Chapter

3

SECTION I: INTRODUCTION

Writing The First Application

Any project that requires database interaction have started looking at ORM tools than considering the traditional approach i.e. JDBC. This saves a huge amount of time revolving around unnecessary chores.

However, to make this more convincible, let's look at a practical implementation and work on it.

This is the only compelling reason why this chapter has been introduced. This chapter aims at convincing the readers/developers about how easy it is, to begin using an ORM tool via **J**ava **P**ersistence **A**PI.

This chapter does not cover the basics or a detailed explanation of ORM tool or the API. Those topics will be covered in the chapters that follow. This chapter leads through the building of a small example called **GuestBook** that uses JPA and a JPA provider.

To get the first application to work, the following needs to be setup:

- Database
- An ORM tool of choice

- Persistence Configuration file
- Entity - **P**lain **O**ld **J**ava **O**bjects [POJOs]

Once all this is in place, the application logic needs to be written which uses JPA to actually do something.

Application Requirement Specifications

The application [example] to be built is called **GuestBook**. This application should be capable of accepting and displaying visitor's comments.

To achieve this, it should provide a user interface that accepts visitor's name and message/comments.

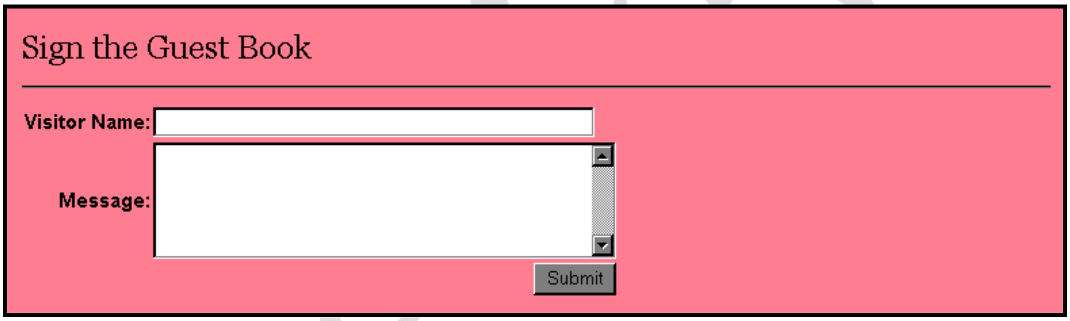
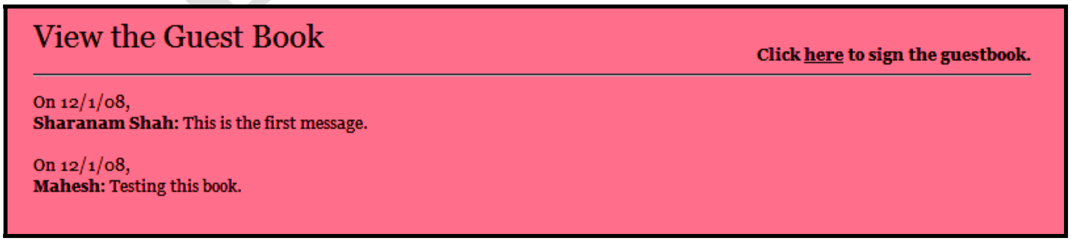


Diagram 3.1: GuestBook data entry form

After such information is captured and stored, other visitors to the application should be able to view all the available comments as shown in diagram 3.2.

This user interface displays the visitor's name along with the message and the date when the message was keyed in. It should also provide a link to sign the GuestBook which when clicked should display the GuestBook data entry form as shown in diagram 3.1.



On 12/1/08,
Sharanam Shah: This is the first message.

On 12/1/08,
Mahesh: Testing this book.

Diagram 3.2: View GuestBook

Where Does ORM/JPA Fit

An ORM tool can be invoked from a Java application either directly or via another framework such as Struts, Spring and so on.

Java Persistence API makes it easy for these frameworks to support in one way or another.

Section VI: Enterprise Application Development explains how an ORM tool and JPA can be configured and integrated with such frameworks.

An ORM tool along with the JPA can be used in:

- A Swing application
- A Servlet
- A Portlet
- A JSP
- An Enterprise application
- Any other kind of Java application that has access to a database

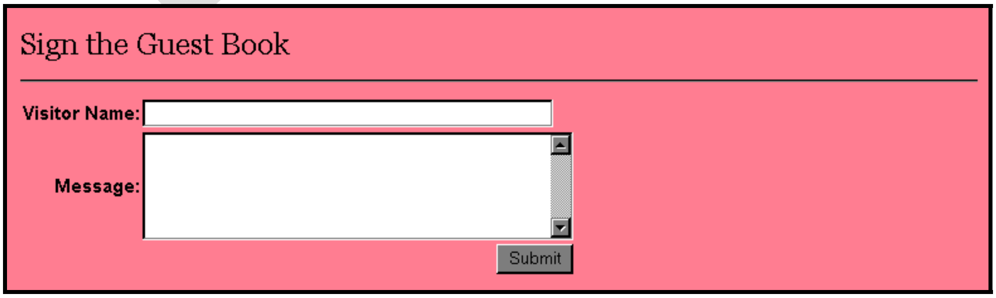
Typically, an ORM tool is used to create a Data Access Layer for an application.

