a Maven-based Spring Boot project.

In this chapter we introduce you to core Vaadin concepts and get our project ready for coding.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Quick introduction to Vaadin

First, let's review a few of the core Vaadin concepts we'll be working with.

What is Vaadin?

Vaadin is a Java framework for building web applications. It has a component-based programming model that allows you to build user interfaces.

Vaadin UI components

The Vaadin platform includes a [large library of UI components](#) that you can use as the building blocks of your application.

You create a new component by initializing a Java object. For instance, to create a [Button](#), you write:

```
Button button = new Button("I'm a button");
```

Layouts

Layouts determine how components display in the browser window. The most common layout components are [HorizontalLayout](#), [VerticalLayout](#), and [Div](#). The first two set the content orientation as horizontal or vertical, respectively, whereas [Div](#) lets you control the positioning with CSS.

You add components to layouts using the `add()` method.

`HorizontalLayout` and `VerticalLayout` provide methods to align items on both the primary and the cross axis. For instance, if you want all components, regardless of their height, to be aligned with the bottom of a `HorizontalLayout`, you can set the default alignment to `Alignment.END`:

```
Button button = new Button("I'm a button");
HorizontalLayout layout = new HorizontalLayout(button, new DatePicker("Pick a date"));
);

layout.setDefaultVerticalComponentAlignment(Alignment.END);
add(layout);
```

Pick a date

I'm a button



Events

You can add functionality to your application by listening to events, such as, click events from buttons, or value-change events from select components.

This example adds the text "Clicked!" to the layout when the button is clicked.

```
button.addClickListener(clickEvent ->
add(new Text("Clicked!")));
```

Where's the HTML?

One unique Vaadin feature is that you can build web applications entirely in Java. This higher level of abstraction makes development more productive and debugging easier.

Vaadin also supports HTML-templates and customizing the code that runs in the browser, but in most cases you needn't worry about this.

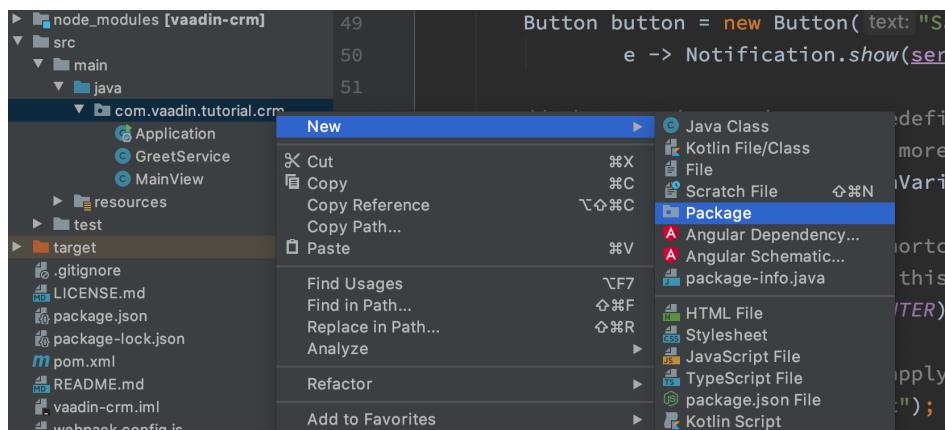
Preparing the project

Defining packages

Our app has both UI and backend code. To keep our code organized, we need to define separate packages for each in the project structure.

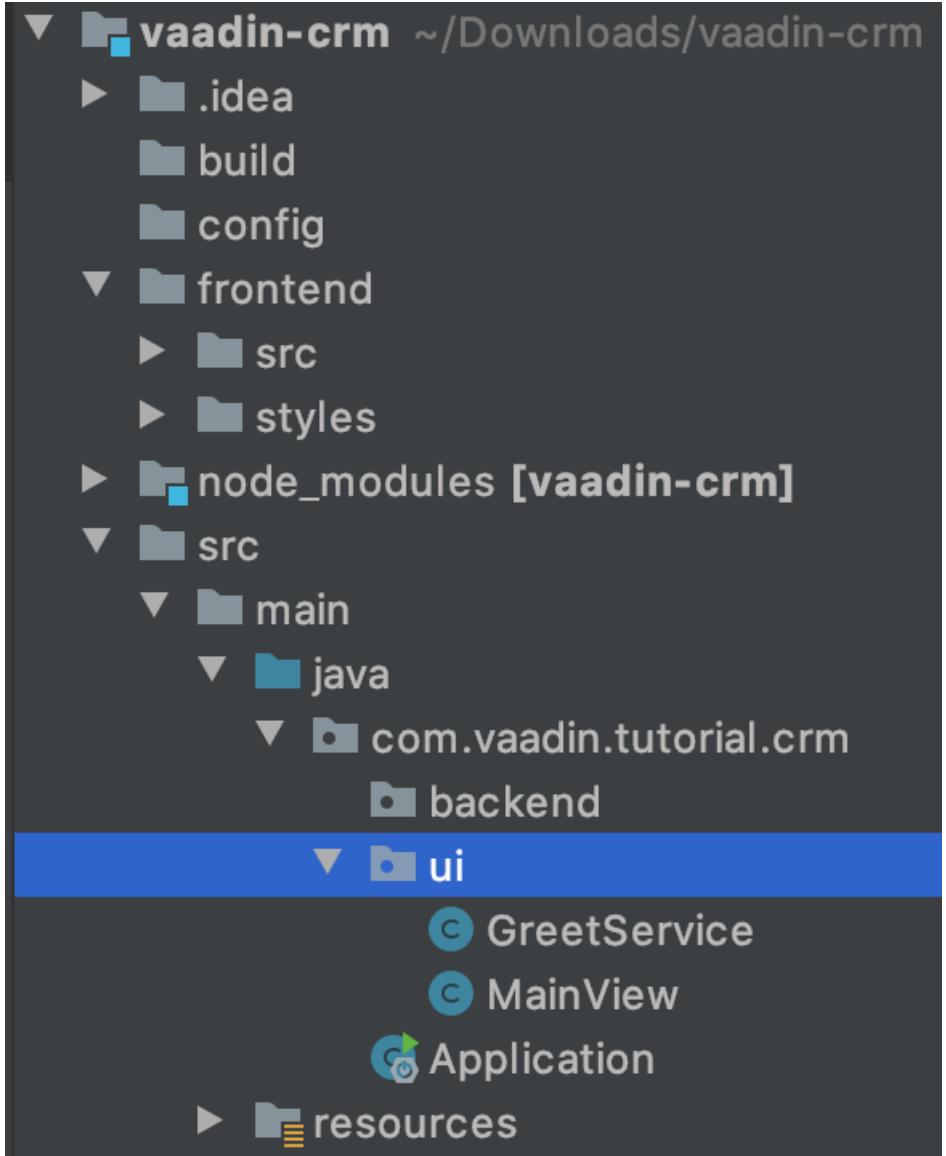
To define packages:

1. Right-click the `com.vaadin.tutorial.crm` package.
2. Select **New > Package** and create a package named `com.vaadin.tutorial.crm.ui`.
3. Repeat this process to create another package named `com.vaadin.tutorial.crm.backend`.



4. Drag `MainView` and `GreetService` classes into the `ui` package. If IntelliJ asks you if you want to refactor the code, say yes.

Your project structure should now look like this:



Setting up the main layout

Next, we clean out unnecessary code and set up our main layout.

To do this:

1. Delete the content of `MainView` and replace it with the code shown below. This removes all unnecessary code and ensures that we start with a clean slate.

`MainView.java`

```
package com.vaadin.tutorial.crm.ui;

import com.vaadin.flow.component.orderedlayout.VerticalLayout;
import com.vaadin.flow.router.Route;

@Route("") ①
public class MainView extends VerticalLayout {

    public MainView() {

    }

}
```

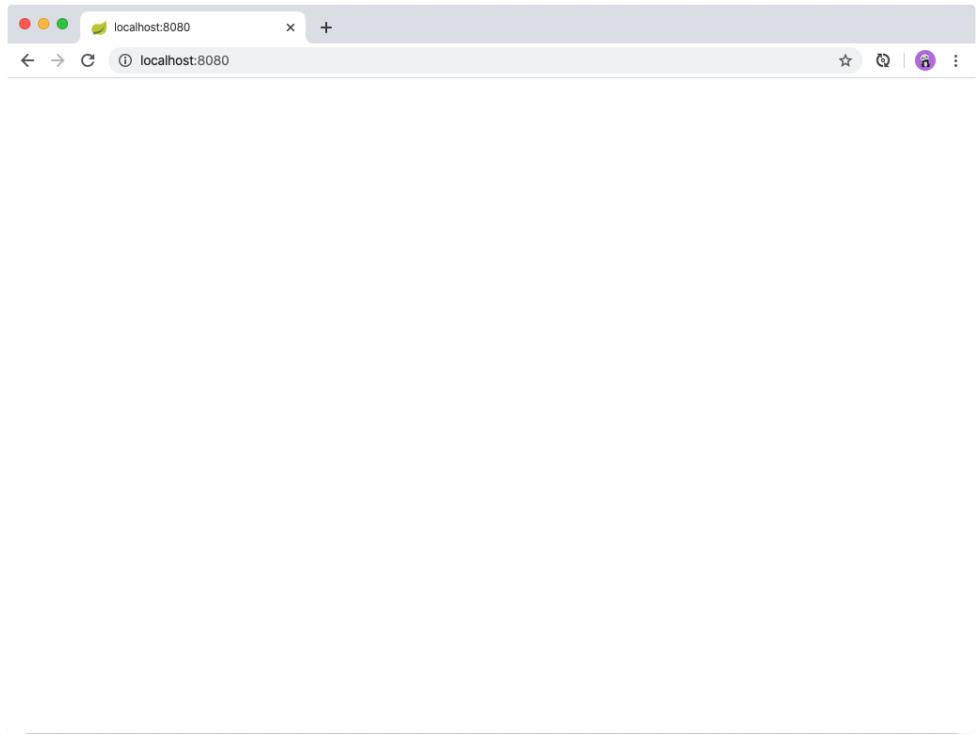
① `@Route("")` maps the view to the root.

2. Next, **delete** the following unnecessary files:

- `GreetService.java`
- `frontend/styles/vaadin-text-field-styles.css`

3. Verify that you are able to run your application.

You should see an empty window in the browser, and no errors in the console.



Before we can start building the UI, we need data to work with. In the next chapter, we'll set up a database and populate it with test data.

You can find the completed source code for this tutorial on [GitHub](#).

Creating a Spring Boot backend: database, JPA repositories, and services

Most real-life applications need to persist and retrieve data from a database. In this tutorial, we use an in-memory H2 database. You can easily adapt the configuration to use another database, like MySQL or Postgres.

There are a fair number of classes to copy and paste to set up your backend. You can make your life easier by downloading a project with all the changes, if you prefer. The download link is at the end of this chapter.

The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Installing the database dependencies

We use Spring Data for data access. Under the hood, it uses Hibernate to map Java objects to database entities through the Java Persistence API. Spring Boot takes care of configuring all these tools for you.

To add database dependencies:

1. In the <dependencies> tag in your pom.xml file, add the following dependencies for H2 and Spring Data:

pom.xml

```
<dependencies>
    <!--all existing dependencies -->

    <!--database dependencies -->
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-data-jpa</artifactId>
    </dependency>
    <dependency>
        <groupId>com.h2database</groupId>
        <artifactId>h2</artifactId>
        <scope>runtime</scope>
    </dependency>
</dependencies>
```

2. Save your file and when IntelliJ asks if you want to enable automatic importing of Maven dependencies, select Enable Auto-Import.

Maven projects need to be imported

[Import Changes](#) [Enable Auto-Import](#)

If IntelliJ doesn't ask you to import dependencies, or if you use another IDE, type `mvn install` in the command line (while in the root of your project folder) to download the dependencies.

H2 is a great database for tutorials because you don't need to install external software. If you prefer, you can easily change to another database. See:

NOTE

- [Setting up MySQL](#)
- [Setting up Postgres](#)

The instructions in the remainder of this tutorial are the same, regardless of which database you use. To keep things simple, we recommend sticking with H2.

Defining the data model

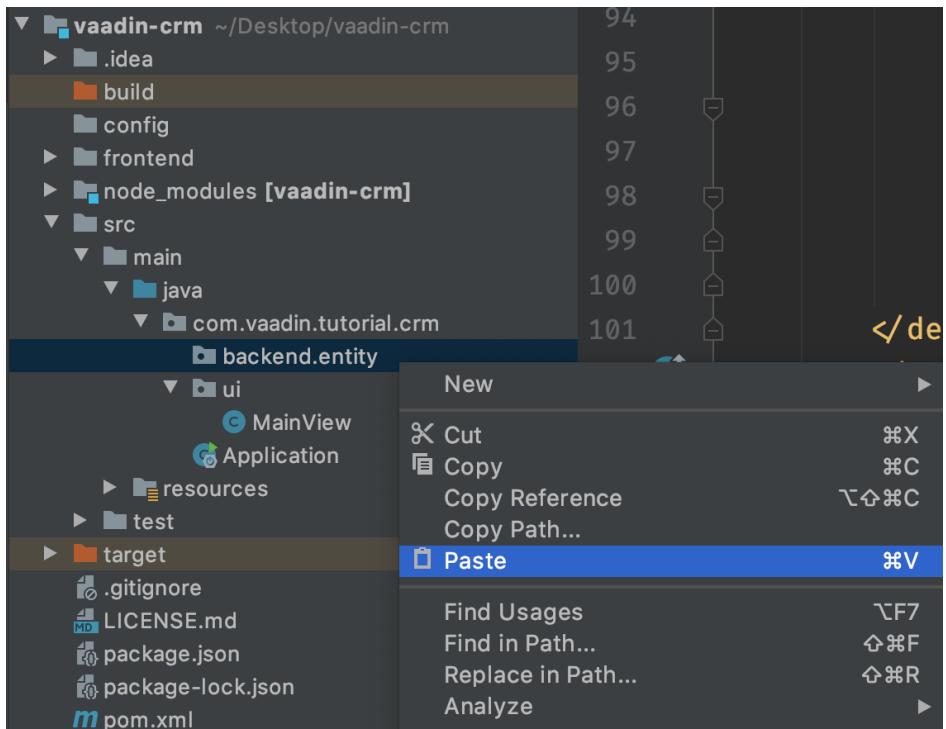
Our application is a customer relationship management (CRM) system that manages contacts and companies. To map content to our database, we need to create the following entity classes:

- **Contact**: An employee at a company.
- **Company**: An entity that can have several employees.
- **AbstractEntity**: A common superclass for both.

To create your entity classes:

1. Create a new package: `com.vaadin.tutorial.crm.backend.entity`.
2. Create three classes, `AbstractEntity`, `Contact`, and `Company`, in the new package, using the code detailed below.

The easiest way to do this is to copy the full class and paste it into the package in the project view. IntelliJ (and most other IDEs) will automatically create the Java file for you.



- Start by adding `AbstractEntity`, the common superclass. It defines how objects ids are generated and how object equality is determined.

AbstractEntity.java

```
package com.vaadin.tutorial.crm.backend.entity;

import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;
import javax.persistence.MappedSuperclass;

@MappedSuperclass
public abstract class AbstractEntity {
    @Id
    @GeneratedValue(strategy= GenerationType.SEQUENCE)
    private Long id;

    public Long getId() {
        return id;
    }

    public boolean isPersisted() {
        return id != null;
    }

    @Override
    public int hashCode() {
        if (getId() != null) {
            return getId().hashCode();
        }
        return super.hashCode();
    }

    @Override
    public boolean equals(Object obj) {
        if (this == obj) {
            return true;
        }
        if (obj == null) {
            return false;
        }
        if (getClass() != obj.getClass()) {
            return false;
        }
        AbstractEntity other = (AbstractEntity) obj;
        if (getId() == null || other.getId() == null) {
            return false;
        }
        return getId().equals(other.getId());
    }
}
```

- b. Next, create the [Contact](#) class:

Contact.java

```
package com.vaadin.tutorial.crm.backend.entity;

import javax.persistence.*;
import javax.validation.constraints.Email;
import javax.validation.constraints.NotEmpty;
import javax.validation.constraints.NotNull;

@Entity
public class Contact extends AbstractEntity implements Cloneable {

    public enum Status {
        ImportedLead, NotContacted, Contacted, Customer, ClosedLost
    }

    @NotNull
    @NotEmpty
    private String firstName = "";

    @NotNull
    @NotEmpty
    private String lastName = "";

    @ManyToOne
    @JoinColumn(name = "company_id")
    private Company company;

    @Enumerated(EnumType.STRING)
    @NotNull
    private Contact.Status status;

    @Email
    @NotNull
    @NotEmpty
    private String email = "";

    public String getEmail() {
        return email;
    }

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

    public Status getStatus() {
        return status;
    }

    public void setStatus(Status status) {
        this.status = status;
    }

    public String getLastname() {
        return lastName;
    }
}
```

```
public void setLastName(String lastName) {
    this.lastName = lastName;
}

public String getFirstName() {
    return firstName;
}

public void setFirstName(String firstName) {
    this.firstName = firstName;
}

public void setCompany(Company company) {
    this.company = company;
}

public Company getCompany() {
    return company;
}

@Override
public String toString() {
    return firstName + " " + lastName;
}
}
```

- c. Finally, copy over the [Company](#) class:

Company.java

```
package com.vaadin.tutorial.crm.backend.entity;

import javax.persistence.*;
import java.util.LinkedList;
import java.util.List;

@Entity
public class Company extends AbstractEntity {
    private String name;

    @OneToMany(mappedBy = "company", fetch = FetchType.EAGER)
    private List<Contact> employees = new LinkedList<>();

    public Company() {
    }

    public Company(String name) {
        setName(name);
    }

    public String getName() {
        return name;
    }

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

    public List<Contact> getEmployees() {
        return employees;
    }
}
```

3. Verify that you're able to build the project successfully.

If you see a lot of errors about missing classes, double check the Maven dependencies and run `mvn install` to make sure they are downloaded.

Creating repositories to access the database

Now that you have defined the data model, the next step is to create repository classes to access the database. Spring Boot makes this a painless process. All you need to do is define an interface that describes the entity type and primary key type, and Spring Data will configure it for you.

To create your repository classes:

1. Create a new package `com.vaadin.tutorial.crm.backend.repository`.
2. Copy the following two repository classes into the package:

ContactRepository.java

```
package com.vaadin.tutorial.crm.backend.repository;

import com.vaadin.tutorial.crm.backend.entity.Contact;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.data.jpa.repository.Query;
import org.springframework.data.repository.query.Param;

import java.util.List;

public interface ContactRepository extends JpaRepository<Contact, Long> {

}
```

CompanyRepository.java

```
package com.vaadin.tutorial.crm.backend.repository;

import com.vaadin.tutorial.crm.backend.entity.Company;
import org.springframework.data.jpa.repository.JpaRepository;

public interface CompanyRepository extends JpaRepository<Company, Long> {
}
```

Creating service classes for business logic

It's good practice to not let UI code access the database directly. Instead, we create service classes that handle business logic and database access. This makes it easier for you to control access and to keep your data consistent.

