Bound to Persist with Vaadin JPAContainer

Vaadin JPAContainer 2.0

Vaadin JPAContainer is a Vaadin Container implementation for binding Vaadin user interface components directly to Java objects persisted using the Java Persistence API

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1. Introduction

1.1. Overview

Most business web applications need to either store data in or retrieve it from a database, or both. However, the data is rarely written directly from the user input to the database. Applications that follow a multilayered architecture have an intermediate business logic or *domain layer*, which is implemented as Java classes.

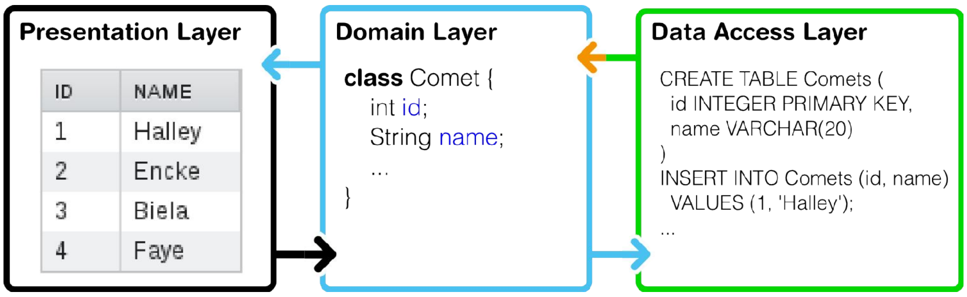


Figure 1: Three-Layer Architecture

The data binding model in Vaadin can be used to bind user interface components to a domain layer. The purpose of *Java Persistence API* is to define how the Java classes of the domain layer are mapped to database tables. Using the mappings, the instances of such classes can be *persisted* – stored in and retrieved from the database – without writing complex queries and copying the values between the queries and the domain model.

Vaadin JPAContainer allows connecting Vaadin user interface components directly to the persistent model objects. It is an implementation of the container interface defined in the Vaadin core framework. You can use the container to display data in a table, tree, any other selection component, or edit the data in a form.

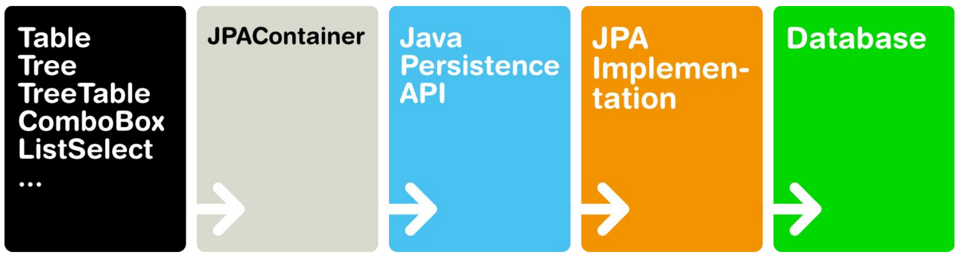


Figure 2: Role of JPAContainer in binding Vaadin components to a database

In this tutorial, we revisit the Vaadin Tutorial presented in vaadin.com/tutorial and make a similar application with persistence using JPAContainer.

But first, we start by going through the basic concepts of Vaadin data binding, Java Persistence API, JPA implementations, relational databases, and the role of JPAContainer to in the darkness bind them.

Then, we are ready to look into installing Vaadin JPAContainer or importing the JPAContainer AddressBook Demo, defining a domain model, and using the JPAContainer in an application.

1.2. Technologies Covered in the Tutorial

The basic purpose of this tutorial is to demonstrate the use of the following technologies:

- Vaadin Framework
- Vaadin JPAContainer
- Java Persistence API
- Java Bean Validation API

We use the following additional tools:

- EclipseLink
- Vaadin Bean Validation add-on
- Hibernate Validator
- H2 Database Engine
- CustomField add-on

Any implementation of the Java Persistence API could be used, but in this tutorial we choose to use EclipseLink, which is the reference implementation of JPA 2.0. Its choice is only relevant in the project configuration.

The Vaadin Bean Validation add-on allows validation of Vaadin forms using the Java Bean Validation API 1.0 (JSR-303). It is based on annotations for the bean properties. We use the Hibernate Validator as the chosen implementation of the API.

For the back-end relational database, we use an in-memory database using the H2 database engine.

The CustomField add-on allows creating composite field components much the same way as the standard CustomComponent in Vaadin core framework.

1.3. Vaadin Data Model

Let us first recapture the Vaadin data model introduced in the Chapter 9: *Binding Components to Data* in Book of Vaadin. It consists of three levels of containment: *properties*, *items*, and *containers*.

1.3.1. Properties

Atomic data is represented as **Property** objects that have a *value* and a *type*. Properties can be bound to **Field** components, such as a **TextField**, or a table cell.

```
// A property of some type
ObjectProperty<String> p =
    new ObjectProperty<String>(“the property value”);

// A field
TextField field = new TextField(“Name”);

// Bind the field to the property
field.setPropertyDataSource(p);
```

The **ObjectProperty** used above is just one implementation of the **Property** interface – in **JPAContainer** we use a different property type.

1.3.2. Items

An **Item** is a collection of properties that is typically bound to a **Form** or a row in a **Table** or some other selection component. Properties of an item are identified by a *property identifier* (PID).

```
// Create an item with two properties
PropertysetItem item = new PropertysetItem();
item.addItemProperty("name",
                     new ObjectProperty<String>("Zaphod"));
item.addItemProperty("age",
                     new ObjectProperty<Integer>(42));

// Bind it to a form
Form form = new Form();
form.setItemDataSource(item);
```

1.3.3. Containers

A **Container** is a collection of items, usually bound to a **Table**, **Tree**, or some other selection component. Items in a container are identified by an item identifier (IID). Normally, all the items in a container have the same type and the same properties.

For a more detailed description of the Vaadin data model, please refer to.

1.3.4. Normal (Non-Persistent) Binding to JavaBeans

Vaadin core library provides **BeanItem** implementation of the **Item** interface to bind bean objects. At the **Container** level, Vaadin provides the **BeanItemContainer** and **BeanContainer** implementations. They are very useful for handling transient (non-persistent) objects.

```
// Here is a bean
public class Bean implements Serializable {
    String name;
    double energy; // Energy content in kJ/100g

    public Bean(String name, double energy) {
        this.name   = name;
        this.energy = energy;
    }

    public String getName() {
        return name;
    }

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

    public double getEnergy() {
        return energy;
    }

    public void setEnergy(double energy) {
        this.energy = energy;
    }
}

...
// Create a container for such beans
BeanItemContainer<Bean> beans =
    new BeanItemContainer<Bean>(Bean.class);

// Add some beans to it
beans.addBean(new Bean("Mung bean",   1452.0));
beans.addBean(new Bean("Chickpea",    686.0));
beans.addBean(new Bean("Lentil",      1477.0));
beans.addBean(new Bean("Common bean", 129.0));
beans.addBean(new Bean("Soybean",     1866.0));

// Bind a table to it
Table table = new Table("Beans of All Sorts", beans);
layout.addComponent(table);
```

Actually, the classes added to a **BeanItemContainer** do not need to be beans; only the setters and getters are relevant, and it is not necessary to implement **Serializable** and have a default constructor.

So, that should be simple. Next, we see how to persist Java classes.

1.4. Java Persistence API

Java Persistence API (JPA) is an API for object-relational mapping (ORM) of Java objects to a relational database. In JPA and entity-relationship modeling in general, a Java class is considered an *entity*. Class (or entity) instances correspond with a row in a database table and member variables of a class with columns. Entities can also have relationships with other entities.

Vaadin JPAContainer supports the JPA 2.0 standard.

1.4.1. Persistence Metadata

JPA requires metadata about the entities and their relationships. The metadata can be defined in an XML metadata file or with Java annotations defined in the `javax.persistence` package. With JPAContainer, you need to provide the metadata as annotations.

For example, if we look at the **Person** class in the JPAContainer AddressBook Demo, we define various database-related metadata for the member variables of a class:

```
@Entity
public class Person {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;

    @NotNull
    @Size(min = 2, max = 24)
    private String firstName;

    @Size(min = 2, max = 24)
    private String lastName;

    @NotNull
    private Department department;
    …
```

The JPA implementation uses reflection to read the annotations and defines a database model automatically from the class definitions.

JPA annotation is discussed in detail later in Section 4.3: *Annotating the Classes for Persistence*.

1.4.2. JPA Implementations

Java Persistence API (JPA) is a specification that is implemented by various JPA implementations. EclipseLink is the reference implementation of JPA 2.0. It is found to be well suited for stateful applications, as is the case with Vaadin.

