



JBoss Enterprise Application Platform 5

Hibernate Core Reference Guide

for Use with JBoss Enterprise Application Platform 5

Edition 5.2.0

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Abstract

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PREFACE

Working with object-oriented software and a relational database can be cumbersome and time consuming in today's enterprise environments. Hibernate is an object/relational mapping tool for Java environments. The term object/relational mapping (ORM) refers to the technique of mapping a data representation from an object model to a relational data model with a SQL-based schema.

Hibernate not only takes care of the mapping from Java classes to database tables (and from Java data types to SQL data types), but also provides data query and retrieval facilities. It can also significantly reduce development time otherwise spent with manual data handling in SQL and JDBC.

Hibernate's goal is to relieve the developer from 95 percent of common data persistence related programming tasks. Hibernate may not be the best solution for data-centric applications that only use stored-procedures to implement the business logic in the database, it is most useful with object-oriented domain models and business logic in the Java-based middle-tier. However, Hibernate can certainly help you to remove or encapsulate vendor-specific SQL code and will help with the common task of result set translation from a tabular representation to a graph of objects.

If you are new to Hibernate and Object/Relational Mapping or even Java, please follow these steps:

1. Read [Chapter 1, Tutorial](#) for a tutorial with step-by-step instructions. The source code for the tutorial is included in the distribution in the **doc/reference/tutorial/** directory.
2. Read [Chapter 2, Architecture](#) to understand the environments where Hibernate can be used.
3. View the **eg/** directory in the Hibernate distribution. It contains a simple standalone application. Copy your JDBC driver to the **lib/** directory and edit **etc/hibernate.properties**, specifying correct values for your database. From a command prompt in the distribution directory, type **ant eg** (using Ant), or under Windows, type **build eg**.
4. Use this reference documentation as your primary source of information. Consider reading *Java Persistence with Hibernate* (<http://www.manning.com/bauer2>) if you need more help with application design, or if you prefer a step-by-step tutorial. Also visit <http://caveatemptor.hibernate.org> and download the example application for Java Persistence with Hibernate.
5. FAQs are answered on the Hibernate website.
6. Third party demos, examples, and tutorials are linked on the Hibernate website.
7. The Community Area on the Hibernate website is a good resource for design patterns and various integration solutions (Tomcat, Struts, EJB, etc.).

If you have questions, use the user forum linked on the Hibernate website. We also provide a JIRA issue tracking system for bug reports and feature requests. If you are interested in the development of Hibernate, join the developer mailing list. If you are interested in translating this documentation into your language, contact us on the developer mailing list.

Commercial development support, production support, and training for Hibernate is available through JBoss Inc. (see <http://www.hibernate.org/SupportTraining/>). Hibernate is a Professional Open Source project and a critical component of the JBoss Enterprise Middleware System (JEMS) suite of products.

CHAPTER 1. TUTORIAL

Intended for new users, this chapter provides an step-by-step introduction to Hibernate, starting with a simple application using an in-memory database. The tutorial is based on an earlier tutorial developed by MichaelGloegl. All code is contained in the `tutorials/web` directory of the project source.



IMPORTANT

This tutorial expects the user have knowledge of both Java and SQL. If you have a limited knowledge of JAVA or SQL, it is advised that you start with a good introduction to that technology prior to attempting to learn Hibernate.



NOTE

The distribution contains another example application under the `tutorial/eg` project source directory.

1.1. PART 1 - THE FIRST HIBERNATE APPLICATION

For this example, we will set up a small database application that can store events we want to attend and information about the host(s) of these events.



NOTE

Although you can use whatever database you feel comfortable using, we will use [HSQLDB](#) (an in-memory, Java database) to avoid describing installation/setup of any particular database servers.

1.1.1. Setup

The first thing we need to do is to set up the development environment. We will be using the "standard layout" advocated by many build tools such as [Maven](#). Maven, in particular, has a good resource describing this [layout](#). As this tutorial is to be a web application, we will be creating and making use of `src/main/java`, `src/main/resources` and `src/main/webapp` directories.

We will be using Maven in this tutorial, taking advantage of its transitive dependency management capabilities as well as the ability of many IDEs to automatically set up a project based on the maven descriptor.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://
maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <groupId>org.hibernate.tutorials</groupId>
  <artifactId>hibernate-tutorial</artifactId>
  <version>1.0.0-SNAPSHOT</version>
  <packaging>war</packaging>
  <name>First Hibernate Tutorial</name>
  <build>
    <!--we dont want the version to be part of the generated war file name-->
    <finalName>${artifactId}</finalName>
    <!--we dont want to use the jars maven provided, we want to use JBoss'
```

```

ones-->
  <plugins>
    <plugin>
      <artifactId>maven-war-plugin</artifactId>
      <configuration>
        <packagingExcludes>WEB-INF/lib/*.jar</packagingExcludes>
      </configuration>
    </plugin>
  </plugins>

</build>
  <dependencies>
    <dependency>
      <groupId>org.hibernate</groupId>
      <artifactId>hibernate-core</artifactId>
      <version>3.3.2.GA_CP04</version>
    <!-- please check the release notes for the correct version you are using -->
    </dependency>
    <!-- Because this is a web app, we also have a dependency on the servlet
    api. -->
    <dependency>
      <groupId>javax.servlet</groupId>
      <artifactId>servlet-api</artifactId>
      <version>2.5</version>
    </dependency>
    <!-- Hibernate uses slf4j for logging, for our purposes here use the simple
    backend -->
    <dependency>
      <groupId>org.slf4j</groupId>
      <artifactId>slf4j-simple</artifactId>
      <version>1.5.8</version>
    </dependency>
    <!-- Hibernate gives you a choice of bytecode providers between cglib and
    javassist -->
    <dependency>
      <groupId>javassist</groupId>
      <artifactId>javassist</artifactId>
      <version>3.12.0.GA</version>
    </dependency>
  </dependencies>
</project>

```



NOTE

It is not a requirement to use Maven. If you wish to use another technology to build this tutorial (such as Ant), the layout will remain the same. The only change is that you will need to manually account for all the needed dependencies. If you use [Ivy](#) to provide transitive dependency management you would still use the dependencies mentioned below. Otherwise, you will need to find all the dependencies, both explicit and transitive, and add them to the projects classpath. If working from the Hibernate distribution bundle, this would mean **hibernate3.jar**, all artifacts in the **lib/required** directory and all files from either the **lib/bytecode/cglib** or **lib/bytecode/javassist** directory; additionally you will need both the servlet-api jar and one of the slf4j logging back ends.

Save this file as `pom.xml` in the project root directory.

1.1.2. The first class

Next, we create a class that represents the event we want to store in the database; it is a simple JavaBean class with some properties:

```
package org.hibernate.tutorial.domain;

import java.util.Date;

public class Event {
    private Long id;

    private String title;
    private Date date;

    public Event() {}

    public Long getId() {
        return id;
    }

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

    public Date getDate() {
        return date;
    }

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

    public String getTitle() {
        return title;
    }

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

This class uses standard JavaBean naming conventions for property getter and setter methods, as well as private visibility for the fields. Although this is the recommended design, it is not required. Hibernate can also access fields directly, the benefit of accessor methods is robustness for refactoring.

The `id` property holds a unique identifier value for a particular event. All persistent entity classes (there are less important dependent classes as well) will need such an identifier property if we want to use the full feature set of Hibernate. In fact, most applications, especially web applications, need to distinguish objects by identifier, so you should consider this a feature rather than a limitation. However, we usually do not manipulate the identity of an object, hence the setter method should be private. Only Hibernate

will assign identifiers when an object is saved. Hibernate can access public, private, and protected accessor methods, as well as public, private and protected fields directly. The choice is up to you and you can match it to fit your application design.

The no-argument constructor is a requirement for all persistent classes; Hibernate has to create objects for you, using Java Reflection. The constructor can be private, however package or public visibility is required for runtime proxy generation and efficient data retrieval without bytecode instrumentation.

Save this file to the `src/main/java/org/hibernate/tutorial/domain` directory.

1.1.3. The mapping file

Hibernate needs to know how to load and store objects of the persistent class. This is where the Hibernate mapping file comes into play. The mapping file tells Hibernate what table in the database it has to access, and what columns in that table it should use.

The basic structure of a mapping file looks like this:

```
<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
    "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="org.hibernate.tutorial.domain">
[... ]
</hibernate-mapping>
```

Hibernate DTD is sophisticated. You can use it for auto-completion of XML mapping elements and attributes in your editor or IDE. Opening up the DTD file in your text editor is the easiest way to get an overview of all elements and attributes, and to view the defaults, as well as some comments. Hibernate will not load the DTD file from the web, but first look it up from the classpath of the application. The DTD file is included in `hibernate-core.jar` (it is also included in the `hibernate3.jar`, if using the distribution bundle).



IMPORTANT

We will omit the DTD declaration in future examples to shorten the code. It is, of course, not optional.

Between the two `hibernate-mapping` tags, include a `class` element. All persistent entity classes (again, there might be dependent classes later on, which are not first-class entities) need a mapping to a table in the SQL database:

```
<hibernate-mapping package="org.hibernate.tutorial.domain">

    <class name="Event" table="EVENTS">

    </class>

</hibernate-mapping>
```

So far we have told Hibernate how to persist and load object of class `Event` to the table `EVENTS`. Each instance is now represented by a row in that table. Now we can continue by mapping the unique identifier property to the table's primary key. As we do not want to care about handling this identifier, we

configure Hibernate's identifier generation strategy for a surrogate primary key column:

```
<hibernate-mapping package="org.hibernate.tutorial.domain">
    <class name="Event" table="EVENTS">
        <id name="id" column="EVENT_ID">
            <generator class="native"/>
        </id>
    </class>
</hibernate-mapping>
```

The **id** element is the declaration of the identifier property. The **name="id"** mapping attribute declares the name of the JavaBean property and tells Hibernate to use the **getId()** and **setId()** methods to access the property. The **column** attribute tells Hibernate which column of the **EVENTS** table holds the primary key value.

The nested **generator** element specifies the identifier generation strategy (aka how are identifier values generated?). In this case we choose **native**, which offers a level of portability depending on the configured database dialect. Hibernate supports database generated, globally unique, as well as application assigned, identifiers. Identifier value generation is also one of Hibernate's many extension points and you can plug-in in your own strategy.



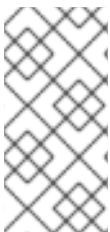
NOTE

native is no longer considered the best strategy in terms of portability. for further discussion, see [Section 25.4, "Identifier generation"](#)

Lastly, we need to tell Hibernate about the remaining entity class properties. By default, no properties of the class are considered persistent:

```
<hibernate-mapping package="org.hibernate.tutorial.domain">
    <class name="Event" table="EVENTS">
        <id name="id" column="EVENT_ID">
            <generator class="native"/>
        </id>
        <property name="date" type="timestamp" column="EVENT_DATE"/>
        <property name="title"/>
    </class>
</hibernate-mapping>
```

Similar to the **id** element, the **name** attribute of the **property** element tells Hibernate which getter and setter methods to use. In this case, Hibernate will search for **getDate()**, **setDate()**, **getTitle()** and **setTitle()** methods.



NOTE

Why does the **date** property mapping include the **column** attribute, but the **title** does not? Without the **column** attribute, Hibernate by default uses the property name as the column name. This works for **title**, however, **date** is a reserved keyword in most databases so you will need to map it to a different name.

The **title** mapping also lacks a **type** attribute. The types declared and used in the mapping files are not Java data types; they are not SQL database types either. These types are called *Hibernate mapping types*, converters which can translate from Java to SQL data types and vice versa. Again, Hibernate will try to determine the correct conversion and mapping type itself if the **type** attribute is not present in the mapping. In some cases this automatic detection using Reflection on the Java class might not have the default you expect or need. This is the case with the **date** property. Hibernate cannot know if the property, which is of `java.util.Date`, should map to a SQL **date**, **timestamp**, or **time** column. Full date and time information is preserved by mapping the property with a **timestamp** converter.



NOTE

Hibernate makes this mapping type determination using reflection when the mapping files are processed. This can take time and resources, so if start up performance is important you should consider explicitly defining the type to use.

Save this mapping file as

```
src/main/resources/org/hibernate/tutorial/domain/Event.hbm.xml.
```

1.1.4. Hibernate configuration

At this point, you should have the persistent class and its mapping file in place. It is now time to configure Hibernate. First let us set up HSQLDB to run in "server mode"



NOTE

We do this do that the data remains between runs.

We will utilize the Maven exec plug-in to launch the HSQLDB server by running: `mvn exec:java -Dexec.mainClass="org.hsqldb.Server" -Dexec.args="-database.0 file:target/data/tutorial"` You will see it start up and bind to a TCP/IP socket; this is where our application will connect later. If you want to start with a fresh database during this tutorial, shutdown HSQLDB, delete all files in the `target/data` directory, and start HSQLDB again.

Hibernate will be connecting to the database on behalf of your application, so it needs to know how to obtain connections. For this tutorial we will be using a standalone connection pool (as opposed to a `javax.sql.DataSource`). Hibernate comes with support for two third-party open source JDBC connection pools: `c3p0` and `proxool`. However, we will be using the Hibernate built-in connection pool for this tutorial.



WARNING

The built-in Hibernate connection pool is not intended for production use.

For Hibernate's configuration, we can use a simple `hibernate.properties` file, a more sophisticated `hibernate.cfg.xml` file, or even complete programmatic setup. Most users prefer the XML configuration file:

```

<?xml version='1.0' encoding='utf-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-configuration-
3.0.dtd">

<hibernate-configuration>

    <session-factory>

        <!-- Database connection settings -->
        <property
name="connection.driver_class">org.hsqldb.jdbcDriver</property>
        <property
name="connection.url">jdbc:hsqldb:hsqldb://localhost</property>
        <property name="connection.username">sa</property>
        <property name="connection.password"></property>

        <!-- JDBC connection pool (use the built-in) -->
        <property name="connection.pool_size">1</property>

        <!-- SQL dialect -->
        <property
name="dialect">org.hibernate.dialect.HSQLDialect</property>

        <!-- Enable Hibernate's automatic session context management -->
        <property name="current_session_context_class">thread</property>

        <!-- Disable the second-level cache -->
        <property
name="cache.provider_class">org.hibernate.cache.NoCacheProvider</property>

        <!-- Echo all executed SQL to stdout -->
        <property name="show_sql">>true</property>

        <!-- Drop and re-create the database schema on startup -->
        <property name="hbm2ddl.auto">update</property>

        <mapping resource="org/hibernate/tutorial/domain/Event.hbm.xml"/>

    </session-factory>

</hibernate-configuration>

```



NOTE

Notice that this configuration file specifies a different DTD

You configure Hibernate's **SessionFactory**. SessionFactory is a global factory responsible for a particular database. If you have several databases, for easier start up you should use several **<session-factory>** configurations in several configuration files.

