Jakarta Enterprise Edition Your First Cup

An Introduction to Jakarta EE, Release 8

Table of Contents

Jakarta Enterprise Edition

Your First Cup: An Introduction to Jakarta EE

Release 8

Contributed 2018, 2019

Jakarta Enterprise Edition Your First Cup: An Introduction to Jakarta EE, Release 8

Preface

This documentation is part of the Java Enterprise Edition contribution to the Eclipse Foundation and is not intended for use in relation to Java Enterprise Edition or Orace GlassFish. The documentation is in the process of being revised to reflect the new Jakarta EE branding. Additional changes will be made as requirements and procedures evolve for Jakarta EE. Where applicable, references to Java EE or Java Enterprise Edition should be considered references to Jakarta EE.

Please see the Title page for additional license information.

This is Your First Cup: An Introduction to Jakarta Platform, Enterprise Edition, a short tutorial for beginning Jakarta EE programmers. This tutorial is designed to give you a hands-on lesson on developing an enterprise application from initial coding to deployment.

Audience

This tutorial is intended for novice Jakarta EE developers. You should be familiar with the Java programming language, particularly the features introduced in Java Platform, Standard Edition 8. While familiarity with enterprise development and Jakarta EE technologies is helpful, this tutorial assumes you are new to developing Jakarta EE applications.

Before You Read This Book

Before you start this tutorial, you should:

- Be familiar with the Java programming language
- Be able to install software on your work machine
- Have a modern web browser installed on your work machine

Related Books and Projects

The following books and projects may be helpful to you in understanding this tutorial:

- The Jakarta EE Tutorial
- The GlassFish Server Open Source Edition documentation set
- The NetBeans IDE documentation

Conventions

The following table describes the typographic conventions that are used in this book.

Convention	Meaning	Example
Boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text.	From the **File** menu, select **New Project**. A **cache** is a copy that is stored locally.
`Monospace`	Monospace type indicates the names of files and directories, commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.	Edit your `.login` file. Use `ls -a` to list all files. `machine_name% you have mail.`
Italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.	The command to remove a file is `rm filename`. Read Chapter 6 in the *User's Guide*. Do *not* save the file.

1 Introduction

This chapter outlines the goals and the prerequisites for completing this tutorial.

Goals of This Tutorial

At the completion of this tutorial, you will:

- Understand the basics of tiered applications
- Understand the basics of the Jakarta EE platform
- Have created a multitiered Jakarta EE application
- Have deployed and run your application on a Jakarta EE server
- Know where to go next for more information on the Jakarta EE platform

Prerequisite Tasks for Completing This Tutorial

To complete this tutorial, you need to complete the following tasks first:

- See the software compatibility notice
- Get the Jakarta EE 8 SDK
- Install the NetBeans IDE distribution for Java EE
- Add GlassFish Server as a server in NetBeans IDE

Software Compatibility Notice

This tutorial is compatible with the following software:

Software	Version
Java Development Kit (JDK)	8 update 144 (8u144) or greater
GlassFish Server	5.0 or greater
NetBeans IDE	8.2 or greater
Eclipse IDE	4.7.0 or greater

Get the Jakarta EE 8 SDK

To get the Jakarta EE 8 SDK, go to `http://www.oracle.com/technetwork/java/jakartaee/downloads/`. Download and install the SDK. The location where you install it is typically `glassfish5` in your home directory, but you can change this.

The tutorial is installed in the `docs/firstcup` directory of your SDK installation.

Install the NetBeans IDE Distribution for Java EE

To get NetBeans IDE, go to `https://netbeans.org/downloads/` and download the Java EE distribution. Install this distribution.

Add GlassFish Server as a Server in NetBeans IDE

Once you have all the necessary downloads, you must configure NetBeans IDE and get the latest tutorial updates.

To run this tutorial in NetBeans IDE, you must register your GlassFish Server installation as a NetBeans server instance. Follow these instructions to register the GlassFish Server in NetBeans IDE.

1. From the **Tools** menu, select **Servers**.
2. In the Servers dialog, click **Add Server**.
3. Under **Choose Server**, select **GlassFish Server** and click **Next**.
4. Under **Server Location**, browse to or enter the location of your GlassFish Server installation.
5. Click **Next**.
6. Under **Domain Location**, select the default domain, `domain1`.
7. Click **Finish**.

2 Understanding Jakarta Platform, Enterprise Edition

This chapter describes the basic concepts behind enterprise application development and examines how an application server is the sum of its Jakarta EE containers.

Overview of Enterprise Applications

This section describes enterprise applications and how they are designed and developed.

As stated above, the Jakarta EE platform is designed to help developers create large-scale, multitiered, scalable, reliable, and secure network applications. A shorthand name for such applications is **enterprise applications**, so called because these applications are designed to solve the problems encountered by large enterprises. Enterprise applications are not only useful for large corporations, agencies, and governments, however. The benefits of an enterprise application are helpful, even essential, for individual developers and small organizations in an increasingly networked world.

The features that make enterprise applications powerful, like security and reliability, often make these applications complex. The Jakarta EE platform reduces the complexity of enterprise application development by providing a development model, API, and runtime environment that allow developers to concentrate on functionality.

Tiered Applications

In a multitiered application, the functionality of the application is separated into isolated functional areas, called tiers. Typically, multitiered applications have a client tier, a middle tier, and a data tier (often called the enterprise information systems tier). The client tier consists of a client program that makes requests to the middle tier. The middle tier is divided into a web tier and a business tier, which handle client requests and process application data, storing it in a permanent data store in the data tier.

Jakarta EE application development concentrates on the middle tier to make enterprise application management easier, more robust, and more secure.