To create your service classes:

1. Create a new package `com.vaadin.tutorial.crm.backend.service`.
2. Copy the following two service classes into the package:

ContactService.java

```
package com.vaadin.tutorial.crm.backend.service;

import com.vaadin.tutorial.crm.backend.entity.Contact;
import com.vaadin.tutorial.crm.backend.repository.CompanyRepository;
import com.vaadin.tutorial.crm.backend.repository.ContactRepository;
import org.springframework.stereotype.Service;

import java.util.List;
import java.util.logging.Level;
import java.util.logging.Logger;

@Service ①
public class ContactService {
    private static final Logger LOGGER = Logger.getLogger(ContactService.class
.getName());
    private ContactRepository contactRepository;
    private CompanyRepository companyRepository;

    public ContactService(ContactRepository contactRepository,
                          CompanyRepository
companyRepository) { ②
        this.contactRepository = contactRepository;
        this.companyRepository = companyRepository;
    }

    public List<Contact> findAll() {
        return contactRepository.findAll();
    }

    public long count() {
        return contactRepository.count();
    }

    public void delete(Contact contact) {
        contactRepository.delete(contact);
    }

    public void save(Contact contact) {
        if (contact == null) { ③
            LOGGER.log(Level.SEVERE,
                       "Contact is null. Are you sure you have connected your form
to the application?");
            return;
        }
        contactRepository.save(contact);
    }
}
```

① The `@Service` annotation lets Spring know that this is a service class and makes it available for injection. This allows you to easily use it from your UI code later on.

② The constructor takes 2 parameters: `ContactRepository` and `CompanyRepository`.

Spring provides instances based on the interfaces we defined earlier.

- ③ For now, most operations are just passed through to the repository. The only exception is the `save` method, which checks for null values before attempting to save.

CompanyService.java

```
package com.vaadin.tutorial.crm.backend.service;

import com.vaadin.tutorial.crm.backend.entity.Company;
import com.vaadin.tutorial.crm.backend.repository.CompanyRepository;
import org.springframework.stereotype.Service;

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

@Service
public class CompanyService {

    private CompanyRepository companyRepository;

    public CompanyService(CompanyRepository companyRepository) {
        this.companyRepository = companyRepository;
    }

    public List<Company> findAll() {
        return companyRepository.findAll();
    }

}
```

Populating with test data

Next, we add a method that generates test data to populate our database. This makes it easier to work with the application.

To do this, add the following method at the end of `ContactService`:

ContactService.java

```
@PostConstruct ①
public void populateTestData() {
    if (companyRepository.count() == 0) {
        companyRepository.saveAll( ②
            Stream.of("Path-Way Electronics", "E-Tech Management", "Path-E-Tech
Management")
                .map(Company::new)
                .collect(Collectors.toList()));
    }

    if (contactRepository.count() == 0) {
        Random r = new Random(0);
        List<Company> companies = companyRepository.findAll();
        contactRepository.saveAll( ③
            Stream.of("Gabrielle Patel", "Brian Robinson", "Eduardo Haugen",
                    "Koen Johansen", "Alejandro Macdonald", "Angel Karlsson", "Yahir
Gustavsson", "Haiden Svensson",
                    "Emily Stewart", "Corinne Davis", "Ryann Davis", "Yurem Jackson",
                    "Kelly Gustavsson",
                    "Eileen Walker", "Katelyn Martin", "Israel Carlsson", "Quinn
Hansson", "Makena Smith",
                    "Danielle Watson", "Leland Harris", "Gunner Karlsen", "Jamar Olsson
", "Lara Martin",
                    "Ann Andersson", "Remington Andersson", "Rene Carlsson", "Elvis
Olsen", "Solomon Olsen",
                    "Jaydan Jackson", "Bernard Nilsen")
                .map(name -> {
                    String[] split = name.split(" ");
                    Contact contact = new Contact();
                    contact.setFirstName(split[0]);
                    contact.setLastName(split[1]);
                    contact.setCompany(companies.get(r.nextInt(companies.size())));
                    contact.setStatus(Contact.Status.values()[r.nextInt(Contact
.Status.values().length)]);
                    String email = (contact.getFirstName() + "." + contact
.getLastName() + "@" + contact.getCompany().getName().replaceAll("[\\s-]", "") +
".com").toLowerCase();
                    contact.setEmail(email);
                    return contact;
                }).collect(Collectors.toList()));
    }
}
```

① The @PostConstruct annotation tells Spring to run this method after constructing ContactService.

② Creates 3 test companies.

③ Creates test contacts.

Finalizing the back end

You need to stop and restart the application to make sure all the new POM dependencies are picked up correctly.

You can download the project with a fully set-up back end below. Unzip the project and follow the instructions in the importing chapter.

[Download from GitHub](#)

In the next chapter, we'll use the back end to populate data into a data grid in the browser.

Adding data and configuring columns in Vaadin Grid

Now that your back end is in place, you're ready to begin building the UI. We start by listing all contacts in a data grid. To do this, we need to create the necessary UI components and hook them up to the back end.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Creating and configuring the Grid

To create and configure the grid:

1. Edit `MainView` and add the following code:

MainView.java

```
// Package and imports omitted

@Route("")
public class MainView extends VerticalLayout {

    private Grid<Contact> grid = new Grid<>(Contact.class); ①

    public MainView() {
        addClassName("list-view"); ②
        setSizeFull(); ③
        configureGrid(); ④

        add(grid); ⑤
    }

    private void configureGrid() {
        grid.addClassName("contact-grid");
        grid.setSizeFull();
        grid.setColumns("firstName", "lastName", "email", "status"); ⑥
    }
}
```

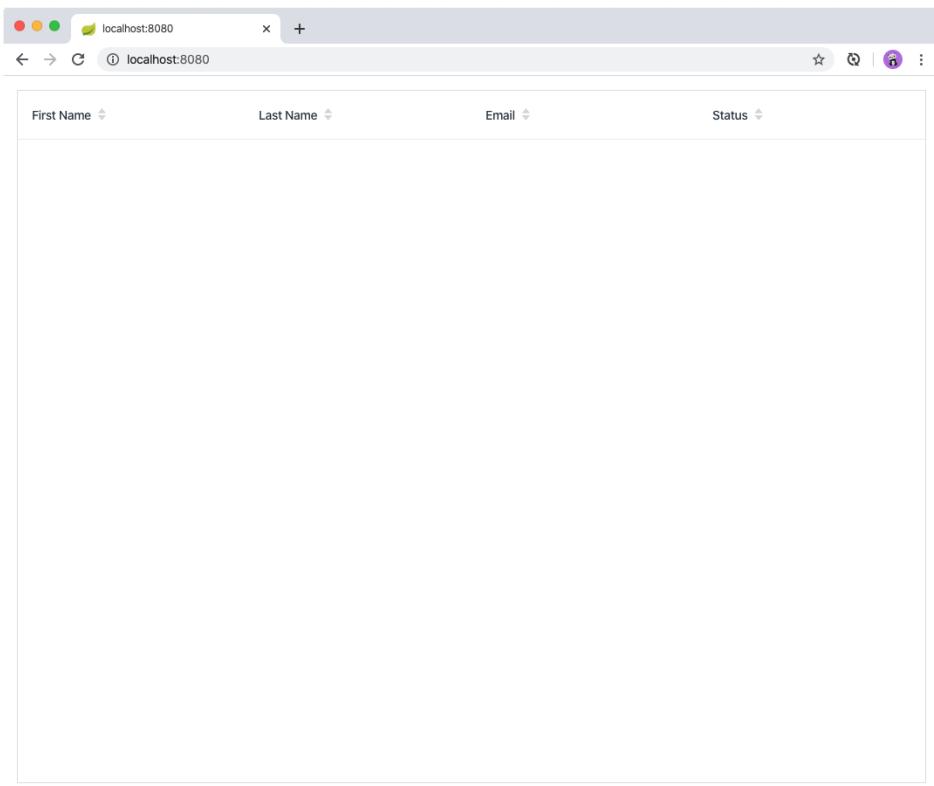
① Defines a new field `grid` and instantiates it to a `Grid` of type `Contact`.

② Gives the component a CSS class name to help with styling.

③ Calls `setSizeFull()` to make `MainView` take up the full size of the browser

window.

- ④ Splits the grid configuration into a separate method. We will add more components to the class later on and this helps to keep things easy to understand.
 - ⑤ Adds the grid to the main layout using the `add(grid)` method.
 - ⑥ Defines the properties of a Contact to shown using the `grid.setColumns(...)` method.
2. Run the application and verify that you now see an empty grid with the correct columns.



Populating the Grid with data from the backend

Next, we hook up the view to the back end, so that we can fetch contacts to show in the grid. We take advantage of Spring's dependency injection to get hold of the back end service, by adding it as a parameter to the constructor. Spring passes it in when `MainView` is created.

To hook your view to the back end:

1. Amend `MainView` as follows:

`MainView.java`

```
@Route("")
public class MainView extends VerticalLayout {

    private ContactService contactService;
    private Grid<Contact> grid = new Grid<>(Contact.class);

    public MainView(ContactService contactService) {
        this.contactService = contactService; ①
        addClassName("list-view");
        setSizeFull();
        configureGrid();

        add(grid);
        updateList(); ②
    }

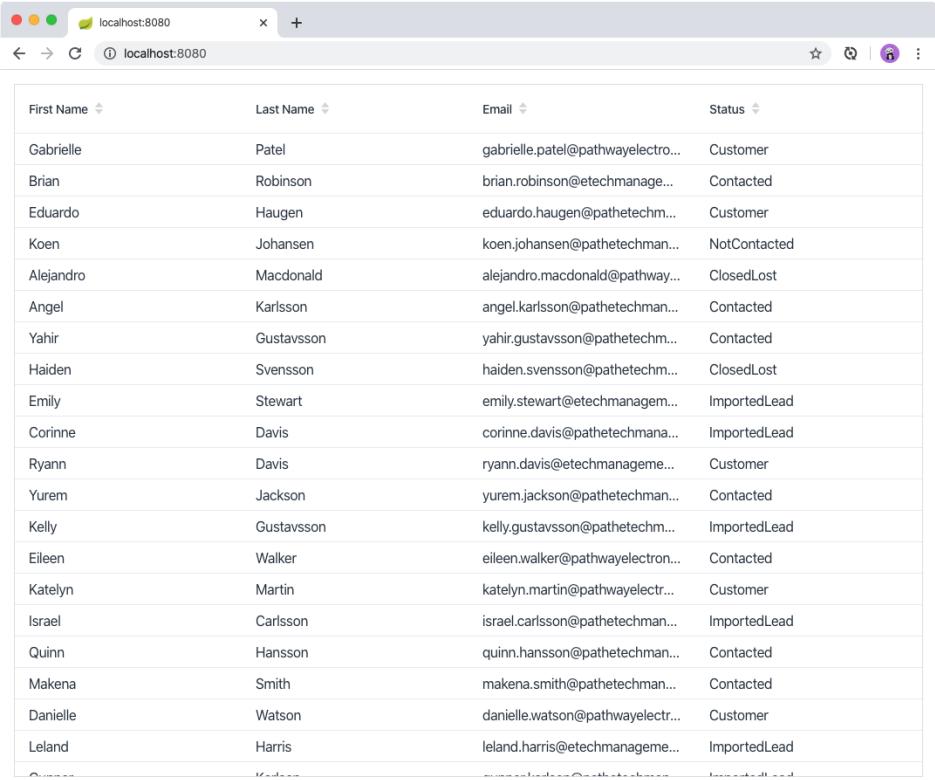
    private void configureGrid() {
        grid.addClassName("contact-grid");
        grid.setSizeFull();
        grid.setColumns("firstName", "lastName", "email", "status");
    }

    private void updateList() {
        grid.setItems(contactService.findAll());
    }
}
```

① Saves `ContactService` in a field, so you have easy access to it later.

② Creates a new method, `updateList()`, that fetches all contacts from the service, and passes them to the grid.

2. Build the project and verify that you now see contacts listed in the grid.



A screenshot of a web browser window displaying a contact list grid. The title bar shows "localhost:8080". The grid has columns for First Name, Last Name, Email, and Status. The data rows list various contacts with their respective details.

First Name	Last Name	Email	Status
Gabrielle	Patel	gabrielle.patel@pathwayelectro...	Customer
Brian	Robinson	brian.robinson@etechmanage...	Contacted
Eduardo	Haugen	eduardo.haugen@pathetechm...	Customer
Koen	Johansen	koen.johansen@pathetechman...	NotContacted
Alejandro	Macdonald	alejandro.macdonald@pathway...	ClosedLost
Angel	Karlsson	angel.karlsson@pathetechman...	Contacted
Yahir	Gustavsson	yahir.gustavsson@pathetechm...	Contacted
Haiden	Svensson	haiden.svensson@pathetechm...	ClosedLost
Emily	Stewart	emily.stewart@etechmanageme...	ImportedLead
Corinne	Davis	corinne.davis@pathetechmana...	ImportedLead
Ryann	Davis	ryann.davis@etechmanageme...	Customer
Yurem	Jackson	yurem.jackson@pathetechman...	Contacted
Kelly	Gustavsson	kelly.gustavsson@pathetechm...	ImportedLead
Eileen	Walker	eileen.walker@pathwayelectron...	Contacted
Katelyn	Martin	katelyn.martin@pathwayelectr...	Customer
Israel	Carlsson	israel.carlsson@pathetechman...	ImportedLead
Quinn	Hansson	quinn.hansson@pathetechman...	Contacted
Makenna	Smith	makenna.smith@pathetechman...	Contacted
Danielle	Watson	danielle.watson@pathwayelectr...	Customer
Leland	Harris	leland.harris@etechmanageme...	ImportedLead

Adding a custom column to the grid

In the previous chapter, when we set up the [data model](#), we defined that each [Contact](#) belongs to a [Company](#). We now want to show that company information as a column in the grid. The problem is that if we add "`"company"`" to the column list, the grid doesn't show the company name, but something like "`com.vaadin.tutorial.crm.backend.e..."`" instead.

The company property is a reference to another object, and the grid shows the fully qualified class name because it doesn't know how we want to display the object. To fix this, we need to change how the company column is defined.

To define the company column:

1. Amend [MainView](#) as follows:

MainView.java

```
private void configureGrid() {
    grid.addClassNames("contact-grid");
    grid.setSizeFull();
    grid.removeColumnByKey("company"); ①
    grid.setColumns("firstName", "lastName", "email", "status");
    grid.addColumn(contact -> { ②
        Company company = contact.getCompany();
        return company == null ? "-" : company.getName();
    }).setHeader("Company");
}
```

① Removes the default column definition with the `removeColumnByKey` method.

② Uses the `addColumn` method to add a custom column.

- `addColumn` gets a `contact` parameter, and returns how it should be shown in the grid. In this case, we show the company name, or a dash if it's empty.
- `setHeader` defines the column header for the custom column.

2 Build the application, and you should now see the company names listed in the grid.

First Name	Last Name	Email	Status	Company
Gabrielle	Patel	gabrielle.patel@pathwa...	Customer	Path-Way Electronics
Brian	Robinson	brian.robinson@etech...	Contacted	E-Tech Management
Eduardo	Haugen	eduardo.haugen@path...	Customer	Path-E-Tech Managem...
Koen	Johansen	koen.johansen@pathet...	NotContacted	Path-E-Tech Managem...
Alejandro	Macdonald	alejandro.macdonald@...	ClosedLost	Path-Way Electronics
Angel	Karlsson	angel.karlsson@pathet...	Contacted	Path-E-Tech Managem...
Yahir	Gustavsson	yahir.gustavsson@path...	Contacted	Path-E-Tech Managem...
Haiden	Svensson	haiden.svensson@path...	ClosedLost	Path-E-Tech Managem...
Emily	Stewart	emily.stewart@etechm...	ImportedLead	E-Tech Management
Corinne	Davis	corinne.davis@pathete...	ImportedLead	Path-E-Tech Managem...
Ryann	Davis	ryann.davis@etechman...	Customer	E-Tech Management
Yurem	Jackson	yurem.jackson@pathet...	Contacted	Path-E-Tech Managem...
Kelly	Gustavsson	kelly.gustavsson@path...	ImportedLead	Path-E-Tech Managem...
Eileen	Walker	eileen.walker@pathway...	Contacted	Path-Way Electronics
Katelyn	Martin	katelyn.martin@pathwa...	Customer	Path-Way Electronics
Israel	Carlsson	israel.carlsson@pathet...	ImportedLead	Path-E-Tech Managem...
Quinn	Hansson	quinn.hansson@pathet...	Contacted	Path-E-Tech Managem...
Makena	Smith	makena.smith@pathete...	Contacted	Path-E-Tech Managem...
Danielle	Watson	danielle.watson@pathw...	Customer	Path-Way Electronics
Leland	Harris	leland.harris@etechma...	ImportedLead	E-Tech Management

Defining column widths

By default, the grid makes each column equally wide. Let's turn on automatic column sizing so that the email and company fields, which are typically longer, get more space. Automatic column sizing tries to make the column wide enough to fit the widest content.

To turn on automatic column sizing:

1. Amend `MainView` as follows:

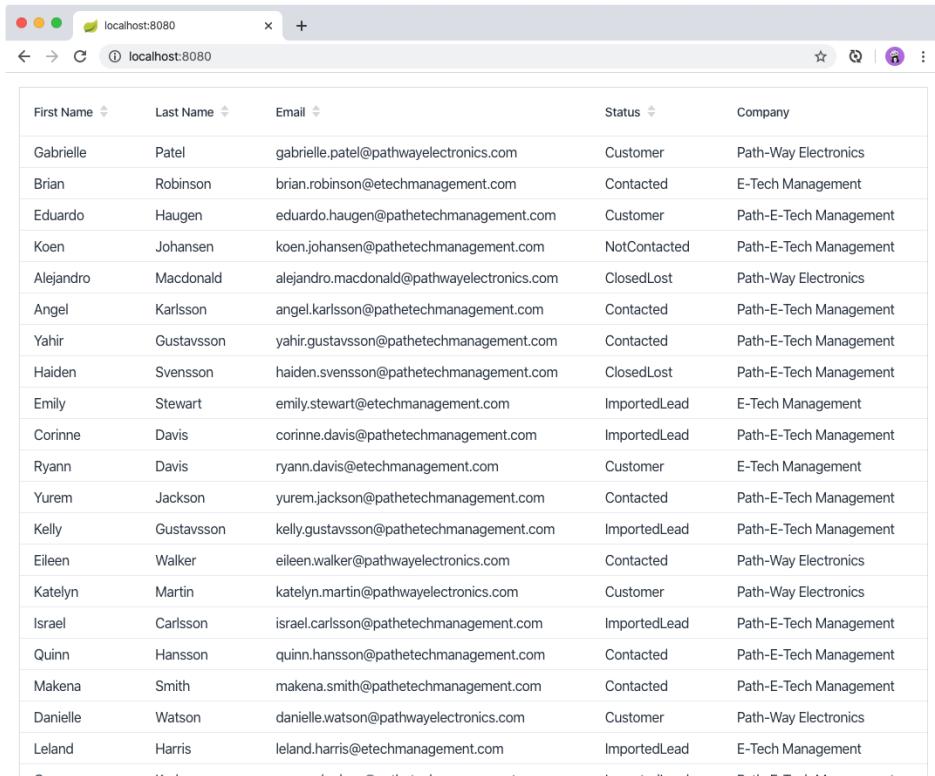
MainView.java

```
private void configureGrid() {
    // column definitions omitted

    grid.getColumns().forEach(col -> col.setAutoWidth(true)); ①
}
```

- ① Automatic width needs to be turned on for each column separately. The easiest way to do it is to call `grid.getColumns()` and then use `forEach` to loop over all of them.