The most typical workflow would be:

- Define the configuration details using a **Persistence Unit**
- Create an **EntityManagerFactory** object by referencing the Persistence Unit
- Instantiate the **EntityManager** object through which the application accesses ORM tool's representation of the database

From this application's [GuestBook] point of view, an ORM tool will be used as follows:

- The user invokes the application
- The "Sign the Guest Book" data entry form is served to allow capturing the visitor's name and comments

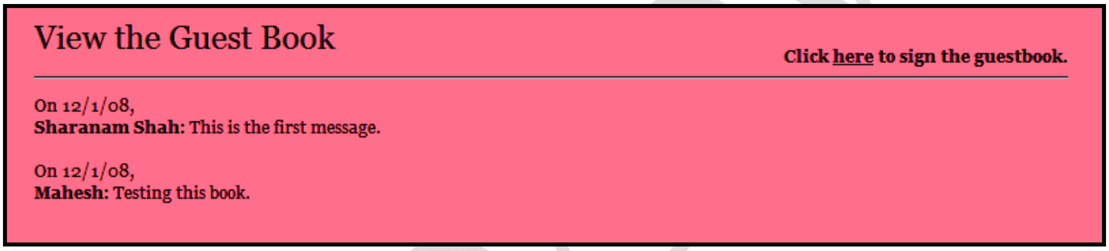


- The user keys in the details and clicks **Submit**

After such information is captured and the form is submitted, the server-side script in this case a JSP [GuestBookView.jsp] takes charge.

This script invokes the ORM as follows:

- Creates an **EntityManagerFactory** object by referencing the Persistence Unit
- Instantiate the **EntityManager** object
- Uses the **persist()** method of the instantiated **EntityManager** object to save the captured data to the configured database
- Uses the **createQuery()** method of the instantiated **EntityManager** object to query the configured database and fetch all the entries to display them



View the Guest Book

Click here to sign the guestbook.

On 12/1/08,
Sharanam Shah: This is the first message.

On 12/1/08,
Mahesh: Testing this book.

This user interface displays the visitor's name along with the message and the date when the message was keyed in.

Let's begin!

Software Requirements

From the application development perspective, the following software will be required on the development machine:

- **J**ava **D**evelopment **K**it
- NetBeans IDE [The development IDE]
- MySQL Community Server [The database server]
- JDBC Driver for MySQL
- Glassfish Application Server v3
  - EclipseLink [Default ORM that comes bundled]

OR

- Glassfish Application Server v2
    - TopLink [Default ORM that comes bundled]

REMINDER

The above mentioned software setups are available in this book's accompanying CDROM.

Library Files

The following Java library [.JAR] is required:

- **JDBC driver:** This will be specific to a relational database to be used. In this case MySQL is used as the database of choice, hence, the database specific JDBC driver file will be **MySQL Connector/J 5.1.7** [can be downloaded from http://www.mysql.com also available in the Book's accompanying CDROM]

HINT

An ORM tool does not include any database specific JDBC drivers. These must be obtained separately. Typically, the database provider offers them, as a separate downloads or bundled with the database installation.

The Application Development Approach

This application will be built using **JSP**.

The **data entry form** that captures the data will be called GuestBookEntry.jsp and the page that will fetch and display the entries will be called GuestBookView.jsp.

The **captured data** will be stored in a **table** called **GuestBook** under the **MySQL** database server.

In the Java application, the **POJO** that will represent the GuestBook database table will be called myApp.Guestbook.java.

Just to make this simple, the application development will be carried out/demonstrated using a development IDE called NetBeans IDE 6.5. Ensure that this IDE [available in the Book's accompanying CDROM] is installed on the development machine prior proceeding further.

Refer to *Appendix A: Installing The NetBeans IDE* for the installation steps.

The following are the steps that will help build this application.

1. Create the database schema
2. Create the Web Application
3. Add the Java libraries [JDBC driver] to the application
4. Create a POJO to represent the table in the database schema
5. Create a Persistence unit that points to the database server [MySQL] using JNDI
6. Annotate the POJO to indicate the mapping between the JavaBean properties and the columns in the table
7. Create JSPs with code spec:
   a. To build an **EntityManagerFactory** object by referencing the Persistence Unit
   b. To obtain an **EntityManager** object from the EntityManagerFactory
   c. To perform the required database operations

Creating Database And Tables In MySQL

Since MySQL is the database server of choice, ensure that the MySQL database engine [available in the Book's accompanying CDROM] is installed on the development machine prior proceeding further. This can also be downloaded from the website http://www.mysql.com/download.

Login to the MySQL database using a valid username and password. The pre-created super administrator called **root** can also be used.

Create the database named GuestBook:

```
CREATE DATABASE GuestBook;
```

Switch to the database GuestBook:

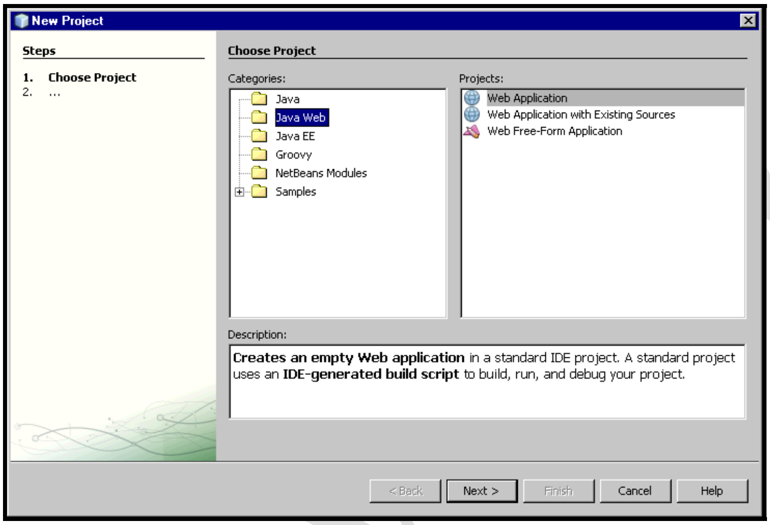
```
USE GuestBook;
```

Create the table named GuestBook:

```
CREATE TABLE GuestBook(
   VisitorNo Int PRIMARY KEY AUTO_INCREMENT,
   VisitorName varchar(50),
   Message varchar(100),
   MessageDate varchar(40));
```

Creating A Web Application

Since NetBeans is the IDE of choice throughout this book. Use it to create a new Web Application Project called **GuestBook**. Run the NetBeans IDE and create a new **Web Application** project, as shown in diagram 3.3.1.