Hibernate is another popular implementation of the standard, where the implementation is provided in Hibernate EntityManager, Hibernate Metamodel Generator, and Hibernate Annotations.

1.5. Rapid Start with Spring Roo

Perhaps the quickest way to create a domain model and persist it with JPAContainer is to use Spring Roo, a rapid development tool for Java applications. It generates code that uses the Spring Framework, Java Persistence API, and Apache Maven. It also allows extending its functionality using add-ons, such as the Vaadin Plugin for Spring Roo. The Vaadin add-on can generate a user interface views based on the data model definitions given to Roo.

For a Spring Roo tutorial with Vaadin, please refer to Chapter 12: *Rapid Development Using Vaadin and Roo* in the Book of Vaadin.

2. Installing Vaadin JPAContainer

This chapter gives basic instructions for installing Vaadin JPAContainer in your own application. If you just wish to go on with the tutorial and install JPAContainer later, you can skip to Chapter 3: *JPAContainer AddressBook Demo*.

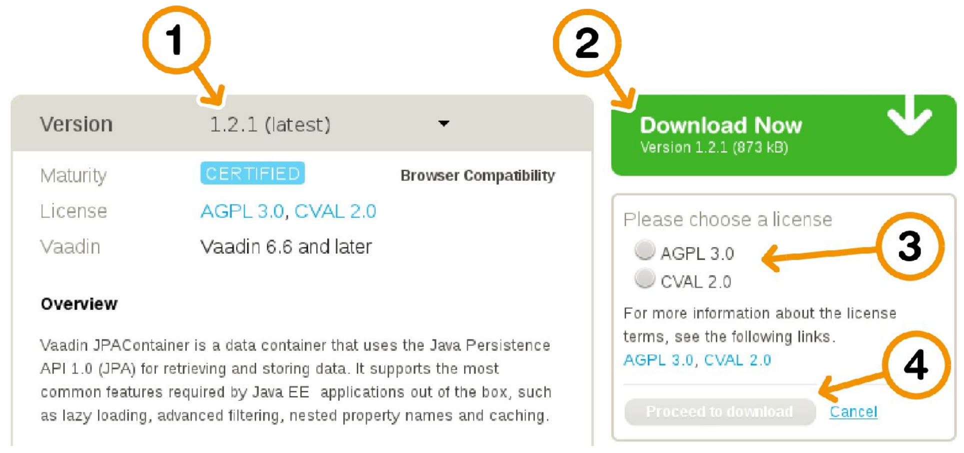
2.1. Installation Options

You have the following options for installing JPAContainer:

- Download installation package from Vaadin Directory
- Define a Maven dependency
- Create a new Vaadin project with a special archetype

2.2. Downloading JPAContainer from Vaadin Directory

JPAContainer is available for immediate download from the Vaadin Directory at http://vaadin.com/directory#addon/vaadin-jpacontainer.



Version 1.2.1 (latest)

Maturity CERTIFIED

License AGPL 3.0, CVAL 2.0

Vaadin Vaadin 6.6 and later

Browser Compatibility

Overview

Vaadin JPAContainer is a data container that uses the Java Persistence API 1.0 (JPA) for retrieving and storing data. It supports the most common features required by Java EE applications out of the box, such as lazy loading, advanced filtering, nested property names and caching.

Version 1.2.1 (873 kB)

Please choose a license

AGPL 3.0

CVAL 2.0

For more information about the license terms, see the following links. AGPL 3.0, CVAL 2.0

Figure 3: Downloading JPAContainer from Vaadin Directory

1. Select **Version** (the latest version is selected by default)
2. Click **Download Now**
3. Select either **AGPL** or **CVAL** license
4. Click **Proceed to download**
5. After downloading the installation package, extract its contents to a local folder using an appropriate ZIP extraction software for your operating system

Dual Licensing Under AGPL and CVAL

Vaadin JPAContainer is available under two licenses: *Affero General Public License* (AGPL) and *Commercial Vaadin Add-on License* (CVAL). If your project is compatible with the open-source AGPL, you can use the add-on for free. Otherwise you must acquire a sufficient number of CVAL licenses before the 30-day trial period ends. Vaadin JPAContainer is distributed as a separate installation package for each license.

Use of Vaadin JPAContainer with the CVAL license is included in the Vaadin PRO subscription.

Free for Pro

2.3. Installation Package Content

Once extracted to a local folder, the contents of the installation directory are illustrated in Figure 4.

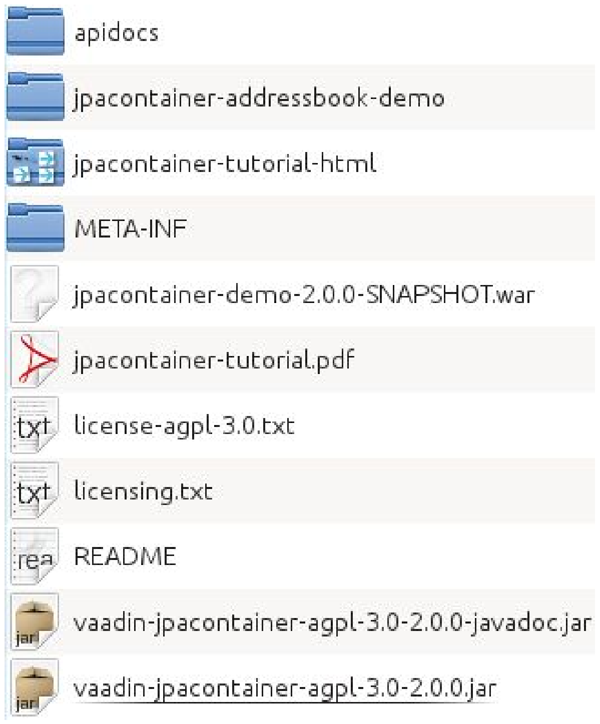

apidocs
jpacontainer-addressbook-demo
jpacontainer-tutorial-html
META-INF
jpacontainer-demo-2.0.0-SNAPSHOT.war
jpacontainer-tutorial.pdf
license-agpl-3.0.txt
licensing.txt
README
vaadin-jpacontainer-agpl-3.0-2.0.0-javadoc.jar
vaadin-jpacontainer-agpl-3.0-2.0.0.jar

Figure 4: Installation Package Contents

The files in the installation package are as follows:

README

A readme file describing the package contents.

licensing.txt

General information about licensing.

license-xxxx-y.y.txt

The full license text for the library.

vaadin-jpacontainer-xxxx-y.y-z.z.z.jar

The actual Vaadin JPAContainer library. The `xxxx` is the license name and `y.y` its version number. The final `z.z.z` is the version number of the Vaadin JPAContainer.

vaadin-jpacontainer-xxxx-y.y-z.z.z-javadoc.jar

JavaDoc documentation JAR for the library. You can use it for example in Eclipse by associating the JavaDoc JAR with the JPAContainer JAR in the build path settings of your project.

apidocs

The JavaDoc API documentation in plain HTML.

jpacontainer-tutorial.pdf

This tutorial in PDF format.

jpacontainer-tutorial

The tutorial in HTML format. The latest version of the tutorial is always available at vaadin.com/download/jpacontainer-tutorial/.

jpacontainer-addressbook-demo

The JPAContainer AddressBook Demo project covered in this tutorial. You can compile and package the application as a WAR with "`mvn package`" or launch it in the Jetty web browser with "`mvn jetty:run`". You can also import the demo project in Eclipse as described in Section 3.1.2: *Importing from Existing Installation Folder*.

jpacontainer-demo-z.z.z.war

The basic JPAContainer demo. It is somewhat more extensive than the AddressBook Demo.

2.4. Including Libraries in Your Project

The Vaadin JPAContainer JAR must be included in the library folder of the web application. It is located in `WEB-INF/lib` path in a web application. In a normal Eclipse web projects the path is `WebContent/WEB-INF/lib`. In Maven projects the JARs are automatically included in the folder, as long as the dependencies are defined correctly.

Required Libraries

You will need the following JARs:

- Vaadin Framework Library
- Vaadin JPAContainer
- Java Persistence API 2.0 (`javax.persistence` package)
- JPA implementation (EclipseLink, Hibernate, ...)
- Database driver or embedded engine (H2, HSQLDB, MySQL, ...)

The Vaadin Framework library is automatically downloaded and updated by the Vaadin Plugin for Eclipse.