The first four **property** elements contain the necessary configuration for the JDBC connection. The dialect **property** element specifies the particular SQL variant Hibernate generates.

**NOTE**

Hibernate is able to correctly determine which dialect to use in most cases. See [Section 25.3, “Dialect resolution”](#) for more information.

Hibernate's automatic session management for persistence contexts is particularly useful in this context. The `hbm2ddl.auto` option turns on automatic generation of database schemas directly into the database. This can also be turned off by removing the configuration option, or redirected to a file with the help of the `SchemaExport` Ant task. Finally, add the mapping file(s) for persistent classes to the configuration.

Save this file as `hibernate.cfg.xml` into the `src/main/resources` directory.

1.1.5. Building with Maven

We will now build the tutorial with Maven. You will need to have Maven installed; it is available from the [Maven download page](#). Maven will read the `/pom.xml` file we created earlier and know how to perform some basic project tasks. First, lets run the `compile` goal to make sure we can compile everything so far:

```
[hibernateTutorial]$ mvn compile
[INFO] Scanning for projects...
[INFO] -----
-----
[INFO] Building First Hibernate Tutorial
[INFO]    task-segment: [compile]
[INFO] -----
-----
[INFO] [resources:resources]
[INFO] Using default encoding to copy filtered resources.
[INFO] [compiler:compile]
[INFO] Compiling 1 source file to
/home/steve/projects/sandbox/hibernateTutorial/target/classes
[INFO] -----
-----
[INFO] BUILD SUCCESSFUL
[INFO] -----
-----
[INFO] Total time: 2 seconds
[INFO] Finished at: Tue Jun 09 12:25:25 CDT 2009
[INFO] Final Memory: 5M/547M
[INFO] -----
-----
```

1.1.6. Start up and helpers

It is time to load and store some `Event` objects, but first you have to complete the setup with some infrastructure code. You have to start Hibernate by building a global `org.hibernate.SessionFactory` object and storing it somewhere for easy access in application code. A `org.hibernate.SessionFactory` is used to obtain `org.hibernate.Session` instances. A `org.hibernate.Session` represents a single-threaded unit of work. The `org.hibernate.SessionFactory` is a thread-safe global object that is instantiated once.

We will create a `HibernateUtil` helper class that takes care of start up and makes accessing the `org.hibernate.SessionFactory` more convenient.

```
package org.hibernate.tutorial.util;

import org.hibernate.SessionFactory;
import org.hibernate.cfg.Configuration;

public class HibernateUtil {

    private static final SessionFactory sessionFactory =
buildSessionFactory();

    private static SessionFactory buildSessionFactory() {
        try {
            // Create the SessionFactory from hibernate.cfg.xml
            return new Configuration().configure().buildSessionFactory();
        }
        catch (Throwable ex) {
            // Make sure you log the exception, as it might be swallowed
            System.err.println("Initial SessionFactory creation failed." +
ex);
            throw new ExceptionInInitializerError(ex);
        }
    }

    public static SessionFactory getSessionFactory() {
        return sessionFactory;
    }
}
```

Save this code as `src/main/java/org/hibernate/tutorial/util/HibernateUtil.java`

This class not only produces the global `org.hibernate.SessionFactory` reference in its static initializer; it also hides the fact that it uses a static singleton. We might just as well have looked up the `org.hibernate.SessionFactory` reference from JNDI in an application server or any other location for that matter.

If you give the `org.hibernate.SessionFactory` a name in your configuration, Hibernate will try to bind it to JNDI under that name after it has been built. Another, better option is to use a JMX deployment and let the JMX-capable container instantiate and bind a `HibernateService` to JNDI. Such advanced options are discussed later.

You now need to configure a logging system. Hibernate uses commons logging and provides two choices: Log4j and JDK 1.4 logging. Most developers prefer Log4j: copy `log4j.properties` from the Hibernate distribution in the `etc/` directory to your `src` directory, next to `hibernate.cfg.xml`. If you prefer to have more verbose output than that provided in the example configuration, you can change the settings. By default, only the Hibernate start up message is shown on stdout.

The tutorial infrastructure is complete and you are now ready to do some real work with Hibernate.

1.1.7. Loading and storing objects

We are now ready to start doing some real work with Hibernate. Let us start by writing an **EventManager** class with a **main()** method:

```
package org.hibernate.tutorial;

import org.hibernate.Session;

import java.util.*;

import org.hibernate.tutorial.domain.Event;
import org.hibernate.tutorial.util.HibernateUtil;

public class EventManager {

    public static void main(String[] args) {
        EventManager mgr = new EventManager();

        if (args[0].equals("store")) {
            mgr.createAndStoreEvent("My Event", new Date());
        }

        HibernateUtil.getSessionFactory().close();
    }

    private void createAndStoreEvent(String title, Date theDate) {
        Session session =
HibernateUtil.getSessionFactory().getCurrentSession();
        session.beginTransaction();

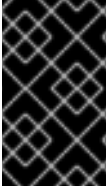
        Event theEvent = new Event();
        theEvent.setTitle(title);
        theEvent.setDate(theDate);
        session.save(theEvent);

        session.getTransaction().commit();
    }
}
```

In **createAndStoreEvent()** we created a new **Event** object and handed it over to Hibernate. At that point, Hibernate takes care of the SQL and executes an **INSERT** on the database.

An `org.hibernate.Session` is designed to represent a single unit of work (a single atomic piece of work to be performed). For now we will keep things simple and assume a one-to-one granularity between a Hibernate `org.hibernate.Session` and a database transaction. To shield our code from the actual underlying transaction system we use the Hibernate **org.hibernate.Transaction** API. In this particular case we are using JDBC-based transactional semantics, but it could also run with JTA.

What does **sessionFactory.getCurrentSession()** do? First, you can call it as many times and anywhere you like once you get hold of your **org.hibernate.SessionFactory**. The **getCurrentSession()** method always returns the "current" unit of work. Remember that we switched the configuration option for this mechanism to "thread" in our **src/main/resources/hibernate.cfg.xml**? Due to that setting, the context of a current unit of work is bound to the current Java thread that executes the application.



IMPORTANT

Hibernate offers three methods of current session tracking. The "thread" based method is not intended for production use; it is merely useful for prototyping and tutorials such as this one. Current session tracking is discussed in more detail later on.

An `org.hibernate.Session` begins when the first call to `getCurrentSession()` is made for the current thread. It is then bound by Hibernate to the current thread. When the transaction ends, either through commit or rollback, Hibernate automatically unbinds the `org.hibernate.Session` from the thread and closes it for you. If you call `getCurrentSession()` again, you get a new `org.hibernate.Session` and can start a new unit of work.

Related to the unit of work scope, should the Hibernate `org.hibernate.Session` be used to execute one or several database operations? The above example uses one `org.hibernate.Session` for one operation. However this is pure coincidence; the example is just not complex enough to show any other approach. The scope of a Hibernate `org.hibernate.Session` is flexible but you should never design your application to use a new Hibernate `org.hibernate.Session` for *every* database operation. Even though it is used in the following examples, consider *session-per-operation* an anti-pattern. A real web application is shown later in the tutorial which will help illustrate this.

See [Chapter 11, Transactions and Concurrency](#) for more information about transaction handling and demarcation. The previous example also skipped any error handling and rollback.

To run this, we will make use of the Maven `exec` plug-in to call our class with the necessary classpath setup: `mvn exec:java -Dexec.mainClass="org.hibernate.tutorial.EventManager" -Dexec.args="store"`



NOTE

You may need to perform `mvn compile` first.

You should see Hibernate starting up and, depending on your configuration, lots of log output. Towards the end, the following line will be displayed:

```
[java] Hibernate: insert into EVENTS (EVENT_DATE, title, EVENT_ID) values
(?, ?, ?)
```

This is the **INSERT** executed by Hibernate.

To list stored events an option is added to the main method:

```
if (args[0].equals("store")) {
    mgr.createAndStoreEvent("My Event", new Date());
}
else if (args[0].equals("list")) {
    List events = mgr.listEvents();
    for (int i = 0; i < events.size(); i++) {
        Event theEvent = (Event) events.get(i);
        System.out.println(
            "Event: " + theEvent.getTitle() + " Time: " +
theEvent.getDate()
        );
    }
}
```

A new `listEvents()` method is also added:

```
private List listEvents() {
    Session session =
    HibernateUtil.getSessionFactory().getCurrentSession();
    session.beginTransaction();
    List result = session.createQuery("from Event").list();
    session.getTransaction().commit();
    return result;
}
```

Here, we are using a Hibernate Query Language (HQL) query to load all existing **Event** objects from the database. Hibernate will generate the appropriate SQL, send it to the database and populate **Event** objects with the data. You can create more complex queries with HQL. See [Chapter 14, HQL: The Hibernate Query Language](#) for more information.

Now we can call our new functionality, again using the Maven exec plug-in: `mvn exec:java -Dexec.mainClass="org.hibernate.tutorial.EventManager" -Dexec.args="list"`

1.2. PART 2 - MAPPING ASSOCIATIONS

So far we have mapped a single persistent entity class to a table in isolation. Let us expand on that a bit and add some class associations. We will add people to the application and store a list of events in which they participate.

1.2.1. Mapping the Person class

The first cut of the **Person** class looks like this:

```
package org.hibernate.tutorial.domain;

public class Person {

    private Long id;
    private int age;
    private String firstname;
    private String lastname;

    public Person() {}

    // Accessor methods for all properties, private setter for 'id'
}
```

Save this to a file named `src/main/java/org/hibernate/tutorial/domain/Person.java`

Next, create the new mapping file as `src/main/resources/org/hibernate/tutorial/domain/Person.hbm.xml`

```
<hibernate-mapping package="org.hibernate.tutorial.domain">

    <class name="Person" table="PERSON">
        <id name="id" column="PERSON_ID">
```



```

        <generator class="native"/>
    </id>
    <property name="age"/>
    <property name="firstname"/>
    <property name="lastname"/>
</class>

</hibernate-mapping>

```

Finally, add the new mapping to Hibernate's configuration immediately after the existing mapping for `Event.hbm.xml`:

```

<mapping resource="events/Event.hbm.xml"/>
<mapping resource="events/Person.hbm.xml"/>

```

Create an association between these two entities. Persons can participate in events, and events have participants. The design questions you have to deal with are: directionality, multiplicity, and collection behavior.

1.2.2. A unidirectional Set-based association

By adding a collection of events to the `Person` class, you can easily navigate to the events for a particular person, without executing an explicit query - by calling `Person#getEvents`. Multi-valued associations are represented in Hibernate by one of the Java Collection Framework contracts; here we choose a `java.util.Set` because the collection will not contain duplicate elements and the ordering is not relevant to our examples:

```

public class Person {

    private Set events = new HashSet();

    public Set getEvents() {
        return events;
    }

    public void setEvents(Set events) {
        this.events = events;
    }
}

```

Before mapping this association, let us consider the other side. We could just keep this unidirectional or create another collection on the `Event`, if we wanted to be able to navigate it from both directions. This is not necessary, from a functional perspective. You can always execute an explicit query to retrieve the participants for a particular event. This is a design choice left to you, but what is clear from this discussion is the multiplicity of the association: "many" valued on both sides is called a *many-to-many* association. Hence, we use Hibernate's many-to-many mapping:

```

<class name="Person" table="PERSON">
    <id name="id" column="PERSON_ID">
        <generator class="native"/>
    </id>
    <property name="age"/>
    <property name="firstname"/>
    <property name="lastname"/>

```

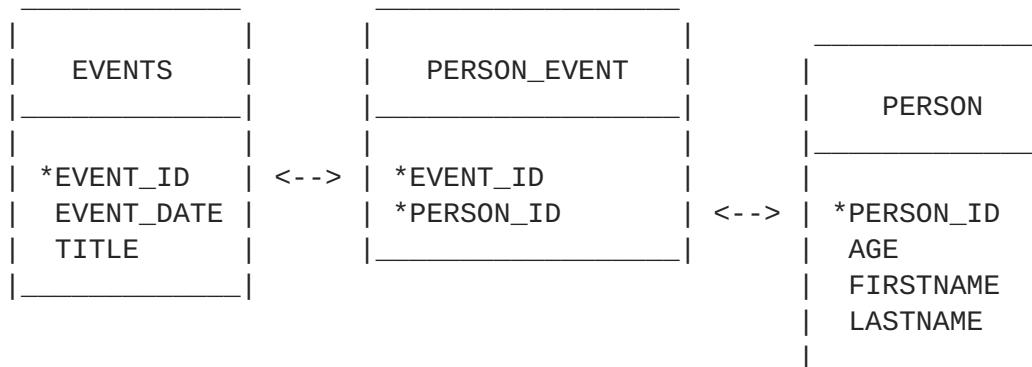
```

<set name="events" table="PERSON_EVENT">
  <key column="PERSON_ID"/>
  <many-to-many column="EVENT_ID" class="Event"/>
</set>

</class>
    
```

Hibernate supports a broad range of collection mappings, a **set** being most common. For a many-to-many association, or *n:m* entity relationship, an association table is required. Each row in this table represents a link between a person and an event. The table name is declared using the **table** attribute of the **set** element. The identifier column name in the association, for the person side, is defined with the **key** element, the column name for the event's side with the **column** attribute of the **many-to-many**. You also have to tell Hibernate the class of the objects in your collection (the class on the other side of the collection of references).