The Client Tier

The client tier consists of application clients that access a Jakarta EE server and that are usually located on a different machine from the server. The clients make requests to the server. The server processes the requests and returns a response back to the client. Many different types of applications can be Jakarta EE clients, and they are not always, or even often, Java applications. Clients can be a web browser, a standalone application, or other servers, and they run on a different machine from the Jakarta EE server.

The Web Tier

The web tier consists of components that handle the interaction between clients and the business tier. Its primary tasks are the following:

- Dynamically generate content in various formats for the client
- Collect input from users of the client interface and return appropriate results from the components in the business tier
- Control the flow of screens or pages on the client
- Maintain the state of data for a user’s session
- Perform some basic logic and hold some data temporarily in managed beans

Table 2-1 lists some of the main Jakarta EE technologies that are used in the web tier in Jakarta EE applications.

Table 2-1 Web-Tier Jakarta EE Technologies

Technology	Purpose
JavaServer Faces technology	A user interface component framework for web applications that allows you to include UI components (such as fields and buttons) on a XHTML page, called a Facelets page; convert and validate UI component data; save UI component data to server-side data stores; and maintain component state
Expression Language	A set of standard tags used in Facelets pages to refer to Jakarta EE components
Servlets	Java programming language classes that dynamically process requests and construct responses, usually for HTML pages
Contexts and Dependency Injection for Java EE	A set of contextual services that make it easy for developers to use enterprise beans along with JavaServer Faces technology in web applications

The Business Tier

The business tier consists of components that provide the business logic for an application. Business logic is code that provides functionality to a particular business domain, like the financial industry, or an e-commerce site. In a properly designed enterprise application, the core functionality exists in the business tier components.

The following Jakarta EE technologies are among those that are used in the business tier in Jakarta EE applications:

- Enterprise JavaBeans (enterprise bean) components
- JAX-RS RESTful web services
- Java Persistence API entities

The Enterprise Information Systems Tier

The enterprise information systems (EIS) tier consists of database servers, enterprise resource planning systems, and other legacy data sources, like mainframes. These resources typically are located on a separate machine from the Jakarta EE server, and are accessed by components on the business tier.

The following Jakarta EE technologies are used to access the EIS tier in Jakarta EE applications:

- The Java Database Connectivity API (JDBC)
- The Java Persistence API
- The Jakarta EE Connector Architecture
- The Java Transaction API (JTA)

Jakarta EE Servers and Containers

A Jakarta EE server is a server application that implements the Jakarta EE platform APIs and provides standard Jakarta EE services. Jakarta EE servers are sometimes called application servers, because they allow you to serve application data to clients, much as web servers serve web pages to web browsers.

Jakarta EE servers host several application component types that correspond to the tiers in a multitiered application. The Jakarta EE server provides services to these components in the form of a container.

Jakarta EE containers are the interface between the component and the lower-level functionality provided by the platform to support that component. The functionality of the container is defined by the platform and is different for each component type. Nonetheless, the server allows the different component types to work together to provide functionality in an enterprise application.

The Web Container

The web container is the interface between web components and the web server. A web component can be a servlet or a JavaServer Faces Facelets page. The container manages the component's life cycle, dispatches requests to application components, and provides interfaces to context data, such as information about the current request.

The EJB Container

The EJB container is the interface between enterprise beans, which provide the business logic in a Jakarta EE application, and the Jakarta EE server. The EJB container runs on the Jakarta EE server and manages the execution of an application's enterprise beans.

The Application Client Container

The application client container is the interface between Jakarta EE application clients (special Java SE applications that use Jakarta EE server components) and the Jakarta EE server. The application client container runs on the client machine and is the gateway between the client application and the Jakarta EE server components that the client uses.

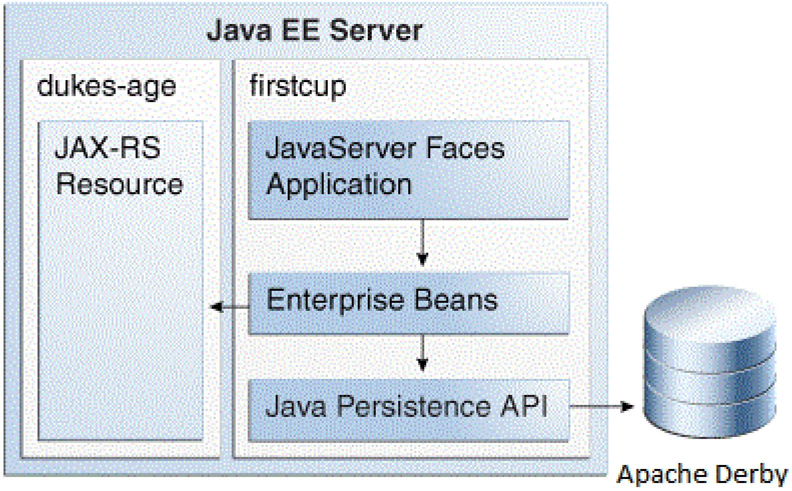
3 Creating Your First Jakarta EE Application

This chapter gives an overview of the example applications and step-by-step instructions on coding and running the `dukes-age` web service example application.

Architecture of the Example Applications

The example applications consist of four main components: `DukesAgeResource`, a JAX-RS RESTful web service; `DukesBirthdayBean`, an enterprise bean; `FirstcupUser`, a Java Persistence API entity; and `firstcup-war`, a web application created with JavaServer Faces Facelets technology.

Figure 3-1 Architecture of the First Cup Example Applications



`DukesAgeResource` is a JAX-RS resource that calculates the age of Duke, the Java mascot. Duke was born May 23, 1995, when the first demo of Java technology was publicly released.