Optional Libraries

Optional libraries included in the AddressBook Demo are:

- Vaadin BeanValidation add-on
- Hibernate Validator
- Logging library (SLF4J, …)
- CustomField add-on

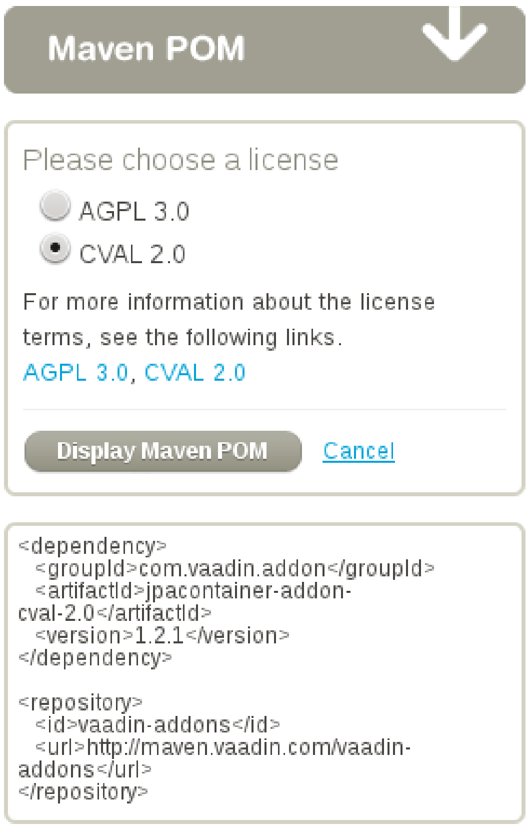
Example

Below is an example listing of the JARs included in `WEB-INF/lib` in the AddressBook demo. The exact version numbers may vary.

```
beanvalidation-addon-0.6.2.jar
customfield-0.9.3.jar
eclipselink-2.2.0.jar
h2-1.3.160.jar
hibernate-validator-4.2.0.Final.jar
javax.persistence-2.0.0.jar
jpacontainer-addon-agpl-3.0-2.0.0-SNAPSHOT.jar
slf4j-api-1.6.1.jar
vaadin-6.7.1.jar
validation-api-1.0.0.GA.jar
```

2.5. Defining Dependencies in Maven

You can find the dependency declaration for the JPAContainer add-on in the Vaadin Directory page, as illustrated in Figure 5.



```
<dependency>
  <groupId>com.vaadin.addon</groupId>
  <artifactId>jpacontainer-addon-
cval-2.0</artifactId>
  <version>1.2.1</version>
</dependency>

<repository>
  <id>vaadin-addons</id>
  <url>http://maven.vaadin.com/vaadin-
addons</url>
</repository>
```

Figure 5: JPAContainer dependency declaration for Maven.

The dependency definition needs to be put in the `pom.xml` file in the project. The demo project requires also various other dependencies, namely for EclipseLink, H2 database, BeanValidator, etc. Please see how they are defined in the `pom.xml`.

Detailed instructions for using Vaadin Add-ons in Maven projects are given in Book of Vaadin Chapter 13: *Using Vaadin Add-ons*, in the Section *Using Add-ons in a Maven Project*.

2.6. Vaadin JPAContainer Maven Archetype

If you wish to create a new JPAContainer enabled Vaadin project with Maven, you can use the `vaadin-archetype-jpacontainer` archetype. Please see the section Creating a Project with Maven in the Book of Vaadin for details on creating a Vaadin project with a Maven archetype.

3. JPAContainer AddressBook Demo

In this JPAContainer tutorial, we create an application similar to the one presented in vaadin.com/tutorial, but with persistence.

The demo project uses Maven, but you can set up a project just as well as a regular Eclipse project.

3.1. Importing the Tutorial Project

Before proceeding further, you should import the demo project to your favorite IDE...well, let's say that is Eclipse. As the project is Maven-based, Eclipse users need to install the m2e (or m2eclipse for older versions) plugin to be able to import Maven projects.

3.1.1. Checking Out from Repository (optional)

If you wish to use the latest version of the demo or do not have the Vaadin JPAContainer installation package at hand, you can check out the demo from the repository. If you do not wish to install Subclipse and the Subclipse SCM connector in Eclipse, which can cause some trouble sometimes, you can do the check-out from the command-line as follows:

1. Install Subversion command-line tools or use some alternative Subversion client

2. Run the following command in a terminal window or use some other Subversion client to do the checkout:

```
$ svn co http://dev.vaadin.com/svn/addons/JPAContain
er/trunk/jpacontainer-addressbook-demo
```

3.1.2. Importing from Existing Installation Folder

The demo project is included in the Vaadin JPAContainer installation package. Once extracted to a local folder or checked out from the repository as described above, you can import it in Eclipse as follows:

1. Install m2e in Eclipse if you have not done so already

2. Select **File → Import** in Eclipse

3. Select **Maven → Existing Maven Projects**, and click **Next**.

4. Click **Browse** to select the `jpacontainer-addressbook-demo` folder where you checked out the project.

5. Click **Finish**.

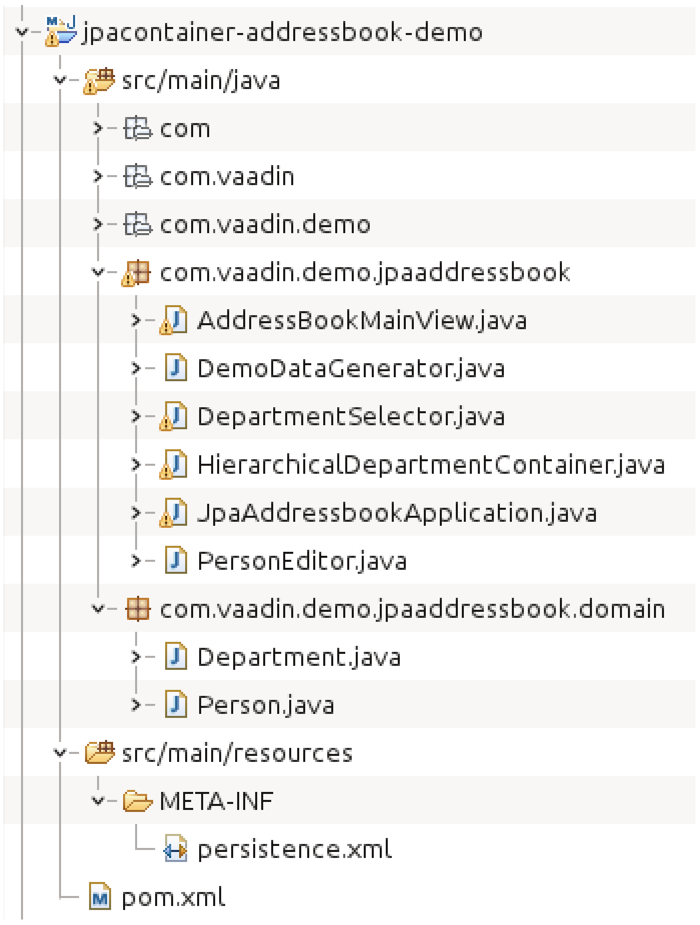
3.1.3. Import from Repository Using Subclipse

If you have installed Subclipse in Eclipse, you should be able to import the demo project a bit easier as follows:

1. Install m2e in Eclipse if you have not done so already
2. Select File → Import
3. Select **Maven → Check out Maven Project from SCM**, and click **Next**.
4. In **SCM URL**, select **svn** and enter URL http://dev.vaadin.com/svn/addons/JPAContainer/trunk/jpacontainer-addressbook-demo
5. Click **Finish**.

3.2. Browsing the Application

Importing the project takes a while. After it is finished, please take some time to inspect the project structure and files in Eclipse. The **Project Explorer** in Eclipse organizes Java source files in source folders, as illustrated in Figure 6.



```
jpacontainer-addressbook-demo
  src/main/java
    com
    com.vaadin
    com.vaadin.demo
    com.vaadin.demo.jpaaddressbook
      AddressBookMainView.java
      DemoDataGenerator.java
      DepartmentSelector.java
      HierarchicalDepartmentContainer.java
      JpaAddressbookApplication.java
      PersonEditor.java
    com.vaadin.demo.jpaaddressbook.domain
      Department.java
      Person.java
  src/main/resources
    META-INF
      persistence.xml
  pom.xml
```

Figure 6: Browsing the project contents with Project Explorer in Eclipse.

com.vaadin.demo.jpaaddressbook

The JPAContainer AddressBook Demo package, which contains the application class (Section 5.2: *Application Class*), the main view class (Section 5.3: *AddressBookMainView*), some UI classes and some helpers.

com.vaadin.demo.jpaaddressbook.domain

Domain classes as described in Chapter 4: *Defining a Domain Model*.

src/main/resources/META-INF/persistence.xml

The persistence configuration, as described in Section 3.3: *Persistence Configuration*.

pom.xml

Maven project configuration file (Portable Object Model). It is a somewhat regular configuration for Vaadin application, as described in the Section 2.5: Creating a Project with Maven in the Book of Vaadin. The most relevant parts are the Vaadin JPAContainer and other dependency definitions, as mentioned in Section 2.5: *Defining Dependencies in Maven*.