The database schema for this mapping is therefore:



1.2.3. Working the association

Now we will bring some people and events together in a new method in **EventManager**:

```

private void addPersonToEvent(Long personId, Long eventId) {
    Session session =
    HibernateUtil.getSessionFactory().getCurrentSession();
    session.beginTransaction();

    Person aPerson = (Person) session.load(Person.class, personId);
    Event anEvent = (Event) session.load(Event.class, eventId);
    aPerson.getEvents().add(anEvent);

    session.getTransaction().commit();
}
    
```

After loading a **Person** and an **Event**, simply modify the collection using the normal collection methods. There is no explicit call to **update()** or **save()**; Hibernate automatically detects that the collection has been modified and needs to be updated. This is called *automatic dirty checking*. You can also try it by modifying the name or the date property of any of your objects. As long as they are in *persistent* state, that is, bound to a particular Hibernate **org.hibernate.Session**, Hibernate monitors any changes and executes SQL in a write-behind fashion. The process of synchronizing the memory state with the database, usually only at the end of a unit of work, is called *flushing*. In our code, the unit of work ends with a commit, or rollback, of the database transaction.

You can load person and event in different units of work. Or you can modify an object outside of an **org.hibernate.Session**, when it is not in a persistent state (if it was persistent before, this state is called *detached*). You can even modify a collection when it is detached:

```
private void addPersonToEvent(Long personId, Long eventId) {
    Session session =
HibernateUtil.getSessionFactory().getCurrentSession();
    session.beginTransaction();

    Person aPerson = (Person) session
        .createQuery("select p from Person p left join fetch
p.events where p.id = :pid")
        .setParameter("pid", personId)
        .uniqueResult(); // Eager fetch the collection so we can
use it detached
    Event anEvent = (Event) session.load(Event.class, eventId);

    session.getTransaction().commit();

    // End of first unit of work

    aPerson.getEvents().add(anEvent); // aPerson (and its collection)
is detached

    // Begin second unit of work

    Session session2 =
HibernateUtil.getSessionFactory().getCurrentSession();
    session2.beginTransaction();
    session2.update(aPerson); // Reattachment of aPerson

    session2.getTransaction().commit();
}
```

The call to **update** makes a detached object persistent again by binding it to a new unit of work, so any modifications you made to it while detached can be saved to the database. This includes any modifications (additions/deletions) you made to a collection of that entity object.

This is not much use in our example, but it is an important concept you can incorporate into your own application. Complete this exercise by adding a new action to the main method of the **EventManager** and call it from the command line. If you need the identifiers of a person and an event - the **save()** method returns it (you might have to modify some of the previous methods to return that identifier):

```
else if (args[0].equals("addpersontoevent")) {
    Long eventId = mgr.createAndStoreEvent("My Event", new
Date());
    Long personId = mgr.createAndStorePerson("Foo", "Bar");
    mgr.addPersonToEvent(personId, eventId);
    System.out.println("Added person " + personId + " to event " +
eventId);
}
```

This is an example of an association between two equally important classes: two entities. As mentioned earlier, there are other classes and types in a typical model, usually "less important". Some you have already seen, like an **int** or a **java.lang.String**. We call these classes *value types*, and their

instances *depend* on a particular entity. Instances of these types do not have their own identity, nor are they shared between entities. Two persons do not reference the same **firstname** object, even if they have the same first name. Value types cannot only be found in the JDK, but you can also write dependent classes yourself such as an **Address** or **MonetaryAmount** class. In fact, in a Hibernate application all JDK classes are considered value types.

You can also design a collection of value types. This is conceptually different from a collection of references to other entities, but looks almost the same in Java.

1.2.4. Collection of values

Let us add a collection of email addresses to the **Person** entity. This will be represented as a **java.util.Set** of **java.lang.String** instances:

```
private Set emailAddresses = new HashSet();

public Set getEmailAddresses() {
    return emailAddresses;
}

public void setEmailAddresses(Set emailAddresses) {
    this.emailAddresses = emailAddresses;
}
```

The mapping of this **Set** is as follows:

```
<set name="emailAddresses" table="PERSON_EMAIL_ADDR">
  <key column="PERSON_ID"/>
  <element type="string" column="EMAIL_ADDR"/>
</set>
```

The difference compared with the earlier mapping is the use of the **element** part which tells Hibernate that the collection does not contain references to another entity, but is rather a collection whose elements are value types, here specifically of type **string**. The lowercase name tells you it is a Hibernate mapping type/converter. Again the **table** attribute of the **set** element determines the table name for the collection. The **key** element defines the foreign-key column name in the collection table. The **column** attribute in the **element** element defines the column name where the email address values will actually be stored.

Here is the updated schema:

EVENTS	PERSON_EVENT		
		PERSON	
PERSON_EMAIL_ADDR			
*EVENT_ID	<-->	*EVENT_ID	
EVENT_DATE		*PERSON_ID	<-->
*PERSON_ID		*PERSON_ID	<-->
TITLE		AGE	

*EMAIL_ADDR				FIRSTNAME	
_____				LASTNAME	
_____				_____	

You can see that the primary key of the collection table is in fact a composite key that uses both columns. This also implies that there cannot be duplicate email addresses per person, which is exactly the semantics we need for a set in Java.

You can now try to add elements to this collection, just like we did before by linking persons and events. It is the same code in Java:

```
private void addEmailToPerson(Long personId, String emailAddress) {
    Session session =
HibernateUtil.getSessionFactory().getCurrentSession();
    session.beginTransaction();

    Person aPerson = (Person) session.load(Person.class, personId);
    // adding to the emailAddress collection might trigger a lazy load
of the collection
    aPerson.getEmailAddresses().add(emailAddress);

    session.getTransaction().commit();
}
```

This time we did not use a *fetch* query to initialize the collection. Monitor the SQL log and try to optimize this with an eager fetch.

1.2.5. Bi-directional associations

Next you will map a bi-directional association. You will make the association between person and event work from both sides in Java. The database schema does not change, so you will still have many-to-many multiplicity.



NOTE

A relational database is more flexible than a network programming language, in that it does not need a navigation direction; data can be viewed and retrieved in any possible way.

First, add a collection of participants to the **Event** class:

```
private Set participants = new HashSet();

public Set getParticipants() {
    return participants;
}

public void setParticipants(Set participants) {
    this.participants = participants;
}
```

Now map this side of the association in **Event.hbm.xml**.

```

<set name="participants" table="PERSON_EVENT" inverse="true">
  <key column="EVENT_ID"/>
  <many-to-many column="PERSON_ID"
class="org.hibernate.tutorial.domain.Person"/>
</set>
    
```

These are normal **set** mappings in both mapping documents. Notice that the column names in **key** and **many-to-many** swap in both mapping documents. The most important addition here is the **inverse="true"** attribute in the **set** element of the **Event**'s collection mapping.

What this means is that Hibernate should take the other side, the **Person** class, when it needs to find out information about the link between the two. This will be a lot easier to understand once you see how the bi-directional link between our two entities is created.

1.2.6. Working bi-directional links

First, keep in mind that Hibernate does not affect normal Java semantics. How did we create a link between a **Person** and an **Event** in the unidirectional example? You add an instance of **Event** to the collection of event references, of an instance of **Person**. If you want to make this link bi-directional, you have to do the same on the other side by adding a **Person** reference to the collection in an **Event**. This process of "setting the link on both sides" is absolutely necessary with bi-directional links.

Many developers program defensively and create link management methods to correctly set both sides (for example, in **Person**):

```

protected Set getEvents() {
    return events;
}

protected void setEvents(Set events) {
    this.events = events;
}

public void addToEvent(Event event) {
    this.getEvents().add(event);
    event.getParticipants().add(this);
}

public void removeFromEvent(Event event) {
    this.getEvents().remove(event);
    event.getParticipants().remove(this);
}
    
```

The get and set methods for the collection are now protected. This allows classes in the same package and subclasses to still access the methods, but prevents everybody else from altering the collections directly. Repeat the steps for the collection on the other side.

What about the **inverse** mapping attribute? For you, and for Java, a bi-directional link is simply a matter of setting the references on both sides correctly. Hibernate, however, does not have enough information to correctly arrange SQL **INSERT** and **UPDATE** statements (to avoid constraint violations). Making one side of the association **inverse** tells Hibernate to consider it a *mirror* of the other side. That is all that is necessary for Hibernate to resolve any issues that arise when transforming a directional

navigation model to a SQL database schema. The rules are straightforward: all bi-directional associations need one side as **inverse**. In a one-to-many association it has to be the many-side, and in many-to-many association you can select either side.

1.3. PART 3 - THE EVENTMANAGER WEB APPLICATION

A Hibernate web application uses **Session** and **Transaction** almost like a standalone application. However, some common patterns are useful. You can now write an **EventManagerServlet**. This servlet can list all events stored in the database, and it provides an HTML form to enter new events.

1.3.1. Writing the basic servlet

First we need create our basic processing servlet. Since our servlet only handles HTTP **GET** requests, we will only implement the **doGet()** method:

```
package org.hibernate.tutorial.web;

// Imports

public class EventManagerServlet extends HttpServlet {

    protected void doGet(
        HttpServletRequest request,
        HttpServletResponse response) throws ServletException,
        IOException {

        SimpleDateFormat dateFormatter = new SimpleDateFormat(
            "dd.MM.yyyy" );

        try {
            // Begin unit of work

            HibernateUtil.getSessionFactory().getCurrentSession().beginTransaction();

            // Process request and render page...

            // End unit of work

            HibernateUtil.getSessionFactory().getCurrentSession().getTransaction().commit();
        }
        catch (Exception ex) {

            HibernateUtil.getSessionFactory().getCurrentSession().getTransaction().rollback();

            if ( ServletException.class.isInstance( ex ) ) {
                throw ( ServletException ) ex;
            }
            else {
                throw new ServletException( ex );
            }
        }
    }
}
```

Save this servlet as

```
src/main/java/org/hibernate/tutorial/web/EventManagerServlet.java
```

The pattern applied here is called *session-per-request*. When a request hits the servlet, a new Hibernate **Session** is opened through the first call to `getCurrentSession()` on the **SessionFactory**. A database transaction is then started. All data access occurs inside a transaction irrespective of whether the data is read or written. Do not use the auto-commit mode in applications.

Do *not* use a new Hibernate **Session** for every database operation. Use one Hibernate **Session** that is scoped to the whole request. Use `getCurrentSession()`, so that it is automatically bound to the current Java thread.

Next, the possible actions of the request are processed and the response HTML is rendered. We will get to that part soon.

Finally, the unit of work ends when processing and rendering are complete. If any problems occurred during processing or rendering, an exception will be thrown and the database transaction rolled back. This completes the **session-per-request** pattern. Instead of the transaction demarcation code in every servlet, you could also write a servlet filter. See the Hibernate website and Wiki for more information about this pattern called *Open Session in View*. You will need it as soon as you consider rendering your view in JSP, not in a servlet.

1.3.2. Processing and rendering

Now you can implement the processing of the request and the rendering of the page.

```

        // Write HTML header
        PrintWriter out = response.getWriter();
        out.println("<html><head><title>Event Manager</title></head>
<body>");

        // Handle actions
        if ( "store".equals(request.getParameter("action")) ) {

            String eventTitle = request.getParameter("eventTitle");
            String eventDate = request.getParameter("eventDate");

            if ( "".equals(eventTitle) || "".equals(eventDate) ) {
                out.println("<b><i>Please enter event title and date.</i>
</b>");
            }
            else {
                createAndStoreEvent(eventTitle,
dateFormatter.parse(eventDate));
                out.println("<b><i>Added event.</i></b>");
            }
        }

        // Print page
        printEventForm(out);
        listEvents(out, dateFormatter);

        // Write HTML footer
        out.println("</body></html>");
        out.flush();
    
```



```
out.close();
```

This coding style, with a mix of Java and HTML, would not scale in a more complex application—keep in mind that we are only illustrating basic Hibernate concepts in this tutorial. The code prints an HTML header and a footer. Inside this page, an HTML form for event entry and a list of all events in the database are printed. The first method is trivial and only outputs HTML:

```
private void printEventForm(PrintWriter out) {
    out.println("<h2>Add new event:</h2>");
    out.println("<form>");
    out.println("Title: <input name='eventTitle' length='50' /><br/>");
    out.println("Date (e.g. 24.12.2009): <input name='eventDate'
length='10' /><br/>");
    out.println("<input type='submit' name='action' value='store' />");
    out.println("</form>");
}
```

The `listEvents()` method uses the Hibernate `Session` bound to the current thread to execute a query:

```
private void listEvents(PrintWriter out, SimpleDateFormat
dateFormatter) {

    List result = HibernateUtil.getSessionFactory()
        .getCurrentSession().createCriteria(Event.class).list();
    if (result.size() > 0) {
        out.println("<h2>Events in database:</h2>");
        out.println("<table border='1'>");
        out.println("<tr>");
        out.println("<th>Event title</th>");
        out.println("<th>Event date</th>");
        out.println("</tr>");
        Iterator it = result.iterator();
        while (it.hasNext()) {
            Event event = (Event) it.next();
            out.println("<tr>");
            out.println("<td>" + event.getTitle() + "</td>");
            out.println("<td>" +
dateFormatter.format(event.getDate()) + "</td>");
            out.println("</tr>");
        }
        out.println("</table>");
    }
}
```

Finally, the `store` action is dispatched to the `createAndStoreEvent()` method, which also uses the `Session` of the current thread:

```
protected void createAndStoreEvent(String title, Date theDate) {
    Event theEvent = new Event();
    theEvent.setTitle(title);
    theEvent.setDate(theDate);
}
```

```

        HibernateUtil.getSessionFactory()
            .getCurrentSession().save(theEvent);
    }

```

The servlet is now complete. A request to the servlet will be processed in a single **Session** and **Transaction**. As earlier in the standalone application, Hibernate can automatically bind these objects to the current thread of execution. This gives you the freedom to layer your code and access the **SessionFactory** in any way you like. Usually you would use a more sophisticated design and move the data access code into data access objects (the DAO pattern). See the Hibernate Wiki for more examples.