New Project

Steps
1. Choose Project
2. ...

Choose Project

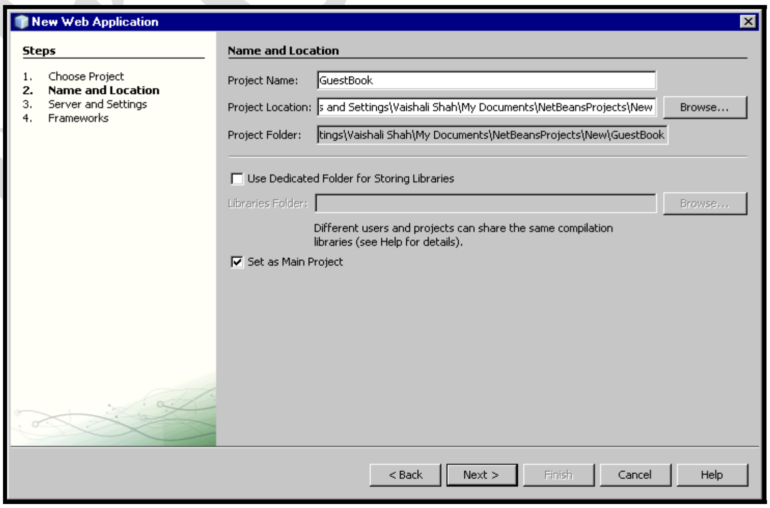
Categories: Java, Java Web, Java EE, Groovy, NetBeans Modules, Samples

Projects: Web Application, Web Application with Existing Sources, Web Free-Form Application

Description:
Creates an empty Web application in a standard IDE project. A standard project uses an **IDE-generated build script** to build, run, and debug your project.

Diagram 3.3.1: New Project

Click Next >. Name this Web application as **GuestBook** as shown in diagram 3.3.2.


New Web Application

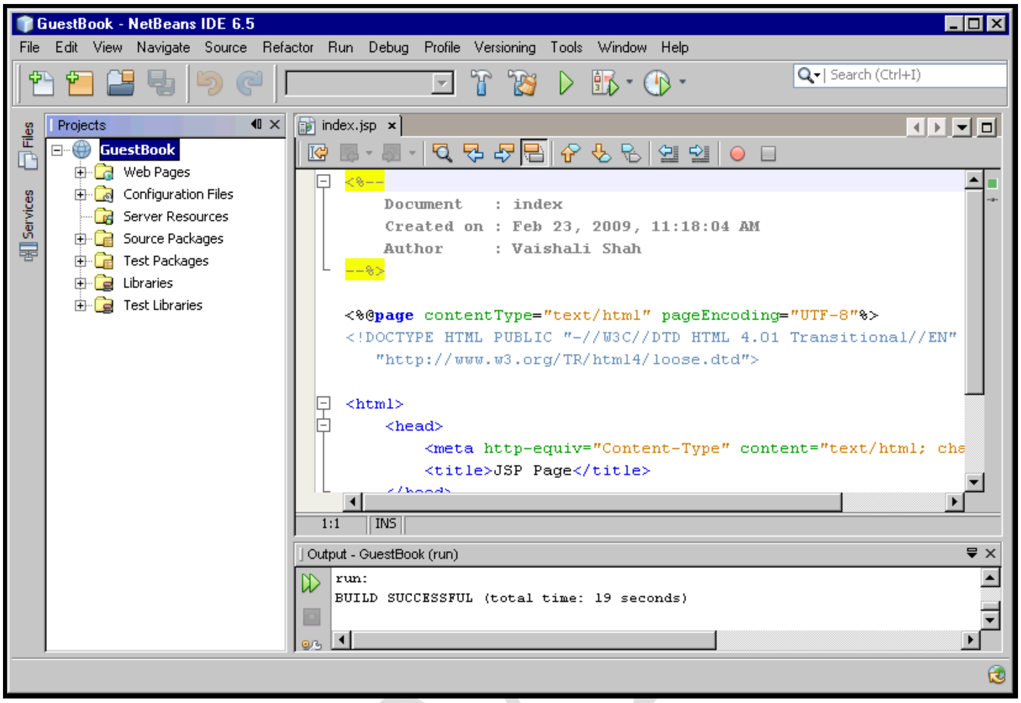
Steps
1. Choose Project
2. Name and Location
3. Server and Settings
4. Frameworks

Name and Location

Project Name: GuestBook
Project Location: s and Settings\Vaishali Shah\My Documents\NetBeansProjects\New
Project Folder: tings\Vaishali Shah\My Documents\NetBeansProjects\New\GuestBook

☐ Use Dedicated Folder for Storing Libraries
Libraries Folder:
Different users and projects can share the same compilation libraries (see Help for details).
☑ Set as Main Project

Diagram 3.3.2: Name and Location



```
<%--
    Document   : index
    Created on : Feb 23, 2009, 11:18:04 AM
    Author     : Vaishali Shah
--%>

<%@page contentType="text/html" pageEncoding="UTF-8"%>
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
   "http://www.w3.org/TR/html4/loose.dtd">

<html>
    <head>
        <meta http-equiv="Content-Type" content="text/html; cha
        <title>JSP Page</title>
```

```
run:
BUILD SUCCESSFUL (total time: 19 seconds)
```

Diagram 3.3.4: GuestBook in NetBeans IDE

Once the NetBeans IDE brings up the GuestBook application, the next step is to add the required library files [JDBC driver] to the GuestBook application.