`DukesBirthdayBean` is a local, no-interface view stateless session bean that calculates the difference between the user's age and Duke's age and stores the user-submitted data in a Java Persistence API entity.

`FirstcupUser` is a Java Persistence API entity that represents a particular user's birthday. It is stored in an Apache Derby table and managed by the `DukesBirthdayBean` business methods.

The `firstcup-war` web application is a JavaServer Faces Facelets application that accesses `DukesAgeResource` to display Duke's age, reads in a date provided by the user, accesses `DukesBirthdayBean` to calculate who is older, and then displays the difference in years between the user and Duke and the average age difference of all users.

The `firstcup-war` web application consists of the following:

- `greeting.xhtml`: A Facelets-enabled XHTML page, which is a page that uses the JavaServer Faces Facelets tag libraries. Users can type their birth date in a field and submit it for comparison against Duke's birth date.
- `response.xhtml`: A Facelets-enabled XHTML page that tells the user whether he or she is older or younger than Duke, based on the date the user entered in the `greeting.xhtml` page, and displays the average age difference of all users.
- `DukesBDay.java`: A CDI managed bean that defines properties to hold the user's birth date, uses the

JAX-RS Client API to get Duke's current age from the `DukesAgeResource` web service, and calculates the age difference between the user and Duke from the enterprise bean.

- `web.xml`: The web application's deployment descriptor, which is used to configure certain aspects of a web application when it is installed. In this case, it is used to provide a mapping to the application's `FacesServlet` instance, which accepts incoming requests, passes them to the life cycle for processing, and initializes resources. It also specifies `greeting.xhtml` as the welcome file for the application.
- `WebMessages.properties` and `WebMessages_es.properties`: Java programming language properties files that contain the localized strings used in `greeting.xhtml` and `response.xhtml`. By default, the English language strings in `WebMessages.properties` are used, but Spanish language strings are also provided in `WebMessages_es.properties`.
- `DukesBirthdayBean.java`: as described above, the enterprise bean packaged within the `firstcup-war` application. `DukesBirthdayBean` calculates the difference between the user's birthday and Duke's birthday.

Tiers in the Example Applications

The example applications have a web tier component (the `firstcup-war` web client), three business tier components (the `DukesAgeResource` web service, the `FirstcupUser` entity, and the `DukesBirthdayBean` enterprise bean), and an enterprise information system (EIS) tier (the data in the Apache Derby database table). The user's web browser is the client tier component, as it accesses the rest of the application through the web tier.

Jakarta EE Technologies Used in the Example Applications

The `DukesAgeResource` web service is a JAX-RS resource. The `DukesBirthdayBean` enterprise bean is a stateless session bean. The `FirstcupUser` entity is a Java Persistence API entity. The `DukesBDay` CDI managed bean uses the JAX-RS client API to access the `DukesAgeResource` web service. The `firstcup-war` web client is a JavaServer Faces application that runs in the web container of the Java EE server.

Coding the dukes-age Example Application

This section describes how to code the `dukes-age` example application, a web application containing a JAX-RS RESTful web service endpoint.

Getting Started

Before you start coding the example, you need to perform some configuration tasks:

1. Register the server with your NetBeans IDE as described in Add GlassFish Server as a Server in NetBeans IDE.
2. Install the Maven archetypes used to create the example applications.

Install the Maven Archetypes

Maven archetypes are templates that create the structure of a particular application. There are two archetypes included in the example, `dukes-age-archetype` and `firstcup-war-archetype`. These archetypes create Jakarta EE 8 web applications that you will then edit and deploy.

Before you can create applications based on the archetypes, you must first install the archetypes and supporting projects to your local Maven repository by following these steps:

1. In NetBeans IDE select **File**, then **Open Project**, navigate to the location where you installed the tutorial (usually `glassfish5/docs/firstcup`), select `example`, deselect the **Open Required Projects** check box, and click **Open Project**.
2. Right-click the `firstcup` project in the Projects pane and select **Build**.

The required projects, including the archetypes, will be built.

Creating the Web Service

The `DukesAgeResource` endpoint is a simple RESTful web service. REST stands for *representational state transfer*, and software architectures that conform to the principles of REST are referred to as *RESTful*. RESTful web services are web-based applications that use the HTTP protocol to access, modify, or delete information contained within a *resource*. A RESTful web service resource is a source of specific information identifiable by a uniform resource identifier (URI), for example `http://example.com/someResource`, and may be manipulated by calling the HTTP protocol's methods, for example GET or POST.

Web services are designed to be independent of their clients. Typically RESTful web services are publicly available to a wide variety of clients, and the clients are located throughout the Internet. This is called "loose coupling", because the clients and servers are connected only by the standard HTTP-based requests and responses, and do not need to know each other’s implementation details. For this reason, `dukes-age` will be developed in its own application module and deployed separately from the `DukesBirthdayBean` enterprise bean and `firstcup-war` web client. The `dukes-age` web application could be deployed on a completely different machine without affecting the functionality of the `firstcup-war` web client.

JAX-RS Resources

The `DukesAgeResource` class is a JAX-RS resource class that responds to HTTP GET requests and returns a `String` representing the age of Duke at the time of the request.

The basic `DukesAgeResource` resource class is generated from the `dukes-age-archetype` Maven archetype. This class is annotated with the `javax.ws.rs.Path` annotation, which specifies the URL suffix to which the resource will respond. The `DukesAgeResource` class has a single method, `getText`, annotated with the `javax.ws.rs.GET` and `javax.ws.rs.Produces` annotations. The `@GET` annotation marks the method as a responder to HTTP GET requests, and `@Produces` specifies the MIME-type of the response sent back from `getText` to clients. In this case, the MIME-type is `text/plain`.