2. Build the app and you should now see that the columns are sized more appropriately.



A screenshot of a web browser window titled "localhost:8080". The table has five columns: First Name, Last Name, Email, Status, and Company. The data rows are as follows:

First Name	Last Name	Email	Status	Company
Gabrielle	Patel	gabrielle.patel@pathwayelectronics.com	Customer	Path-Way Electronics
Brian	Robinson	brian.robinson@etechmanagement.com	Contacted	E-Tech Management
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer	Path-E-Tech Management
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted	Path-E-Tech Management
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost	Path-Way Electronics
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted	Path-E-Tech Management
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted	Path-E-Tech Management
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost	Path-E-Tech Management
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead	E-Tech Management
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead	Path-E-Tech Management
Ryann	Davis	ryann.davis@etechmanagement.com	Customer	E-Tech Management
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted	Path-E-Tech Management
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead	Path-E-Tech Management
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted	Path-Way Electronics
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer	Path-Way Electronics
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead	Path-E-Tech Management
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted	Path-E-Tech Management
Makena	Smith	makena.smith@pathetechmanagement.com	Contacted	Path-E-Tech Management
Danielle	Watson	danielle.watson@pathwayelectronics.com	Customer	Path-Way Electronics
Leland	Harris	leland.harris@etechmanagement.com	ImportedLead	E-Tech Management

In the next tutorial, we'll add filtering to the application, so it's easier to find the right contact.

You can find the completed source code for this tutorial on [GitHub](#).

Filtering rows in Vaadin Grid

In the [previous tutorial](#), we created a data grid and filled it with contact details stored in the database. In this tutorial, we continue by adding a text field to filter the contents of the grid.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Adding a text field for filtering

Start by adding a text field above the grid. Remember, `MainView` is a `VerticalLayout`, so you need to add the text field before the grid.

MainView.java

```
public class MainView extends VerticalLayout {
    private ContactService contactService;

    private Grid<Contact> grid = new Grid<>(Contact.class);
    private TextField filterText = new TextField(); ①

    public MainView(ContactService contactService) {
        this.contactService = contactService;
        addClassName("list-view");
        setSizeFull();
        configureFilter(); ②
        configureGrid();

        add(filterText, grid); ③
        updateList();
    }

    private void configureFilter() {
        filterText.setPlaceholder("Filter by name..."); ④
        filterText.setClearButtonVisible(true); ⑤
        filterText.setValueChangeMode(ValueChangeMode.LAZY); ⑥
        filterText.addValueChangeListener(e -> updateList()); ⑦
    }
    // Grid configuration omitted
}
```

① Creates a field for the `TextField`.

② Calls the `configureFilter()` method to configure what the filter should do.

③ Updates the `add()` method call to add both `filterText` and `grid`.

④ Sets placeholder text so users know what to type in the field.

- ⑤ Sets the clear button to visible so users can easily clear the filter.
- ⑥ Sets the value change mode to `LAZY` so the text field will notify you of changes automatically after a short timeout in typing.
- ⑦ Calls the `updateList` method whenever the value changes. We'll update the logic to filter the content shortly.

Implementing filtering in the back end

We could implement the filtering in two ways:

1. Keep a copy of the contacts list in the view and filter it using Java streams.
2. Defer the filtering to the back end (database).

It's a best practice to avoid keeping references to lists of objects in Vaadin views, as this can lead to excessive memory usage.

We'll add filtering support to the back end:

1. Amend `ContactService` as follows:

ContactService.java

```
public class ContactService {  
    private static final Logger LOGGER = Logger.getLogger(ContactService.class  
.getName());  
    private ContactRepository contactRepository;  
    private CompanyRepository companyRepository;  
  
    public ContactService(ContactRepository contactRepository,  
                           CompanyRepository  
companyRepository) {  
        this.contactRepository = contactRepository;  
        this.companyRepository = companyRepository;  
    }  
  
    public List<Contact> findAll() {  
        return contactRepository.findAll();  
    }  
  
    public List<Contact> findAll(String stringFilter) { ①  
        if (stringFilter == null || stringFilter.isEmpty()) { ②  
            return contactRepository.findAll();  
        } else {  
            return contactRepository.search(stringFilter); ③  
        }  
    }  
  
    // remaining methods omitted  
}
```

① Adds a new `findAll` method that takes a filter text as a parameter.

② If the filter text is not empty, search the database for that text.

③ Otherwise, return all contacts

2 Add the `search` method to the contacts repository.

ContactRepository.java

```
public interface ContactRepository extends JpaRepository<Contact, Long> {  
  
    @Query("select c from Contact c " +  
          "where lower(c.firstName) like lower(concat('%', :searchTerm, '%')) " +  
          "or lower(c.lastName) like lower(concat('%', :searchTerm, '%'))") ①  
    List<Contact> search(@Param("searchTerm") String searchTerm); ②  
}
```

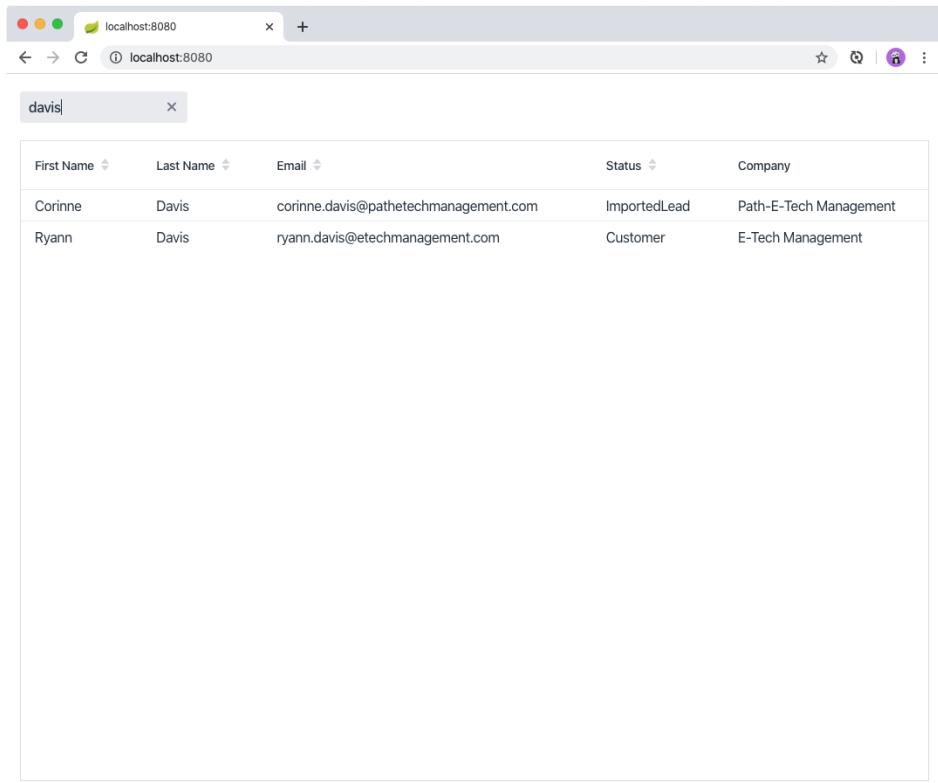
① Uses the `@Query` annotation to define a custom query. In this case, it checks if the string matches the first or the last name, and ignores the case. The query uses [Java Persistence Query Language \(JPQL\)](#) which is an SQL-like language for querying JPA managed databases.

- ② Selects the Spring Framework import for `@Param`.
3. Update the way `MainView` updates the contacts. This is the method that is called every time the filter text field changes.

MainView.java

```
private void updateList() {  
    grid.setItems(contactService.findAll(filterText.getValue()));  
}
```

4. Build the application and try out the filtering. You should be able to filter the contacts by entering a term in the text field.



The screenshot shows a web browser window with the address bar set to "localhost:8080". A search bar at the top contains the text "davis". Below the search bar is a table grid displaying contact information. The columns are labeled "First Name", "Last Name", "Email", "Status", and "Company". There are two rows of data:

First Name	Last Name	Email	Status	Company
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead	Path-E-Tech Management
Ryann	Davis	ryann.davis@etechmanagement.com	Customer	E-Tech Management

So far, we've created an application that shows and filters contacts that are stored in a database. Next, we'll add a form to add, remove, and edit contacts.

You can find the completed source code for this tutorial on [GitHub](#).

Creating your own reusable components in Vaadin

In the [previous tutorial](#), we added filtering to the grid that lists contacts stored in a database. In this tutorial, we build a form component to add, remove, and edit contacts.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Vaadin is a component-based framework. You've already worked with several components, like [Grid](#), [TextField](#), and [VerticalLayout](#). But, the real power of the component-based architecture is in the ability to create your own components.

Instead of building an entire view in a single class, your view can be composed of smaller components that each handle different parts of the view. The advantage of this approach is that individual components are easier to understand and test. The top-level view is used mainly to orchestrate the components.

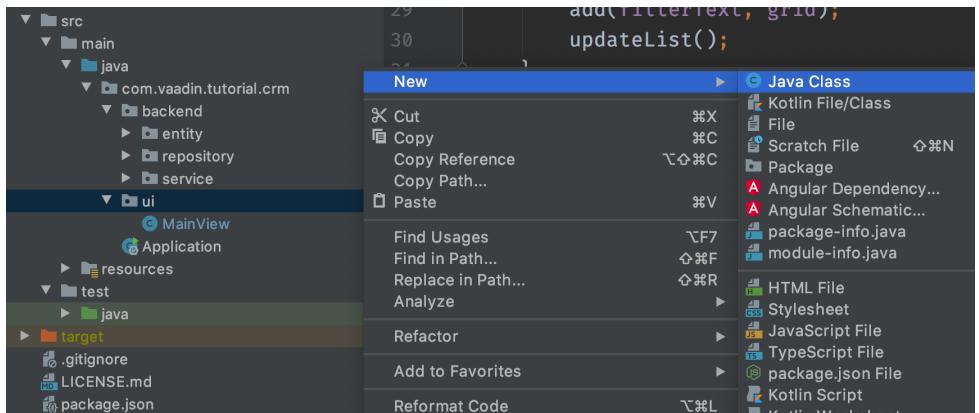
Creating a form component

Our form component will have:

- Text fields for the first and last name.
- An email field.
- Two select fields: one to select the company and the other to select the contact status.

The screenshot shows a user interface for a form component. It consists of five input fields arranged in two rows. The first row contains 'First name' and 'Last name'. The second row contains 'Email' and 'Company'. Below these is a 'Status' field with a dropdown arrow. At the bottom right are three buttons: 'Save' (blue), 'Delete' (red), and 'Cancel' (light blue).

To create the form, copy the code below and paste it into the `ui` package. IntelliJ will create a new Java class, [ContactForm](#).



ContactForm.java

```

public class ContactForm extends FormLayout { ①

    TextField firstName = new TextField("First name"); ②
    TextField lastName = new TextField("Last name");
    EmailField email = new EmailField("Email");
    ComboBox<Contact.Status> status = new ComboBox<>("Status");
    ComboBox<Company> company = new ComboBox<>("Company");

    Button save = new Button("Save"); ③
    Button delete = new Button("Delete");
    Button close = new Button("Cancel");

    public ContactForm() {
        addClassName("contact-form"); ④
        add(firstName,
            lastName,
            email,
            company,
            status,
            createButtonsLayout()); ⑤
    }

    private HorizontalLayout createButtonsLayout() {
        save.addThemeVariants(ButtonVariant.LUMO_PRIMARY); ⑥
        delete.addThemeVariants(ButtonVariant.LUMO_ERROR);
        close.addThemeVariants(ButtonVariant.LUMO_TERTIARY);

        save.addClickShortcut(Key.ENTER); ⑦
        close.addClickShortcut(Key.ESCAPE);

        return new HorizontalLayout(save, delete, close); ⑧
    }
}

```

① `ContactForm` extends `FormLayout`: a responsive layout that shows form fields in 1 or 2

columns depending on viewport width.

- ② Creates all the UI components as fields in the component.
- ③ Uses the `com.vaadin.ui` import for `Button`, not the one from the `crud` package.
- ④ Gives the component a CSS class name so we can style it later
- ⑤ Adds all the UI components. The buttons require a bit of extra configuration so we create and call a new method, `createButtonsLayout()`.
- ⑥ Makes the buttons visually distinct from each other using built-in `theme variants`.
- ⑦ Defines keyboard shortcuts: `Enter` to save and `Escape` to close the editor
- ⑧ Returns a `HorizontalLayout` containing the buttons to place them next to each other.

Adding the form to main view

The next step is to add the form to the main view.

To do this, amend `MainView` as follows:

```
public class MainView extends VerticalLayout {  
    private ContactService contactService;  
  
    private Grid<Contact> grid = new Grid<>(Contact.class);  
    private TextField filterText = new TextField();  
    private ContactForm form; ①  
  
    public MainView(ContactService contactService) {  
        this.contactService = contactService;  
        addClassName("list-view");  
        setSizeFull();  
  
        configureGrid();  
        configureFilter();  
  
        form = new ContactForm(); ②  
  
        Div content = new Div(grid, form); ③  
        content.addClassNames("content");  
        content.setSizeFull();  
  
        add(filterText, content); ④  
        updateList();  
    }  
    // other methods omitted.  
}
```

- ① Creates a field for the form so you have access to it from other methods later on.
- ② Initialize the form in the constructor.
- ③ Creates a `Div` that wraps the `grid` and the `form`, gives it a CSS class name, and makes it full size.
- ④ Adds the `content` layout to the main layout.

Making the layout responsive

To make the layout responsive and usable on both mobile and desktop, we need to add CSS.

To do this, replace the content of `<project root>/frontend/shared-styles.css` with the following styles:

`shared-styles.css`

```
/* List view */
.list-view .content {
  display: flex; ①
}

.list-view .contact-grid {
  flex: 2; ②
}

.list-view .contact-form {
  flex: 1;
  padding: var(--lumo-space-m); ③
}

@media all and (max-width: 1100px) { ④
  .list-view.editing .toolbar,
  .list-view.editing .contact-grid {
    display: none;
  }
}
```

- ① Uses [CSS Flexbox](#) to manage the layout
- ② Allocates 2/3 of the available width to the grid and 1/3 to the form.
- ③ Uses the [Vaadin Lumo theme custom property](#), `--lumo-space-m`, to add standard padding in the form
- ④ Hides the toolbar and grid when editing on narrow screens (we'll add some logic to handle this shortly).

Importing CSS styles into main the view

Next, we load the CSS file by adding a `CssImport` annotation in `MainView`.

To add and load the new CSS styles:

1. Amend `MainView` as follows:

MainView.java

```
@Route("")
@CssImport("./styles/shared-styles.css") ①
public class MainView extends VerticalLayout {
    ...
}
```

① The import path needs to be relative to the `frontend` folder

2. Stop and restart the server to ensure the CSS is loaded.

3. Verify that the main view looks the way it should. The form should now display next to the grid.

The screenshot shows a web application running at `localhost:8080`. The main page displays a table of contacts with columns for First Name, Last Name, Email, and Status. A modal dialog is open on the right side, showing fields for First name, Last name, Email, Company, and Status, along with Save, Delete, and Cancel buttons.

First Name	Last Name	Email	Status
Gabrielle	Patel	gabrielle.patel@pathwayelectronics.com	Customer
Brian	Robinson	brian.robinson@etechmanagement.com	Contacted
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead
Ryann	Davis	ryann.davis@etechmanagement.com	Customer
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted
Makenna	Smith	makenna.smith@pathetechmanagement.com	Contacted
Danielle	Watson	danielle.watson@pathwayelectronics.com	Customer

The visual part of the form is now complete. In the next tutorial, we'll make it functional.

You can find the completed source code for this tutorial on [GitHub](#).

Vaadin form data binding and validation

In the [previous tutorial](#), we started building a reusable form component. In this tutorial, we define the form component API and use data binding to make the form functional.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Binding object properties to input fields

A form is a collection of input fields that are connected to a data model, a [Contact](#) in this case. Forms validate user input and make it easy to get an object populated with input values from the UI.

Vaadin users the [Binder](#) class to build forms. It binds UI fields to data object fields by name. For instance, it takes a UI field named `firstName` and maps it to the `firstName` field of the data object, and the `lastName` field to the `lastName` field, and so on. This is why the field names in [Contact](#) and [ContactForm](#) are the same.

NOTE Binder also supports an [advanced API](#) where you can configure data conversions and additional validation rules, but for this application, the simple API is sufficient.

Binder can use validation rules that are defined on the data object in the UI. This means you can run the same validations in both the browser and before saving to the database, without duplicating code.

Creating the binder

The first step is to create a new binder field in the contact form.

To do this, add the `BeanValidationBinder` field to `ContactForm` as follows:

ContactForm.java

```
// Other fields omitted
Binder<Contact> binder = new BeanValidationBinder<>(Contact.class); ①

public ContactForm() {
    addClassName("contact-form");
    binder.bindInstanceFields(this); ②
    // Rest of constructor omitted
}
```

- ① `BeanValidationBinder` is a `Binder` that is aware of bean validation annotations. By passing it in the `Contact.class`, we define the type of object we are binding to.
- ② `bindInstanceFields` matches fields in `Contact` and `ContactForm` based on their names.

With these two lines of code, you've made the UI fields ready to be connected to a contact. We'll do that next.

Decoupling components

Object-oriented programming allows you to decouple objects and this helps to increase their reusability.

In our app, we create a form component and use it in the `MainView`. The most straightforward approach would appear to be to let the form call methods on `MainView` directly to save a contact. But what happens if you need the same form in another view? Or if you want to write a test to verify that the form works as intended? In both cases, the dependency on `MainView` makes it more complex than is necessary. Coupling a component to a specific parent typically makes it more difficult to reuse and test.

Instead, we should aim to make components that work in the same way as a `Button` component: you can use them anywhere. You configure the component by setting properties, and it notifies you of events through listeners.

Creating a reusable component is as simple as making sure it can be configured through setters, and that it fires events whenever something happens. Using the component should not have side effects, for instance it shouldn't change anything in the database by itself.

Defining the form component API

With the visual part of the component complete, the next step is to define the form component API. This is how developers interact with the form.

A good rule of thumb when designing an API for a reusable component is: *properties in, events out*. Users should be able to fully configure a component by setting properties. They should be notified of all relevant events, without the need to manually call getters to see if things have changed.