Adding The Required Library Files

*It's a good practice to manually create a dedicated **lib** folder with all the required library files in the project folder and then using NetBeans add libraries from this folder as the source.*

To do so,

Create a directory called **lib** under <Drive>:**NetBeansProjects**\GuestBook. [**NetBeansProjects** is the folder where NetBeans places the projects created]

JDBC Driver For MySQL

MySQL provides connectivity to client applications developed in the Java EE 5 via a JDBC driver named **MySQL Connector/J**.

MySQL Connector/J is a native Java driver that converts JDBC calls into the network protocol used by the MySQL database. MySQL Connector/J is a Type 4 driver, which means that MySQL Connector is pure Java code spec and communicates directly with the MySQL server using the MySQL protocol.

MySQL Connector/J allows the developers working with Java EE 5, to build applications, which interact with MySQL and connect all corporate data even in a heterogeneous environment.

Visit the site http://www.mysql.com to download the MySQL Connector/J JDBC Driver.

At the time of writing this book the latest version of the **MySQL Connector/J** was **5.1.7** [available in this Book's accompanying CDROM].

After it is downloaded, using any unzip utility such as Winzip unzip the contents of the zip file. Copy the **mysql-connector-java-X.X.X-bin.jar** library file to the **lib** directory created earlier under <Drive>:\NetBeansProjects\GuestBook to store the JDBC library file.

Now add this library file to the project using NetBeans. Expand the Web application project structure in the **Project** pane, if not already expanded. Right-click on the **Libraries** folder, select the **Add JAR/Folder...** menu item as shown in diagram 3.4.1.

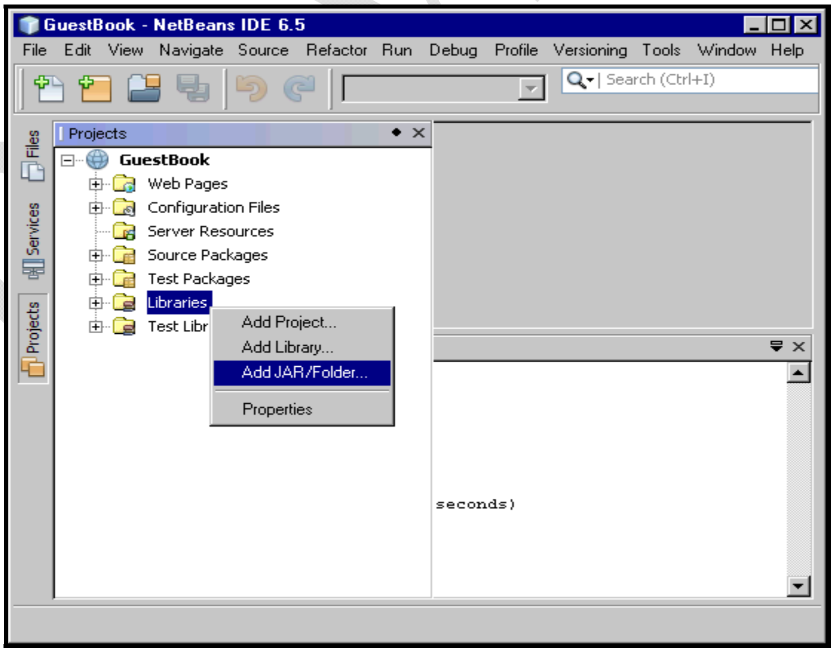


Diagram 3.4.1: Add Jar/Folder

Now, let's move to the application development area.

Creating A JavaBean Class

To hold the captured data in a structured manner, a bean class is required. This class should expose the following properties:

Property Name	To Store
visitorNo	The Primary Key value
visitorName	Visitor's Name
message	Message that the visitor enters
messageDate	The date/time on which the message was entered

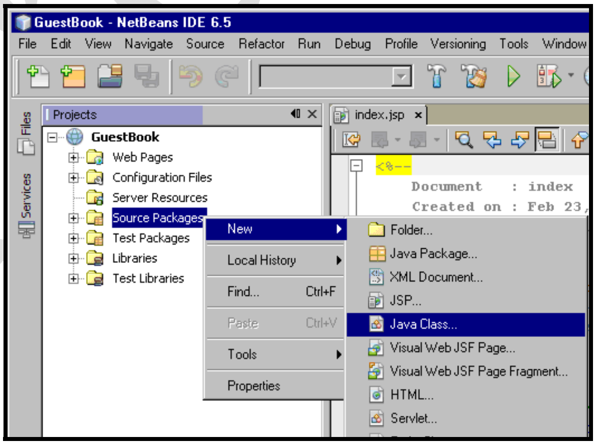
The primary purpose of having such a class is to hold individual guestbook entry as and when they are captured.

This class must be annotated with **javax.persistence.Entity**. Entity classes become a table in a relational database. Instances of this class becomes rows in the table.

All entities must have a primary key. Keys can be a single field or a combination of fields. JPA also allows to auto generate the primary key in the database using the @GeneratedValue annotation.