3.3. Persistence Configuration

Persistence configuration is done in a `persistence.xml` file. In the demo project, it is located in `src/main/resources/META-INF` folder. The configuration includes defining the following:

- The persistence unit
- The persistence provider
- The database driver and connection
- Logging

The `persistence.xml` file is packaged as `WEB-INF/classes/META-INF/persistence.xml` in the WAR. This is done automatically in a Maven build at the `package` phase.

3.3.1. Persistence XML Schema

The beginning of the `persistence.xml` file defines the used schema and namespaces:

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence
    xmlns="http://java.sun.com/xml/ns/persistence"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="
      http://java.sun.com/xml/ns/persistence
      http://java.sun.com/xml/ns/persistence/persistence_2_
0.xsd"
    version="2.0">
```

3.3.2. Defining the Persistence Unit

The root element of the persistence definition is `persistence-unit`. Its name attribute is used in the application when referring to the persistence unit. In Section 5.2: *Application Class* we define a global `PERSISTENCE_UNIT` identifier for referring to the unit.

```
    <persistence-unit name="addressbook">
```

Persistence Provider

The `provider` is the JPA provider implementation used. We use the EclipseLink JPA, so we define its provider class here.

```
        <provider>
            org.eclipse.persistence.jpa.PersistenceProvider
        </provider>
```

Listing the Persistent Classes

In this example, we allow including unlisted classes for persistence. The alternative is to specify each persistent class with a `<class>` element.

```
        <exclude-unlisted-classes>
            false
        </exclude-unlisted-classes>
```

JPA provider specific parameters are specified under the `properties` element. As we use EclipseLink JPA, the parameters are specific to that. If you use another provider, please refer to its documentation for the parameters.

```
        <properties>
          …
```

3.3.3. Database Connection

EclipseLink allows using JDBC for database connection. We use the H2 database, so we need to define its driver here.

```
 <property name="eclipselink.jdbc.platform"
value="org.eclipse.persistence.platform.database.H2Platfor
m" />
 <property name="eclipselink.jdbc.driver"
           value="org.h2.Driver" />
```

We use an in-memory database for the demo with the following connection URL definition:

```
 <property name="eclipselink.jdbc.url"
           value="jdbc:h2:~/jpacontaineraddressbookh2db" />
```

We can just use the default user name and password for the H2 database.

```
 <property name="eclipselink.jdbc.user"
           value="sa" />
 <property name="eclipselink.jdbc.password"
           value="sa" />
```

3.3.4. Logging Configuation

We set the logging level for EclipseLink JPA:

```
<property name="eclipselink.logging.level"
          value="FINE" />
```

3.3.5. Other Settings

The rest is some Data Definition Language settings for EclipseLink. During development, when we use generated example data, we want EclipseLink to drop tables before trying to create them. In production environments, you should use “`create-tables`”.

```
    <property name="eclipselink.ddl-generation"
              value="drop-and-create-tables" />
```

And there's no need to generate SQL files, just execute them directly to the database.

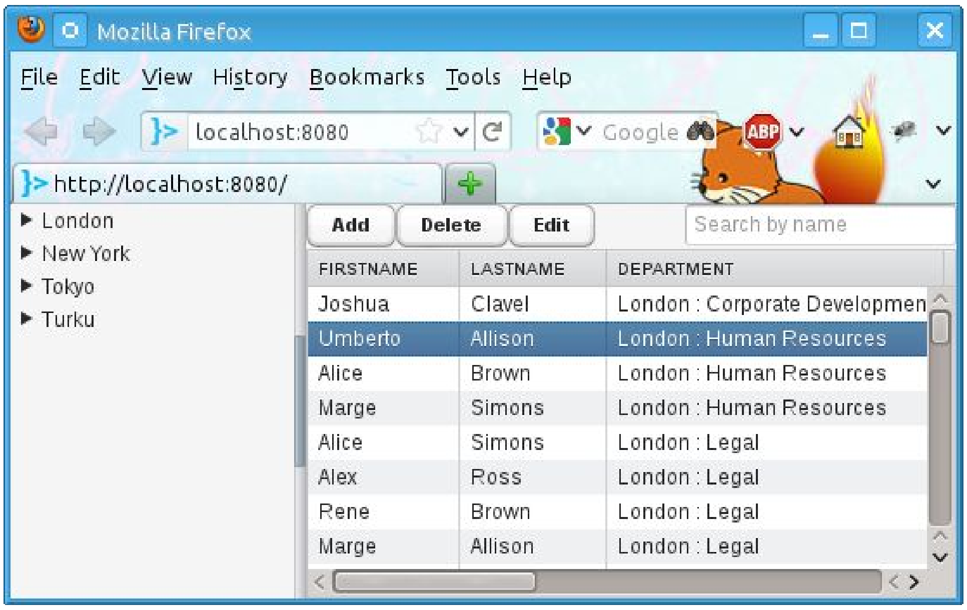
```
    <property name="eclipselink.ddl-generation.output-mode"
              value="database" />
   </properties>
  </persistence-unit>
</persistence>
```

3.4. Running the Application

If you imported the project as a Maven project, you can launch it in a server as follows:

1. Stop any web server you may have running in port 8080.
2. Right-click the project folder in Project Explorer and select **Run As → Maven Build...**.
3. In the **Edit Configuration** window that opens, enter “`package jetty:run`” in the **Goals** field and click **Run**. Wait for a while as the light-weight Jetty web server is launched.
4. Open a web browser with URL http://localhost:8080/.

The AddressBook Demo application should work as shown in Figure 7.



FIRSTNAME	LASTNAME	DEPARTMENT
Joshua	Clavel	London : Corporate Developmen
Umberto	Allison	London : Human Resources
Alice	Brown	London : Human Resources
Marge	Simons	London : Human Resources
Alice	Simons	London : Legal
Alex	Ross	London : Legal
Rene	Brown	London : Legal
Marge	Allison	London : Legal

Figure 7: JPAContainer AddressBook Demo.

3.5. Browsing the Sources Online

You can also browse the source code of the demo project on-line at http://dev.vaadin.com/browser/svn/addons/JPAContainer/trunk/jpacontainer-addressbook-demo.

4. Defining a Domain Model

In this chapter, we look into defining a domain model, implementing it as Java classes, and then enabling persistence by annotating the classes with JPA annotations.

4.1. A Domain Model

The AddressBook has a simple domain model with two entities: a **Person** and a **Department**.

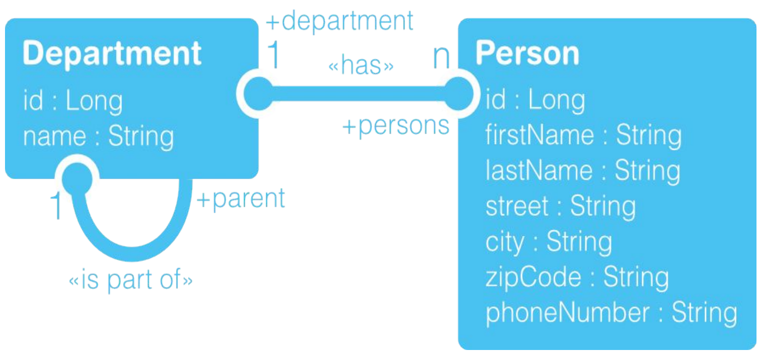


Figure 8: Domain Model

A **Department** has an integer (Long) identifier and a name. Departments have a hierarchy, which is represented by a `parent` reference. Each department has *n* persons working in it.

A **Person** has also an integer (Long) identifier and a first and last names, as well as basic contact information. A person works in a department.

4.2. Defining the Classes

The classes are defined in the `com.vaadin.demo.jpaaddressbook.domain` package of the demo project.

Department Class

The **Department** class is defined from the domain model in as follows:

```
public class Department {
    private Long id;
    private String name;
    private Set<Person> persons;
    private Boolean superDepartment;
    private Department parent;

    … setters and getters …
}
```

Notice that we added a *superDepartment* member that was not in the domain model. It is a shorthand variable that is only used internally for optimization to mark departments that only have sub-department and no personnel.

```java
public boolean isSuperDepartment() {
    if (superDepartment == null) {
        superDepartment = getPersons().size() == 0;
    }
    return superDepartment;
}
```

In addition, we define a *hierarchicalName* property that only has a getter and is not associated with a member variable. Its value is the hierarchy path calculated dynamically using the *toString()* method.