Creating the dukes-age Application Using the Maven Archetype

In NetBeans IDE, create a new web project using the `dukes-age-archetype` Maven archetype.

Create the Project in NetBeans IDE

1. From the **File** menu, select **New Project**.
2. Under **Categories**, select **Maven**.
3. Under **Projects**, select **Project from Archetype**.
4. Click **Next**.
5. In the **Search** field, enter `dukes-age`.
6. In the **Known Archetypes** field, select `dukes-age-archetype`.
7. Click **Next**.
8. In the **Project Name** field, enter `dukes-age`.
9. In the **Package** field, enter `firstcup.dukesage.resource`.
10. Click **Finish**.

    You should now see the module you created in the Projects tab. The project is created in the

`NetBeansProjects` directory under your home directory.

The `dukes-age-archetype` archetype creates the structure of the JAX-RS endpoint application, including:

- The `DukesAgeResource` resource class
- The `web.xml` deployment descriptor

After you create the basic application structure with the archetype, you will configure how the application will run, implement the functionality of the resource class, and then deploy the application.

Configure the dukes-age Web Application

Set the default URL that is brought up in a web browser when you run `dukes-age`.

1. In the **Projects** tab, right-click the `dukes-age` project and select **Properties**.
2. Under **Categories**, click **Run**.
3. Under **Server**, select the GlassFish Server instance you configured.
4. Under **Relative URL** enter `/webapi/dukesAge`.
5. Click **OK**.

Implement the getText Method

Add code to `DukesAgeResource.getText` that calculates Duke's age at the time of the request. To do this, use the `java.util.Calendar` and `java.util.GregorianCalendar` classes to create an object representing the date May 23, 1995, Duke's birthday. Then create another `Calendar` object representing today's date, and subtract today's year from Duke's birth year. If today's date falls before May 23, subtract a year from this result. Then return the result as a `String` representation.

1. Expand the **Source Packages** node, expand the `firstcup.dukesage.resource` node, then double-click the `DukesAgeResource.java` file to open it in the editor window.
2. Highlight the current code in `getText` and replace it with the following code:

```
// Create a new Calendar for Duke's birthday
Calendar dukesBirthday = new GregorianCalendar(1995, Calendar.MAY, 23);
// Create a new Calendar for today
Calendar now = GregorianCalendar.getInstance();

// Subtract today's year from Duke's birth year, 1995
int dukesAge = now.get(Calendar.YEAR) - dukesBirthday.get(Calendar.YEAR);
dukesBirthday.add(Calendar.YEAR, dukesAge);

// If today's date is before May 23, subtract a year from Duke's age
if (now.before(dukesBirthday)) {
    dukesAge--;
}
// Return a String representation of Duke's age
return "" + dukesAge;
```

3. In the editor window, right-click and select **Format**.
4. From the **File** menu, select **Save** to save the file.

Starting GlassFish Server and the Database Server

Follow these steps to start GlassFish Server and Apache Derby.

1. Click the **Services** tab.
2. Expand **Servers**.
3. Right-click the GlassFish Server instance and select **Start**.

   Both the database server and the GlassFish Server instance will start. In the tab where the GlassFish Server instance is running, you can see the contents of the server log.

Building and Deploying the Web Service Endpoint

Build `dukes-age.war`, the JAX-RS web application, and deploy it to your GlassFish Server instance.

In the **Projects** tab, right-click `dukes-age` and select **Run**.

After `dukes-age.war` deploys successfully to GlassFish Server, a web browser will load the URL of the `DukesAgeResource` path, and you'll see the returned `String` representing Duke's age.

At this point, you've successfully created, deployed, and run your first Jakarta EE application. Now you will create a web application that uses this web service data.

4 Creating Your Second Web Application

This chapter gives step-by-step instructions on coding and running the `firstcup-war` web application, which uses the `dukes-age` web service described in Chapter 3, "Creating Your First Jakarta EE Application". The `firstcup-war` web application is a more complicated application that uses several different Jakarta EE APIs.

The firstcup-war Project

The `firstcup-war` web application project consists of the Java Persistence API entity, the enterprise bean, and the JavaServer Faces web front end.

The `firstcup-war` example application consumes the data from the `dukes-age` web service using the JAX-RS client API. A JavaServer Faces web front end asks users to enter their birthdays to find out who is older, the user or Duke. This data is stored in an Apache Derby database table using the Java Persistence API. The business logic, which provides the core functionality of the application, is handled by an enterprise bean.

All the tiers described in Tiered Applications are present in the `firstcup-war` web application. The web or client tier is the JavaServer Faces front end. The enterprise information systems, or EIS, tier is the Derby database. The business tier is the enterprise bean.

Creating the Web Application Project Using the Archetype

Follow these steps to create a new web application project using the `firstcup-war-archetype` in NetBeans IDE.

1. From the **File** menu, select **New Project**.
2. Under **Projects**, select **Project from Archetype**.
3. Click **Next**.
4. In the **Search** field, enter `firstcup`.
5. In the **Known Archetypes** field, select `firstcup-war-archetype`.
6. Click **Next**.
7. In the **Project Name** field, enter `firstcup-war`.
8. In the **Package** field, enter `firstcup`.
9. Click **Finish**.

   You should now see the module you created in the **Projects** tab.

The `firstcup-war-archetype` archetype creates the structure of the web application, including the following:

- Basic entity classes
- Basic enterprise bean classes
- Basic backing bean classes
- Basic Facelets XHTML components and views
- The `web.xml`, `faces-config.xml`, and `persistence.xml` deployment descriptors

After you create the basic application structure with the archetype, you will configure how the application will run, implement the functionality of the classes, implement the Facelets views, and then deploy the application.