With this in mind, here's what our API will cover:

Properties in:

- Set the contact.
- Set the list of companies.

Events out:

- Save.
- Delete.
- Close.

Setting the company and contact status

The two properties that need to be handled are the contact shown in the form and the list of companies shown in the dropdown.

To set the company and contact status:

1. In [ContactForm](#), add the company list as a constructor parameter. We do this first, because the company list is needed before a contact can be edited.

ContactForm.java

```
public ContactForm(List<Company> companies) { ①
    addClassName("contact-form");
    binder.bindInstanceFields(this);

    company.setItems(companies); ②
    company.setItemLabelGenerator(Company::getName); ③
    status.setItems(Contact.Status.values()); ④

    //omitted
}
```

- ① Adds a list of [Company](#) objects as a parameter to the constructor.
- ② Sets the list of [companies](#) as the items in the company combo box.
- ③ Tells the combo box to use the name of the company as the display value.
- ④ Populates the status dropdown with the values from the [Contact.Status](#) enum.

WARNING

You will get a compilation error if you build the application at this point. This is because you have not yet passed a list of companies in [MainView](#).

2. In [MainView](#), update the constructor to take [CompanyService](#) as a parameter, and then use this service to pass a list of all companies.

MainView.java

```
public MainView(ContactService contactService,
                 CompanyService companyService) { ①
    this.contactService = contactService;
    addClassName("list-view");
    setSizeFull();

    configureGrid();
    configureFilter();

    form = new ContactForm(companyService.findAll()); ②

    add(filterText, grid, form);
    updateList();
}
```

① Auto wires (injects) `CompanyService` as a constructor parameter.

② Finds all companies and passes them to `ContactForm`.

Updating the contact

Next, we need to create a setter for the `contact` because it can change over time as a user browses through the contacts.

To do this, add the following in the `ContactForm` class:

ContactForm.java

```
public void setContact(Contact contact) {
    binder.setBean(contact); ①
}
```

① Calls `binder.setBean` to bind the values from the contact to the UI fields

Setting up events

Vaadin comes with an event-handling system for components. We've already used it to listen to value-change events from the `filter text field`. We want the form component to have a similar way of informing parents of events.

To do this, add the following at the end of the `ContactForm` class:

ContactForm.java

```
// Events
public static abstract class ContactFormEvent extends ComponentEvent<ContactForm> {
    private Contact contact;

    protected ContactFormEvent(ContactForm source, Contact contact) { ①
        super(source, false);
        this.contact = contact;
    }

    public Contact getContact() {
        return contact;
    }
}

public static class SaveEvent extends ContactFormEvent {
    SaveEvent(ContactForm source, Contact contact) {
        super(source, contact);
    }
}

public static class DeleteEvent extends ContactFormEvent {
    DeleteEvent(ContactForm source, Contact contact) {
        super(source, contact);
    }
}

public static class CloseEvent extends ContactFormEvent {
    CloseEvent(ContactForm source) {
        super(source, null);
    }
}

public <T extends ComponentEvent<?>> Registration addListener(Class<T> eventType,
    ComponentEventListener<T> listener) { ②
    return getEventBus().addListener(eventType, listener);
}
```

- ① `ContactFormEvent` is a common superclass for all the events. It contains the `contact` that was edited or deleted.
- ② The `addListener` method uses Vaadin's event bus to register the custom event types. Select the `com.vaadin` import for `Registration` if IntelliJ asks.

Saving, deleting, and closing the form

With the event types defined, we can now inform anyone using `ContactForm` of relevant events.

To add `save`, `delete` and `close` event listeners, add the following to the `ContactForm` class:

ContactForm.java

```
private Component createButtonsLayout() {
    // omitted

    save.addClickListener(event -> validateAndSave()); ①
    delete.addClickListener(event -> fireEvent(new DeleteEvent(this, binder.getBean()
))); ②
    close.addClickListener(event -> fireEvent(new CloseEvent(this))); ③

    binder.addStatusChangeListener(e -> save.setEnabled(binder.isValid())); ④
    return new HorizontalLayout(save, delete, close);
}

private void validateAndSave() {
    if (binder.isValid()) { ⑤
        fireEvent(new SaveEvent(this, binder.getBean()));
    }
}
```

① The save button calls the `validateAndSave` method

② The delete button fires a delete event and passes the currently-edited contact.

③ The cancel button fires a close event.

④ Validates the form every time it changes. If it is invalid, it disables the save button to avoid invalid submissions.

⑤ Only fires a save event if the form is valid.

In the next tutorial, we'll connect the form to the main view so that the selected contact in the form can be edited.

You can find the completed source code for this tutorial on [GitHub](#).

Communicating between components using events and properties

In the [previous tutorial](#), we created a reusable form component to edit contacts. In this tutorial we'll hook it up to our application. Our form will:

- Show the contact currently-selected in the grid.
- Be hidden when no contact is selected.
- Save and delete contacts in the database.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Showing selected contacts in the form

The first step is to show the selected grid row in the form. This is also known as creating a master-detail view.

To do this, amend [MainView](#) as follows:

MainView.java

```
public MainView(ContactService contactService,
                CompanyService companyService) {
    //omitted
    closeEditor(); ①
}

private void configureGrid() {
    // Omitted

    grid.asSingleSelect().addValueChangeListener(event -> ②
        editContact(event.getValue()));
}

public void editContact(Contact contact) { ③
    if (contact == null) {
        closeEditor();
    } else {
        form.setContact(contact);
        form.setVisible(true);
        addClassName("editing");
    }
}

private void closeEditor() {
    form.setContact(null);
    form.setVisible(false);
    removeClassName("editing");
}

// Remaining methods omitted
```

- ① The `closeEditor()` call at the end of the constructor Sets the form contact to `null`, clearing out old values. Hides the form. Removes the `"editing"` CSS class from the view.
- ② `addValueChangeListener` adds a listener to the grid. The `Grid` component supports **multi and single-selection modes**. We only want to select a single `Contact`, so we use the `asSingleSelect()` method. The `getValue()` method returns the `Contact` in the selected row or null if there's no selection.
- ③ `editContact` sets the selected contact in the `ContactForm` and hides or shows the form, depending on the selection. It also sets the `"editing"` CSS class name when editing.

Build the application. You should now be able to select contacts in the grid and see them in the form. But, none of the buttons work yet.

First Name	Last Name	Email	Status
Gabrielle	Patel	gabrielle.patel@pathwayelectronics.com	Customer
Brian	Robinson	brian.robinson@etechmanagement.com	Contacted
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead
Ryann	Davis	ryann.davis@etechmanagement.com	Customer
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted
Makenna	Smith	makenna.smith@pathetechmanagement.com	Contacted
Danielle	Watson	danielle.watson@pathwayelectronics.com	Customer

Handling form events We designed the `ContactForm` API to be reusable: it is configurable through properties and it fires the necessary events. So far, we've passed a list of companies and the contact to the form. Now all we need to do is listen for the events to complete the integration.

To handle event listeners, amend `MainView` as follows:

MainView.java

```
public MainView(ContactService contactService,
                CompanyService companyService) {
    this.contactService = contactService;
    addClassName("list-view");
    setSizeFull();

    configureGrid();
    configureFilter();

    form = new ContactForm(companyService.findAll());
    form.addListener(ContactForm.SaveEvent.class, this::saveContact); ①
    form.addListener(ContactForm.DeleteEvent.class, this::deleteContact); ②
    form.addListener(ContactForm.CloseEvent.class, e -> closeEditor()); ③

    Div content = new Div(grid, form);
    content.addClassName("content");
    content.setSizeFull();

    add(filterText, content);
    updateList();
    closeEditor();
}

private void saveContact(ContactForm.SaveEvent event) {
    contactService.save(event.getContact());
    updateList();
    closeEditor();
}

private void deleteContact(ContactForm.DeleteEvent event) {
    contactService.delete(event.getContact());
    updateList();
    closeEditor();
}
```

① Save calls `saveContact`, it:

- Uses `contactService` to save the contact in the event to the database.
- Updates the list.
- Closes the editor.

② Delete calls `deleteContact`, it:

- Uses `contactService` to delete the contact from the database.
- Updates the list.
- Closes the editor.

- ③ Close closes the editor.

Build the application and verify that you are now able to update and delete contacts.

The screenshot shows a web browser window with two tabs open, both labeled "localhost:8080". The main content area displays a table of contacts with columns: First Name, Last Name, Email, and Status. A modal dialog is overlaid on the page, allowing for the creation or modification of a contact. The modal has fields for First name (set to "IAM"), Last name (set to "UPDATED"), Email (set to "gabrielle.patel@pathwayelectronics.com"), Company (set to "Path-Way Electronics"), and Status (set to "Customer"). At the bottom of the modal are three buttons: "Save" (blue), "Delete" (red), and "Cancel".

First Name	Last Name	Email	Status
I AM	UPDATED	gabrielle.patel@pathwayelectronics.com	Customer
Brian	Robinson	brian.robinson@etechmanagement.com	Contacted
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead
Ryann	Davis	ryann.davis@etechmanagement.com	Customer
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted
Makenna	Smith	makenna.smith@pathetechmanagement.com	Contacted
Danielle	Watson	danielle.watson@pathwayelectronics.com	Customer

Adding new contacts

The final step is to add a button to add new contacts. We'll position the button next to the filter field.

1. In `MainView`, create a `HorizontalLayout` that wraps the text field and the button, rename the `configureFilter` method to `configureToolbar`, and replace its contents, as follows:

MainView.java

```
private HorizontalLayout getToolbar() { ①
    filterText.setPlaceholder("Filter by name...");
    filterText.setClearButtonVisible(true);
    filterText.setValueChangeMode(ValueChangeMode.LAZY);
    filterText.addValueChangeListener(e -> updateList());

    Button addContactButton = new Button("Add contact");
    addContactButton.addClickListener(click -> addContact()); ②

    HorizontalLayout toolbar = new HorizontalLayout(filterText, addContactButton
); ③
    toolbar.addClassNames("toolbar");
    return toolbar;
}
```

① Returns a `HorizontalLayout`.

② The "Add contact" button calls `addContact` when clicked.

③ Adds a `HorizontalLayout` with the filter input field and a button, gives it a CSS class name "`toolbar`" that is used for the responsive layouting.

2. Define the `addContact()` method as follows:

MainView.java

```
void addContact() {
    grid.asSingleSelect().clear(); ①
    editContact(new Contact()); ②
}
```

① Deselects the grid so that a previously selected `Contact` is no longer highlighted when the user adds a new contact.

② Creates a new `Contact` and passes it to `editContact`.

3. Update the `MainView` constructor to use the new toolbar as follows:

MainView.java

```
public MainView(ContactService contactService,
                CompanyService companyService) {
    this.contactService = contactService;
    addClassName("list-view");
    setSizeFull();
①   configureGrid();

    form = new ContactForm(companyService.findAll());
    form.addListener(ContactForm.SaveEvent.class, this::saveContact);
    form.addListener(ContactForm.DeleteEvent.class, this::deleteContact);
    form.addListener(ContactForm.CloseEvent.class, e -> this.closeEditor());
    closeEditor();

    Div content = new Div(grid, form);
    content.addClassName("content");
    content.setSizeFull();

    add(getToolbar(), content); ②
    updateList();
}
```

① Removes the `configureFilter()` method call.

② Replaces the `filterText` component with a call to `getToolbar()`.

Build the application and verify that you are now able to add new contacts. New contacts are added at the end of the list, so you may need to scroll or use the filter to find them.

The screenshot shows a web browser window with the address bar displaying "localhost:8080". The main content area has a header "new" and a "Add contact" button. Below this is a table with columns: First Name, Last Name, Email, and Status. A row contains the values "I AM", "NEW", "new@contact.com", and "ImportedLead". A modal dialog is overlaid on the page, containing fields for First name (with value "I AM"), Last name (with value "NEW"), Email (with value "new@contact.com"), Company (with value "Path-Way Electronics"), and Status (with value "ImportedLead"). At the bottom of the modal are three buttons: "Save" (blue), "Delete" (red), and "Cancel" (blue).

First Name	Last Name	Email	Status
I AM	NEW	new@contact.com	ImportedLead

First name
I AM

Last name
NEW

Email
new@contact.com

Company
Path-Way Electronics

Status
ImportedLead

Save Delete Cancel

In the next tutorial, we'll add a second screen to the application and learn how to navigate between views.

You can find the completed source code for this tutorial on [GitHub](#).

Navigating between views in Vaadin

So far in this tutorial series, we've built a CRM application for listing and editing contacts. In this chapter, we add a dashboard view to the application. We also add a responsive application layout, with a header and a navigation sidebar that can be toggled on small screens.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Defining routes

Any Vaadin component can be made a navigation target by adding an `@Route("<path>")` annotation. Routes can be nested by defining the parent layout in the annotation: `@Route(value = "list", parent=MainView.class)`.

Creating the parent list and child view

We want our application to have:

- A shared parent layout with two child views:

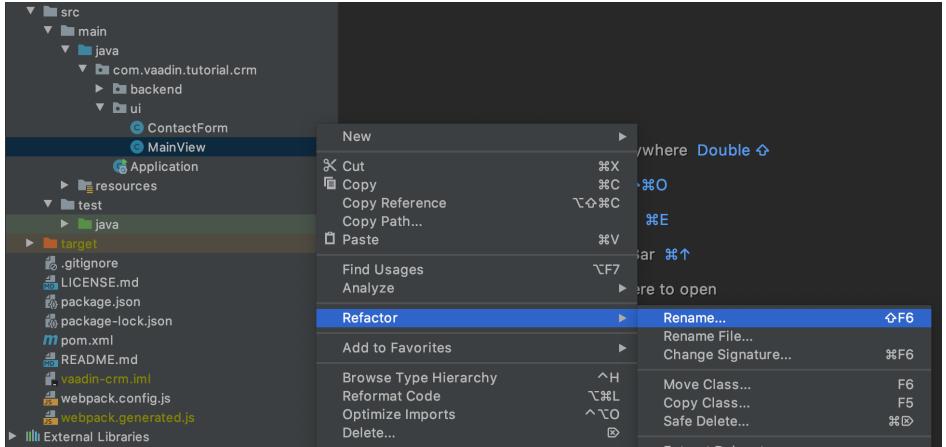
`MainLayout`: AppLayout with header and navigation:

- a. `ListView`: The default view, mapped to "".
- b. `DashboardView`: Mapped to "dashboard".

- A responsive app layout and navigation links.

Let's begin:

1. Start by renaming `MainView` to `ListView`. Right click `MainView` and select Refactor > Rename. When IntelliJ asks if you want to rename the file, answer yes.



2. Create a new Java class named `MainLayout` with the following content. This is the shared parent layout of both views in the application.

MainLayout.java

```
@CssImport("./styles/shared-styles.css") ①
public class MainLayout extends AppLayout { ②
    public MainLayout() {
        createHeader();
        createDrawer();
    }

    private void createHeader() {
        H1 logo = new H1("Vaadin CRM");
        logo.addClassNames("logo");

        HorizontalLayout header = new HorizontalLayout(new DrawerToggle(), logo);
        ③

        header.setDefaultVerticalComponentAlignment(
            FlexComponent.Alignment.CENTER); ④
        header.setWidth("100%");
        header.addClassNames("header");
    }

    addToNavbar(header); ⑤

}

private void createDrawer() {
    RouterLink listLink = new RouterLink("List", ListView.class); ⑥
    listLink.setHighlightCondition(HighlightConditions.sameLocation()); ⑦

    addToDrawer(new VerticalLayout(listLink)); ⑧
}
}
```

- ① Adds the `@CssImport` annotation to `MainLayout`. We'll remove it from `ListView` later.
- ② `AppLayout` is a Vaadin layout with a header and a responsive drawer.
- ③ `DrawerToggle` is a menu button that toggles the visibility of the sidebar.
- ④ Centers the components in the `header` along the vertical axis.
- ⑤ Adds the `header` layout to the app layout's nav bar.
- ⑥ Creates a `RouterLink` with the text "List" and `ListView.class` as the destination view
- ⑦ Sets `setHighlightCondition(HighlightConditions.sameLocation())` to avoid highlighting the link for partial route matches. (Technically, every route starts with an empty route, so without this it would always show up as active even though the user is not on the view)
- ⑧ Wraps the link in a `VerticalLayout` and adds it to the `AppLayout's drawer

3. Add the following CSS to `frontend/styles/shared-styles.css`

`shared-styles.css`

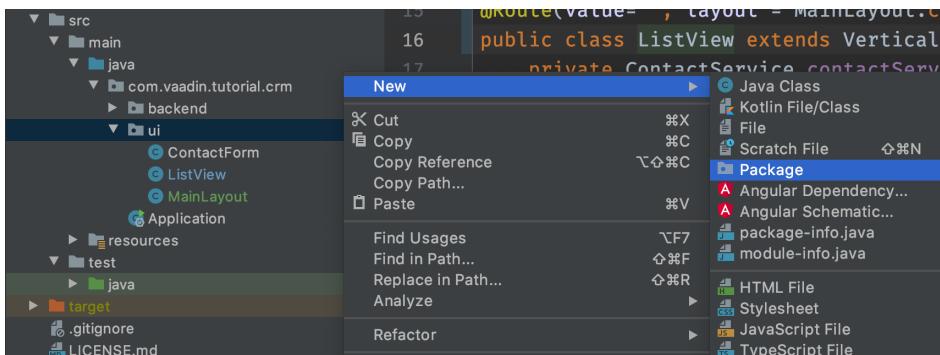
```
/* Main layout */

a[highlight] {
    font-weight: bold;
    text-decoration: underline;
}

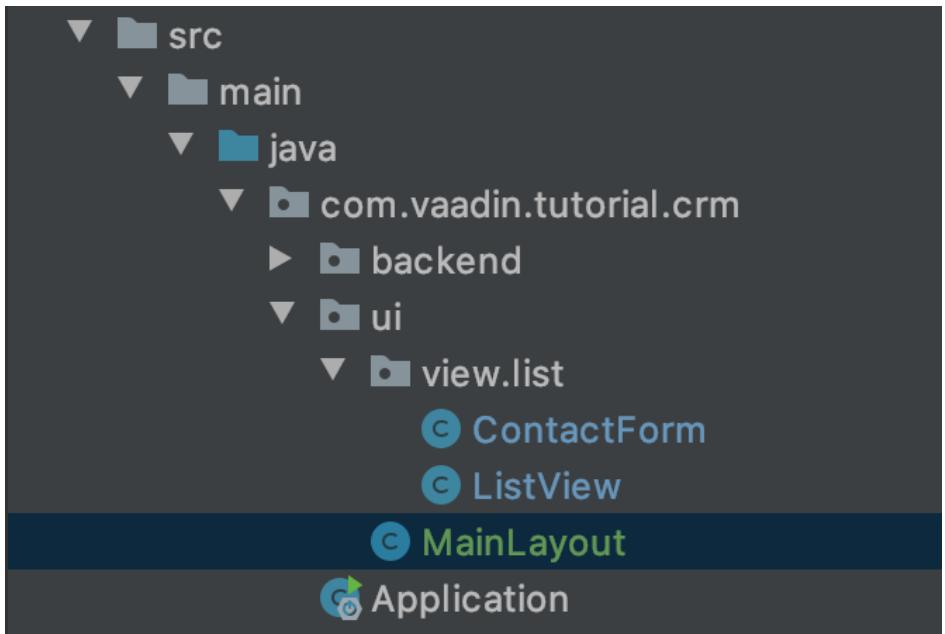
.header {
    padding: 0 var(--lumo-space-m);
}

.header h1.logo {
    font-size: 1em;
    margin: var(--lumo-space-m);
}
```

4. Create a new package for the list view, `com.vaadin.tutorial.crm.ui.view.list`. Separate packages for each view makes it easier to keep our project organized.