```java
public String getHierarchicalName() {
    if (parent != null) {
        return parent.toString() + " : " + name;
    }
    return name;
}

public String toString() {
    return getHierarchicalName();
}
```

Person Class

The **Person** class is defined from the domain model in as follows:

```java
public class Person {
    private Long id;
    private String firstName;
    private String lastName;
    private String street;
    private String city;
    private String zipCode;
    private String phoneNumber;
    private Department department;

    … setters and getters …
}
```

4.3. Annotating the Classes for Persistence

Let us look at the basic JPA metadata annotations as they are used in the **Department** class of the tutorial project. The annotations are defined in the `javax.persistence` package. Please refer to JPA reference documentation for the complete list of possible annotations.

4.3.1. @Entity

Each class that is enabled as a persistent entity must have the `@Entity` annotation.

```
@Entity
public class Department {
```

4.3.2. @Id

Entities must have an identifier that is used as the primary key for the table. It is used for various purposes in database queries, most commonly for joining tables.

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

The identifier is generated automatically in the database. The strategy for generating the identifier is defined with the `@GeneratedValue` annotation.

4.3.3. @OneToMany

As noted earlier, entities can have relationships. The **Department** entity of the domain model has one-to-many relationship with the **Person** entity ("Department has persons"). This relationship is represented with the `@OneToMany` annotation.

```
@OneToMany(mappedBy = "department")
private Set<Person> persons;
```

4.3.4. @ManyToOne

Many departments can belong to the same higher-level department, represented with `@ManyToOne` annotation.

```
@ManyToOne
private Department parent;
```

4.3.5. @Transient

Properties that are not persisted are marked as transient with the `@Transient` annotation.

```
@Transient
private Boolean superDepartment;
…
@Transient
```

```
public String getHierarchicalName() {
…
```

5. Application Architecture

This chapter describes the top-level user interface architecture of the JPAContainer AddressBook application.

5.1. Overview

The AddressBook application in the regular Vaadin Tutorial provides a reference architecture for Vaadin projects. The JPAContainer AddressBook takes this architecture further by including the persistence layer. It demonstrates the following tasks:

- Building a user interface view
- Binding the UI to the persistent domain model with JPAContainer
- Management of JPAContainer instances with a container factory
- Persistence using EntityManager
- Use of the ThreadLocal pattern to access global data
- Filtering a JPAContainer

5.2. Application Class

The **JpaAddressbookApplication** is the main class of the application.

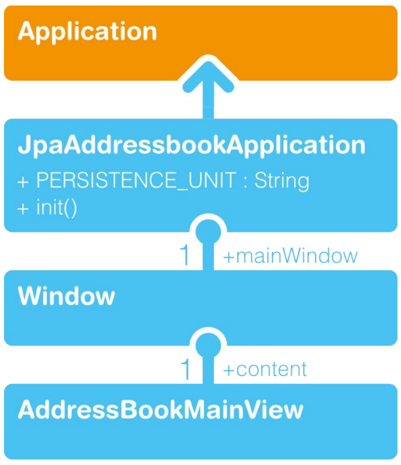


Figure 9: AddressBook Application Class

The application class has the following tasks:

- Hold a global identifier for the persistence unit
- Generate example data in the database
- Create the main view

The application class is defined in the `com.vaadin.demo.jpaaddressbook` package as follows:

```
public class JpaAddressbookApplication
       extends Application {
```

We hold a globally accessible identifier string for the persistence unit in the application class. It is used for instantiating a **JPAContainer** or an entity manager.

```
    public static final String PERSISTENCE_UNIT =
                                            "addressbook";
```

The demo data is static global data generated already during the initialization of the application class as follows:

```

    static {
        DemoDataGenerator.create();
    }
    …
```

The *init()* method of the application is trivial as the application only has one view which is managed in the **AddressBookMainView** class:

```
    @Override
    public void init() {
        Window window = new Window();
        setMainWindow(window);
        window.setContent(new AddressBookMainView());
    }
```

5.3. AddressBookMainView

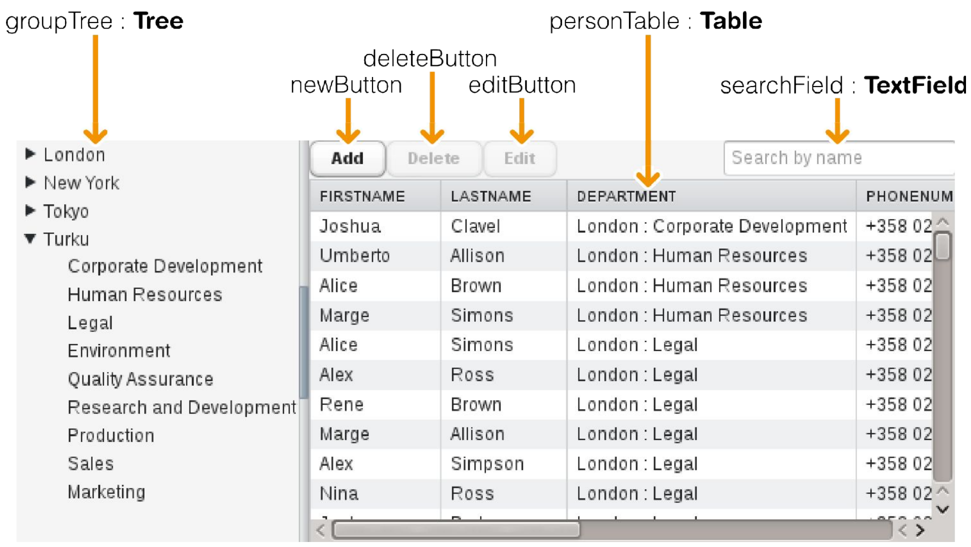
The main view of the application is realized in the **AddressBookMainView** class, which also handles most of the user interface logic. It extends from **HorizontalSplitPanel** to allow the user to resize the content.

5.3.1. Overview of the User Interface

The main view is shown in Figure 10.

On the left side of the split panel, we have a **Tree** component, which lets the user to browse and select a department that is used to filter the table on the right.

On the right side, we have a **Table** component, which shows all the persons in the selected department, and if no department is selected, all persons. It also contains buttons for adding, deleting, and editing items, as described in detail in Chapter 6: *Creating, Reading, Updating, and Deleting*.



- ▶ London
- ▶ New York
- ▶ Tokyo
- ▼ Turku
  - Corporate Development
  - Human Resources
  - Legal
  - Environment
  - Quality Assurance
  - Research and Development
  - Production
  - Sales
  - Marketing

FIRSTNAME	LASTNAME	DEPARTMENT	PHONENUM
Joshua	Clavel	London : Corporate Development	+358 02
Umberto	Allison	London : Human Resources	+358 02
Alice	Brown	London : Human Resources	+358 02
Marge	Simons	London : Human Resources	+358 02
Alice	Simons	London : Legal	+358 02
Alex	Ross	London : Legal	+358 02
Rene	Brown	London : Legal	+358 02
Marge	Allison	London : Legal	+358 02
Alex	Simpson	London : Legal	+358 02
Nina	Ross	London : Legal	+358 02

Figure 10: AddreddBookMainView

The underlying class relationships for the user interface are shown in Figure 11.

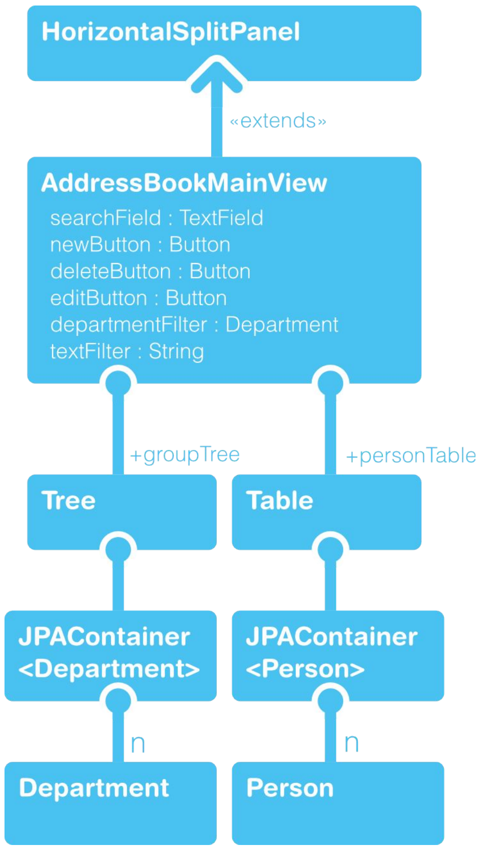


Figure 11: AddressBookMainView class diagram

Both the **Tree** and the **Table** are bound to a **JPAContainer** holding **Department** and **Person** objects, respectively.

5.4. Creating and Using a JPAContainer

The constructor of **AddressBookMainView** creates the **JPAContainer**s for the **Department** and **Person** objects shown in the tree and the table. References to the containers are kept for shorthand in member variables.