Modifying the Java Persistence API Entity

The Java Persistence API allows you to create and use Java programming language classes that represent data in a database table. A Java Persistence API *entity* is a lightweight, persistent Java programming language object that represents data in a data store. To create or modify entities, or to remove them from the data store, call the operations of the Java Persistence API *entity manager*. To query entities, or to query the data encapsulated by the persistent fields or properties of a entity, use the Java Persistence Query Language (JPQL), a language similar to SQL that operates on entities.

In `firstcup-war`, there is a single entity that defines one query.

Edit the Constructor of the FirstcupUser Entity

Add code to the constructor for `FirstcupUser`.

1. Expand the **Source Packages** node, expand the `firstcup.entity` node, then double-click the `FirstcupUser.java` file to open it in the editor window.
2. Below the field definitions in the `FirstcupUser` class, add the following code in bold to the second, two-argument constructor:

```
    public FirstcupUser(Date date, int difference) {
        Calendar cal = new GregorianCalendar();
        cal.setTime(date);
        birthday = cal;
        ageDifference = difference;
    }
```

3. Right-click in the editor window and select **Format**.

Add a Named Query to the FirstcupUser Entity

Add a JPQL named query to the `FirstcupUser` entity that returns the average age difference of all `firstcup-war` users.

This query uses the `AVG` aggregate function to return the average of all the values of the `ageDifference` property of the `FirstcupUser` entities.

1. Directly before the class definition, copy and paste in the following code:

```
@NamedQuery(name="findAverageAgeDifferenceOfAllFirstcupUsers",
query="SELECT AVG(u.ageDifference) FROM FirstcupUser u")
```

The `@NamedQuery` annotation appears just before the class definition of the entity and has two required attributes: `name`, with the unique name for this query; and `query`, the JPQL query definition.

2. Right-click in the editor window and select **Format**.
3. From the **File** menu, select **Save**.

Modifying the Enterprise Bean

`DukesBirthdayBean` is a *stateless session bean*. Stateless session beans are enterprise beans that do not maintain a conversational state with a client. With stateless session beans, the client makes isolated requests that do not depend on any previous state or requests. If an application requires conversational state, use *stateful session beans*.

`DukesBirthdayBean` is a local enterprise bean that uses a no-interface view:

- A *local enterprise bean* is visible only within the application in which it is deployed.
- Enterprise beans with a *no-interface* view do not need a separate business interface that the enterprise bean class implements. The enterprise bean class is the only coding artifact needed to create a local, no-interface enterprise bean.

`DukesBirthdayBean` will be packaged within the same WAR file as the Facelets web front end.

Implement a Business Method to DukesBirthdayBean that Gets the Average Age Difference of firstcup-war Users

Add code to a business method to the `DukesBirthdayBean` session bean to call the `findAverageAgeDifferenceOfAllFirstcupUsers` named query in `FirstcupUser` that returns the average age difference of all users.

1. Expand the **Source Packages** node, expand the `firstcup.ejb` node, then double-click the `DukesBirthdayBean.java` file to open it in the editor window.
2. Find the business method called `getAverageAgeDifference` and add the following code in bold by copying and pasting:

```
public Double getAverageAgeDifference() {
    Double avgAgeDiff = (Double)
        em.createNamedQuery("findAverageAgeDifferenceOfAllFirstcupUsers")
                            .getSingleResult();
    logger.log(Level.INFO, "Average age difference is: {0}",  avgAgeDiff);
    return avgAgeDiff;
}
```

   The named query in `FirstcupUser` is called by using the `createNamedQuery` method in `EntityManager`. Because this query returns a single number, the `getSingleResult` method is called on the returned `Query` object. The query returns a `Double`.

3. Right-click in the editor window and select **Format**.

Implement a Business Method for Calculating the Age Difference Between Duke and the User

Add code to a business method that calculates the difference in age in years between Duke and the user and creates a new `FirstcupUser` entity.

1. Find the `getAgeDifference` business method and add the following code in bold:

```
public int getAgeDifference(Date date) {
    int ageDifference;

    Calendar theirBirthday = new GregorianCalendar();
    Calendar dukesBirthday = new GregorianCalendar(1995, Calendar.MAY, 23);

    // Set the Calendar object to the passed-in Date
    theirBirthday.setTime(date);

    // Subtract the user's age from Duke's age
    ageDifference = dukesBirthday.get(Calendar.YEAR)
            - theirBirthday.get(Calendar.YEAR);
    logger.log(Level.INFO, "Raw ageDifference is: {0}",  ageDifference);
    // Check to see if Duke's birthday occurs before the user's. If so,
    // subtract one from the age difference
    if (dukesBirthday.before(theirBirthday) && (ageDifference> 0)) {
        ageDifference--;
    }

    // Create and store the user's birthday in the database
    FirstcupUser user = new FirstcupUser(date, ageDifference);
    em.persist(user);

    logger.log(Level.INFO, "Final ageDifference is: {0}",  ageDifference);

    return ageDifference;
}
```

This method creates the `Calendar` objects used to calculate the difference in age between the user and Duke and performs the actual calculation of the difference in age.

Similar to the `DukesAgeResource.getText` code, `getAgeDifference` subtracts Duke's birthday year from the user's birthday year to get a raw age difference. If Duke's birthday falls before the user's, and the raw difference is more than 0, it subtracts one year from the age difference.

A new `FirstcupUser` entity is created with the user's birthday and age difference, then stored in Derby by calling the `persist` method in `EntityManager`.

The final age difference is returned as an `int`.