1.3.3. Deploying and testing

To deploy this application for testing we must create a Web ARchive (WAR). First we must define the WAR descriptor as `src/main/webapp/WEB-INF/web.xml`

```

<?xml version="1.0" encoding="UTF-8"?>
<web-app version="2.4"
  xmlns="http://java.sun.com/xml/ns/j2ee"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://java.sun.com/xml/ns/j2ee
http://java.sun.com/xml/ns/j2ee/web-app_2_4.xsd">

  <servlet>
    <servlet-name>Event Manager</servlet-name>
    <servlet-
class>org.hibernate.tutorial.web.EventManagerServlet</servlet-class>
  </servlet>

  <servlet-mapping>
    <servlet-name>Event Manager</servlet-name>
    <url-pattern>/eventmanager</url-pattern>
  </servlet-mapping>
</web-app>

```

To build and deploy call `mvn package` in your project directory and copy the `hibernate-tutorial.war` file into your `$JBOSS_HOME/server/$CONFIG/deploy` directory.

Once deployed and JBoss is running, access the application at `http://localhost:8080/hibernate-tutorial/eventmanager`. Watch the server log (in `$JBOSS_HOME/server/$CONFIG/log/server.log`) to see Hibernate initialize when the first request hits your servlet (the static initializer in `HibernateUtil` is called) and to get the detailed output if any exceptions occurs.

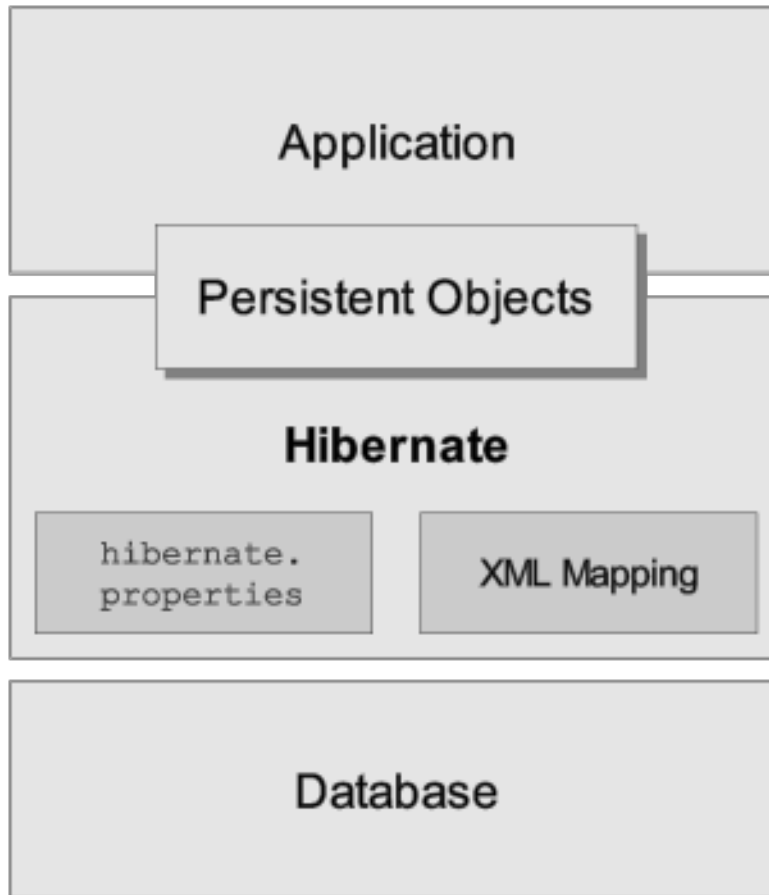
1.4. SUMMARY

This tutorial covered the basics of writing a simple standalone Hibernate application and a small web application. More tutorials are available from the Hibernate [website](#).

CHAPTER 2. ARCHITECTURE

2.1. OVERVIEW

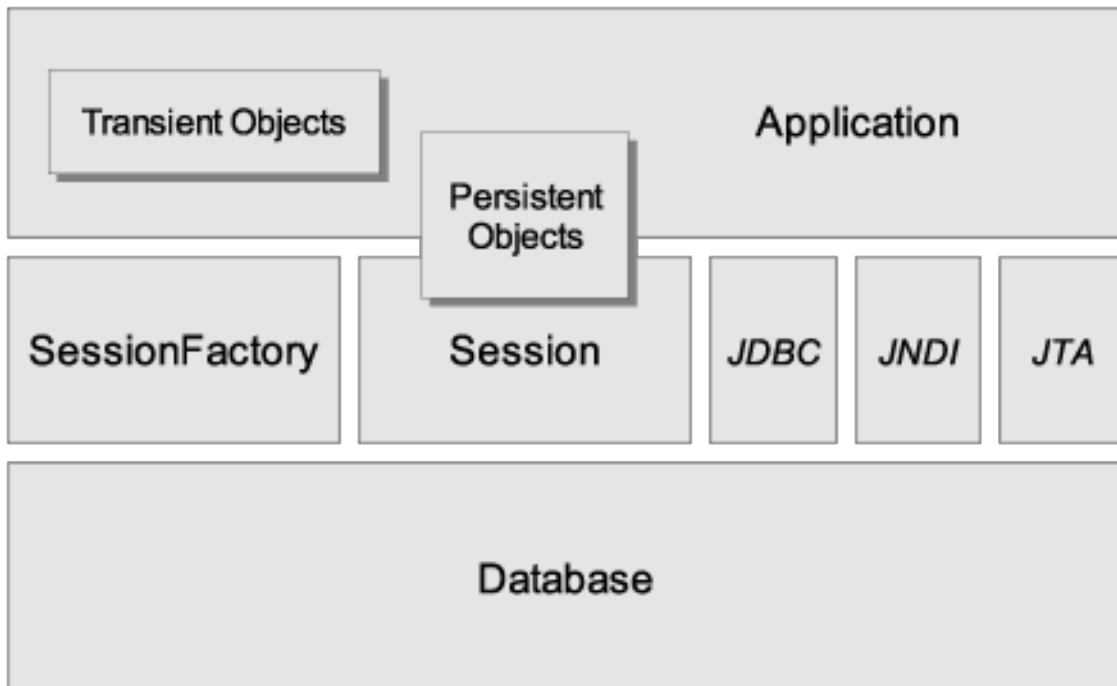
The diagram below provides a high-level view of the Hibernate architecture:



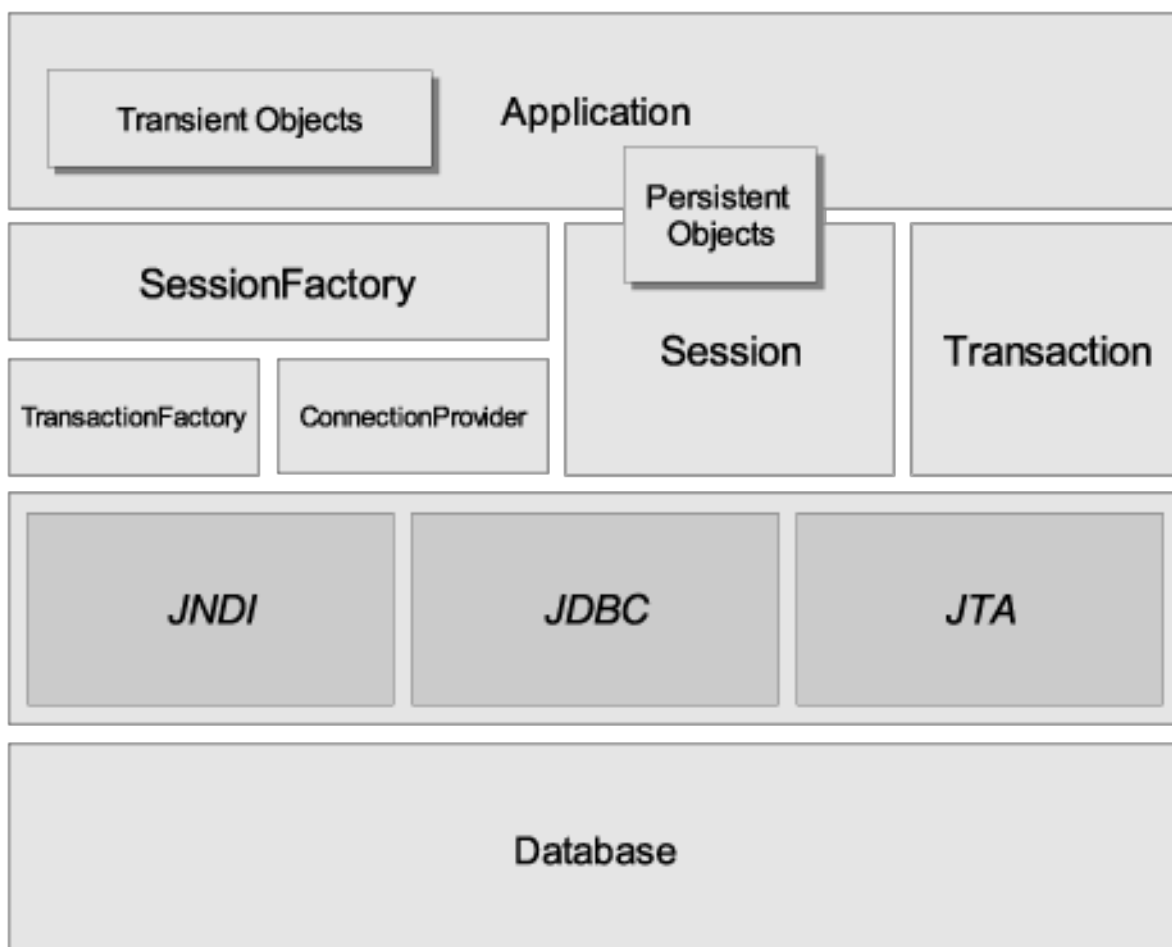
We do not have the scope in this document to provide a more detailed view of all the runtime architectures available; Hibernate is flexible and supports several different approaches. We will, however, show the two extremes: "minimal" architecture and "comprehensive" architecture.

This next diagram illustrates how Hibernate utilizes database and configuration data to provide persistence services, and persistent objects, to the application.

The "minimal" architecture has the application provide its own JDBC connections and manage its own transactions. This approach uses a minimal subset of Hibernate's APIs:



The "comprehensive" architecture abstracts the application away from the underlying JDBC/JTA APIs and allows Hibernate to manage the details.



Here are some definitions of the objects depicted in the diagrams:

SessionFactory (`org.hibernate.SessionFactory`)

A threadsafe, immutable cache of compiled mappings for a single database. A factory for **Session** and a client of **ConnectionProvider**, **SessionFactory** can hold an optional (second-level) cache of data that is reusable between transactions at a process, or cluster, level.

Session (org.hibernate.Session)

A single-threaded, short-lived object representing a conversation between the application and the persistent store. It wraps a JDBC connection and is a factory for **Transaction**. **Session** holds a mandatory first-level cache of persistent objects that are used when navigating the object graph or looking up objects by identifier.

Persistent objects and collections

Short-lived, single threaded objects containing persistent state and business function. These can be ordinary JavaBeans/POJOs. They are associated with exactly one **Session**. Once the **Session** is closed, they will be detached and free to use in any application layer (for example, directly as data transfer objects to and from presentation).

Transient and detached objects and collections

Instances of persistent classes that are not currently associated with a **Session**. They may have been instantiated by the application and not yet persisted, or they may have been instantiated by a closed **Session**.

Transaction (org.hibernate.Transaction)

(Optional) A single-threaded, short-lived object used by the application to specify atomic units of work. It abstracts the application from the underlying JDBC, JTA or CORBA transaction. A **Session** might span several **Transactions** in some cases. However, transaction demarcation, either using the underlying API or **Transaction**, is never optional.

ConnectionProvider (org.hibernate.connection.ConnectionProvider)

(Optional) A factory for, and pool of, JDBC connections. It abstracts the application from underlying **Datasource** or **DriverManager**. It is not exposed to application, but it can be extended and/or implemented by the developer.

SessionFactory (org.hibernate.SessionFactory)

(Optional) A factory for **Transaction** instances. It is not exposed to the application, but it can be extended and/or implemented by the developer.

Extension Interfaces

Hibernate offers a range of optional extension interfaces you can implement to customize the behavior of your persistence layer. See the API documentation for details.

Given a "minimal" architecture, the application bypasses the **Transaction/SessionFactory** and/or **ConnectionProvider** APIs to communicate with JTA or JDBC directly.

2.2. INSTANCE STATES

An instance of a persistent class can be in one of three different states. These states are defined in relation to a *persistence context*. The Hibernate **Session** object is the persistence context. The three different states are as follows:

transient

The instance is not associated with any persistence context. It has no persistent identity or primary key value.

persistent

The instance is currently associated with a persistence context. It has a persistent identity (primary key value) and can have a corresponding row in the database. For a particular persistence context, Hibernate *guarantees* that persistent identity is equivalent to Java identity in relation to the in-memory location of the object.

detached

The instance was once associated with a persistence context, but that context was closed, or the instance was serialized to another process. It has a persistent identity and can have a corresponding row in the database. For detached instances, Hibernate does not guarantee the relationship between persistent identity and Java identity.

2.3. JMX INTEGRATION

JMX is the J2EE standard for the management of Java components. Hibernate can be managed via a JMX standard service. AN MBean implementation is provided in the distribution:
org.hibernate.jmx.HibernateService.

For an example of how to deploy Hibernate as a JMX service on the JBoss Enterprise Application Server, refer to [Section 3.8.4, “JMX deployment”](#).

Another feature available as a JMX service is runtime Hibernate statistics. See [Section 3.4.6, “Hibernate statistics”](#) for more information.

2.4. JCA SUPPORT

Hibernate can also be configured as a JCA connector. Please see the website for more information. Please note, however, that at this stage Hibernate JCA support is under development.

2.5. CONTEXTUAL SESSIONS

Most applications using Hibernate need some form of "contextual" session, where a given session is in effect throughout the scope of a given context. However, across applications the definition of what constitutes a context is typically different; different contexts define different scopes to the notion of current. Applications using Hibernate prior to version 3.0 tended to utilize either home-grown **ThreadLocal**-based contextual sessions, helper classes such as **HibernateUtil**, or utilized third-party frameworks, such as Spring or Pico, which provided proxy/interception-based contextual sessions.