```
public class AddressBookMainView
       extends HorizontalSplitPanel
       implements ComponentContainer {
   …
   private JPAContainer<Department> departments;
   private JPAContainer<Person> persons;
   …
   public AddressBookMainView() {
       departments = new HierarchicalDepartmentContainer();
```

The **HierarchicalDepartmentContainer** and how it is bound to an entity manager as described is Section 5.4.2: *Setting the Entity Provider* below.

5.4.1. Using the JPAContainerFactory to Create a JPAContainer

JPAContainerFactory contains static methods for building **JPAContainer**s from either a persistence context name (persistence unit) or from a **EntityManager** instance.

The static *make()* method used in the demo creates a new **JPAContainer** backed by a **CachingMutableLocalEntityProvider**, using the name of the persistence unit. This particular method can be used if you do not know and do not need or want to know the instance of an **EntityManager** that is used, which is the case in simple instances. An instance of **EntityManagerFactory** will be created for the persistence unit and used to build entity managers.

```
    persons = JPAContainerFactory.make(Person.class,
            JpaAddressbookApplication.PERSISTENCE_UNIT);
    …
```

5.4.2. Setting the Entity Provider

If you create a **JPAContainer** object without the factory, as we did for the `departments` container earlier, you must set an entity provider for it before you can use it. For the **HierarchicalDepartmentContainer**, we set it in the constructor. We use the efficient **CachingLocalEntityProvider** as there is no need to make modifications through this container.

```
public class HierarchicalDepartmentContainer
       extends JPAContainer<Department> {

    public HierarchicalDepartmentContainer() {
        super(Department.class);

        // Create and set the entity provider
        setEntityProvider(
            new CachingLocalEntityProvider<Department>(
                Department.class,
                JPAContainerFactory
```

```
                   .createEntityManagerForPersistenceUnit(
                       JpaAddressbookApplication
                           .PERSISTENCE_UNIT)));
        …
    }
    …
```

The underlying JPA entity manager is created with the **JPAContainerFactory** using the *createEntityManagerForPersistenceUnit()* method. The factory caches the entity managers for each persistence unit. In the demo application, it is always the one identified with the `PERSISTENCE_UNIT` in the application class.

5.4.3. Binding a JPAContainer

Binding the **Person** table to the **JPAContainer** is done simply in the constructor of the **Table** just as with any Vaadin container:

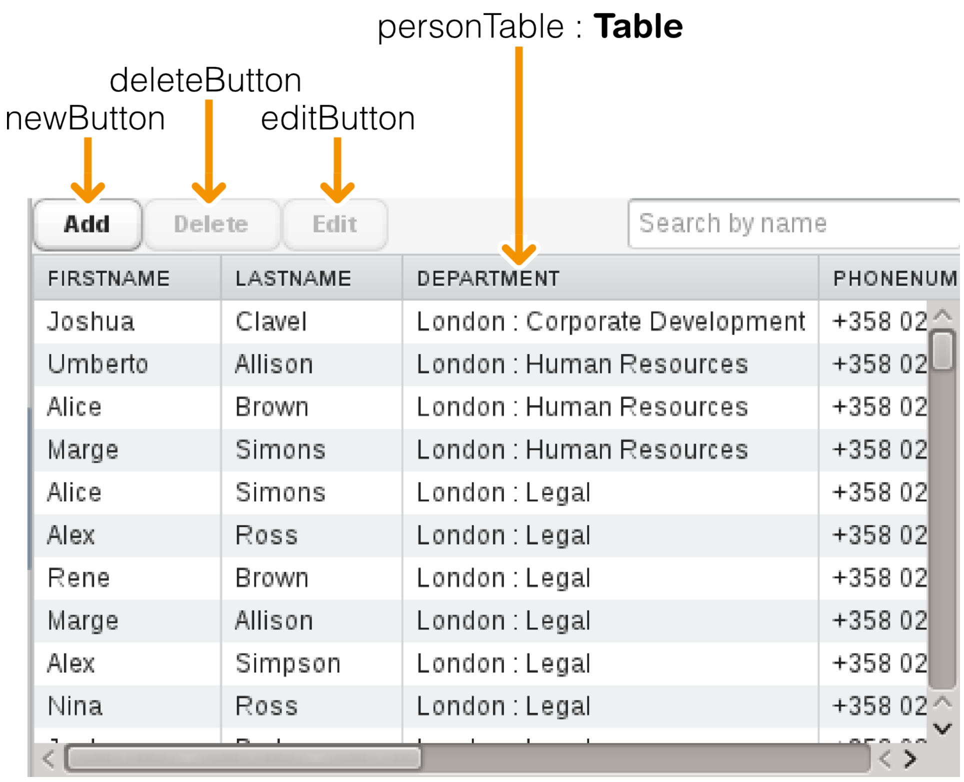
```
    private void buildMainArea() {
        …
        personTable = new Table(null, persons);
        …
```

6. Creating, Reading, Updating, and Deleting

This chapter focuses on how the **AddressBookMainView** implements CRUD – creation, reading, updating, and deletion of data objects in the domain model. The basics of these tasks were covered in the Vaadin Tutorial (notice that the code is not exactly the same), so we concentrate on the parts relevant to using JPAContainer.

6.1. Building the CRUD Area

The right side of the main view contains a CRUD area where you can add items in the **Person** table by clicking the **Add** button, delete them with the **Delete** button, and edit the selected person with the **Edit** button.



FIRSTNAME	LASTNAME	DEPARTMENT	PHONENUM
Joshua	Clavel	London : Corporate Development	+358 02
Umberto	Allison	London : Human Resources	+358 02
Alice	Brown	London : Human Resources	+358 02
Marge	Simons	London : Human Resources	+358 02
Alice	Simons	London : Legal	+358 02
Alex	Ross	London : Legal	+358 02
Rene	Brown	London : Legal	+358 02
Marge	Allison	London : Legal	+358 02
Alex	Simpson	London : Legal	+358 02
Nina	Ross	London : Legal	+358 02

Figure 12: The CRUD area

The user interface controls for the CRUD as well as the **JPAContainer** references are defined as member variables:

```
public class AddressBookMainView
       extends HorizontalSplitPanel
       implements ComponentContainer {
    private Tree groupTree;
    private Table personTable;
    private TextField searchField;

    private Button newButton;
    private Button deleteButton;
    private Button editButton;

    private JPAContainer<Department> departments;
    private JPAContainer<Person> persons;

    private Department departmentFilter;
    private String textFilter;
```

The `departments` and `persons` members are merely shorthand references to the containers managed by the **ContainerFactory**, as explained next.

6.2. Creating an Item

New **Person** items are created by clicking the **Add** button. The button is created in the *buildMainArea()* method as follows:

```
newButton = new Button("Add");
newButton.addListener(new Button.ClickListener() {
```

When the button is clicked, a new **Person** object is created and wrapped in a **BeanItem** to allow binding it to a **Form**.

```
    @Override
    public void buttonClick(ClickEvent event) {
      final BeanItem<Person> newPersonItem =
              new BeanItem<Person>(new Person());
```

Editing is done in a **PersonEditor** window documented in Section 6.3: *Editing an Item in a PersonEditor*. The editor class defines an **EditorSavedListener** interface for handling **EditorSavedEvent**s fired when the user clicks "**Save**" in the editor.

```
      PersonEditor personEditor =
              new PersonEditor(newPersonItem);

      personEditor.addListener(new EditorSavedListener() {
```

The PersonEditor is described in more detail in Section 6.3: *Editing an Item in a PersonEditor*.

Adding an Entity to the JPAContainer

When saved, the edited new item is taken out of the **BeanItem** wrapper and added to the **JPAContainer<Person>** with the *addEntity()* method.