2. Right-click in the editor window and select **Format**.
3. From the **File** menu, choose **Save**.

Modifying the Web Client

To add the correct functionality to the web client, you need to perform the following tasks:

- Modify the `DukesBDay` managed bean class
- Modify the Facelets pages

Modify the DukesBDay Managed Bean Class

`DukesBDay` is a CDI managed bean that acts as a backing bean. A managed bean is a lightweight container-managed object that supports a set of basic services. A backing bean is a managed bean that provides temporary data storage for the values of the components included on a particular JavaServer Faces page. The JavaServer Faces application instantiates the managed bean and stores it in scope. The section following this one describes more about managed beans and how to configure them.

This section describes how to modify the `DukesBDay` class.

Call the dukes-age Web Service to Retrieve Duke’s Current Age

Now modify the `getAge` method of `DukesBDay` to call the `dukes-age` web service using the JAX-RS Client API. This will retrieve Duke’s current age, so it can be compared to the user’s age.

1. Expand the **Source Packages** node, expand the `firstcup.web` node, then double-click the `DukesBDay.java` file to open it in the editor window.
2. Find the `getAge` method and implement its functionality by copying and pasting the following code in bold:

```
public int getAge() {
    try {
        Client client = ClientBuilder.newClient();
        WebTarget target =
        client.target("http://localhost:8080/dukes-age/webapi/dukesAge");
        String response = target.request().get(String.class);
        age = Integer.parseInt(response);
    } catch (IllegalArgumentException | NullPointerException |
             WebApplicationException ex) {
        logger.severe("processing of HTTP response failed");
    }
    return age;
}
```

3. In the editor window, right-click and select **Format**.
4. From the **File** menu, select **Save**.

Get the Age Difference from the DukesBirthdayBean Enterprise Bean

Now modify the `processBirthday` method to get the difference in age between the user's age and Duke's age from the `DukesBirthdayBean` EJB, set the `absAgeDiff` variable to the absolute value of the age difference, and set a result string that will forward the user to the display page.

1. Find the `processBirthday` method and implement the functionality by copying and pasting the following code in bold:

   ```
   public String processBirthday() {
       this.setAgeDiff(dukesBirthdayBean.getAgeDifference(yourBD));
       logger.log(Level.INFO, "age diff from dukesbday {0}", ageDiff);
       this.setAbsAgeDiff(Math.abs(this.getAgeDiff()));
       logger.log(Level.INFO, "absAgeDiff {0}", absAgeDiff);
   this.setAverageAgeDifference(dukesBirthdayBean.getAverageAgeDifference());
   logger.log(Level.INFO, "averageAgeDifference {0}", averageAgeDifference);
       return "/response.xhtml";
   }
   ```

   This method calls the `getAgeDifference` method of `DukesBirthdayBean` to get the age difference and store it in the `ageDiff` property, sets the absolute age difference stored in the `absAgeDiff` property, and sets the average age difference stored in the `averageAgeDifference` property. It returns the relative URL of the response page to which the user will be forwarded.

2. In the editor window, right-click and select **Format**.
3. From the **File** menu, select **Save**.

Creating the Facelets Client

The Facelets client consists of a *resource library*, a *composite component*, and two XHTML files.

Resource Libraries in firstcup-war

A JavaServer Faces resource library is a collection of user-created components collected in a standard location in a web application. Resource libraries are identified according to a *resource identifier*, a string that represents a particular resource within a web application. Resources can be packaged either at the root of the web application or on the web application's classpath.

A resource packaged in the web application root must be in a subdirectory of a `resources` directory at the web application root.

```
resources/resource-identifier
```

A resource packaged in the web application classpath must be in a subdirectory of the `META-INF/resources` directory within a web application.

```
META-INF/resources/resource-identifier
```

Resource identifiers are unique strings that conform to the following format:

```
[locale-prefix/][library-name /]resource-name [/resource-version]
```

Elements of the resource identifier in brackets (`[]`) are optional. A resource name, identifying a particular resource (a file or a graphic, for example), is required. In `firstcup-war`, a resource library with the name `components` is packaged in the web application root, and this library contains one resource, a file called `inputDate.xhtml`. The resource identifier for this resource is therefore `components/inputDate.xhtml`, and it is located in the web application root at `resources/components/inputDate.xhtml`.

The inputDate Composite Component

A composite component is a set of user-defined JavaServerFaces and Facelets components located in a resource. In `firstcup-war`, the `inputDate.xhtml` resource, located in the `components` resource library, is a composite component that contains tags for reading in a date the user enters in a form. Composite components consist of an *interface* definition and an *implementation*.

The interface definition is specified with the `<cc:interface>` tag to define which attributes are exposed to pages that use the composite component. Attributes are identified with the `<cc:attribute>` tag.

The `inputDate.xhtml` interface definition is as follows. It defines a single attribute, `date`, that must be specified in pages that use the `inputDate` composite component.

```
<cc:interface>
    <cc:attribute name="date" />
</cc:interface>
```

The implementation of the composite component is specified with the `<cc:implementation>` tag. The tags within the `<cc:implementation>` are the actual component tags that will be added to pages that use the composite component. They can be any HTML render kit, JavaServer Faces, or Facelets tags. The `#{cc.attrs.attribute-name}` expression is used to get the value of the specified attribute from the page or component that is using the composite component.

The implementation of the `inputDate` composite component is as follows. An HTML input text component will store the entered text into the `date` attribute, accessed by the `#{cc.attrs.date}` expression. A JavaServer Faces `convertDateTime` component will convert the entered text to a date with the form of `MM/dd/yyyy` (04/13/2014, for example).

```
<cc:implementation>
    <h:inputText id="getdate" value="#{cc.attrs.date}">
        <f:convertDateTime pattern="MM/dd/yyyy" />
    </h:inputText>
    <p/>
    <h:message for="getdate" style="color:red" />
</cc:implementation>
```

If there's an error with the input of the `inputText` component, the form submission is unsuccessful, and a warning message is displayed. The message output is specified by the `<h:message>` tag, which is connected to the `inputText` component that has the id `getdate`.