The following are the steps to create the entity class using the NetBeans IDE:

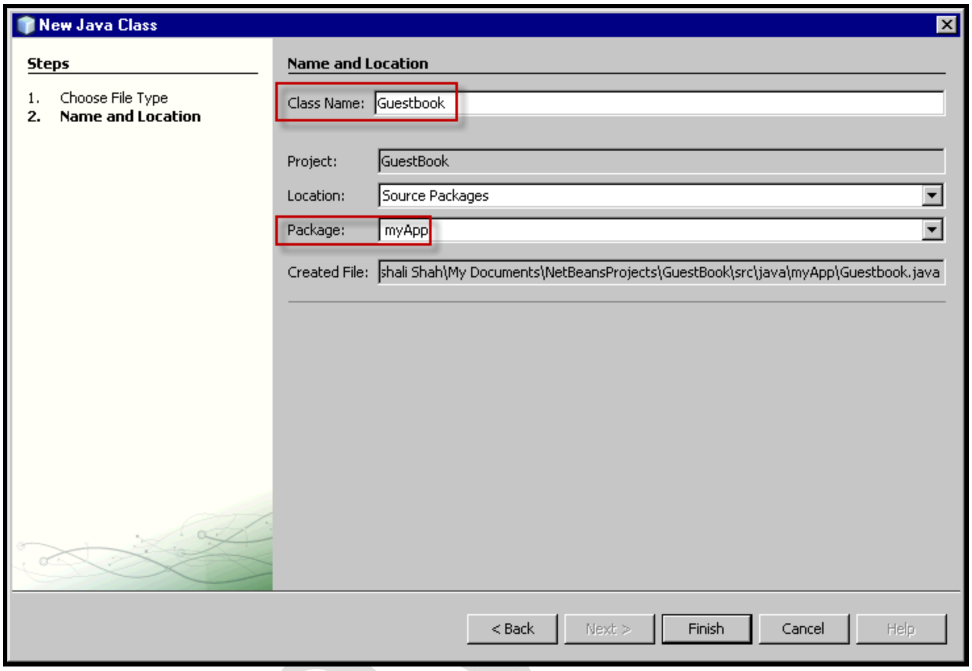
1. Right click **Sources Package** directory, select **New → Java Class...** as shown in diagram 3.5.1



```
<%--
    Document   : index
    Created on : Feb 23
```

Diagram 3.5.1: Creating entity Class

2. Enter **Guestbook** in the Class Name textbox and enter **myApp** in the **Package** drop down list box as shown in diagram 3.5.2



Name and Location

Class Name: Guestbook

Project: GuestBook

Location: Source Packages

Package: myApp

Created File: shali Shah\My Documents\NetBeansProjects\GuestBook\src\java\myApp\Guestbook.java

Diagram 3.5.2: Naming the Java class file

3. Click **Finish**

This creates the bean class named Guestbook.java under the package called **myApp**.

Guestbook.java [Code Spec]

Edit the **Guestbook.java** file with the following contents.

Imports For JPA

```
package myApp;

import javax.persistence.Column;
import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;
import javax.persistence.Table;

```

The identifier property [@Id] **visitorNo** maps to a column named **VisitorNo**

- The Primary Key value will be generated by MySQL [@GeneratedValue]

```
CREATE TABLE GuestBook(
    VisitorNo Int PRIMARY KEY AUTO_INCREMENT,
    VisitorName varchar(50),
    Message varchar(100),
    MessageDate varchar(40));
```

- Other properties **visitorName**, **message**, **messageDate** map to columns **VisitorName**, **Message**, **MessageDate** respectively

HINT

By default each field is mapped to a column with the name of the field. However, if column names are different than the field names, they can be specified using @Column(name="ColumnName").

All these attributes of the **Guestbook** class have JavaBean style property **accessor methods**.

The class also has a constructor with no parameters.

Creating Persistence Unit [persistence.xml]

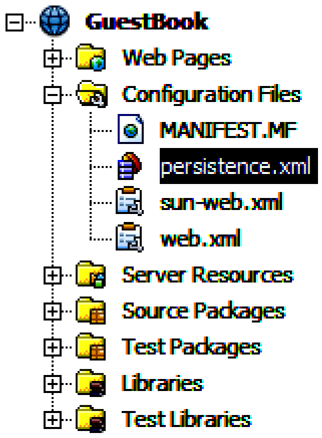
JPA uses the **persistence.xml** file to create the connection and setup the required environment. This file is used to provide the information which is necessary for making database connections. In this file the JNDI data source that indicates the database driver, the database location, the user and the password is specified.

The NetBeans IDE comes bundled with a plug-in that allows creating a persistence unit using a simple wizard.

To create persistence.xml using this plug-in, click **File → New File**, select the **Persistence** category and choose the option **Persistence Unit** and click **Next** as shown in diagram 3.6.1.

Click **Finish**.

This creates the **persistence.xml** file.