```
          @Override
          public void editorSaved(EditorSavedEvent event) {
              persons.addEntity(newPersonItem.getBean());
          }
      });
      …
```

Once written in the container, the **Table** bound to the container is automatically updated to display the new item (notice that it is added to the end).

6.3. Editing an Item in a PersonEditor

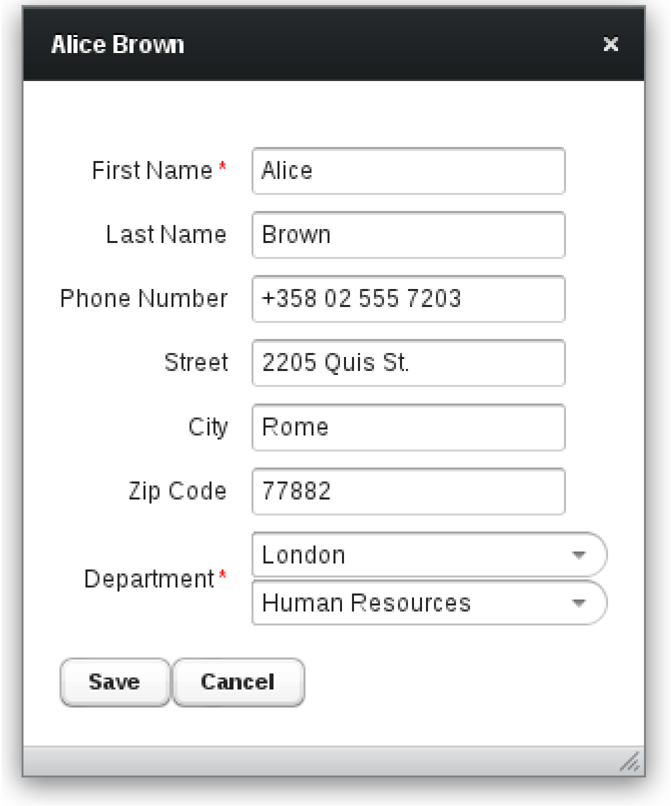
The **Edit** button is disabled by default and enabled when an item is selected in the table. When clicked, the **PersonEditor** is opened for editing the currently selected item:

```
editButton = new Button("Edit");
editButton.addListener(new Button.ClickListener() {
    @Override
    public void buttonClick(ClickEvent event) {
        getApplication().getMainWindow()
          .addWindow(new PersonEditor(
             personTable.getItem(personTable.getValue())));
    }
});
```

The *getValue()* returns the item identifier of the currently selected item (not the item itself) and *getItem()* returns the actual item using the ID. Notice that the JPA entity ID of the **Person** entity is used also as the item identifier.

PersonEditor

The **PersonEditor** is a sub-window that contains a **Form** for editing a **Person** item.


Alice Brown

First Name *	Alice
Last Name	Brown
Phone Number	+358 02 555 7203
Street	2205 Quis St.
City	Rome
Zip Code	77882
Department *	London
	Human Resources

Figure 13: The PersonEditor

The **PersonEditor** is a sub-window that extends the **Window**. It also handles button clicks and creates the field components for the form.

```
public class PersonEditor extends Window
        implements Button.ClickListener, FormFieldFactory {
    private final Item personItem;
    private Form editorForm;
    private Button saveButton;
    private Button cancelButton;
```

The item to edit is given to the constructor as a parameter. When editing an existing item with the **Edit** button, the item is an **EntityItem<Person>**. When editing a new item added with the **Add** button, the item is a temporary **BeanItem<Person>** wrapper, as the person is not yet added to the **JPAContainer**.

```
    public PersonEditor(Item personItem) {
        this.personItem = personItem;
```

We use a **BeanValidationForm** from the Vaadin BeanValidation add-on to edit the item. We enable buffering by calling *setWriteThrough(false)*, because otherwise the edited values would be written directly to the **JPAContainer**. With buffering, they are written only after *commit()* is called.

```
        editorForm =
            new BeanValidationForm<Person>(Person.class);
        editorForm.setFormFieldFactory(this);
        editorForm.setWriteThrough(false);
        editorForm.setImmediate(true);
```

And finally, we bind the person item to the form:

```
        editorForm.setItemDataSource(personItem,
            Arrays.asList("firstName", "lastName",
            "phoneNumber", "street", "city", "zipCode",
            "department"));
        …
```

Saving the Form

When the **Save** button is clicked, the buffered form is written to the underlying data model by calling *commit()*. In case of editing an existing item, the data is written directly to the **JPAContainer<Person>** and to the database. If editing a new item added with the **Add** button, the data is written to the **BeanItem<Person>**.

```
@Override
public void buttonClick(ClickEvent event) {
    if (event.getButton() == saveButton) {
        editorForm.commit();
```

Then an **EditorSavedEvent** is fired, to be received in an **EditorSavedListener**, as described in Section 6.2: *Creating an Item*. This allows the **Add** button mechanism to move the new **Person** object from the **BeanItem<Person>** to the **JPAContainer<Person>**.

```
        fireEvent(new EditorSavedEvent(this, personItem));
    } else if (event.getButton() == cancelButton) {
```

Otherwise, just discard the form. Then, close the sub-window.

```
        editorForm.discard();
    }
    close();
}
```

6.4. Deleting an Item

Deleting an item is done simply with the *removeItem()* method.

```
deleteButton = new Button("Delete");
deleteButton.addListener(new Button.ClickListener() {
    @Override
    public void buttonClick(ClickEvent event) {
        persons.removeItem(personTable.getValue());
    }
});
deleteButton.setEnabled(false);
```

The *getValue()* returns the item identifier of the currently selected item (not the item itself) and *removeItem()* removes the item with the ID. Notice that the JPA entity ID of the **Person** entity is used also as the item identifier.

7. Presenting Hierarchical Data

This chapter describes how to bind **JPAContainer** to a hierarchical component, such as a **Tree** or **TreeTable**.

7.1. JPAContainer is Hierarchical

JPAContainer implements the **HierarchicalEntityContainer** interface, which extends the **Container.Hierarchical** interface that defines hierarchical representation of data in a **Container**. You can bind any such container to a **Tree** or a **TreeTable**.

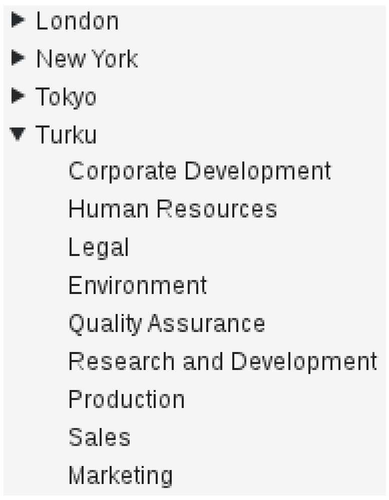


Figure 14: Tree Bound to a Hierarchical JPAContainer<Department>

The **HierarchicalEntityContainer** requires that the hierarchy is represented by parent references in the entities. Recall from the Chapter 4: *Defining a Domain Model* that the **Department** entity contains an *«is part of»* relationship with itself, represented with a *parent* property. The relationship is shown in Figure 15.

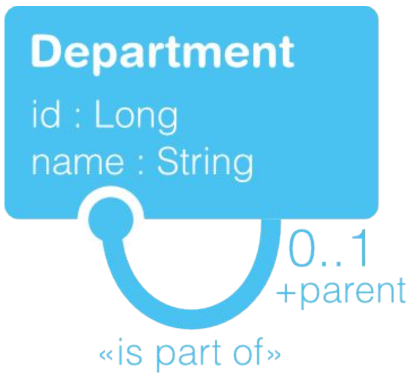


Figure 15: Hierarchy Representation in the Domain Model

7.2. Defining Hierarchy Relationship

The hierarchy relationships for the **JPAContainer<Department>** are defined by extending it as **HierarchicalDepartmentContainer** that makes the necessary settings.

7.2.1. Setting the Parent Reference Property

The property representing the hierarchy by parenthood is defined with the *setParentProperty()* method. In our domain model, the property name is coincidentally "`parent`".

```
public class HierarchicalDepartmentContainer
       extends JPAContainer<Department> {

    public HierarchicalDepartmentContainer() {
        super(Department.class);

        …

        setParentProperty("parent");
    }
    …
```

7.2.2. Redefining the areChildrenAllowed() Behaviour

The class overrides the *areChildrenAllowed()* method to customize the logic for when children are allowed, that is, when the expansion marker is shown. We want to have only the non-leaf items expandable in the tree. Children are therefore allowed only for the root items, that is, the "super departments" having the `superDepartment` property as `true`.

```
@Override
public boolean areChildrenAllowed(Object itemId) {
    return super.areChildrenAllowed(itemId) &&
           getItem(itemId).getEntity()
               .isSuperDepartment();
}
```

The *areChildrenAllowed()* in the **JPAContainer** superclass should be called to make basic checks.

7.3. Creating Hierarchical Entities

The **Department** entities are created in the **DemoDataGenerator** by writing directly to the JPA **EntityManager**, so that we do not use JPAContainer for this at all. We simply use the *setParent()* for the children to set the hierarchy relationship.