Starting with version 3.0.1, Hibernate added the **SessionFactory.getCurrentSession()** method. Initially, this assumed usage of **JTA** transactions, where the **JTA** transaction defined both the scope and context of a current session. Given the maturity of the numerous stand-alone **JTA TransactionManager** implementations, most, if not all, applications should be using **JTA** transaction management, whether or not they are deployed into a **J2EE** container. Based on that, the **JTA**-based contextual sessions are all you need to use.

However, as of version 3.1, the processing behind **SessionFactory.getCurrentSession()** is now pluggable. To that end, a new extension interface, **org.hibernate.context.CurrentSessionContext**, and a new configuration parameter,

`hibernate.current_session_context_class`, have been added to allow pluggability of the scope and context of defining current sessions.

See the Javadocs for the `org.hibernate.context.CurrentSessionContext` interface for a detailed discussion of its contract. It defines a single method, `currentSession()`, by which the implementation is responsible for tracking the current contextual session. Out-of-the-box, Hibernate comes with three implementations of this interface:

- `org.hibernate.context.JTASessionContext`: current sessions are tracked and scoped by a **JTA** transaction. The processing here is exactly the same as in the older JTA-only approach. See the Javadocs for details.
- `org.hibernate.context.ThreadLocalSessionContext`: current sessions are tracked by thread of execution. See the Javadocs for details.
- `org.hibernate.context.ManagedSessionContext`: current sessions are tracked by thread of execution. However, you are responsible to bind and unbind a **Session** instance with static methods on this class: it does not open, flush, or close a **Session**.

The first two implementations provide a "one session - one database transaction" programming model. This is also known and used as *session-per-request*. The beginning and end of a Hibernate session is defined by the duration of a database transaction. If you use programmatic transaction demarcation in plain JSE without JTA, you are advised to use the Hibernate **Transaction** API to hide the underlying transaction system from your code. If you use JTA, you can utilize the JTA interfaces to demarcate transactions. If you execute in an EJB container that supports CMT, transaction boundaries are defined declaratively and you do not need any transaction or session demarcation operations in your code. Refer to [Chapter 11, *Transactions and Concurrency*](#) for more information and code examples.

The `hibernate.current_session_context_class` configuration parameter defines which `org.hibernate.context.CurrentSessionContext` implementation should be used. For backwards compatibility, if this configuration parameter is not set but a `org.hibernate.transaction.TransactionManagerLookup` is configured, Hibernate will use the `org.hibernate.context.JTASessionContext`. Typically, the value of this parameter would just name the implementation class to use. For the three out-of-the-box implementations, however, there are three corresponding short names: "jta", "thread", and "managed".

CHAPTER 3. CONFIGURATION

Hibernate is designed to operate in many different environments and, as such, there is a broad range of configuration parameters. Fortunately, most have sensible default values and Hibernate is distributed with an example `hibernate.properties` file in `etc/` that displays the various options. Simply put the example file in your classpath and customize it to suit your needs.

3.1. PROGRAMMATIC CONFIGURATION

An instance of `org.hibernate.cfg.Configuration` represents an entire set of mappings of an application's Java types to an SQL database. The `org.hibernate.cfg.Configuration` is used to build an immutable `org.hibernate.SessionFactory`. The mappings are compiled from various XML mapping files.

You can obtain a `org.hibernate.cfg.Configuration` instance by instantiating it directly and specifying XML mapping documents. If the mapping files are in the classpath, use `addResource()`. For example:

```
Configuration cfg = new Configuration()
    .addResource("Item.hbm.xml")
    .addResource("Bid.hbm.xml");
```

An alternative way is to specify the mapped class and allow Hibernate to find the mapping document for you:

```
Configuration cfg = new Configuration()
    .addClass(org.hibernate.auction.Item.class)
    .addClass(org.hibernate.auction.Bid.class);
```

Hibernate will then search for mapping files named `/org/hibernate/auction/Item.hbm.xml` and `/org/hibernate/auction/Bid.hbm.xml` in the classpath. This approach eliminates any hardcoded file names.

A `org.hibernate.cfg.Configuration` also allows you to specify configuration properties. For example:

```
Configuration cfg = new Configuration()
    .addClass(org.hibernate.auction.Item.class)
    .addClass(org.hibernate.auction.Bid.class)
    .setProperty("hibernate.dialect",
"org.hibernate.dialect.MySQLInnoDBDialect")
    .setProperty("hibernate.connection.datasource",
"java:comp/env/jdbc/test")
    .setProperty("hibernate.order_updates", "true");
```

This is not the only way to pass configuration properties to Hibernate. Some alternative options include:

1. Pass an instance of `java.util.Properties` to `Configuration.setProperties()`.
2. Place a file named `hibernate.properties` in a root directory of the classpath.
3. Set `System` properties using `java -Dproperty=value`.
4. Include `<property>` elements in `hibernate.cfg.xml` (this is discussed later).

If you want to get started quickly `hibernate.properties` is the easiest approach.

The `org.hibernate.cfg.Configuration` is intended as a start up object that will be discarded once a `SessionFactory` is created.

3.2. OBTAINING A SESSIONFACTORY

When all mappings have been parsed by the `org.hibernate.cfg.Configuration`, the application must obtain a factory for `org.hibernate.Session` instances. This factory is intended to be shared by all application threads:

```
SessionFactory sessions = cfg.buildSessionFactory();
```

Hibernate does allow your application to instantiate more than one `org.hibernate.SessionFactory`. This is useful if you are using more than one database.

3.3. JDBC CONNECTIONS

It is advisable to have the `org.hibernate.SessionFactory` create and pool JDBC connections for you. If you take this approach, opening a `org.hibernate.Session` is as simple as:

```
Session session = sessions.openSession(); // open a new Session
```

Once you start a task that requires access to the database, a JDBC connection will be obtained from the pool.

Before you can do this, you first need to pass some JDBC connection properties to Hibernate. All Hibernate property names and semantics are defined on the class `org.hibernate.cfg.Environment`. The most important settings for JDBC connection configuration are outlined below.

Hibernate will obtain and pool connections using `java.sql.DriverManager` if you set the following properties:

Table 3.1. Hibernate JDBC Properties

Property name	Purpose
<code>hibernate.connection.driver_class</code>	<i>JDBC driver class</i>
<code>hibernate.connection.url</code>	<i>JDBC URL</i>
<code>hibernate.connection.username</code>	<i>database user</i>
<code>hibernate.connection.password</code>	<i>database user password</i>
<code>hibernate.connection.pool_size</code>	<i>maximum number of pooled connections</i>

Hibernate's own connection pooling algorithm is, however, quite rudimentary. It is intended to help you get started and is *not intended for use in a production system*, or even for performance testing. You should use a third party pool for best performance and stability. Just replace the

hibernate.connection.pool_size property with connection pool specific settings. This will turn off Hibernate's internal pool. For example, you might like to use c3p0.

C3P0 is an open source JDBC connection pool distributed along with Hibernate in the **lib** directory. Hibernate will use its **org.hibernate.connection.C3P0ConnectionProvider** for connection pooling if you set hibernate.c3p0.* properties. If you would like to use Proxool, refer to the packaged **hibernate.properties** and the Hibernate web site for more information.

The following is an example **hibernate.properties** file for c3p0:

```
hibernate.connection.driver_class = org.postgresql.Driver
hibernate.connection.url = jdbc:postgresql://localhost/mydatabase
hibernate.connection.username = myuser
hibernate.connection.password = secret
hibernate.c3p0.min_size=5
hibernate.c3p0.max_size=20
hibernate.c3p0.timeout=1800
hibernate.c3p0.max_statements=50
hibernate.dialect = org.hibernate.dialect.PostgreSQLDialect
```

For use inside an application server, you should almost always configure Hibernate to obtain connections from an application server **javax.sql.DataSource** registered in JNDI. You will need to set at least one of the following properties:

Table 3.2. Hibernate Datasource Properties

Property name	Purpose
hibernate.connection.datasource	<i>datasource JNDI name</i>
hibernate.jndi.url	<i>URL of the JNDI provider (optional)</i>
hibernate.jndi.class	<i>class of the JNDI InitialContextFactory (optional)</i>
hibernate.connection.username	<i>database user (optional)</i>
hibernate.connection.password	<i>database user password (optional)</i>

Here is an example **hibernate.properties** file for an application server provided JNDI datasource:

```
hibernate.connection.datasource = java:/comp/env/jdbc/test
hibernate.transaction.factory_class = \
    org.hibernate.transaction.JTATransactionFactory
hibernate.transaction.manager_lookup_class = \
    org.hibernate.transaction.JBossTransactionManagerLookup
hibernate.dialect = org.hibernate.dialect.PostgreSQLDialect
```

JDBC connections obtained from a JNDI datasource will automatically participate in the container-managed transactions of the application server.

Arbitrary connection properties can be given by prepending "**hibernate.connection**" to the connection property name. For example, you can specify a charSet connection property using `hibernate.connection.charSet`.

You can define your own plug-in strategy for obtaining JDBC connections by implementing the interface `org.hibernate.connection.ConnectionProvider`, and specifying your custom implementation via the `hibernate.connection.provider_class` property.

3.4. OPTIONAL CONFIGURATION PROPERTIES

There are a number of other properties that control the behavior of Hibernate at runtime. All are optional and have reasonable default values.



WARNING

Some of these properties are system-level only. System-level properties can be set only via `java -Dproperty=value` or `hibernate.properties`. They *cannot* be set by the other techniques described above.

Table 3.3. Hibernate Configuration Properties

Property name	Purpose
<code>hibernate.dialect</code>	<p>The classname of a Hibernate <code>org.hibernate.dialect.Dialect</code> which allows Hibernate to generate SQL optimized for a particular relational database. e.g. full.classname.of.Dialect</p> <p>In most cases Hibernate will actually be able to choose the correct <code>org.hibernate.dialect.Dialect</code> implementation based on the JDBC metadata returned by the JDBC driver.</p>
<code>hibernate.show_sql</code>	<p>Write all SQL statements to console. This is an alternative to setting the log category <code>org.hibernate.SQL</code> to <code>debug</code>. e.g. true false</p>
<code>hibernate.format_sql</code>	<p>Pretty print the SQL in the log and console. e.g. true false</p>
<code>hibernate.default_schema</code>	<p>Qualify unqualified table names with the given schema/tablespace in generated SQL. e.g. SCHEMA_NAME</p>

Property name	Purpose
hibernate.default_catalog	Qualifies unqualified table names with the given catalog in generated SQL. e.g. CATALOG_NAME
hibernate.session_factory_name	The org.hibernate.SessionFactory will be automatically bound to this name in JNDI after it has been created. e.g. jndi/composite/name
hibernate.max_fetch_depth	Sets a maximum "depth" for the outer join fetch tree for single-ended associations (one-to-one, many-to-one). A 0 disables default outer join fetching. e.g. recommended values between 0 and 3
hibernate.default_batch_fetch_size	Sets a default size for Hibernate batch fetching of associations. e.g. recommended values 4, 8, 16
hibernate.default_entity_mode	Sets a default mode for entity representation for all sessions opened from this SessionFactory dynamic-map, dom4j, pojo
hibernate.order_updates	Forces Hibernate to order SQL updates by the primary key value of the items being updated. This will result in fewer transaction deadlocks in highly concurrent systems. e.g. true false
hibernate.generate_statistics	If enabled, Hibernate will collect statistics useful for performance tuning. e.g. true false
hibernate.use_identifier_rollback	If enabled, generated identifier properties will be reset to default values when objects are deleted. e.g. true false
hibernate.use_sql_comments	If turned on, Hibernate will generate comments inside the SQL, for easier debugging, defaults to false . e.g. true false

Table 3.4. Hibernate JDBC and Connection Properties

Property name	Purpose
hibernate.jdbc.fetch_size	A non-zero value determines the JDBC fetch size (calls Statement.setFetchSize()).

Property name	Purpose
hibernate.jdbc.batch_size	A non-zero value enables use of JDBC2 batch updates by Hibernate. e.g. recommended values between 5 and 30
hibernate.jdbc.batch_versioned_data	Set this property to true if your JDBC driver returns correct row counts from executeBatch() . It is usually safe to turn this option on. Hibernate will then use batched DML for automatically versioned data. Defaults to false . e.g. true false
hibernate.jdbc.factory_class	Select a custom org.hibernate.jdbc.Batcher . Most applications will not need this configuration property. e.g. classname.of.BatcherFactory
hibernate.jdbc.use_scrollable_resultset	Enables use of JDBC2 scrollable resultsets by Hibernate. This property is only necessary when using user-supplied JDBC connections. Hibernate uses connection metadata otherwise. e.g. true false
hibernate.jdbc.use_streams_for_binary	Use streams when writing/reading binary or serializable types to/from JDBC. <i>*system-level property*</i> e.g. true false
hibernate.jdbc.use_get_generated_keys	Enables use of JDBC3 PreparedStatement.getGeneratedKeys() to retrieve natively generated keys after insert. Requires JDBC3+ driver and JRE1.4+, set to false if your driver has problems with the Hibernate identifier generators. By default, it tries to determine the driver capabilities using connection metadata. e.g. true false
hibernate.connection.provider_class	The classname of a custom org.hibernate.connection.ConnectionProvider which provides JDBC connections to Hibernate. e.g. classname.of.ConnectionProvider
hibernate.connection.isolation	Sets the JDBC transaction isolation level. Check java.sql.Connection for meaningful values, but note that most databases do not support all isolation levels and some define additional, non-standard isolations. e.g. 1, 2, 4, 8

Property name	Purpose
hibernate.connection.autocommit	Enables autocommit for JDBC pooled connections (it is not recommended). e.g. true false
hibernate.connection.release_mode	Specifies when Hibernate should release JDBC connections. By default, a JDBC connection is held until the session is explicitly closed or disconnected. For an application server JTA datasource, use after_statement to aggressively release connections after every JDBC call. For a non-JTA connection, it often makes sense to release the connection at the end of each transaction, by using after_transaction . auto will choose after_statement for the JTA and CMT transaction strategies and after_transaction for the JDBC transaction strategy. e.g. auto (default) on_close after_transaction after_statement This setting only affects Sessions returned from SessionFactory.openSession . For Sessions obtained through SessionFactory.getCurrentSession , the CurrentSessionContext implementation configured for use controls the connection release mode for those Sessions . See Section 2.5, "Contextual sessions"
hibernate.connection.<propertyName>	Pass the JDBC property <propertyName> to DriverManager.getConnection() .
hibernate.jndi.<propertyName>	Pass the property <propertyName> to the JNDI InitialContextFactory .