This file is populated with the appropriate code spec**:**

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence version="1.0" 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_1_0.xsd">
  <persistence-unit name="GuestBookPU" transaction-type="RESOURCE_LOCAL">
    <non-jta-data-source>jdbc/GuestBook</non-jta-data-source>
    <exclude-unlisted-classes>false</exclude-unlisted-classes>
    <properties/>
  </persistence-unit>
</persistence>
```

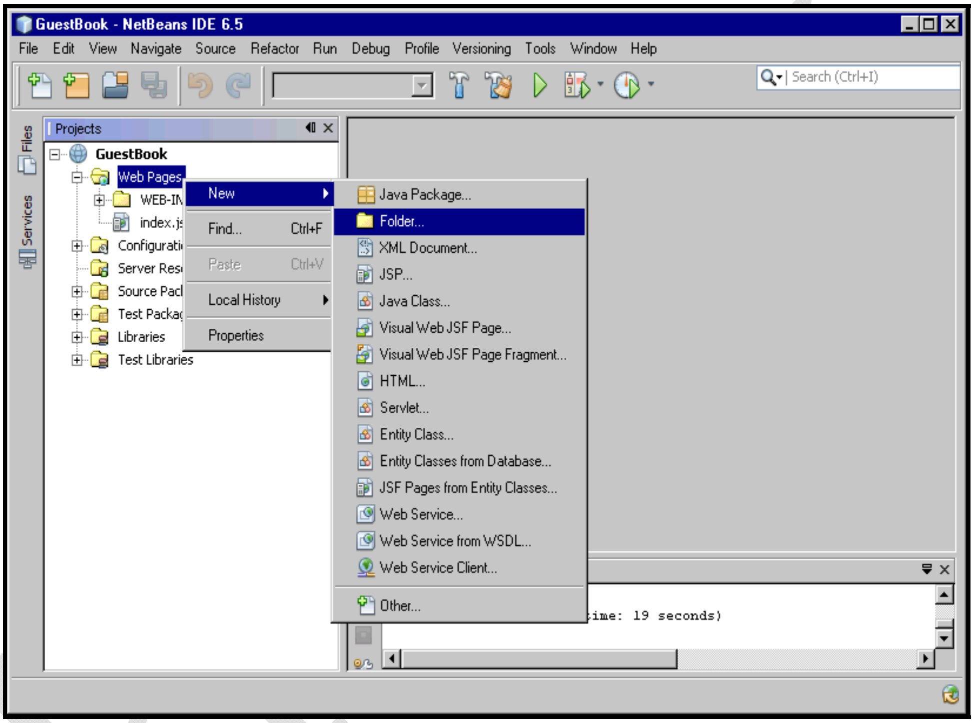
This wizard also creates a **server resource** file. This file automatically creates a JNDI data source on the application server when this application is deployed.

Creating JSPs

Before creating the JSP, let's create a directory to hold JSPs.

The following are the steps to create the directory:

1. Right click **Web Pages** directory, select **New → Folder...** as shown in diagram 3.7.1



```
ime: 19 seconds)
```

Diagram 3.7.1: Creating Folder

2. Enter the name **JSP** in the **Folder Name** textbox as shown in diagram 3.7.2

3. Click **Finish**

This creates the JSP named GuestBookEntry.jsp under the JSP directory created earlier.

GuestBookEntry.jsp [Code Spec]

Edit the **GuestBookEntry.jsp** file with the following contents.

```
<%@ page language="java" contentType="text/html; charset=ISO-8859-1"
pageEncoding="ISO-8859-1"%>
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
"http://www.w3.org/TR/html4/loose.dtd">
<html>
    <head>
        <meta http-equiv="Content-Type" content="text/html;charset=ISO-8859-1">
        <title>Guest Book</title>
    </head>
    <body bgcolor="pink">
        <table border="0" cellpadding="0" cellspacing="0" align="center" width="760">
            <tr>
                <td>
                    <table border="0" cellpadding="0" cellspacing="0" width="100%">
                        <tr>
                            <td valign="top" align="left" style="padding-right:0px; padding-left:0px;
                            padding-bottom:0px; font:24px/30px Georgia; width:228px; color:#786e4e;
                            padding-top:0px; height:37px;">
                                Sign the Guest Book
                            </td>
                        </tr>
                    </table>
                </td>
            </tr>
            <tr align="left" valign="top">
                <td height="20">
                    <hr />
                </td>
            </tr>
            <tr>
                <td>
                    <form action="<%=request.getContextPath()%>/JSP/GuestBookView.jsp"
                    method="post">
            <table border="0" cellpadding="0" cellspacing="2">
              <tr>
                <td align="right">
                  <font style="font-size:15px; font-family:Arial,Times,serif;
                  font-weight:bold;">Visitor Name:</font>
                </td>
                <td>
                  <input name="guest" maxlength="25" size="50" />
                </td>
              </tr>
              <tr>
                <td align="right">
                  <font style="font-size:15px; font-family:Arial,Times,serif;
                  font-weight:bold;">Message:</font>
                </td>
                <td>
                  <textarea rows="5" cols="40" name="message"></textarea>
                </td>
              </tr>
              <tr>
                <td colspan="2" align="right">
                  <input type="submit" name="btnSubmit" value="Submit" />
                </td>
              </tr>
            </table>
          </form>
        </td>
      </tr>
    </table>
  </body>
</html>
```

Explanation:

This is the data entry form that allows capturing the visitor's name and comments and submits the data to another server-side script called GuestBookView.jsp for further processing.

GuestBookView.jsp [Code Spec]

Using NetBeans create one more JSP called GuestBookView.jsp using the same steps as shown earlier.

Edit the **GuestBookView.jsp** file with the following contents.

```
<%@page contentType="text/html" pageEncoding="UTF-8" import="java.util.List,
java.util.Iterator, myApp.Guestbook, javax.persistence.*" %>
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
  "http://www.w3.org/TR/html4/loose.dtd">                 Import for JPA
<%!
   private EntityManagerFactory emf;
   private EntityManager em;
   private EntityTransaction tx;
   List<Guestbook> guestbook;
%>
                                          Building an             Referencing the
                                          EntityManagerFactory    Persistence Unit
<%
   emf = Persistence.createEntityManagerFactory("GuestBookPU");
   em = emf.createEntityManager();
                                                              Obtaining an
   String submit = request.getParameter("btnSubmit");         EntityManager object
   if(submit != null && ("Submit").equals(submit)) {
      try {
         String guest = request.getParameter("guest");
         String message = request.getParameter("message");
         String messageDate = new java.util.Date().toString();

         Guestbook gb = new Guestbook();                      Populating the entity
         gb.setVisitorName(guest);                            with captured data
         gb.setMessage(message);
         gb.setMessageDate(messageDate);

         tx = em.getTransaction();
         tx.begin();                                  Beginning a transaction
         em.persist(gb);                              Persisting the entity
         tx.commit();                                 Committing a transaction
      }
      catch (RuntimeException e) {
         if(tx != null) tx.rollback();
         throw e;
      }
      response.sendRedirect("GuestBookView.jsp");
```