Implement the inputDate Composite Component

Modify the `inputDate` composite component in the `components` resource library.

1. Expand **Web Pages**, then `resources`, then `components`, and open `inputDate.xhtml`.
2. Add the composite component interface definition between the opening and closing `<cc:interface>` tags in `inputDate.xhtml`:

   ```
   <cc:interface>
       <cc:attribute name="date" />
   </cc:interface>
   ```

3. Add the composite component implementation between the opening and closing `cc:implementation` tags:

```
<cc:implementation>
    <h:inputText id="getdate" value="#{cc.attrs.date}">
        <f:convertDateTime pattern="MM/dd/yyyy" />
    </h:inputText>
    <p/>
    <h:message for="getdate" style="color:red" />
</cc:implementation>
```

4. In the editor window, right-click and select **Format**.
5. From the **File** menu, select **Save**.

The Facelets Web Interface

The `firstcup-war` web application interface has two XHTML files. The `greeting.xhtml` file displays Duke’s current age and the form where the user can enter a birthday. The `response.xhtml` file displays the age difference between the user and Duke.

The `greeting.xhtml` file contains several pieces of the `firstcup-war` application detailed previously. It uses the localized strings contained in `WebMessages.properties` and `WebMessages_es.properties`. It uses the `DukesBDay` managed bean to call both the `DukesAgeResource` JAX-RS web service and the `DukesBirthdayBean` enterprise bean. It uses the `inputDate` composite component to create the input for the user to enter a birthday.

Here’s the content of the `greeting.xhtml` file.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html
      PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
      "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" lang="en"
      xmlns:h="http://xmlns.jcp.org/jsf/html"
      xmlns:fc="http://xmlns.jcp.org/jsf/composite/components">
    <h:head>
        <title>Firstcup Greeting Page</title>
    </h:head>
    <h:body>
        <h:form>
            <h2>
                <h:outputText value="#{bundle.Welcome}"/>
            </h2>
            <h:outputText value="#{bundle.DukeIs} "/>
            <h:outputText value="#{dukesBDay.age} #{bundle.YearsOldToday}"/>
            <p/>
            <h:outputText value="#{bundle.Instructions}"/>
            <p/>
            <h:outputText value="#{bundle.YourBD} "/>
            <fc:inputDate id="userBirthday" date="#{dukesBDay.yourBD}" />
            <p/>
            <h:commandButton value="#{bundle.Submit}"
                             action="#{dukesBDay.processBirthday}"/>
        </h:form>

    </h:body>
</html>
```

The `greeting.xhtml` file uses the HTML RenderKit and the `components` resource library tag libraries. The `components` tag library has a prefix of `fc`, and is used to specify the `inputDate` composite component in the form below. The `<fc:inputDate id="userBirthday" date="#{dukesBDay.yourBD}" />` tag has the required `date` attribute, and it stores the value in the `yourBD` property in the `DukesBDay` managed bean by using the EL expression `#{dukesBDay.yourBD}`.

The localized strings are referenced by the EL expressions `#{bundle.property-name}`. For example, the `<h:outputText value="#{bundle.Welcome}"/>` tag will display the following string in English locales:

```
Hi. I'm Duke. Let's find out who's older -- you or I.
```

The `<h:commandButton>` tag creates a Submit button and specifies that a successful submission should render the `response.xhtml` file by setting the `action` attribute to `#{dukesBDay.processBirthday}`. The `processBirthday` method returns the value `"/response.xhtml"`. The `action` attribute is used to define navigation rules for forms in Facelets pages.

The `response.xhtml` file displays the age difference between the user and Duke and the average age difference of all users so far. Different strings are displayed based on whether the user is the same age, younger, or older than Duke. The text can be displayed or not based on the conditions specified by the `rendered` attribute of the `<h:outputText>` tag. The conditions used in the `rendered` attribute are Expression Language (EL) alternatives to the Java programming language conditional operators to allow XML parsing of the XHTML file.

Table 4-1 Conditional Operator EL Language Alternatives

Logical Condition	**Java Programming Language Conditional Operator**	**EL Alternative**
AND	`&&`	`&&`
EQUALS	`==`	`==`
LESS THAN	`<`	`lt`
GREATER THAN	`>`	`gt`

Here’s the content of the `response.xhtml` file.

```
<?xml version='1.0' encoding='UTF-8' ?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml"
      xmlns:h="http://xmlns.jcp.org/jsf/html">
    <h:head>
        <title>Response Page</title>
    </h:head>
    <h:body>
        <h:form>
            <h:outputText value="#{bundle.YouAre} "/>
            <h:outputText value="#{bundle.SameAge}"
                          rendered="#{dukesBDay.ageDiff == 0}"/>
            <h:outputText value="#{dukesBDay.absAgeDiff}"
                          rendered="#{dukesBDay.ageDiff lt 0}"/>
            <h:outputText value=" #{bundle.Year} "
                          rendered="#{dukesBDay.ageDiff == -1}"/>
            <h:outputText value=" #{bundle.Years} "
                          rendered="#{dukesBDay.ageDiff lt -1}"/>
            <h:outputText value="#{bundle.Younger}"
                          rendered="#{dukesBDay.ageDiff lt 0}"/>
            <h:outputText value="#{dukesBDay.absAgeDiff}"
                          rendered="#{dukesBDay.ageDiff gt 0}"/>
            <h:outputText value=" #{bundle.Year} "
                          rendered="#{dukesBDay.ageDiff == 1}"/>
            <h:outputText value=" #{bundle.Years} "
                          rendered="#{dukesBDay.ageDiff gt 1}"/>
            <h:outputText value="#{bundle.Older}"
                          rendered="#{dukesBDay.ageDiff gt 0}"/>
            <p/>
            <h:outputText
                value="#{bundle.AverageAge} #{dukesBDay.averageAgeDifference}."/>
            <p/>
            <h:commandButton id="back" value="#{bundle.Back}" action="greeting"/>
        </h:form>
    </h:body>
</html>
```

For example, the `#{bundle.SameAge}` string is displayed if the user and Duke have the same birthday, as specified by the condition `#{dukesBDay.ageDiff == 0}` in the `rendered` attribute. That is, the following string is displayed when the `ageDiff` property of `DukesBDay` equals `0`:

```
You are the same age as Duke!
```

The form also contains a `<h:commandButton>` tag that creates a **Back** button, which directs the user back to the `greeting.xhtml` page, as specified in the `action` attribute.

Add the Form to greeting.xhtml

Add the form that provides the user interface for displaying Duke's age and specifying the user's birthday.

1. In the **Projects** tab, double-click `greeting.xhtml` in the `firstcup-war` project and, in the editor window, replace the text between the `<h:form>` and `</h:form>` tags with the following:

   ```
   <h2>
       <h:outputText value="#{bundle.Welcome}"/>
   </h2>
   <h:outputText value="#{bundle.DukeIs} "/>
   <h:outputText value="#{dukesBDay.age} #{bundle.YearsOldToday}"/>
   <p/>
   <h:outputText value="#{bundle.Instructions}"/>
   <p/>
   <h:outputText value="#{bundle.YourBD} "/>
   <fc:inputDate id="userBirthday" date="#{dukesBDay.yourBD}" />
   <p/>
   <h:commandButton value="#{bundle.Submit}"
                    action="#{dukesBDay.processBirthday}"/>
   ```

2. In the editor window, right-click and select **Format**.
3. From the **File** menu, select **Save**.

Add the Form to response.html

Add a form that displays the age difference between Duke and the user, displays the average age difference of all users, and allows the user to navigate back to `greeting.xhtml`.

1. In the **Projects** tab, double-click `response.xhtml` in the `firstcup-war` project and, in the editor window, replace the text between the `<h:form>` and `</h:form>` tags with the following:

```
    <h:outputText value="#{bundle.YouAre} "/>
    <h:outputText value="#{bundle.SameAge}"
                  rendered="#{dukesBDay.ageDiff == 0}"/>
    <h:outputText value="#{dukesBDay.absAgeDiff}"
                  rendered="#{dukesBDay.ageDiff lt 0}"/>
    <h:outputText value=" #{bundle.Year} "
                  rendered="#{dukesBDay.ageDiff == -1}"/>
    <h:outputText value=" #{bundle.Years} "
                  rendered="#{dukesBDay.ageDiff lt -1}"/>
    <h:outputText value="#{bundle.Younger}"
                  rendered="#{dukesBDay.ageDiff lt 0}"/>
    <h:outputText value="#{dukesBDay.absAgeDiff}"
                  rendered="#{dukesBDay.ageDiff gt 0}"/>
    <h:outputText value=" #{bundle.Year} "
                  rendered="#{dukesBDay.ageDiff == 1}"/>
    <h:outputText value=" #{bundle.Years} "
                  rendered="#{dukesBDay.ageDiff gt 1}"/>
    <h:outputText value="#{bundle.Older}"
                  rendered="#{dukesBDay.ageDiff gt 0}"/>
    <p/>
    <h:outputText
        value="#{bundle.AverageAge} #{dukesBDay.averageAgeDifference}." />
    <p/>
    <h:commandButton id="back" value="#{bundle.Back}" action="greeting"/>
```

2. In the editor window, right-click and select **Format**.
3. From the **File** menu, select **Save**.

Building, Packaging, Deploying, and Running the firstcup-war Web Application

In this section, you will build the `firstcup-war` web application, deploy it to the server, and run the application.

Build, Package, and Deploy the firstcup-war Web Application

Now build and package the `DukesBirthdayBean` enterprise bean, the `FirstcupUser` entity, and the `firstcup-war` web client into a WAR file, `firstcup-war.war`, then deploy it to the server.

1. In the **Projects** tab, select the `firstcup-war` project.
2. Right-click `firstcup-war` and select **Run**.

After `firstcup-war.war` deploys successfully to GlassFish Server, a web browser will load the application URL.

Run the firstcup-war Application

1. On the greeting page, enter your birth date in the **Your birthday** field. Make sure you use the date pattern specified on the page: MM/dd/yyyy.
2. Click **Submit**.
3. After the `response.xhtml` page is displayed, click **Back** to return to the `greeting.xhtml` page.
4. Enter a different birthday in the text field and click **Submit** again to see how the average age of First Cup users changes.

5 Next Steps

This chapter provides additional resources for learning more about enterprise application architecture, the Jakarta EE platform, and GlassFish Server.

The Jakarta EE Tutorial

The Jakarta EE Tutorial documents the technologies that make up the Jakarta EE platform. The Jakarta EE Tutorial describes each piece of the platform in detail, and includes code examples that demonstrate how to use each piece of the platform.

More Information on the Jakarta EE Platform

For more information on the Jakarta EE platform, see these resources:

- The GlassFish project (`https://javaee.github.io/glassfish/`)
- The Aquarium (`http://blogs.oracle.com/theaquarium/`), a blog about GlassFish Server and open-source Jakarta EE projects