5. Move `ListView` and `ContactForm` into the new package. The resulting package structure should look like this:



- Finally, in `ListView` update the `@Route` mapping to use the new `MainLayout` and delete the `@CSSImport` annotation.

`ListView.java`

```
@Route(value="", layout = MainLayout.class) ①
②
@Override
public class ListView extends VerticalLayout {
    ...
}
```

- ① `ListView` still matches the empty path, but now uses `MainLayout` as its parent.
- ② The `@CSSImport` annotation is now removed, as it is now on `MainLayout` instead.
- ③ Adds a title to the page.

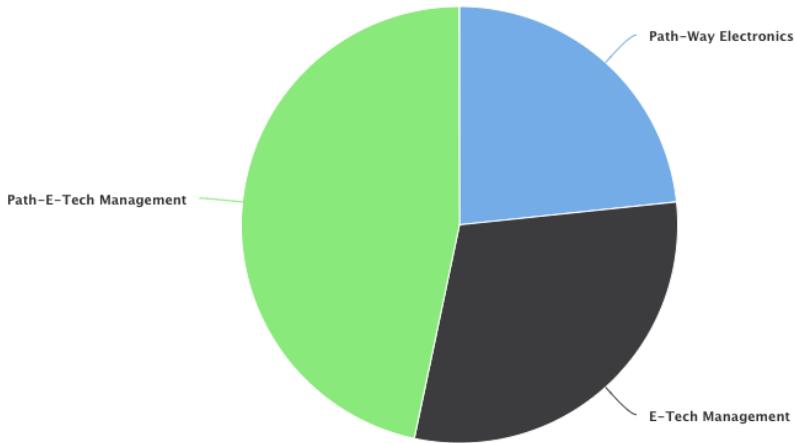
- Run the application. You should now see a header and a sidebar on the list view.

First Name	Last Name	Email	Status	Company
Gabrielle	Patel	gabrielle.patel@pathwayelectronics.com	Customer	Path-Way Ele
Brian	Robinson	brian.robinson@etechmanagement.com	Contacted	E-Tech Mana
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer	Path-E-Tech
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted	Path-E-Tech
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost	Path-Way Ele
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted	Path-E-Tech
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted	Path-E-Tech
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost	Path-E-Tech
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead	E-Tech Mana
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead	Path-E-Tech
Ryann	Davis	ryann.davis@etechmanagement.com	Customer	E-Tech Mana
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted	Path-E-Tech
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead	Path-E-Tech
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted	Path-Way Ele
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer	Path-Way Ele
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead	Path-E-Tech
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted	Path-E-Tech

Creating the dashboard view

Now let's create a new dashboard view. This view will show stats: the number of contacts in the system and a pie chart of the number of contacts per company.

30 contacts



1. Create a new package `com.vaadin.tutorial.crm.ui.view.dashboard` by right clicking the list package and selecting **New > Package**.
2. In the new package, create a new Java class named **DashboardView**.

DashboardView.java

```
package com.vaadin.tutorial.crm.ui.view.dashboard;

import com.vaadin.flow.component.orderedlayout.VerticalLayout;
import com.vaadin.flow.router.Route;
import com.vaadin.tutorial.crm.backend.service.CompanyService;
import com.vaadin.tutorial.crm.backend.service.ContactService;
import com.vaadin.tutorial.crm.ui.MainLayout;

@Route(value = "dashboard", layout = MainLayout.class) ①
@PageTitle("Dashboard | Vaadin CRM") ②
public class DashboardView extends VerticalLayout {

    private ContactService contactService;
    private CompanyService companyService;

    public DashboardView(ContactService contactService, CompanyService
companyService) { ③
        this.contactService = contactService;
        this.companyService = companyService;
        addClassName("dashboard-view");
        setDefaultHorizontalComponentAlignment(Alignment.CENTER); ④
    }
}
```

- ① `DashboardView` is mapped to the "`dashboard`" path and uses `MainLayout` as a parent layout.
- ② Sets the page title.
- ③ Takes both `ContactService` and `CompanyService` as constructor parameters and save them as fields.
- ④ Centers the contents of the layout.

3. Create a method to display the number of contacts in the system.

DashboardView.java

```
private Component getContactStats() {
    Span stats = new Span(contactService.count() + " contacts"); ①
    stats.addClassNames("contact-stats");
    return stats;
}
```

- ① `contactService.count()` gives us the number of contacts in the database. It returns a `Span` with the count and a text explanation.

4. Add the following CSS to `frontend/styles/shared-styles.css`

shared-styles.css

```
/* Dashboard view */

.dashboard-view .contact-stats {
    font-size: 4em;
    margin: 1em 0;
}
```

5. In [CompanyService](#), add the following method to create the pie chart. As an alternative, you could calculate the number of employees per company right in the view, but it's better to move this logic into [CompanyService](#) so it can be reused later in other views.

NOTE

Vaadin charts is a collection of data visualization components that is a part of the [Vaadin Vaadin Pro subscription](#). Vaadin charts comes with a free trial that you can activate in the browser. All Vaadin Pro tools and components are free for students through the [GitHub Student Developer Pack](#). You can skip the chart if you only want to use free components.

CompanyService.java

```
public Map<String, Integer> getStats() {
    HashMap<String, Integer> stats = new HashMap<>();
    findAll().forEach(company -> stats.put(company.getName(), company.getEmployees()
        .size())); ①
    return stats;
}
```

- ① Loops through each company and returns a [Map](#) containing the company name and number of employees.

6. In [DashboardView](#), create a method to construct the chart:

DashboardView.java

```
private Chart getCompaniesChart() {
    Chart chart = new Chart(ChartType.PIE); ①

    DataSeries dataSeries = new DataSeries(); ②
    Map<String, Integer> companies = companyService.getStats();
    companies.forEach((company, employees) ->
        dataSeries.add(new DataSeriesItem(company, employees))); ③
    chart.getConfiguration().setSeries(dataSeries); ④
    return chart;
}
```

① Creates a new pie chart.

② Charts use a DataSeries for data.

- ③ Adds a `DataSetItem`, containing the company name and number of employees, for each company.
 - ④ Sets the data series to the chart configuration.
7. Add both components to the `DashboardView` in the constructor to display the company stats.

`DashboardView.java`

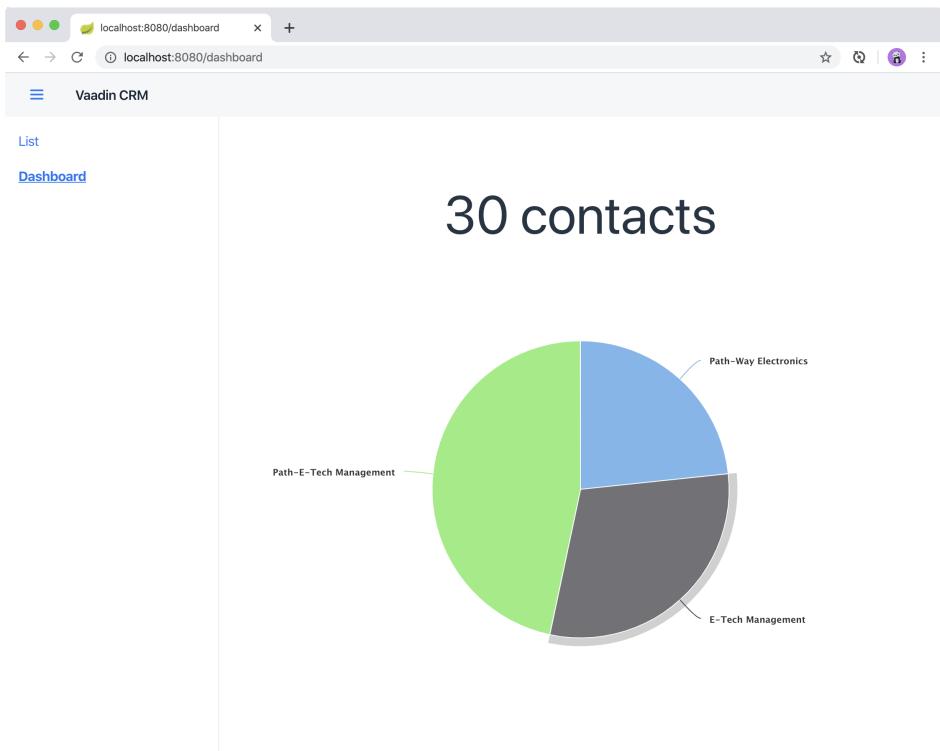
```
public DashboardView(ContactService contactService, CompanyService  
companyService) {  
    this.contactService = contactService;  
    this.companyService = companyService;  
  
    add(getContactStats(), getCompaniesChart());  
}
```

8. Add a navigation link to `DashboardView` in the `MainLayout` drawer:

`MainLayout.java`

```
private void createDrawer() {  
    RouterLink listLink = new RouterLink("List", ListView.class);  
    listLink.setHighlightCondition(HighlightConditions.sameLocation());  
  
    addToDrawer(new VerticalLayout(  
        listLink,  
        new RouterLink("Dashboard", DashboardView.class)  
    ));  
}
```

9. Build and run the application. You should now be able to navigate to the dashboard view and see stats on your CRM contacts. If you want to, go ahead and add or remove contacts in the list view to see that the dashboard reflects your changes.



In the next tutorial, we'll secure the application by adding a login screen.

You can find the completed source code for this tutorial on [GitHub](#).

Adding a login screen to a Vaadin app with Spring Security

So far in this tutorial series, we've built a CRM application that has one view for listing and editing contacts, and a dashboard view for showing stats.

In this tutorial we set up Spring Security and add a login screen to limit access to logged in users.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Creating a login view

1. Start by creating a new package `com.vaadin.tutorial.crm.ui.view.login`.
2. Create a new class, `LoginView`, in the new package.

LoginView.java

```
package com.vaadin.tutorial.crm.ui.view.login;

import com.vaadin.flow.component.html.H1;
import com.vaadin.flow.component.login.LoginForm;
import com.vaadin.flow.component.orderedlayout.VerticalLayout;
import com.vaadin.flow.router.BeforeEnterEvent;
import com.vaadin.flow.router.BeforeEnterObserver;
import com.vaadin.flow.router.PageTitle;
import com.vaadin.flow.router.Route;

import java.util.Collections;

@Route("login") ①
@PageTitle("Login | Vaadin CRM")

public class LoginView extends VerticalLayout implements BeforeEnterObserver {

    private LoginForm login = new LoginForm(); ②

    public LoginView(){
        addClassName("login-view");
        setSizeFull();
        setAlignItems(Alignment.CENTER); ③
        setJustifyContentMode(JustifyContentMode.CENTER);

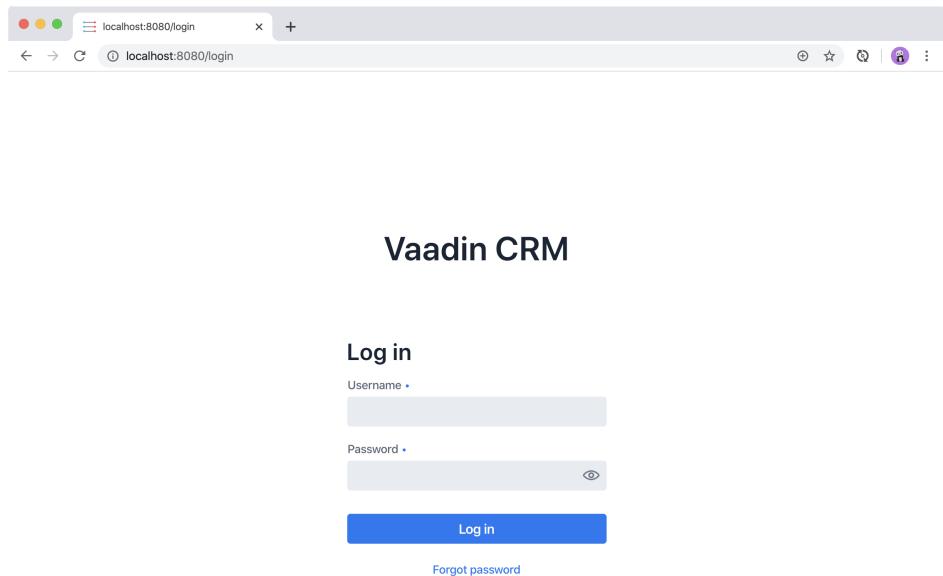
        login.setAction("login"); ④

        add(new H1("Vaadin CRM"), login);
    }

    @Override
    public void beforeEnter(BeforeEnterEvent event) {
        // inform the user about an authentication error
        if(!event.getLocation() ⑤
            .getQueryParameters()
            .getParameters()
            .getOrDefault("error", Collections.emptyList())
            .isEmpty()) {
            login.setError(true);
        }
    }
}
```

- ① Maps the view to the "login" path. `LoginView` should take up the whole browser window, so we don't use `MainLayout` as the parent.
- ② Instantiates a `LoginForm` component to capture username and password.
- ③ Makes `LoginView` full size and centers its content both horizontally and vertically, by calling `setAlignItems(Alignment.CENTER)` and `setJustifyContentMode(JustifyContentMode.CENTER)`.

- ④ Sets the `LoginForm` action to "login" to post the login form to Spring Security.
 - ⑤ Reads query parameters and shows an error if a login attempt fails.
3. Build the application and navigate to <http://localhost/login>. You should see a centered login form.



Setting up Spring Security to handle logins

With the login screen in place, we now need to configure Spring Security to perform the authentication and to prevent unauthorized users from accessing views.

Installing Spring Security dependencies

1. Start by adding the following 2 dependencies in your `pom.xml`:

pom.xml

```
<dependency>
    <groupId>org.springframework.security</groupId>
    <artifactId>spring-security-web</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.security</groupId>
    <artifactId>spring-security-config</artifactId>
</dependency>
```

2. Check that the dependencies are downloaded. If you enabled automatic downloads in an earlier tutorial, you're all set. If you didn't, or are unsure, run `mvn install` from the command line to download the dependencies.
3. Next, disable Spring MVC auto configuration on the `Application` class, as this interferes with how Vaadin works and can cause strange reloading behavior.

Application.class

```
@SpringBootApplication(exclude = ErrorMvcAutoConfiguration.class)
public class Application extends SpringBootServletInitializer {
    ...
}
```

Configuring Spring Security

1. Create a new package `com.vaadin.tutorial.crm.security` for classes related to security.
2. In the new package create the following classes using the code detailed below:
 - `SecurityUtils`: Utility methods.
 - `CustomRequestCache`: A cache to keep track of unauthenticated requests.
 - `SecurityConfiguration`: Spring Security configuration.

TIP

Paste the class code into the package and IntelliJ will automatically create the class for you.

- a. `SecurityUtils`

SecurityUtils.java

```
package com.vaadin.tutorial.crm.security;

import com.vaadin.flow.server.ServletHelper;
import com.vaadin.flow.shared.ApplicationConstants;
import org.springframework.security.authentication.AnonymousAuthenticationToken;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.context.SecurityContextHolder;

import javax.servlet.http.HttpServletRequest;
import java.util.stream.Stream;

public final class SecurityUtils {

    private SecurityUtils() {
        // Util methods only
    }

    static boolean isFrameworkInternalRequest(HttpServletRequest request) {
①        final String parameterValue = request.getParameter(
ApplicationConstants.REQUEST_TYPE_PARAMETER);
        return parameterValue != null
            && Stream.of(ServletHelper.RequestType.values())
            .anyMatch(r -> r.getIdentifier().equals(parameterValue));
    }

    static boolean isUserLoggedIn() { ②
        Authentication authentication = SecurityContextHolder.getContext()
            .getAuthentication();
        return authentication != null
            && !(authentication instanceof AnonymousAuthenticationToken)
            && authentication.isAuthenticated();
    }
}
```

- ① `isFrameworkInternalRequest` determines if a request is internal to Vaadin.
- ② `isUserLoggedIn` checks if the current user is logged in.

b. CustomRequestCache

CustomRequestCache.java

```
package com.vaadin.tutorial.crm.security;

import org.springframework.security.web.savedrequest.HttpSessionRequestCache;

import javax.servlet.http.HttpServletRequest;
import javax.servlet.http.HttpServletResponse;

class CustomRequestCache extends HttpSessionRequestCache {

    @Override
    public void saveRequest(HttpServletRequest request, HttpServletResponse response) { ①
        if (!SecurityUtils.isFrameworkInternalRequest(request)) {
            super.saveRequest(request, response);
        }
    }
}
```

- ① Saves unauthenticated requests so we can redirect the user to the page they were trying to access once they're logged in.

c. SecurityConfiguration

SecurityConfiguration.java

```
package com.vaadin.tutorial.crm.security;

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.config.annotation.web.builders.WebSecurity;
import org.springframework.security.config.annotation.web.configuration.EnableWebSecurity;
import org.springframework.security.config.annotation.web.configuration.WebSecurityConfigurerAdapter;
import org.springframework.security.core.userdetails.User;
import org.springframework.security.core.userdetails.UserDetails;
import org.springframework.security.core.userdetails.UserDetailsService;
import org.springframework.security.provisioning.InMemoryUserDetailsManager;

@EnableWebSecurity ①
@Configuration ②
public class SecurityConfiguration extends WebSecurityConfigurerAdapter {

    private static final String LOGIN_PROCESSING_URL = "/login";
    private static final String LOGIN_FAILURE_URL = "/login?error";
    private static final String LOGIN_URL = "/login";
    private static final String LOGOUT_SUCCESS_URL = "/login";

}
```

① `@EnableWebSecurity` turns on Spring Security for the application.

② `@Configuration` tells Spring Boot to use this class for configuring security.