Table 3.5. Hibernate Cache Properties

Property name	Purpose
hibernate.cache.provider_class	The classname of a custom CacheProvider . e.g. classname.of.CacheProvider
hibernate.cache.use_minimal_puts	Optimizes second-level cache operation to minimize writes, at the cost of more frequent reads. This setting is most useful for clustered caches and, in Hibernate3, is enabled by default for clustered cache implementations. e.g. true false

Property name	Purpose
<code>hibernate.cache.use_query_cache</code>	Enables the query cache. Individual queries still have to be set cacheable. e.g. true false
<code>hibernate.cache.use_second_level_cache</code>	Can be used to completely disable the second level cache, which is enabled by default for classes which specify a <code><cache></code> mapping. e.g. true false
<code>hibernate.cache.query_cache_factory</code>	The classname of a custom QueryCache interface, defaults to the built-in StandardQueryCache . e.g. classname.of.QueryCache
<code>hibernate.cache.region_prefix</code>	A prefix to use for second-level cache region names. e.g. prefix
<code>hibernate.cache.use_structured_entries</code>	Forces Hibernate to store data in the second-level cache in a more human-friendly format. e.g. true false
<code>hibernate.query.plan_cache_max_strong_references</code>	Sets the maximum number of strong references held in the cache. e.g. 128 (default)
<code>hibernate.query.plan_cache_max_soft_references</code>	Sets the maximum number of soft references held in the cache. Set this value to Integer.MAX_VALUE to replicate the behavior of 5.1.1 and earlier. e.g. 2048 (default)

Table 3.6. Hibernate Transaction Properties

Property name	Purpose
<code>hibernate.transaction.factory_class</code>	The classname of a TransactionFactory to use with Hibernate Transaction API (defaults to JDBCTransactionFactory). e.g. classname.of.TransactionFactory
<code>jta.UserTransaction</code>	A JNDI name used by JTATransactionFactory to obtain the JTA UserTransaction from the application server. e.g. jndi/composite/name

Property name	Purpose
<code>hibernate.transaction.manager_lookup_class</code>	The classname of a TransactionManagerLookup . It is required when JVM-level caching is enabled or when using hilo generator in a JTA environment. e.g. <code>classname.of.TransactionManagerLookup</code>
<code>hibernate.transaction.flush_before_completion</code>	If enabled, the session will be automatically flushed during the before completion phase of the transaction. Built-in and automatic session context management is preferred, see Section 2.5, "Contextual sessions" . e.g. true false
<code>hibernate.transaction.auto_close_session</code>	If enabled, the session will be automatically closed during the after completion phase of the transaction. Built-in and automatic session context management is preferred, see Section 2.5, "Contextual sessions" . e.g. true false

Table 3.7. Miscellaneous Properties

Property name	Purpose
<code>hibernate.current_session_context_class</code>	Supply a custom strategy for the scoping of the "current" Session . See Section 2.5, "Contextual sessions" for more information about the built-in strategies. e.g. jta thread managed custom.Class
<code>hibernate.query.factory_class</code>	Chooses the HQL parser implementation. e.g. <code>org.hibernate.hql.ast.ASTQueryTranslatorFactory</code> or <code>org.hibernate.hql.classic.ClassicQueryTranslatorFactory</code>
<code>hibernate.query.substitutions</code>	Is used to map from tokens in Hibernate queries to SQL tokens (tokens might be function or literal names, for example). e.g. hqlLiteral=SQL_LITERAL, hqlFunction=SQLFUNC

Property name	Purpose
<code>hibernate.hbm2ddl.auto</code>	Automatically validates or exports schema DDL to the database when the SessionFactory is created. With create-drop , the database schema will be dropped when the SessionFactory is closed explicitly. e.g. validate update create create-drop
<code>hibernate.cglib.use_reflection_optimizer</code>	Enables the use of CGLIB instead of runtime reflection (System-level property). Reflection can sometimes be useful when troubleshooting. Hibernate always requires CGLIB even if you turn off the optimizer. You cannot set this property in <code>hibernate.cfg.xml</code> . e.g. true false

3.4.1. SQL Dialects

Always set the `hibernate.dialect` property to the correct `org.hibernate.dialect.Dialect` subclass for your database. If you specify a dialect, Hibernate will use sensible defaults for some of the other properties listed above. This means that you will not have to specify them manually.

Table 3.8. Hibernate SQL Dialects (`hibernate.dialect`)

RDBMS	Dialect
DB2	<code>org.hibernate.dialect.DB2Dialect</code>
DB2 AS/400	<code>org.hibernate.dialect.DB2400Dialect</code>
DB2 OS390	<code>org.hibernate.dialect.DB2390Dialect</code>
PostgreSQL	<code>org.hibernate.dialect.PostgreSQLDialect</code>
MySQL	<code>org.hibernate.dialect.MySQL5Dialect</code>
MySQL with InnoDB	<code>org.hibernate.dialect.MySQL5InnoDBDialect</code>
MySQL with MyISAM	<code>org.hibernate.dialect.MySQLMyISAMDialect</code>
Oracle (any version)	<code>org.hibernate.dialect.Oracle8iDialect</code>
Oracle 9i	<code>org.hibernate.dialect.Oracle9iDialect</code>

RDBMS	Dialect
Oracle 10g	<code>org.hibernate.dialect.Oracle10gDialect</code>
Sybase	<code>org.hibernate.dialect.SybaseDialect</code>
Sybase Anywhere	<code>org.hibernate.dialect.SybaseAnywhereDialect</code>
Microsoft SQL Server	<code>org.hibernate.dialect.SQLServerDialect</code>
Microsoft SQL Server 2008	<code>org.hibernate.dialect.SQLServer2008Dialect</code>
SAP DB	<code>org.hibernate.dialect.SAPDBDialect</code>
Informix	<code>org.hibernate.dialect.InformixDialect</code>
HypersonicSQL	<code>org.hibernate.dialect.HSQLDialect</code>
Ingres	<code>org.hibernate.dialect.IngresDialect</code>
Progress	<code>org.hibernate.dialect.ProgressDialect</code>
Mckoi SQL	<code>org.hibernate.dialect.MckoiDialect</code>
Interbase	<code>org.hibernate.dialect.InterbaseDialect</code>
Pointbase	<code>org.hibernate.dialect.PointbaseDialect</code>
FrontBase	<code>org.hibernate.dialect.FrontbaseDialect</code>
Firebird	<code>org.hibernate.dialect.FirebirdDialect</code>

3.4.2. Outer Join Fetching

If your database supports ANSI, Oracle or Sybase style outer joins, *outer join fetching* will often increase performance by limiting the number of round trips to and from the database. This is, however, at the cost of possibly more work performed by the database itself. Outer join fetching allows a whole graph of objects connected by many-to-one, one-to-many, many-to-many and one-to-one associations to be retrieved in a single SQL **SELECT**.

Outer join fetching can be disabled *globally* by setting the property `hibernate.max_fetch_depth` to `0`. A setting of `1` or higher enables outer join fetching for one-to-one and many-to-one associations that have been mapped with `fetch="join"`.

See [Section 19.1, “Fetching strategies”](#) for more information.

3.4.3. Binary Streams

Oracle limits the size of `byte` arrays that can be passed to and/or from its JDBC driver. If you wish to use large instances of `binary` or `serializable` type, you should enable `hibernate.jdbc.use_streams_for_binary`. *This is a system-level setting only.*

3.4.4. Second-level and query cache

The properties prefixed by `hibernate.cache` allow you to use a process or cluster scoped second-level cache system with Hibernate. See the [Section 19.2, “The Second Level Cache”](#) for more information.

3.4.5. Query Language Substitution

You can define new Hibernate query tokens using `hibernate.query.substitutions`. For example:

```
hibernate.query.substitutions true=1, false=0
```

This would cause the tokens `true` and `false` to be translated to integer literals in the generated SQL.

```
hibernate.query.substitutions toLowercase=LOWER
```

This would allow you to rename the SQL `LOWER` function.

3.4.6. Hibernate statistics

If you enable `hibernate.generate_statistics`, Hibernate exposes a number of metrics that are useful when tuning a running system via `SessionFactory.getStatistics()`. Hibernate can even be configured to expose these statistics via JMX. Read the Javadoc of the interfaces in `org.hibernate.stats` for more information.

3.5. LOGGING

Hibernate utilizes [Simple Logging Facade for Java](#) (SLF4J) in order to log various system events. SLF4J can direct your logging output to several logging frameworks (`NOP`, `Simple`, `log4j version 1.2`, `JDK 1.4 logging`, `JCL` or `logback`) depending on your chosen binding.

In order to set up logging you will need `slf4j-api.jar` in your classpath together with the jar file for your preferred binding - `slf4j-log4j12.jar` in the case of Log4J. See the SLF4J [documentation](#) for more detail. To use Log4j you will also need to place a `log4j.properties` file in your classpath. An example properties file is distributed with Hibernate in the `src/` directory.

It is recommended that you familiarize yourself with Hibernate's log messages. A lot of work has been put into making the Hibernate log as detailed as possible, without making it unreadable. It is an essential troubleshooting device. The most interesting log categories are the following:

Table 3.9. Hibernate Log Categories

Category	Function
<code>org.hibernate.SQL</code>	Log all SQL DML statements as they are executed
<code>org.hibernate.type</code>	Log all JDBC parameters
<code>org.hibernate.tool.hbm2ddl</code>	Log all SQL DDL statements as they are executed
<code>org.hibernate.pretty</code>	Log the state of all entities (max 20 entities) associated with the session at flush time
<code>org.hibernate.cache</code>	Log all second-level cache activity
<code>org.hibernate.transaction</code>	Log transaction related activity
<code>org.hibernate.jdbc</code>	Log all JDBC resource acquisition
<code>org.hibernate.hql.ast.AST</code>	Log HQL and SQL ASTs during query parsing
<code>org.hibernate.secure</code>	Log all JAAS authorization requests
<code>org.hibernate</code>	Log everything. This is a lot of information but it is useful for troubleshooting

When developing applications with Hibernate, you should almost always work with **debug** enabled for the category `org.hibernate.SQL`, or, alternatively, the property `hibernate.show_sql` enabled.

3.6. IMPLEMENTING A NAMINGSTRATEGY

The interface `org.hibernate.cfg.NamingStrategy` allows you to specify a "naming standard" for database objects and schema elements.

You can provide rules for automatically generating database identifiers from Java identifiers or for processing "logical" column and table names given in the mapping file into "physical" table and column names. This feature helps reduce the verbosity of the mapping document, eliminating repetitive noise (`TBL_` prefixes, for example). The default strategy used by Hibernate is quite minimal.

You can specify a different strategy by calling `Configuration.setNamingStrategy()` before adding mappings:

```
SessionFactory sf = new Configuration()
    .setNamingStrategy(ImprovedNamingStrategy.INSTANCE)
    .addFile("Item.hbm.xml")
    .addFile("Bid.hbm.xml")
    .buildSessionFactory();
```

`org.hibernate.cfg.ImprovedNamingStrategy` is a built-in strategy that might be a useful starting point for some applications.

3.7. XML CONFIGURATION FILE

An alternative approach to configuration is to specify a full configuration in a file named **hibernate.cfg.xml**. This file can be used as a replacement for the **hibernate.properties** file or, if both are present, to override properties.

The XML configuration file is by default expected to be in the root of your **CLASSPATH**. Here is an example:

```
<?xml version='1.0' encoding='utf-8'?>
<!DOCTYPE hibernate-configuration PUBLIC
    "-//Hibernate/Hibernate Configuration DTD//EN"
    "http://hibernate.sourceforge.net/hibernate-configuration-3.0.dtd">

<hibernate-configuration>

    <!-- a SessionFactory instance listed as /jndi/name -->
    <session-factory
        name="java:hibernate/SessionFactory">

        <!-- properties -->
        <property
name="connection.datasource">java:/comp/env/jdbc/MyDB</property>
        <property
name="dialect">org.hibernate.dialect.MySQLDialect</property>
        <property name="show_sql">>false</property>
        <property name="transaction.factory_class">
            org.hibernate.transaction.JTATransactionFactory
        </property>
        <property
name="jta.UserTransaction">java:comp/UserTransaction</property>

        <!-- mapping files -->
        <mapping resource="org/hibernate/auction/Item.hbm.xml"/>
        <mapping resource="org/hibernate/auction/Bid.hbm.xml"/>

        <!-- cache settings -->
        <class-cache class="org.hibernate.auction.Item" usage="read-
write"/>
        <class-cache class="org.hibernate.auction.Bid" usage="read-
only"/>
        <collection-cache collection="org.hibernate.auction.Item.bids"
usage="read-write"/>

    </session-factory>

</hibernate-configuration>
```

The advantage of this approach is the externalization of the mapping file names to configuration. The **hibernate.cfg.xml** is also more convenient once you have to tune the Hibernate cache. It is your choice to use either **hibernate.properties** or **hibernate.cfg.xml**. Both are equivalent, except for the above mentioned benefits of using the XML syntax.