```
    }
%>
```

Here, an iterator is used to traverse through the List object called guestbook. This list object was populated earlier by:

```
guestbook = em.createQuery("SELECT g from Guestbook g").getResultList();
```

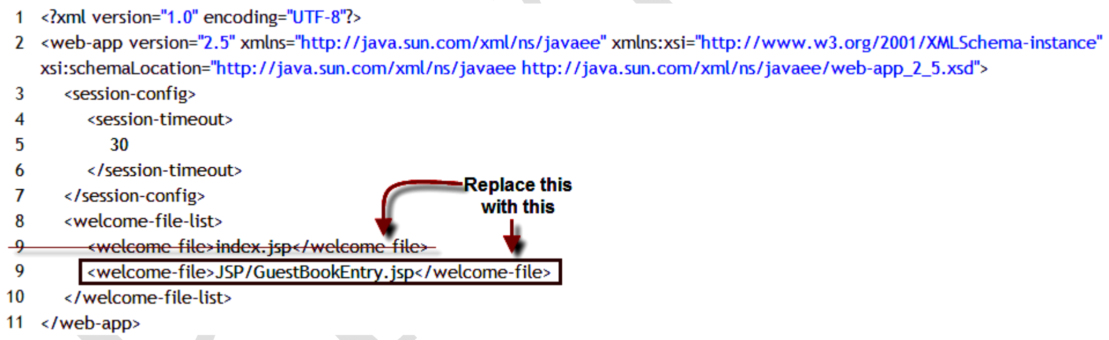
Using <TABLE>, <TR> and <TD> the elements of the List object are placed.

Editing The web.xml File

In NetBeans, by default, the web.xml file uses the index.jsp file as the welcome file i.e. whenever the application is run the web.xml file will display the index.jsp file.

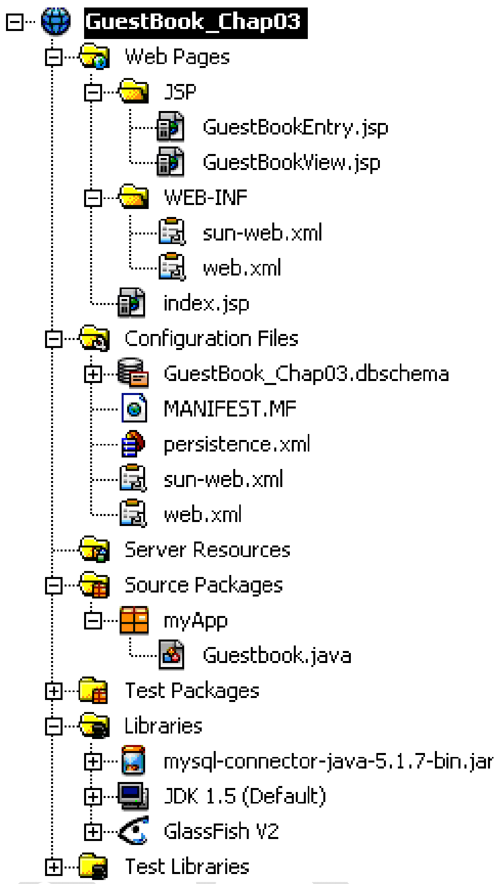
This file needs to be edited to invoke the application's data entry form [GuestBookEntry.jsp] every time it's invoked.

Edit the web.xml file with following contents:



```
<?xml version="1.0" encoding="UTF-8"?>
<web-app version="2.5" xmlns="http://java.sun.com/xml/ns/javaee" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://java.sun.com/xml/ns/javaee http://java.sun.com/xml/ns/javaee/web-app_2_5.xsd">
    <session-config>
        <session-timeout>
            30
        </session-timeout>
    </session-config>
    <welcome-file-list>
        ~~<welcome-file>index.jsp</welcome-file>~~
        <welcome-file>JSP/GuestBookEntry.jsp</welcome-file>
    </welcome-file-list>
</web-app>
```

The GuestBook Application Structure



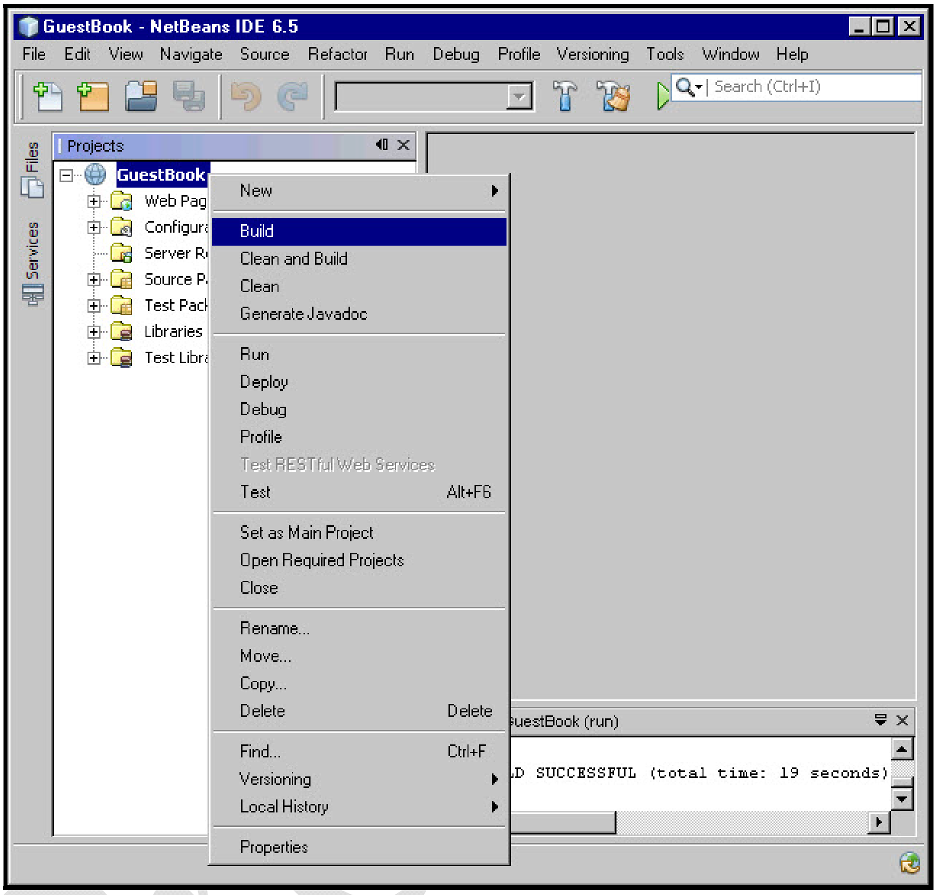
```
GuestBook_Chap03
  Web Pages
    JSP
      GuestBookEntry.jsp
      GuestBookView.jsp
    WEB-INF
      sun-web.xml
      web.xml
    index.jsp
  Configuration Files
    GuestBook_Chap03.dbschema
    MANIFEST.MF
    persistence.xml
    sun-web.xml
    web.xml
  Server Resources
  Source Packages
    myApp
      Guestbook.java
  Test Packages
  Libraries
    mysql-connector-java-5.1.7-bin.jar
    JDK 1.5 (Default)
    GlassFish V2
  Test Libraries
```

Running The GuestBook Application

Now that the application is ready, let's run this application [source code available on this Book's accompanying CDROM].

Begin by **building** the project, using the NetBeans IDE.

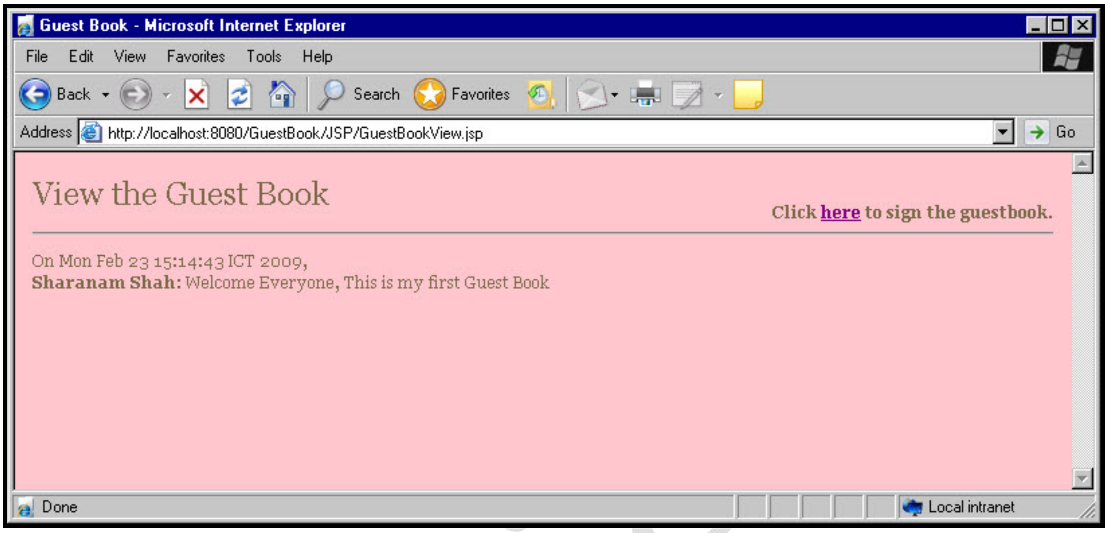
To do so, right click the **GuestBook project** and select the **Build** menu item as shown in diagram 3.8.1.



```
D SUCCESSFUL (total time: 19 seconds)
```

Diagram 3.8.1: Building the project

Then run the application by right clicking the **GuestBook** project and selecting the **Run** menu item as shown in diagram 3.8.2.


Guest Book - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://localhost:8080/GuestBook/JSP/GuestBookView.jsp
Go
Done
Local intranet

View the Guest Book

Click here to sign the guestbook.

On Mon Feb 23 15:14:43 ICT 2009,
Sharanam Shah: Welcome Everyone, This is my first Guest Book

Diagram 3.8.5: Viewing data

When the GuestBookView.jsp page appears, the data entered by the user is stored in the MySQL database table named GuestBook that was created earlier.

To ensure that this was done successfully, open MySQL command line utility and query the table to view the following output:

```
+-----------+---------------+-----------------------------------------------+-----------------------------+
| VisitorNo | VisitorName   | Message                                       | MessageDate                 |
+-----------+---------------+-----------------------------------------------+-----------------------------+
|         1 | Sharanam Shah | Welcome Everyone, This is my first Guest Book | Mon Feb 23 15:14:43 ICT 2009 |
+-----------+---------------+-----------------------------------------------+-----------------------------+
1 row in set (0.00 sec)
```

Click **here** link available on the top right corner of the page to go back to the Guest Book data entry form.

This chapter dealt with building a Web application and integrating JPA and Eclipselink into that application that exemplifies the core JPA concepts discussed in the first two chapters.

The Book CDROM holds the complete application source code built using the NetBeans IDE for the following applications:

- ❑ GuestBook_Chap03_TopLink [Using GlassFish v2 → TopLink]
- ❑ GuestBook_Chap03_EclipseLink [Using GlassFish v3 → EclipseLink]

This can be directly used by making appropriate changes [username/password] to the configuration file [persistence.xml / sun-resource.xml].