3. Add a method to block unauthenticated requests to all pages, except the login page.

SecurityConfiguration.java

```
@Override  
protected void configure(HttpSecurity http) throws Exception {  
    http.csrf().disable() ①  
        .requestCache().requestCache(new CustomRequestCache()) ②  
        .and().authorizeRequests() ③  
        .requestMatchers(SecurityUtils::isFrameworkInternalRequest).permitAll()  
    ④  
  
    .anyRequest().authenticated() ⑤  
  
    .and().formLogin() ⑥  
        .loginPage(LOGIN_URL).permitAll()  
        .loginProcessingUrl(LOGIN_PROCESSING_URL) ⑦  
        .failureUrl(LOGIN_FAILURE_URL)  
    .and().logout().logoutSuccessUrl(LOGOUT_SUCCESS_URL); ⑧  
}
```

- ① Disables cross-site request forgery (CSRF) protection, as Vaadin already has CSRF protection.
- ② Uses `CustomRequestCache` to track unauthorized requests so that users are redirected appropriately after login.
- ③ Turns on authorization.
- ④ Allows all internal traffic from the Vaadin framework.
- ⑤ Allows all authenticated traffic.
- ⑥ Enables form-based login and permits unauthenticated access to it.
- ⑦ Configures the login page URLs.
- ⑧ Configures the logout URL.

4. Add another method to configure test users.

SecurityConfiguration.java

```
@Bean  
@Override  
public UserDetailsService userDetailsService() {  
    UserDetails user =  
        User.withUsername("user")  
            .password("{noop}password")  
            .roles("USER")  
            .build();  
  
    return new InMemoryUserDetailsManager(user);  
}
```

- Defines a single user with the username "user" and password "password" in an in-memory [DetailsManager](#).

WARNING

We do not recommend that you configure users directly in the code for applications in production. You can easily change this Spring Security configuration to use an authentication provider for LDAP, JAAS, and other real world sources. [Read more about Spring Security authentication providers](#).

5. Finally, exclude Vaadin-framework communication and static assets from Spring Security.

[SecurityConfiguration.java](#)

```
@Override  
public void configure(WebSecurity web) {  
    web.ignoring().antMatchers(  
        "/VAADIN/**",  
        "/favicon.ico",  
        "/robots.txt",  
        "/manifest.webmanifest",  
        "/sw.js",  
        "/offline.html",  
        "/icons/**",  
        "/images/**",  
        "/styles/**",  
        "/h2-console/**");  
}
```

Restricting access to Vaadin views

Spring Security restricts access to content based on paths. Vaadin applications are single-page applications. This means that they do not trigger a full browser refresh when you navigate between views, even though the path does change. To secure a Vaadin application, we need to wire Spring Security to the Vaadin navigation system.

To do this, create a new class in the [security](#) package, [ConfigureUIServiceInitListener](#).

ConfigureUIServiceInitListener.java

```
package com.vaadin.tutorial.crm.security;

import com.vaadin.flow.component.UI;
import com.vaadin.flow.router.BeforeEnterEvent;
import com.vaadin.flow.server.ServiceInitEvent;
import com.vaadin.flow.server.VaadinServiceInitListener;
import com.vaadin.tutorial.crm.ui.view.login.LoginView;
import org.springframework.stereotype.Component;

@Component ①
public class ConfigureUIServiceInitListener implements VaadinServiceInitListener {

    @Override
    public void serviceInit(ServiceInitEvent event) {
        event.getSource().addUIInitListener(uiEvent -> { ②
            final UI ui = uiEvent.getUI();
            ui.addBeforeEnterListener(this::authenticateNavigation);
        });
    }

    private void authenticateNavigation(BeforeEnterEvent event) {
        if (!LoginView.class.equals(event.getNavigationTarget())
            && !SecurityUtils.isUserLoggedIn()) { ③
            event.rerouteTo(LoginView.class);
        }
    }
}
```

① The `@Component` annotation registers the listener. Vaadin will pick it up on startup.

② In `serviceInit`, we listen for the initialization of the UI (the internal root component in Vaadin) and then add a listener before every view transition.

③ In `authenticateNavigation`, we reroute all requests to the login, if the user is not logged in

TIP

You can read more about fine-grained access control in the [Spring Security tutorial series](#).

Adding a logout link

You can now log in to the application. The final thing we need to do is add a logout link to the application header.

1. In `MainLayout`, add a link to the header:

MainLayout.java

```
private void createHeader() {
    H1 logo = new H1("Vaadin CRM");
    logo.addClassNames("logo");

    Anchor logout = new Anchor("/logout", "Log out"); ①

    HorizontalLayout header = new HorizontalLayout(new DrawerToggle(), logo,
    logout); ②
    header.expand(logo); ③
    header.setDefaultVerticalComponentAlignment(FlexComponent.Alignment.CENTER);
    header.setWidth("100%");
    header.addClassNames("header");

    addToNavbar(header);
}
```

- ① Creates a new `Anchor` (`<a>` tag) that links to `/logout`.
 - ② Adds the link last in the header layout.
 - ③ Calls `header.expand(logo)` to make the logo take up all the extra space in the layout. This pushes the logout button to the far right.
2. Stop and restart the server to pick up the new Maven dependencies. You should now be able to log in and out of the app. Verify that you can't access <http://localhost/dashboard> without being logged in.

First Name	Last Name	Email	Status	Company
Gabrielle	Patel	gabrielle.patel@pathwayelectronics.com	Customer	Path-Way Elec
Brian	Robinson	brian.robinson@techmanagement.com	Contacted	E-Tech Manag
Eduardo	Haugen	eduardo.haugen@pathetechmanagement.com	Customer	Path-E-Tech M
Koen	Johansen	koen.johansen@pathetechmanagement.com	NotContacted	Path-E-Tech M
Alejandro	Macdonald	alejandro.macdonald@pathwayelectronics.com	ClosedLost	Path-Way Elec
Angel	Karlsson	angel.karlsson@pathetechmanagement.com	Contacted	Path-E-Tech M
Yahir	Gustavsson	yahir.gustavsson@pathetechmanagement.com	Contacted	Path-E-Tech M
Haiden	Svensson	haiden.svensson@pathetechmanagement.com	ClosedLost	Path-E-Tech M
Emily	Stewart	emily.stewart@etechmanagement.com	ImportedLead	E-Tech Manag
Corinne	Davis	corinne.davis@pathetechmanagement.com	ImportedLead	Path-E-Tech M
Ryann	Davis	ryann.davis@etechmanagement.com	Customer	E-Tech Manag
Yurem	Jackson	yurem.jackson@pathetechmanagement.com	Contacted	Path-E-Tech M
Kelly	Gustavsson	kelly.gustavsson@pathetechmanagement.com	ImportedLead	Path-E-Tech M
Eileen	Walker	eileen.walker@pathwayelectronics.com	Contacted	Path-Way Elec
Katelyn	Martin	katelyn.martin@pathwayelectronics.com	Customer	Path-Way Elec
Israel	Carlsson	israel.carlsson@pathetechmanagement.com	ImportedLead	Path-E-Tech M
Quinn	Hansson	quinn.hansson@pathetechmanagement.com	Contacted	Path-E-Tech M

You have now built a full-stack CRM application with navigation and authentication. In the next tutorial, you'll learn how to make the application installable on mobile and desktop.

You can find the completed source code for this tutorial on [GitHub](#).

Turning a Vaadin app into an installable PWA

In this chapter, we turn the completed CRM application into a progressive web application (PWA) so that users can install it.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

What is a PWA?

The term PWA is used to describe modern web applications that offer a native app-like user experience. PWA technologies make applications faster, more reliable, and more engaging. PWAs can be installed on most mobile devices and on desktop when using supported browsers. They can even be listed in the Microsoft Store and Google Play Store. You can learn more about the underlying technologies and features in the [Vaadin PWA documentation](#).

Two main components enable PWA technologies:

- **ServiceWorker**: A JavaScript worker file that controls network traffic and enables custom cache control.
- Web app manifest: A JSON file that identifies the web app as an installable app.

Generating PWA resources

Vaadin provides the `@PWA` annotation that automatically generates the required PWA resources.

Add the `@PWA` annotation to `MainLayout` as follows:

MainLayout.java

```
@CssImport("./styles/shared-styles.css")
@PWA(①
    name = "VaadinCRM", ②
    shortName = "CRM") ③
public class MainLayout extends AppLayout {
    ...
}
```

① The `@PWA` annotation tells Vaadin to create a `ServiceWorker` and a manifest file.

② `name` is the full name of the application for the manifest file.

- ③ `shortName` should be short enough to fit under an icon when installed, and should not exceed 12 characters.

Customizing the app icon

1. Start by creating a new folder `src/main/webapp`.
2. Create a new subfolder `src/main/webapp/icons` and add your own icon image named `icon.png`. The image resolution should be 512 px x 512 px. This overrides the default image in the starter.

You can use your own icon, or save the image below, by right clicking and selecting **Save Image**.



Customizing the offline page

Vaadin creates a generic offline fallback page that displays when the application is launched offline. Replacing this default page with a custom page that follows your own design guidelines makes your app more polished.

1. Use the code below to create `offline.html` in the new `src/main/webapp` folder:

`offline.html`

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8"/>
  <meta name="viewport" content="width=device-width, initial-scale=1.0"/>
  <meta http-equiv="X-UA-Compatible" content="ie=edge"/>
  <title>Offline | Vaadin CRM</title>
  <link rel="stylesheet" href=".//styles/offline.css"> ①
</head>
<body>

<div class="content">
   ②
  <h1>Oh deer, you're offline</h1>
  <p>Your internet connection is offline. Get back online to continue using  
Vaadin CRM.</p>
</div>
<script>
  window.addEventListener('online', location.reload);
</script> ③
</body>
</html>
```

- ① The page loads a CSS file, `offline.css`.
 - ② The page displays an image, `offline.png`.
 - ③ The JavaScript snippet reloads the page if the browser detects that it's back online.
2. Create two new folders, `src/main/webapp/styles` and `src/main/webapp/images`.
 3. In the `styles` folder, create `offline.css` and add the following styles:

offline.css

```
body {  
    display: flex; ①  
    flex-direction: column;  
    align-items: center;  
    font-family: sans-serif;  
    color: #555;  
}  
  
.content {  
    width: 80%;  
}  
  
.offline-image {  
    width: 100%;  
    margin: 4em 0px;  
}
```

① Makes the page a flexbox that centers content horizontally.

4. Add the following image (or use one of your own) to the `images` folder and name it `offline.png`.



5. Make the files available offline by adding them to the `@PWA` annotation in `MainLayout` as follows:

MainLayout.java

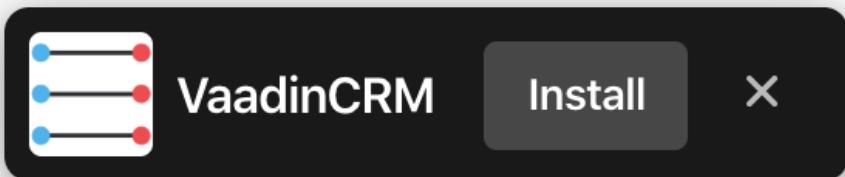
```
@CssImport("./styles/shared-styles.css")  
@PWA(  
    name = "VaadinCRM",  
    shortName = "VaadinCRM",  
    offlineResources = { ①  
        "./styles/offline.css",  
        "./images/offline.png"})  
public class MainLayout extends AppLayout {  
    ...  
}
```

① `offlineResources` is a list of files that Vaadin will make available offline through the `ServiceWorker`.

WARNING

Even though the paths for the CSS files is identical in the Java file, `shared-styles.css` is loaded from `frontend/styles/shared-styles.css`, whereas `offline.css` is loaded from `src/main/java/webapp/styles/offline.css`. If you have trouble accessing files while offline, check that these files are in the correct folders.

6. Restart the app. On supported browsers, you will now see an install prompt that you can use to install the application:



Testing the offline page

Shut down the server in IntelliJ and refresh the browser (or launch the installed app). You should now see the custom offline page.



Oh deer, you're offline

Your internet connection is offline. Get back online to continue using Vaadin CRM.

In the next chapter, we cover testing the application: both unit tests and in-browser tests.

You can find the completed source code for this tutorial on [GitHub](#).

Testing Spring Boot apps with unit and integration tests

It is a common best practice to test as little code as possible in a single test. In this way, when things go wrong, only relevant tests fail. For UI testing, there are three main approaches:

- Unit tests: for simple UI logic.
- Integration tests: for more advanced UI logic.
- End-to-end tests: to test what the user sees.

Unit and integration tests can be run standalone, that is, without any external dependencies, such as a running server or database.

End-to-end tests require the application to be deployed and are run in a browser window to simulate an actual user.

In this chapter, we write and run unit and integration tests. We cover end-to-end tests in the next chapter.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Creating and running unit tests for simple UI logic

The most minimalistic way of testing is to create a plain Java unit test. This only works with UI classes with no dependencies, no auto wiring etc. For the [ContactForm](#), you can create a unit test to verify that the form fields are correctly populated, based on the given bean.

CAUTION

All test classes should go in the test folder, `src/test/java`. Pay special attention to the package names. We use package-access to class fields. If the test isn't in the same package as the class that's being tested, you will get errors.

1. Start by deleting the tests included with the starter: `AbstractViewTest.java`` and `LoginViewIT.java`.
2. In the `test` folder, create a new package, `com.vaadin.tutorial.crm.ui.view.list`, and add a new `ContactFormTest.java` file with the code below. When prompted, select the `org.junit` import of `@Before`.

ContactFormTest.java

```
public class ContactFormTest {  
    private List<Company> companies;  
    private Contact marcUsher;  
    private Company company1;  
    private Company company2;  
  
    @Before  
    public void setupData() {  
        companies = new ArrayList<>();  
        company1 = new Company("Vaadin Ltd");  
        company2 = new Company("IT Mill");  
        companies.add(company1);  
        companies.add(company2);  
  
        marcUsher = new Contact();  
        marcUsher.setFirstName("Marc");  
        marcUsher.setLastName("Usher");  
        marcUsher.setEmail("marc@usher.com");  
        marcUsher.setStatus(Contact.Status.NotContacted);  
        marcUsher.setCompany(company2);  
    }  
}
```

- The `@Before` annotation adds dummy data that is used for testing. This method is executed before each `@Test` method.

3. Now, add a test method that uses `ContactForm`:

ContactFormTest.java

```
@Test  
public void formFieldsPopulated() {  
    ContactForm form = new ContactForm(companies);  
    form.setContact(marcUsher); ①  
    Assert.assertEquals("Marc", form.firstName.getValue());  
    Assert.assertEquals("Usher", form.lastName.getValue());  
    Assert.assertEquals("marc@usher.com", form.email.getValue());  
    Assert.assertEquals(company2, form.company.getValue());  
    Assert.assertEquals(Contact.Status.NotContacted, form.status.getValue()); ②  
}
```

- ① Validates that the fields are populated correctly, by first initializing the contact form with some companies, and then setting a contact bean for the form.
- ② Uses standard JUnit `assertEquals` methods to compare the values from the fields available through the `ContactForm` instance:

4. Similarly, test the save functionality of `ContactForm`:

- First, initialize a `ContactForm` with an empty contact:

ContactFormTest.java

```
@Test  
public void saveEventHasCorrectValues() {  
    ContactForm form = new ContactForm(companies);  
    Contact contact = new Contact();  
    form.setContact(contact);  
}
```

- b. Continue the method by populating values into the form:

saveEventHasCorrectValues()

```
form.firstName.setValue("John");  
form.lastName.setValue("Doe");  
form.company.setValue(company1);  
form.email.setValue("john@doe.com");  
form.status.setValue(Contact.Status.Customer);
```

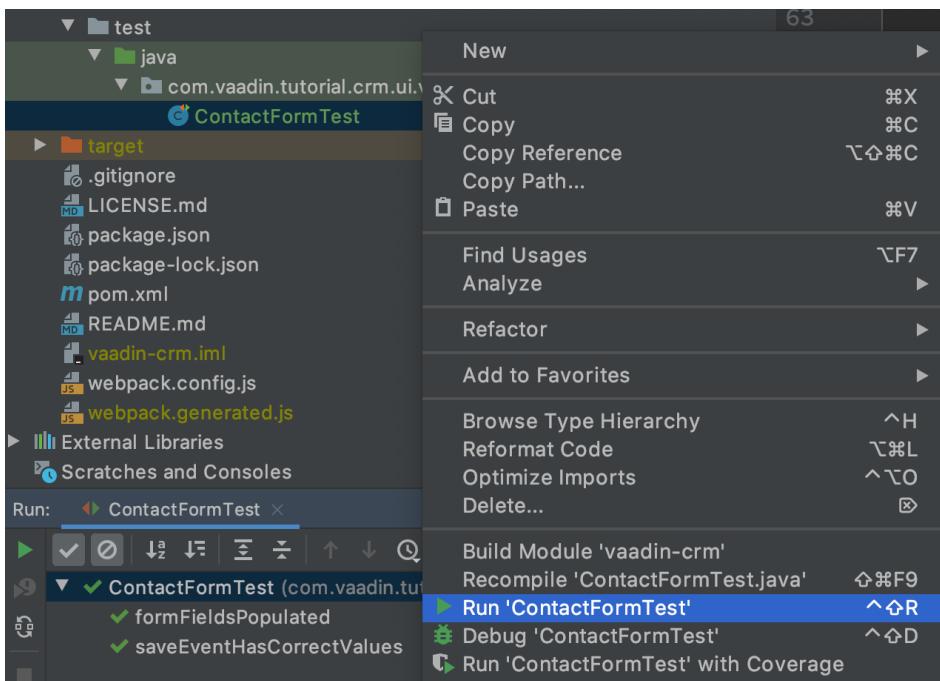
- c. Finally, add the following code to the end of `saveEventHasCorrectValues()` to click the save button and assert that the values from the fields end up in the bean:

saveEventHasCorrectValues()

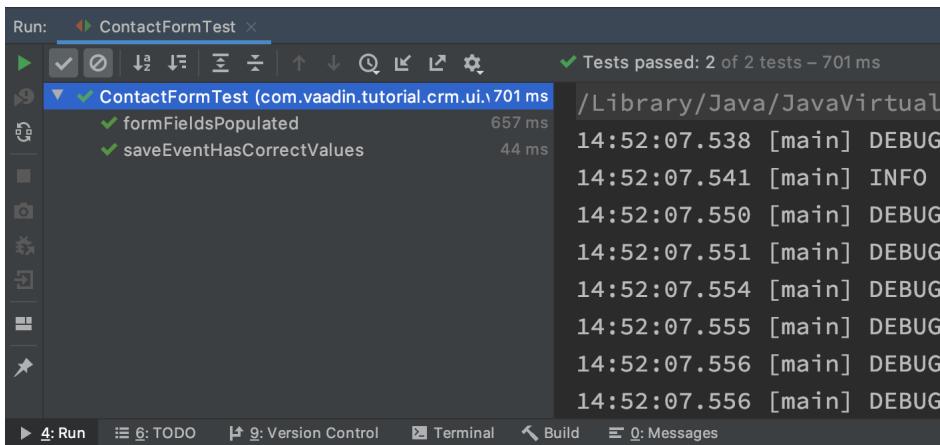
```
AtomicReference<Contact> savedContactRef = new AtomicReference<>(null);  
form.addListener(ContactForm.SaveEvent.class, e -> {  
    savedContactRef.set(e.getContact()); ①  
});  
form.save.click();  
Contact savedContact = savedContactRef.get(); ②  
  
Assert.assertEquals("John", savedContact.getFirstName());  
Assert.assertEquals("Doe", savedContact.getLastName());  
Assert.assertEquals("john@doe.com", savedContact.getEmail());  
Assert.assertEquals(company1, savedContact.getCompany());  
Assert.assertEquals(Contact.Status.Customer, savedContact.getStatus()); ③
```

- ① As `ContactForm` fires an event on save and the event data is needed for the test, an `AtomicReference` is used to store the event data, without using a class field.
- ② Clicks the save button and asserts that the values from the fields end up in the bean.
- ③ Once the event data is available, you can use standard `assertEquals` calls to verify that the bean contains the expected values.

5. To run the unit test, right click `ContactFormTest` and Select Run 'ContactFormTest'.



6. When the test finishes, you will see the results at the bottom of the IDE window in the test runner panel. As you can see, both tests passed.



Creating and running integration tests for more advanced UI logic

To test a class that uses `@Autowired`, a database, or any other feature provided by Spring Boot, you can no longer use plain JUnit tests. Instead, you can use the Spring Boot test runner. This does add a little overhead, but it makes more features available to your test.

1. First, add the `spring-boot-starter-test` dependency to the project's `pom.xml` to be able to use the features:

`pom.xml`

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
    <exclusions>
        <exclusion>
            <groupId>org.junit.vintage</groupId>
            <artifactId>junit-vintage-engine</artifactId>
        </exclusion>
    </exclusions>
</dependency>
```

2. To set up a unit test for `ListView`, create a new file, `ListViewTest`, in the `com.vaadin.tutorial.crm.ui.views.list` package:

`ListViewTest.java`

```
@RunWith(SpringRunner.class)
@SpringBootTest
public class ListViewTest {

    @Autowired
    private ListView listView;

    @Test
    public void formShownWhenContactSelected() {
    }
}
```

- The `@RunWith(SpringRunner.class)` and `@SpringBootTest` annotations make sure that the Spring Boot application is initialized before the tests are run and allow you to use `@Autowired` in the test.
3. In the `ListView` class:
 - a. Add the Spring `@Component` annotation to make it possible to `@Autowired` it. Also add `@Scope("prototype")` to ensure every test run gets a fresh instance.