With the XML configuration, starting Hibernate is then as simple as:

```
SessionFactory sf = new Configuration().configure().buildSessionFactory();
```

You can select a different XML configuration file using:

```
SessionFactory sf = new Configuration()
    .configure("catdb.cfg.xml")
    .buildSessionFactory();
```

3.8. J2EE APPLICATION SERVER INTEGRATION

Hibernate has the following integration points for J2EE infrastructure:

- *Container-managed datasources*: Hibernate can use JDBC connections managed by the container and provided through JNDI. Usually, a JTA compatible **TransactionManager** and a **ResourceManager** take care of transaction management (CMT), especially distributed transaction handling across several datasources. You can also demarcate transaction boundaries programmatically (BMT), or you might want to use the optional Hibernate **Transaction** API for this to keep your code portable.
- *Automatic JNDI binding*: Hibernate can bind its **SessionFactory** to JNDI after start up.
- *JTA Session binding*: the Hibernate **Session** can be automatically bound to the scope of JTA transactions. Simply lookup the **SessionFactory** from JNDI and get the current **Session**. Let Hibernate manage flushing and closing the **Session** when your JTA transaction completes. Transaction demarcation is either declarative (CMT) or programmatic (BMT/UserTransaction).
- *JMX deployment*: if you have a JMX capable application server (e.g. JBoss Enterprise Application Platform), you can choose to deploy Hibernate as a managed MBean. This saves you the one line start up code to build your **SessionFactory** from a **Configuration**. The container will start up your **HibernateService** and also take care of service dependencies (datasource has to be available before Hibernate starts, etc).

Depending on your environment, you might have to set the configuration option **hibernate.connection.aggressive_release** to true if your application server shows "connection containment" exceptions.

3.8.1. Transaction strategy configuration

The Hibernate **Session** API is independent of any transaction demarcation system in your architecture. If you let Hibernate use JDBC directly through a connection pool, you can begin and end your transactions by calling the JDBC API. If you run in a J2EE application server, you might want to use bean-managed transactions and call the JTA API and **UserTransaction** when needed.

To keep your code portable between these two (and other) environments we recommend the optional Hibernate **Transaction** API, which wraps and hides the underlying system. You have to specify a factory class for **Transaction** instances by setting the Hibernate configuration property **hibernate.transaction.factory_class**.

There are three standard, or built-in, choices:

org.hibernate.transaction.JDBCTransactionFactory

delegates to database (JDBC) transactions (default)

org.hibernate.transaction.JTATransactionFactory

delegates to container-managed transactions if an existing transaction is underway in this context (for example, EJB session bean method). Otherwise, a new transaction is started and bean-managed transactions are used.

org.hibernate.transaction.CMTTransactionFactory

delegates to container-managed JTA transactions

You can also define your own transaction strategies (for a CORBA transaction service, for example).

Some features in Hibernate (i.e., the second level cache, Contextual Sessions with JTA, etc.) require access to the JTA **TransactionManager** in a managed environment. In an application server, since J2EE does not standardize a single mechanism, you have to specify how Hibernate should obtain a reference to the **TransactionManager**:

Table 3.10. JTA TransactionManagers

Transaction Factory	Application Server
org.hibernate.transaction.JBossTransactionManagerLookup	JBoss
org.hibernate.transaction.WeblogicTransactionManagerLookup	Weblogic
org.hibernate.transaction.WebSphereTransactionManagerLookup	WebSphere
org.hibernate.transaction.WebSphereExtendedJTATransactionLookup	WebSphere 6
org.hibernate.transaction.OrionTransactionManagerLookup	Orion
org.hibernate.transaction.ResinTransactionManagerLookup	Resin
org.hibernate.transaction.JOTMTransactionManagerLookup	JOTM
org.hibernate.transaction.JOnASTransactionManagerLookup	JOnAS
org.hibernate.transaction.JRun4TransactionManagerLookup	JRun4
org.hibernate.transaction.BESTransactionManagerLookup	Borland ES

3.8.2. JNDI-bound `SessionFactory`

A JNDI-bound Hibernate `SessionFactory` can simplify the lookup function of the factory and create new `Sessions`. This is not, however, related to a JNDI bound `DataSource`; both simply use the same registry.

If you wish to have the `SessionFactory` bound to a JNDI namespace, specify a name (e.g. `java:hibernate/SessionFactory`) using the property `hibernate.session_factory_name`. If this property is omitted, the `SessionFactory` will not be bound to JNDI. This is especially useful in environments with a read-only JNDI default implementation (in Tomcat, for example).

When binding the `SessionFactory` to JNDI, Hibernate will use the values of `hibernate.jndi.url`, `hibernate.jndi.class` to instantiate an initial context. If they are not specified, the default `InitialContext` will be used.

Hibernate will automatically place the `SessionFactory` in JNDI after you call `cfg.buildSessionFactory()`. This means you will have this call in some start up code, or utility class in your application, unless you use JMX deployment with the `HibernateService` (this is discussed later in greater detail).

If you use a JNDI `SessionFactory`, an EJB or any other class, you can obtain the `SessionFactory` using a JNDI lookup.

It is recommended that you bind the `SessionFactory` to JNDI in a managed environment and use a `static` singleton otherwise. To shield your application code from these details, we also recommend to hide the actual lookup code for a `SessionFactory` in a helper class, such as `HibernateUtil.getSessionFactory()`. Note that such a class is also a convenient way to start Hibernate (Refer to [Section 1.1.6](#), "Start up and helpers").

3.8.3. Current Session context management with JTA

The easiest way to handle `Sessions` and transactions is Hibernate's automatic "current" `Session` management. For a discussion of contextual sessions see [Section 2.5](#), "Contextual sessions". Using the "jta" session context, if there is no Hibernate `Session` associated with the current JTA transaction, one will be started and associated with that JTA transaction the first time you call `sessionFactory.getCurrentSession()`. The `Sessions` retrieved via `getCurrentSession()` in the "jta" context are set to automatically flush before the transaction completes, close after the transaction completes, and aggressively release JDBC connections after each statement. This allows the `Sessions` to be managed by the life cycle of the JTA transaction to which it is associated, keeping user code clean of such management concerns. Your code can either use JTA programmatically through `UserTransaction`, or (recommended for portable code) use the Hibernate `Transaction` API to set transaction boundaries. If you run in an EJB container, declarative transaction demarcation with CMT is preferred.

3.8.4. JMX deployment

The line `cfg.buildSessionFactory()` still has to be executed somewhere to get a `SessionFactory` into JNDI. You can do this either in a `static` initializer block, like the one in `HibernateUtil`, or you can deploy Hibernate as a *managed service*.

Hibernate is distributed with `org.hibernate.jmx.HibernateService` for deployment on an application server with JMX capabilities, such as JBoss Enterprise Application Platform. The actual deployment and configuration is vendor-specific. Here is an example `jboss-service.xml` for JBoss 4.0.x:


```

<?xml version="1.0"?>
<server>

<mbean code="org.hibernate.jmx.HibernateService"
  name="jboss.jca:service=HibernateFactory,name=HibernateFactory">

  <!-- Required services -->
  <depends>jboss.jca:service=RARDeployer</depends>
  <depends>jboss.jca:service=LocalTxCM,name=HsqlDS</depends>

  <!-- Bind the Hibernate service to JNDI -->
  <attribute name="JndiName">java:/hibernate/SessionFactory</attribute>

  <!-- Datasource settings -->
  <attribute name="Datasource">java:HsqlDS</attribute>
  <attribute
name="Dialect">org.hibernate.dialect.HSQLDialect</attribute>

  <!-- Transaction integration -->
  <attribute name="TransactionStrategy">
    org.hibernate.transaction.JTATransactionFactory</attribute>
  <attribute name="TransactionManagerLookupStrategy">
org.hibernate.transaction.JBossTransactionManagerLookup</attribute>
  <attribute name="FlushBeforeCompletionEnabled">true</attribute>
  <attribute name="AutoCloseSessionEnabled">true</attribute>

  <!-- Fetching options -->
  <attribute name="MaximumFetchDepth">5</attribute>

  <!-- Second-level caching -->
  <attribute name="SecondLevelCacheEnabled">true</attribute>
  <attribute
name="CacheProviderClass">org.hibernate.cache.EhCacheProvider</attribute>
  <attribute name="QueryCacheEnabled">true</attribute>

  <!-- Logging -->
  <attribute name="ShowSqlEnabled">true</attribute>

  <!-- Mapping files -->
  <attribute
name="MapResources">auction/Item.hbm.xml,auction/Category.hbm.xml</attribu
te>

</mbean>

</server>

```

This file is deployed in a directory called **META-INF** and packaged in a JAR file with the extension **.sar** (service archive). You also need to package Hibernate, its required third-party libraries, your compiled persistent classes, as well as your mapping files in the same archive. Your enterprise beans (usually session beans) can be kept in their own JAR file, but you can include this EJB JAR file in the main service archive to get a single (hot-)deployable unit.

CHAPTER 4. PERSISTENT CLASSES

Persistent classes are classes in an application that implement the entities of the business problem (e.g. Customer and Order in an E-commerce application). Not all instances of a persistent class are considered to be in the persistent state. For example, an instance can instead be transient or detached.

Hibernate works best if these classes follow some simple rules, also known as the Plain Old Java Object (POJO) programming model. However, none of these rules are hard requirements. Indeed, Hibernate3 assumes very little about the nature of your persistent objects. You can express a domain model in other ways (using trees of **Map** instances, for example).

4.1. A SIMPLE POJO EXAMPLE

Most Java applications require a persistent class representing felines. For example:

```
package eg;
import java.util.Set;
import java.util.Date;

public class Cat {
    private Long id; // identifier

    private Date birthdate;
    private Color color;
    private char sex;
    private float weight;
    private int litterId;

    private Cat mother;
    private Set kittens = new HashSet();

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

    void setBirthdate(Date date) {
        birthdate = date;
    }
    public Date getBirthdate() {
        return birthdate;
    }

    void setWeight(float weight) {
        this.weight = weight;
    }
    public float getWeight() {
        return weight;
    }

    public Color getColor() {
        return color;
    }
}
```

```

void setColor(Color color) {
    this.color = color;
}

void setSex(char sex) {
    this.sex=sex;
}
public char getSex() {
    return sex;
}

void setLitterId(int id) {
    this.litterId = id;
}
public int getLitterId() {
    return litterId;
}

void setMother(Cat mother) {
    this.mother = mother;
}
public Cat getMother() {
    return mother;
}
void setKittens(Set kittens) {
    this.kittens = kittens;
}
public Set getKittens() {
    return kittens;
}

// addKitten not needed by Hibernate
public void addKitten(Cat kitten) {
    kitten.setMother(this);
    kitten.setLitterId( kittens.size() );
    kittens.add(kitten);
}
}

```

The four main rules of persistent classes are explored in more detail in the following sections.

4.1.1. Implement a no-argument constructor

Cat has a no-argument constructor. All persistent classes must have a default constructor (which can be non-public) so that Hibernate can instantiate them using **Constructor.newInstance()**. It is recommended that you have a default constructor with at least *package* visibility for runtime proxy generation in Hibernate.

4.1.2. Provide an identifier property (optional)

Cat has a property called **id**. This property maps to the primary key column of a database table. The property might have been called anything, and its type might have been any primitive type, any primitive "wrapper" type, **java.lang.String** or **java.util.Date**. If your legacy database table has composite keys, you can use a user-defined class with properties of these types (see the section on composite identifiers later in the chapter.)

The identifier property is strictly optional. You can leave them off and let Hibernate keep track of object identifiers internally. We do not recommend this, however.

In fact, some functionality is available only to classes that declare an identifier property:

- Transitive reattachment for detached objects (cascade update or cascade merge) - see [Section 10.11, “Transitive persistence”](#)
- `Session.saveOrUpdate()`
- `Session.merge()`

We recommend that you declare consistently-named identifier properties on persistent classes and that you use a nullable (i.e., non-primitive) type.

4.1.3. Prefer non-final classes (optional)

A central feature of Hibernate, *proxies*, depends upon the persistent class being either non-final, or the implementation of an interface that declares all public methods.

You can persist **final** classes that do not implement an interface with Hibernate. You will not, however, be able to use proxies for lazy association fetching which will ultimately limit your options for performance tuning.

You should also avoid declaring **public final** methods on the non-final classes. If you want to use a class with a **public final** method, you must explicitly disable proxying by setting **lazy="false"**.

4.1.4. Declare accessors and mutators for persistent fields (optional)

Cat declares accessor methods for all its persistent fields. Many other ORM tools directly persist instance variables. It is better to provide an indirection between the relational schema and internal data structures of the class. By default, Hibernate persists JavaBeans style properties and recognizes method names of the form **getFoo**, **isFoo** and **setFoo**. If required, you can switch to direct field access for particular properties.

Properties need *not* be declared public - Hibernate can persist a property with a default, **protected** or **private** get / set pair.

4.2. IMPLEMENTING INHERITANCE

A subclass must also observe the first and second rules. It inherits its identifier property from the superclass, **Cat**. For example:

```
package eg;

public class DomesticCat extends Cat {
    private String name;

    public String getName() {
        return name;
    }
    protected void setName(String name) {
        this.name=name;
    }
}
```

4.3. IMPLEMENTING `equals()` AND `hashCode()`

You have to override the `equals()` and `hashCode()` methods if you:

- intend to put instances of persistent classes in a **Set** (the recommended way to represent many-valued associations); *and*
- intend to use reattachment of detached instances

Hibernate guarantees equivalence of persistent identity (database row) and Java identity only inside a particular session scope. When you mix instances retrieved in different sessions, you must implement `equals()` and `hashCode()` if you wish to have meaningful semantics for **Sets**.

The most obvious way is to implement `equals()/hashCode()` by comparing the identifier value of both objects. If the value is the same, both must be the same database row, because they are equal. If both are added to a **Set**, you will only have one element in the **Set**. Unfortunately, you cannot use that approach with generated identifiers. Hibernate will only assign identifier values to objects that are persistent; a newly created instance will not have any identifier value. Furthermore, if an instance is unsaved and currently in a **Set**, saving it will assign an identifier value to the object. If `equals()` and `hashCode()` are based on the identifier value, the hash code would change, breaking the contract of the **Set**. See the Hibernate website for a full discussion of this problem. This is not a Hibernate issue, but normal Java semantics of object identity and equality.