```
em.getTransaction().begin();
Random r = new Random(0);
for (String o : officeNames) {
    Department geoGroup = new Department();
    geoGroup.setName(o);
```

```
      for (String g : groupsNames) {
        Department group = new Department();
        group.setName(g);

        … add persons to the group …

        group.setParent(geoGroup);
        group.setPersons(gPersons);
        em.persist(group);
    }
    em.persist(geoGroup);
}

em.getTransaction().commit();
```

8. Filtering Data

This step describes how to create filters for a **JPAContainer**.

8.1. Overview

The JPAContainer AddressBook demo provides two different ways to filter the persons in the **JPAContainer<Person>** container, attached to the **Table**. First, the user can select a department from the tree on the left, in which case the persons are filtered by the department (or the super-department) they belong to. Second, the use can do text search to filter persons by their name property.

Filtering a **JPAContainer** does not differ significantly from regular container filtering described in the section Filterable Containers in the Book of Vaadin.

8.2. Filtering by Entity

Filtering persons by a department is done with a **Department** object stored as a member variable in the **AddressBookMainView**:

```
private Department departmentFilter;
```

8.2.1. Setting the Filter

Selecting an item in the department tree fires a value change event, which we handle to set the department filter.

```
groupTree = new Tree(null, departments);
groupTree.setItemCaptionPropertyId("name");
groupTree.setImmediate(true);
groupTree.setSelectable(true);
groupTree.addListener(new Property.ValueChangeListener() {
    @Override
    public void valueChange(ValueChangeEvent event) {
        Object id = event.getProperty().getValue();
        if (id != null) {
```

Now, we can get the selected item from the container with *getItem()*, which returns an **EntityItem<Department>** wrapper. We can get a **Department** object reference with *getEntity()*.

```
            Department entity =
                    departments.getItem(id).getEntity();
```

Then, we just set the filter and apply the filters in *updateFilters()*.

```
            departmentFilter = entity;
        } else if (departmentFilter != null) {
            departmentFilter = null;
        }
        updateFilters();
    }
```

```
});
```

8.2.2. Adding and Applying the Filter

The *updateFilters()* applies the department filter (as well as the other filter). We first clear up any existing filters and disable the **JPAContainer<Person>** automatic applying of filters immediately when they are added. As applying a filter takes a bit time and we have two filters, we want to apply them both at once.

```
private void updateFilters() {
    persons.setApplyFiltersImmediately(false);
    persons.removeAllContainerFilters();
```

As we have a two-level department hierarchy, we need to handle the cases for a department and super-department separately.

```
    if (departmentFilter != null) {
        // two level hierarchy at max in our demo
        if (departmentFilter.getParent() == null) {
            persons.addContainerFilter(
                    new Equal("department.parent",
                              departmentFilter));
        } else {
            persons.addContainerFilter(
                    new Equal("department",
                              departmentFilter));
        }
    }
    …
```

The **Equal** constructor creates a filter that compares a container property in the **JPAContainer<Person>** to a value. The value of the `department` property of a **Person** bean is a **Department** object, so we can compare it to the stored filter object.

The **Equal** filter allows referencing nested bean properties with dot notation, so we were able to refer to the `parent` property in the **Department** bean.

It is important to notice that even though the **JPAContainer<Department>** and **JPAContainer<Person>** were created separately using the entity manager, the **Department** entities referenced in the **Person** container are the same objects as in the **Department** container.

Applying the Filters

The filters are applied at the end of the *updateFilters()* method as follows:

```
persons.applyFilters();
```

Notice that this applies also the text filter described next.

8.3. Filtering by a String Property Value

Filtering persons by a text filter is done with string stored as a member variable in the **AddressBookMainView**:

```
private String textFilter;
```

The search field is a **TextField** and the input is handled interactively with a text change listener. It simply stores the current input value in the filter string as follows:

```
searchField = new TextField();
searchField.setInputPrompt("Search by name");
searchField.addListener(new TextChangeListener() {
    @Override
    public void textChange(TextChangeEvent event) {
        textFilter = event.getText();
        updateFilters();
    }
});
```

We use the filter string in a composite filter that checks whether the filter string matches the beginning of either `firstName` or `lastName` of a **Person** entity.

```
if (textFilter != null && !textFilter.equals("")) {
    Or or = new Or(new Like("firstName",
                        textFilter + "%", false),
                   new Like("lastName",
                        textFilter + "%", false));
    persons.addContainerFilter(or);
}
```

The filter is applied along with the department filter as described earlier.

9. Vaadin Bean Validation

This chapter describes the bean validation in the JPAContainer AddressBook Demo.

9.1. Overview

The AddressBook Demo uses the *Vaadin Bean Validation add-on* for validating the beans after editing, before they are committed to the database.

The Vaadin Bean Validation add-on consists of a Vaadin validator and a form that automatically applies that validator. It uses the Java Bean Validation API 1.0 (JSR-303) for validating beans based on annotations on their fields.

To use the add-on, the project needs an implementation of the Bean Validation API. In our example project, we use the *Hibernate Validator*.

9.2. Annotations

The validations constraints are defined in the entity classes as annotations. For example, in the **Person** class, we use the `@NotNull` and `@Size` constraints for some of the bean properties.

```
@Entity
public class Person {
    …
    @NotNull
    @Size(min = 2, max = 24)
    private String firstName;
    @Size(min = 2, max = 24)
    private String lastName;
    …
    @NotNull
    @ManyToOne
    private Department department;
    …
```

For a complete list of allowed constraints for different data types, please see the Bean Validation API documentation.

9.3. Using the Validator

The Bean Validation is used by using the **BeanValidationForm<>** instead of the regular form. The constructor of the generic type requires the bean type as a parameter.

```
public PersonEditor(Item personItem) {
    this.personItem = personItem;
    editorForm =
        new BeanValidationForm<Person>(Person.class);
        ...
```

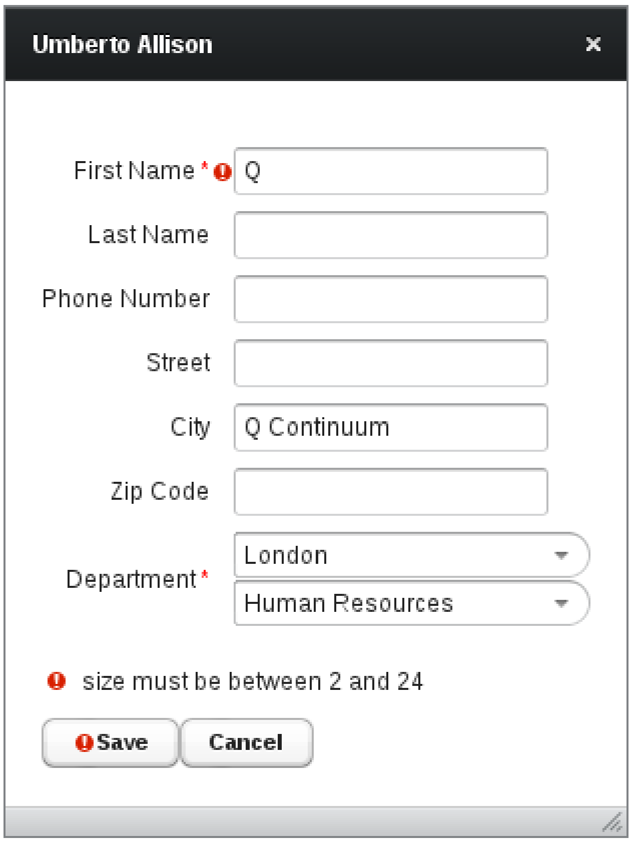
After that, using bean validation is totally transparent as the **BeanValidationForm** attaches special bean validators to field as they are attached to the form.

9.3.1. Doing Validation

The validators are checked along with possible other validators when *commit()* or *validate()* is called for the form. In the **PersonEditor** we run *commit()* simply as follows:

```
public void buttonClick(ClickEvent event) {
    if (event.getButton() == saveButton) {
        editorForm.commit();
        fireEvent(new EditorSavedEvent(this, personItem));
    } else if (event.getButton() == cancelButton) {
        editorForm.discard();
    }
    close();
}
```

Bean validation is shown in action in Figure 16. Failing validation results in an error message.


Umberto Allison

First Name *	Q
Last Name	
Phone Number	
Street	
City	Q Continuum
Zip Code	
Department *	London
	Human Resources

size must be between 2 and 24

Figure 16: Bean Validation

9.3.2. Locale Setting for Bean Validation

The messages are defined in the bean validation implementation, in a `ValidationMessages.properties` file. The message is shown in the language specified with the locale setting for the form. The default language is English, but Hibernate Validator contains translations of the messages for a number of languages. If other languages are needed, you need to provide a translation of the properties file.