TIP

We didn't need to add the annotation for normal application usage, as all @Route classes are automatically instantiated by Vaadin in a Spring-compatible way.

- b. Remove the `private` keyword. This changes the private fields to package private, and allows you to access the grid and form of the `ListView` in your test case.

`ListView.java`

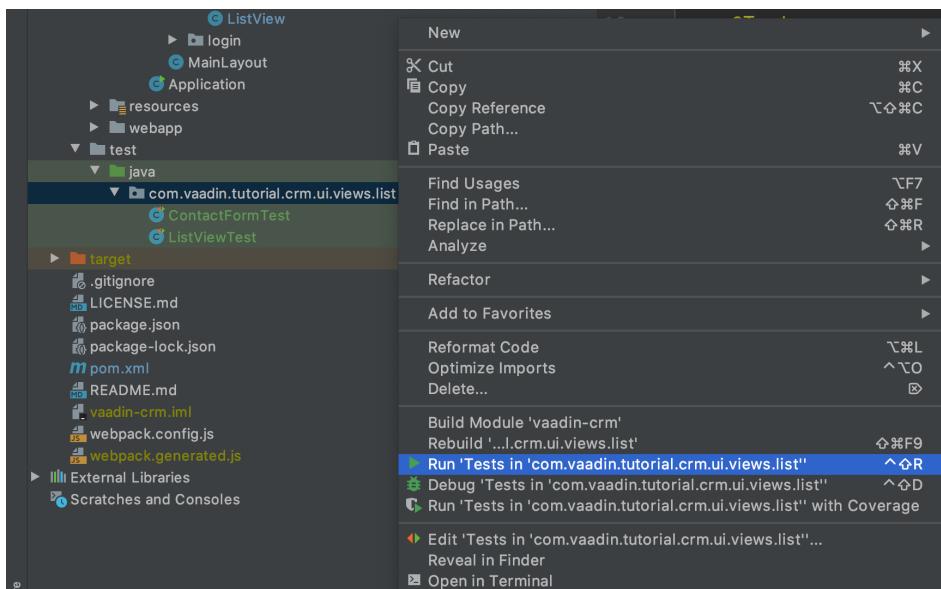
```
@Component
@Scope("prototype")
@Route(value = "", layout = MainLayout.class)
@PageTitle("Contacts | Vaadin CRM")
public class ListView extends VerticalLayout {

    ContactForm form;
    Grid<Contact> grid = new Grid<>(Contact.class);
    TextField filterText = new TextField();

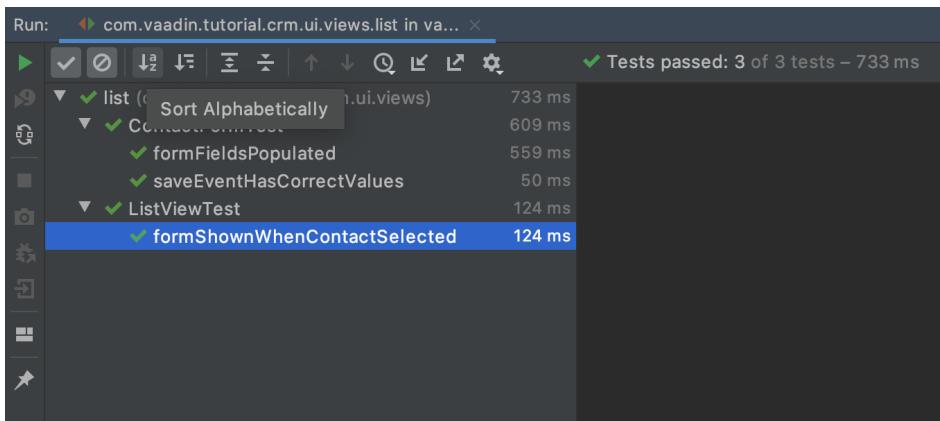
    ContactService contactService;

    // rest omitted
}
```

4. Right click the package that contains both tests, and select Run tests in 'com.vaadin.tutorial.crm.ui.views.list'.



5. You should see that both test classes run and result in 3 successful tests.



You probably noticed that running the tests the second time took much longer. This is the price of being able to use `@Autowired` and other Spring features and can cost many seconds of startup time.

NOTE

You can improve the startup time by explicitly listing the needed dependencies in the `@SpringBootTest` annotation using `classes={...}`, mock parts of the application, or using other advanced techniques which are out of scope for this tutorial. Pivotal's [Spring Boot Testing Best Practices](#) has tips to speed up your tests.

6. You can now add the actual test implementation, which selects the first row in the grid and validates that this shows the form with the selected `Contact`:

ListViewTest.java

```
@Test
public void formShownWhenContactSelected() {
    Grid<Contact> grid = listView.grid;
    Contact firstContact = getFirstItem(grid);

    ContactForm form = listView.form;

    Assert.assertFalse(form.isVisible());
    grid.asSingleSelect().setValue(firstContact);
    Assert.assertTrue(form.isVisible());
    Assert.assertEquals(firstContact, form.binder.getBean());
}

private Contact getFirstItem(Grid<Contact> grid) {
    return( (ListDataProvider<Contact>) grid.getDataProvider()).getItems()
        .iterator().next();
}
```

- The test verifies that the form logic works by:

Asserting that the form is initially hidden.

- Selecting the first item in the grid and verifying that:
- The form is visible.
- The form is bound to the correct `Contact`.

7. Rerun the tests. They should all pass.

You now know how to test the application logic both in isolation with unit tests and by injecting dependencies to test the integration between several components. In the next chapter, we cover how to test the entire application in the browser.

You can find the completed source code for this tutorial on [GitHub](#).

Testing Vaadin apps in the browser with end-to-end tests

End-to-end (e2e) tests are used to test the entire application. They're far more coarse grained than unit or integration tests. This makes them well suited to check that the application works as a whole, and to catch any regressions that may be missed by more specific tests.

End-to-end tests are executed in a browser window, controlled by a web driver and run on the server where the application is deployed. You need to setup 3 things:

1. Configure Maven to start the Spring Boot server before running tests and to stop it afterwards.
2. Make sure you have Chrome installed and install a web driver manager that will download the needed web driver.
3. Create a base test class that starts a browser and opens the application URL.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

NOTE

The end-to-end tests use [Vaadin TestBench](#), which is a commercial tool that is a part of the Vaadin Pro Subscription. You can get a free trial at <https://vaadin.com/trial>. All Vaadin Pro tools and components are free for students through the [GitHub Student Developer Pack](#).

Configuring Maven to start the server

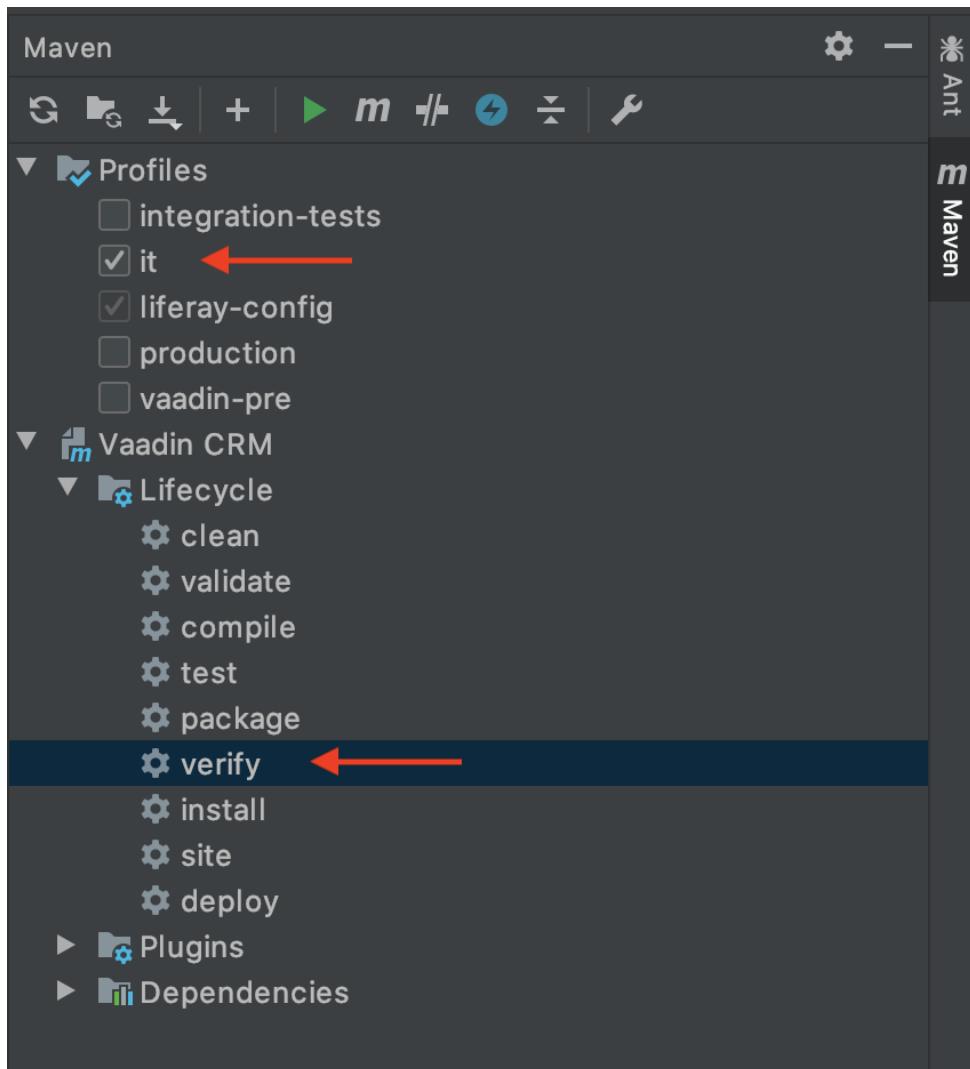
To run integration tests, you need to make sure that the Maven configuration starts and stops Spring Boot at the proper times. If you configure this as a separate profile in your `pom.xml`, you can easily skip running the tests.

In your `pom.xml`, remove the existing `integration-test` profile and add the following profile:

pom.xml

```
<profile>
  <id>it</id>
  <build>
    <plugins>
      <plugin>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-maven-plugin</artifactId>
        <executions>
          <execution>
            <id>start-spring-boot</id>
            <phase>pre-integration-test</phase>
            <goals>
              <goal>start</goal>
            </goals>
          </execution>
          <execution>
            <id>stop-spring-boot</id>
            <phase>post-integration-test</phase>
            <goals>
              <goal>stop</goal>
            </goals>
          </execution>
        </executions>
      </plugin>
      <!-- Runs the integration tests (*IT) after the server is started -->
      <plugin>
        <groupId>org.apache.maven.plugins</groupId>
        <artifactId>maven-failsafe-plugin</artifactId>
        <executions>
          <execution>
            <goals>
              <goal>integration-test</goal>
              <goal>verify</goal>
            </goals>
          </execution>
        </executions>
        <configuration>
          <trimStackTrace>>false</trimStackTrace>
          <enableAssertions>true</enableAssertions>
        </configuration>
      </plugin>
    </plugins>
  </build>
</profile>
```

Integration tests are run by executing `mvn -Pit verify` from the command line, or by selecting the `it` profile and running the verify goal from the Maven menu in IntelliJ.



The `pre-integration-test` and `post-integration-test` executions take care of starting and stopping Spring Boot before the `integration-test` phase of the build is executed. In the `integration-test` phase, the `maven-failsafe-plugin` runs any tests named `*IT.java` found in `src/test/java`. You should set the `trimStackTrace` option to `false` to print full stack traces and ease debugging.

Setting up Chrome and its webdriver to control the browser

For browser tests to work, you need Chrome installed on the machine that runs the tests.

To avoid installing the web driver manually, add a dependency to `webdrivermanager` in your `pom.xml`:

`pom.xml`

```
<dependency>
    <groupId>io.github.bonigarcia</groupId>
    <artifactId>webdrivermanager</artifactId>
    <version>3.7.1</version>
    <scope>test</scope>
</dependency>
----
```

- This is used from the JUnit test class and downloads the correct version of the Chrome web driver, if it is missing.

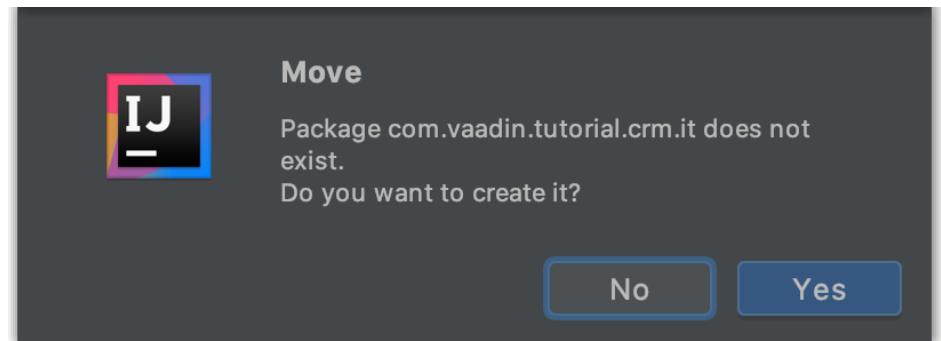
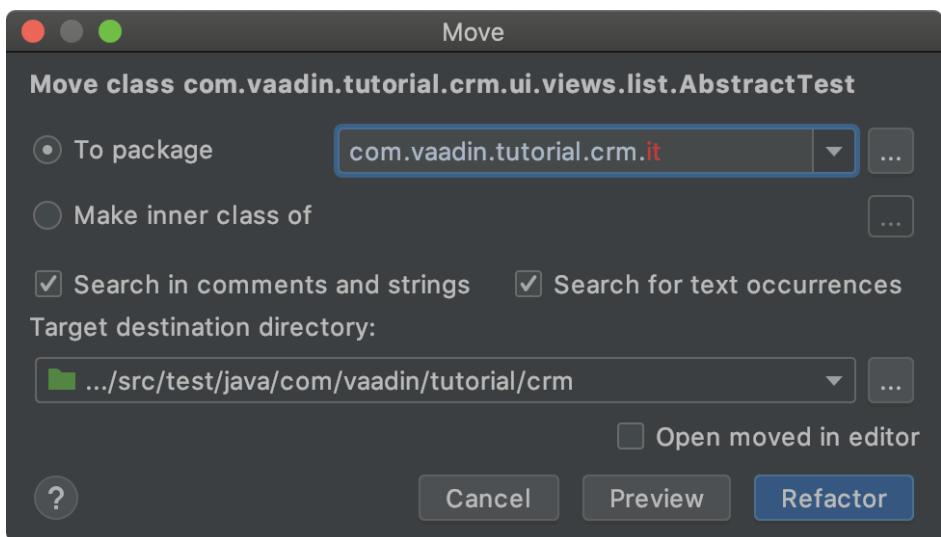
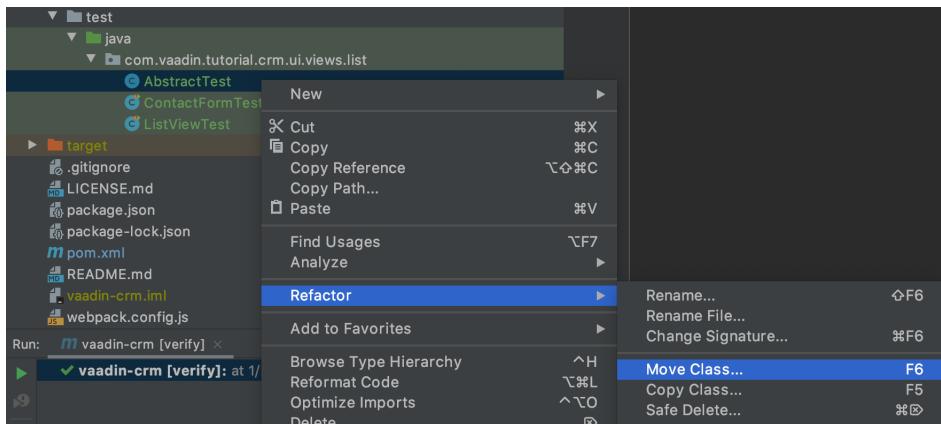
Creating the base test class

To avoid repetition in each test class, it is a good idea to put common logic in an abstract class and have all tests extend this class. Most of the heavy lifting about starting browsers etc. is handled by `ParallelTest` in TestBench, but there are a couple of useful things you can add to the abstract class.

1. Create a new class, `AbstractTest`. Be sure to place it in `src/test/java` and not `src/main/java`.

TIP

IntelliJ collapses empty packages by default, so it's easiest to first create the class in the existing test package, and then move it to the correct package.



AbstractTest.java

```
package com.vaadin.tutorial.crm.it;

public abstract class AbstractTest extends ParallelTest {
    @BeforeClass
    public static void setupClass() {
        WebDriverManager.chromedriver().setup(); ①
    }

    @Rule
    public ScreenshotOnFailureRule rule = new ScreenshotOnFailureRule(this, true
); ②
}
```

- ① We start by invoking the `WebDriverManager` before any test method is invoked. TestBench does not invoke the web driver manager.
 - ② `ScreenshotOnFailureRule` tells TestBench to grab a screenshot before exiting, if a test fails. This helps you understand what went wrong when tests do not pass.
- 2 Next, add the application URL that the tests should open before trying to interact with the application. For this you need the host name where the application runs ("localhost" in development), the port the server uses (set to 8080 in `application.properties`), and information about the route to start from.

AbstractTest.java

```
private static final String SERVER_HOST = InetAddress.findSiteLocalAddress();
private static final int SERVER_PORT = 8080;
private final String route;

@Before
public void setup() throws Exception {
    super.setup();
    getDriver().get(getURL(route)); // Opens the given URL in the browser
}

protected AbstractTest(String route) {
    this.route = route;
}

private static String getURL(String route) {
    return String.format("http://:%d/%s", SERVER_HOST, SERVER_PORT, route);
}
```

3. To avoid excessive logging from `WebDriverManager` when running the tests, add the following workaround:

`AbstractTest.java`

```
static {
    // Prevent debug logging from Apache HTTP client
    Logger root = (Logger) LoggerFactory.getLogger(Logger.ROOT_LOGGER_NAME);
    root.setLevel(Level.INFO);
}
```

4. Select the following Logger dependencies:

- a. `org.slf4j.LoggerFactory`
- b. `ch.qos.logback.classic.Level`
- c. `ch.qos.logback.classic.Logger`

Testing the login view

Now that your setup is complete, you can start developing your first test: ensuring that a user can log in. For this test you need to open the base URL.

1. Create a new class, `LoginIT`, in the same package as `AbstractTest`:

`LoginIT.java`

```
package com.vaadin.tutorial.crm.it;

public class LoginIT extends AbstractTest {
    public LoginIT() {
        super("");
    }
}
```

NOTE

The name of the class should end in `IT` for the test runner to pick it up as an integration test. If you name it `LoginTest` instead, it will be run as a unit test and the server will not be started and the test will fail.

2. Add an `@Test` method to validate that you can log in as "user":

LoginIT.java

```
@Test  
public void loginAsValidUserSucceeds() {  
    // Find the LoginForm used on the page  
    LoginFormElement form = $(LoginFormElement.class).first();  
    // Enter the credentials and log in  
    form.getUsernameField().setValue("user");  
    form.getPasswordField().setValue("password");  
    form.getSubmitButton().click();  
    // Ensure the login form is no longer visible  
    Assert.assertFalse($(LoginFormElement.class).exists());  
}
```

TIP

While developing tests it is not very efficient to run the tests as `mvn -Pit verify`. Instead, you can start the server manually by launching the `Application` class or with `spring-boot:run`. You can then execute the selected test in your IDE and you do not have to wait for the server to start every time.

3. Start the application normally, then right click `LoginIT.java` and select Run 'LoginIT'.

NOTE

the first time you run the test, you will be asked to start a trial or validate your existing license. Follow the instructions in the browser window that opens.

Creating a view object

You can now add a second test: validating that you cannot log in with an invalid password.

For this test, you need to write the same code to access the components in the view, as you did for the first test. To make your tests more maintainable, you can create a view object (a.k.a. call page object or element class) for each view. A view object provides a high-level API to interact with the view and hides the implementation details.

1. For the login view, create the `LoginViewElement` class in a new package, `com.vaadin.tutorial.crm.it.elements.login`:

LoginViewElement.java

```
package com.vaadin.tutorial.crm.it.elements.login;

@Attribute(name = "class", contains = "login-view") ①
public class LoginViewElement extends VerticalLayoutElement {

    public boolean login(String username, String password) {
        LoginFormElement form = $(LoginFormElement.class).first();
        form.getUsernameField().setValue(username);
        form.getPasswordField().setValue(password);
        form.getSubmitButton().click();

        // Return true if we end up on another page
        return !$(LoginViewElement.class).onPage().exists();
    }

}
```

- a. Selects the `com.vaadin.testbench.annotations.Attribute` import.

CAUTION

To make the correct functionality available from super classes, the hierarchy of the view object should match the hierarchy of the view (`public class LoginView extends VerticalLayout` vs `public class LoginViewElement extends VerticalLayoutElement`).

- b. Adding the `@Attribute(name = "class", contains = "login-view")` annotation allows you to find the `LoginViewElement` using the TestBench query API, for example:

```
LoginViewElement loginView = $(LoginViewElement.class).onPage().first();
```

The annotation searches for the `login-view` class name, which is set for the login view in the constructor. The `onPage()` call ensures that the whole page is searched. By default a `$` query starts from the active element.

2. Now that the the `LoginViewElement` class is available, you can refactor your `loginAsValidUserSucceeds` test to be:

LoginIT.java

```
@Test
public void loginAsValidUserSucceeds() {
    LoginViewElement loginView = $(LoginViewElement.class).onPage().first();
    Assert.assertTrue(loginView.login("user", "password"));
}
```

3. Add a test to use an invalid password as follows:

LoginIT.java

```
@Test  
public void loginAsInvalidUserFails() {  
    LoginViewElement loginView = $(LoginViewElement.class).onPage().first();  
    Assert.assertFalse(loginView.login("user", "invalid"));  
}
```

4. Continue testing the other views by creating similar view objects and IT classes.

In the next tutorial we cover how to make a production build of the application and deploy it to a cloud platform.

You can find the completed source code for this tutorial on [GitHub](#).

Deploying a Spring Boot app on AWS Elastic Beanstalk

In this final tutorial in the series, we show you how to deploy the Spring Boot application we have built on [Amazon Web Services \(AWS\)](#) with [AWS Elastic Beanstalk \(EB\)](#). EB is a service that orchestrates other AWS services like virtual servers, load balancers, storage, and databases.

So far in this series, the application has used an in-memory H2 database. For the deployed application, we will use a MySQL server for persistent storage instead.

You can download the completed source code at the bottom. The code from the previous tutorial chapter can be found [here](#), if you want to jump directly into this chapter.

Preparing the application for production

Before we can deploy the app, we need to make it ready for production. More specifically, we need to build the app with Vaadin production mode enabled and add a separate configuration file to configure the production database and ports.

When you build a production version of a Vaadin app, the following happens: All the front-end resources are bundled and minified to speed up the app load time. Vaadin runs in production mode to hide debugging and other sensitive information from the browser.

Creating a separate configuration for production

We want to run different databases during development and in production. To support this, we need to create a separate configuration file for the production build.

Create a new file, [application-prod.properties](#), in `src/main/resources`.

TIP

Do not store sensitive information like passwords in properties files that get committed to a version control system like Git. Instead, use environment variables that can be kept on the server.

application-prod.properties

```
server.port=5000 ①
spring.datasource.url=jdbc:mysql://${RDS_HOSTNAME}:${RDS_PORT}/${RDS_DB_NAME} ②
spring.datasource.username=${RDS_USERNAME}
spring.datasource.password=${RDS_PASSWORD}
spring.jpa.hibernate.ddl-auto=create
```

- ① Elastic Beanstalk maps the internal port 5000 to the external port 80 to expose the application to the internet.
- ② Elastic Beanstalk will provide environment variables with information about the database so we don't need to store them in the property file.

WARNING

`spring.jpa.hibernate.ddl-auto=create` deletes and re-creates the database on every deployment. A more proper solution is to use a database migration tool like Liquibase.

Adding MySQL support

Add MySQL as a dependency to your project's `pom.xml` file.

pom.xml

```
<dependency>
    <groupId>mysql</groupId>
    <artifactId>mysql-connector-java</artifactId>
    <scope>runtime</scope>
</dependency>
```

Creating a production build of the Vaadin app

Use the Maven `production` profile to create a production-optimized build. Add the `skipTests` parameter to avoid running tests.

```
mvn clean package -Pproduction -DskipTests
```

You now have a production-ready application JAR in `target/vaadin-crm-<version>.jar`. Next, we set up the AWS environment for deploying it.

Creating an AWS account

The first thing you need to do is create an AWS account, if you don't already have one. You can sign up for an AWS Free Tier account that provides limited usage of many AWS

products.

WARNING

AWS is a paid service and following the instructions below may result in charges.
Carefully review the billing costs on AWS to avoid any surprises.

Setting up a Java application on Elastic Beanstalk

First create the app environment on Elastic Beanstalk:

1. Create a new application in the [Elastic Beanstalk console](#).

Welcome to AWS Elastic Beanstalk

With Elastic Beanstalk, you can **deploy**, **monitor**, and **scale** an application quickly and easily. Let us do the heavy lifting so you can focus on your business.

To deploy your **existing web application**, create an **application source bundle** and then **create a new application**. If you're using **Git** and would prefer to use it with our command line tool, please see [Getting Started with the EB CLI](#).

To deploy a **sample application**, click **Get started**, choose a name, select a platform and click **Create app**.

You simply upload your code and Elastic Beanstalk automatically handles the deployment, from capacity provisioning, load balancing, and automatic scaling to web application health monitoring, with ongoing fully managed patch and security updates. [Learn more](#)

Get started

Get Started in Three Easy Steps

Select a Platform

Upload an Application or Use a Sample

Run it!

Start Now by Selecting Your Platform

...and more

2. Create an environment for the application with the following configurations, and then click **Configure more options**:

- **Application name:** Vaadin CRM
- **Environment tier:** Web server environment.
- **Platform:** Corretto 11.

- **Application code:** Sample application. You can leave the other fields empty.

Elastic Beanstalk Management | us-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=us-west-2#/gettingStarted

Create a web app

Create a new application and environment with a sample application or your own code. By creating an environment, you allow AWS Elastic Beanstalk to manage AWS resources and permissions on your behalf. [Learn more](#)

Application information

Application name Vaadin CRM

Up to 100 Unicode characters, not including forward slash (/).

Application tags

Base configuration

Platform (BETA) Corretto 11

Choose [Configure more options](#) for more platform configuration options.

Application code Sample application
Get started right away with sample code.

Upload your code
Upload a source bundle from your computer or copy one from Amazon S3.

[Upload](#) ZIP or WAR

[Cancel](#) [Configure more options](#) **Create application**

3. Go to **Software > Modify** and add an environment property, and then click **Save**:

- **Name:** SPRING_PROFILES_ACTIVE
- **Value:** prod

The screenshot shows the AWS Elastic Beanstalk Management console with the URL us-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=us-west-2#/gettingStarted. The page displays settings for 'Instance log streaming to CloudWatch Logs'. Under 'Log streaming', the 'Enabled' checkbox is checked, and the retention period is set to 7 days. The 'Lifecycle' setting is 'Keep logs after terminating environment'. Below this, the 'Environment properties' section lists several environment variables with their values:

Name	Value
GRADLE_HOME	/usr/local/gradle
JAVA_HOME	/usr/lib/vm/java
M2	/usr/local/apache-maven/bin
M2_HOME	/usr/local/apache-maven
SPRING_PROFILES_ACTIVE	prod
<empty>	<empty>

A red arrow points to the 'SPRING_PROFILES_ACTIVE' row. At the bottom right of the properties table are 'Cancel' and 'Save' buttons.

4. Go to **Database > Modify** and set up an Amazon RDS SQL database with the following configurations, and then click **Save**:

- The defaults are fine for our purposes.
- Add a username and password. Elastic Beanstalk will make these available to your application through the environment variables you set up in the properties file.

Create environment

us-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=us-west-2#/newEnvironment?applicationName=foo

For production environments, you can configure your instances to connect to a database. [Learn more](#)

Restore a snapshot

Restore an existing snapshot in your account, or create a new database.

Snapshot: None

Database settings

Choose an engine and instance type for your environment's database.

Engine: mysql

Engine version: 5.7.22

Instance class: db.t2.micro

Storage: 5 GB

Choose a number between 5 GB and 1024 GB.

Username: crm

Password:

Retention: Delete

When you terminate your environment, your database instance is also terminated. Choose **Create snapshot** to save a snapshot of the database prior to termination. Snapshots incur standard storage charges.

Availability: Low (one AZ)

[Cancel](#) [Save](#)

The screenshot shows the 'Create environment' wizard in the AWS Elastic Beanstalk console. The 'Database settings' section is open, allowing users to choose MySQL as the engine, set the instance class to db.t2.micro, and specify a storage size of 5 GB. It also includes fields for a database username and password, and a retention policy for snapshots. A note at the bottom explains that terminating the environment will also delete the database. At the bottom right are 'Cancel' and 'Save' buttons.

CAUTION

This database setup is suitable for the tutorial, but in a real production application, the database should not be tied to the lifecycle of the environment. Otherwise you may inadvertently delete the database if you remove the server. See [Using Elastic Beanstalk with Amazon Relational Database Service](#).

5. Click Create app.

NOTE Creating the application environment and database can take up to 15 minutes.

Deploying the Elastic Beanstalk app

1. In the EB console Dashboard, click Upload and Deploy and upload your newly-built JAR file, `target/vaadin-crm-<version>.jar`.

VaadinCrm-env - Dashboard

us-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=us-west-2#environment/dashboard?applicationName=Vaadin%20C...

Elastic Beanstalk Vaadin CRM Create New Application

All Applications > Vaadin CRM > VaadinCrm-env (Environment ID: e-28jn4ixa83, URL: VaadinCrm-env.eba-ezix7hnz.us-west-2.elasticbeanstalk.com) Actions

Dashboard Overview Refresh

Configuration

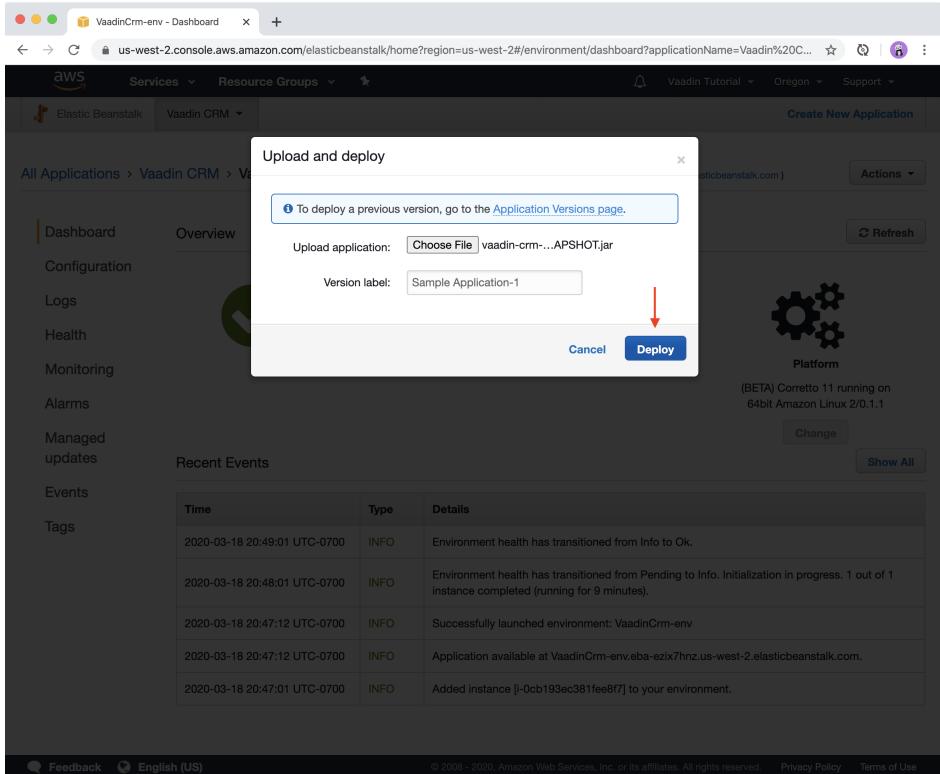
Logs Health Ok Causes Running Version Sample Application Upload and Deploy Platform (BETA) Corretto 11 running on 64bit Amazon Linux 2/0.1.1 Change Show All

Health Monitoring Alarms Managed updates Events Tags Recent Events

Time	Type	Details
2020-03-18 20:49:01 UTC-0700	INFO	Environment health has transitioned from Info to Ok.
2020-03-18 20:48:01 UTC-0700	INFO	Environment health has transitioned from Pending to Info. Initialization in progress. 1 out of 1 instance completed (running for 9 minutes).
2020-03-18 20:47:12 UTC-0700	INFO	Successfully launched environment: VaadinCrm-env
2020-03-18 20:47:12 UTC-0700	INFO	Application available at VaadinCrm-env.eba-ezix7hnz.us-west-2.elasticbeanstalk.com.
2020-03-18 20:47:01 UTC-0700	INFO	Added instance [i-0cb193ec381fee8f7] to your environment.

Feedback English (US)

© 2008 - 2020, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use



- After the environment has updated (this can take several minutes), the environment Health should indicate as Ok (green tick) and your application should run and be accessible on the web through the link at the top of the dashboard. If the health is not Ok, go to Logs (in the EB console) to troubleshoot the problem.

VaadinCrm-env - Dashboard Login | Vaadin CRM

us-west-2.console.aws.amazon.com/elasticbeanstalk/home?region=us-west-2#/environment/dashboard?applicationName=Vaadin%20C...

AWS Services Resource Groups

Elastic Beanstalk Vaadin CRM Create New Application

All Applications > Vaadin CRM > VaadinCrm-env (Environment ID: e-28jn4ixa83, URL: VaadinCrm-env.eba-ezix7hnz.us-west-2.elasticbeanstalk.com) Actions

Dashboard Overview Refresh

Configuration

Logs Health Ok Causes Running Version Sample Application-1 Platform (BETA) Corretto 11 running on 64bit Amazon Linux 2/0.1.1 Change Show All

Health

Monitoring

Alarms

Managed updates

Events

Tags

Recent Events

Time	Type	Details
2020-03-18 20:53:21 UTC-0700	INFO	Environment update completed successfully.
2020-03-18 20:53:21 UTC-0700	INFO	New application version was deployed to running EC2 instances.
2020-03-18 20:53:01 UTC-0700	INFO	Environment health has transitioned from Ok to Info. Application update in progress on 1 instance. 0 out of 1 instance completed (running for 45 seconds).
2020-03-18 20:52:50 UTC-0700	INFO	Deploying new version to instance(s).
2020-03-18 20:52:10 UTC-0700	INFO	Environment update is starting.

Feedback English (US)

© 2008 - 2020, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use



Vaadin CRM

Log in

Username •

Password • 👁

[Forgot password](#)

You can find the completed source code for this tutorial on [GitHub](#).

Next steps

Good job on completing the tutorial series! You now have all the skills you need to get started building real-life applications with Spring Boot and Vaadin.

You can find more information about both in the respective frameworks' documentation:

- [Spring Boot documentation](#)
- [Vaadin documentation](#)

Share your experience

Please let us know what you thought of the tutorial series and if you have ideas for other topics you want us to cover. You can reach us on [Twitter](#) or by posting a comment below.

This guide is specifically designed as a practical introduction to web application development using Java. It covers the entire development process, from setup to deployment, following a step-by-step approach. You can replicate each section at your own pace as you follow along.

Learn more on Vaadin at
vaadin.com/learn

vaadin}>