It is recommended that you implement `equals()` and `hashCode()` using *Business key equality*. Business key equality means that the `equals()` method compares only the properties that form the business key. It is a key that would identify our instance in the real world (a *natural* candidate key):

```
public class Cat {

    ...
    public boolean equals(Object other) {
        if (this == other) return true;
        if ( !(other instanceof Cat) ) return false;

        final Cat cat = (Cat) other;

        if ( !cat.getLitterId().equals( getLitterId() ) ) return false;
        if ( !cat.getMother().equals( getMother() ) ) return false;

        return true;
    }

    public int hashCode() {
        int result;
        result = getMother().hashCode();
        result = 29 * result + getLitterId();
        return result;
    }
}
```

A business key does not have to be as solid as a database primary key candidate (see [Section 11.1.3, “Considering object identity”](#)). Immutable or unique properties are usually good candidates for a business key.

4.4. DYNAMIC MODELS



NOTE

The following features are currently considered experimental and may change in the near future.

Persistent entities do not necessarily have to be represented as POJO classes or as JavaBean objects at runtime. Hibernate also supports dynamic models (using **Maps** of **Maps** at runtime) and the representation of entities as DOM4J trees. With this approach, you do not write persistent classes, only mapping files.

By default, Hibernate works in normal POJO mode. You can set a default entity representation mode for a particular **SessionFactory** using the **default_entity_mode** configuration option (see [Table 3.3, “Hibernate Configuration Properties”](#)).

The following examples demonstrate the representation using **Maps**. First, in the mapping file an **entity-name** has to be declared instead of, or in addition to, a class name:

```
<hibernate-mapping>

  <class entity-name="Customer">

    <id name="id"
      type="long"
      column="ID">
      <generator class="sequence"/>
    </id>

    <property name="name"
      column="NAME"
      type="string"/>

    <property name="address"
      column="ADDRESS"
      type="string"/>

    <many-to-one name="organization"
      column="ORGANIZATION_ID"
      class="Organization"/>

    <bag name="orders"
      inverse="true"
      lazy="false"
      cascade="all">
      <key column="CUSTOMER_ID"/>
      <one-to-many class="Order"/>
    </bag>
```

```
</class>
```

```
</hibernate-mapping>
```

Even though associations are declared using target class names, the target type of associations can also be a dynamic entity instead of a POJO.

After setting the default entity mode to **dynamic-map** for the **SessionFactory**, you can, at runtime, work with **Maps of Maps**:

```
Session s = openSession();
Transaction tx = s.beginTransaction();

// Create a customer
Map david = new HashMap();
david.put("name", "David");

// Create an organization
Map foobar = new HashMap();
foobar.put("name", "Foobar Inc.");

// Link both
david.put("organization", foobar);

// Save both
s.save("Customer", david);
s.save("Organization", foobar);

tx.commit();
s.close();
```

One of the main advantages of dynamic mapping is quick turnaround time for prototyping, without the need for entity class implementation. However, you lose compile-time type checking and will likely deal with many exceptions at runtime. As a result of the Hibernate mapping, the database schema can easily be normalized and sound, allowing to add a proper domain model implementation on top later on.

Entity representation modes can also be set on a per **Session** basis:

```
Session dynamicSession =.pojoSession.getSession(EntityMode.MAP);

// Create a customer
Map david = new HashMap();
david.put("name", "David");
dynamicSession.save("Customer", david);
...
dynamicSession.flush();
dynamicSession.close();
...
// Continue on.pojoSession
```

Please note that the call to **getSession()** using an **EntityMode** is on the **Session** API, not the **SessionFactory**. That way, the new **Session** shares the underlying JDBC connection, transaction, and other context information. This means you do not have to call **flush()** and **close()** on the secondary **Session**, and also leave the transaction and connection handling to the primary unit of work.

More information about the XML representation capabilities can be found in [Chapter 18, XML Mapping](#).

4.5. TUPLIZERS

`org.hibernate.tuple.Tuplizer`, and its sub-interfaces, are responsible for managing a particular representation of a piece of data given that representation's `org.hibernate.EntityMode`. If a given piece of data is thought of as a data structure, then a tuplizer is the thing that knows how to create such a data structure and how to extract values from and inject values into such a data structure. For example, for the POJO entity mode, the corresponding tuplizer knows how create the POJO through its constructor. It also knows how to access the POJO properties using the defined property accessors.

There are two high-level types of Tuplizers, represented by the `org.hibernate.tuple.entity.EntityTuplizer` and `org.hibernate.tuple.component.ComponentTuplizer` interfaces. `EntityTuplizers` are responsible for managing the above mentioned contracts in regards to entities, while `ComponentTuplizers` do the same for components.

Users can also plug in their own tuplizers. Perhaps you require that a `java.util.Map` implementation other than `java.util.HashMap` be used while in the dynamic-map entity-mode. Or perhaps you need to define a different proxy generation strategy than the one used by default. Both would be achieved by defining a custom tuplizer implementation. Tuplizer definitions are attached to the entity or component mapping they are meant to manage. Going back to the example of our customer entity:

```
<hibernate-mapping>
  <class entity-name="Customer">
    <!--
      Override the dynamic-map entity-mode
      tuplizer for the customer entity
    -->
    <tuplizer entity-mode="dynamic-map"
      class="CustomMapTuplizerImpl"/>

    <id name="id" type="long" column="ID">
      <generator class="sequence"/>
    </id>

    <!-- other properties -->
    ...
  </class>
</hibernate-mapping>
```

```
public class CustomMapTuplizerImpl
  extends org.hibernate.tuple.entity.DynamicMapEntityTuplizer {
  // override the buildInstantiator() method to plug in our custom
  map...
  protected final Instantiator buildInstantiator(
    org.hibernate.mapping.PersistentClass mappingInfo) {
    return new CustomMapInstantiator( mappingInfo );
  }

  private static final class CustomMapInstantiator
    extends org.hibernate.tuple.DynamicMapInstantiator {
    // override the generateMap() method to return our custom map...
    protected final Map generateMap() {
```



```

        return new CustomMap();
    }
}

```

4.6. ENTITYNAMERESOLVERS

The `org.hibernate.EntityNameResolver` interface is a contract for resolving the entity name of a given entity instance. The interface defines a single method `resolveEntityName` which is passed the entity instance and is expected to return the appropriate entity name (null is allowed and would indicate that the resolver does not know how to resolve the entity name of the given entity instance). Generally speaking, an `org.hibernate.EntityNameResolver` is going to be most useful in the case of dynamic models. One example might be using proxied interfaces as your domain model. The hibernate test suite has an example of this exact style of usage under the `org.hibernate.test.dynamicentity.tuplizer2`. Here is some of the code from that package for illustration.

```

/**
 * A very trivial JDK Proxy InvocationHandler implementation where we
 * proxy an interface as
 * the domain model and simply store persistent state in an internal Map.
 * This is an extremely
 * trivial example meant only for illustration.
 */
public final class DataProxyHandler implements InvocationHandler {
    private String entityName;
    private HashMap data = new HashMap();

    public DataProxyHandler(String entityName, Serializable id) {
        this.entityName = entityName;
        data.put( "Id", id );
    }

    public Object invoke(Object proxy, Method method, Object[] args)
    throws Throwable {
        String methodName = method.getName();
        if ( methodName.startsWith( "set" ) ) {
            String propertyName = methodName.substring( 3 );
            data.put( propertyName, args[0] );
        }
        else if ( methodName.startsWith( "get" ) ) {
            String propertyName = methodName.substring( 3 );
            return data.get( propertyName );
        }
        else if ( "toString".equals( methodName ) ) {
            return entityName + "#" + data.get( "Id" );
        }
        else if ( "hashCode".equals( methodName ) ) {
            return new Integer( this.hashCode() );
        }
        return null;
    }

    public String getEntityName() {
        return entityName;
    }
}

```

```

        public HashMap getData() {
            return data;
        }
    }

    /**
     *
     */
    public class ProxyHelper {
        public static String extractEntityName(Object object) {
            // Our custom java.lang.reflect.Proxy instances actually bundle
            // their appropriate entity name, so we simply extract it from
            there
            // if this represents one of our proxies; otherwise, we return
            null
            if ( Proxy.isProxyClass( object.getClass() ) ) {
                InvocationHandler handler = Proxy.getInvocationHandler( object
            );
                if ( DataProxyHandler.class.isAssignableFrom(
            handler.getClass() ) ) {
                    DataProxyHandler myHandler = ( DataProxyHandler ) handler;
                    return myHandler.getEntityName();
                }
            }
            return null;
        }

        // various other utility methods ....
    }

    /**
     * The EntityNameResolver implementation.
     * IMPL NOTE : An EntityNameResolver really defines a strategy for how
     entity names should be
     * resolved. Since this particular impl can handle resolution for all of
     our entities we want to
     * take advantage of the fact that SessionFactoryImpl keeps these in a Set
     so that we only ever
     * have one instance registered. Why? Well, when it comes time to
     resolve an entity name,
     * Hibernate must iterate over all the registered resolvers. So keeping
     that number down
     * helps that process be as speedy as possible. Hence the equals and
     hashCode impls
     */
    public class MyEntityNameResolver implements EntityNameResolver {
        public static final MyEntityNameResolver INSTANCE = new
    MyEntityNameResolver();

        public String resolveEntityName(Object entity) {
            return ProxyHelper.extractEntityName( entity );
        }

        public boolean equals(Object obj) {

```

```

        return getClass().equals( obj.getClass() );
    }

    public int hashCode() {
        return getClass().hashCode();
    }
}

public class MyEntityTuplizer extends PojoEntityTuplizer {
    public MyEntityTuplizer(EntityMetamodel entityMetamodel,
PersistentClass mappedEntity) {
        super( entityMetamodel, mappedEntity );
    }

    public EntityNameResolver[] getEntityNameResolvers() {
        return new EntityNameResolver[] { MyEntityNameResolver.INSTANCE };
    }

    public String determineConcreteSubclassEntityName(Object
entityInstance, SessionFactoryImplementor factory) {
        String entityName = ProxyHelper.extractEntityName( entityInstance
);
        if ( entityName == null ) {
            entityName = super.determineConcreteSubclassEntityName(
entityInstance, factory );
        }
        return entityName;
    }

    ...
}

```

In order to register an **org.hibernate.EntityNameResolver** users must either:

1. Implement a custom [Section 4.5, “Tuplizers”](#), implementing the **getEntityNameResolvers** method.
2. Register it with the **org.hibernate.impl.SessionFactoryImpl** (which is the implementation class for **org.hibernate.SessionFactory**) using the **registerEntityNameResolver** method.

CHAPTER 5. BASIC O/R MAPPING

5.1. MAPPING DECLARATION

Object/relational mappings are usually defined in an XML document. The mapping document is designed to be readable and hand-editable. The mapping language is Java-centric, meaning that mappings are constructed around persistent class declarations and not table declarations.

Please note that even though many Hibernate users choose to write the XML by hand, a number of tools exist to generate the mapping document. These include XDoclet, Middlegen and AndromDA.

Here is an example mapping:

```
<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
    "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="eg">

    <class name="Cat"
        table="cats"
        discriminator-value="C">

        <id name="id">
            <generator class="native"/>
        </id>

        <discriminator column="subclass"
            type="character"/>

        <property name="weight"/>

        <property name="birthdate"
            type="date"
            not-null="true"
            update="false"/>

        <property name="color"
            type="eg.types.ColorUserType"
            not-null="true"
            update="false"/>

        <property name="sex"
            not-null="true"
            update="false"/>

        <property name="litterId"
            column="litterId"
            update="false"/>

        <many-to-one name="mother"
            column="mother_id"
            update="false"/>

    </class>

</hibernate-mapping>
```

```

        <set name="kittens"
            inverse="true"
            order-by="litter_id">
            <key column="mother_id"/>
            <one-to-many class="Cat"/>
        </set>

        <subclass name="DomesticCat"
            discriminator-value="D">

            <property name="name"
                type="string"/>

        </subclass>

    </class>

    <class name="Dog">
        <!-- mapping for Dog could go here -->
    </class>

</hibernate-mapping>

```

We will now discuss the content of the mapping document. We will only describe, however, the document elements and attributes that are used by Hibernate at runtime. The mapping document also contains some extra optional attributes and elements that affect the database schemas exported by the schema export tool (for example, the **not-null** attribute).

5.1.1. Doctype

All XML mappings should declare the doctype shown. The actual DTD can be found at the URL above, in the directory **hibernate-x.x.x/src/org/hibernate**, or in **hibernate3.jar**. Hibernate will always look for the DTD in its classpath first. If you experience lookups of the DTD using an Internet connection, check the DTD declaration against the contents of your classpath.

5.1.1.1. EntityResolver

Hibernate will first attempt to resolve DTDs in its classpath. It does this is by registering a custom **org.xml.sax.EntityResolver** implementation with the SAXReader it uses to read in the xml files. This custom **EntityResolver** recognizes two different systemId namespaces:

- a **hibernate namespace** is recognized whenever the resolver encounters a systemId starting with **http://hibernate.sourceforge.net/**. The resolver attempts to resolve these entities via the classloader which loaded the Hibernate classes.
- a **user namespace** is recognized whenever the resolver encounters a systemId using a **classpath://** URL protocol. The resolver will attempt to resolve these entities via (1) the current thread context classloader and (2) the classloader which loaded the Hibernate classes.

The following is an example of utilizing user namespacing:

```

<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
    "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd" [

```

```

        <!ENTITY types SYSTEM "classpath://your/domain/types.xml">
    ]>

    <hibernate-mapping package="your.domain">
        <class name="MyEntity">
            <id name="id" type="my-custom-id-type">
                ...
            </id>
        <class>
            &types;
        </hibernate-mapping>
    
```

Where **types.xml** is a resource in the **your.domain** package and contains a custom [Section 5.2.3](#), “Custom value types”.

5.1.2. Hibernate-mapping

This element has several optional attributes. The **schema** and **catalog** attributes specify that tables referred to in this mapping belong to the named schema and/or catalog. If they are specified, tablename will be qualified by the given schema and catalog names. If they are missing, tablename will be unqualified. The **default-cascade** attribute specifies what cascade style should be assumed for properties and collections that do not specify a **cascade** attribute. By default, the **auto-import** attribute allows you to use unqualified class names in the query language.

```

<hibernate-mapping
    schema="schemaName"
    catalog="catalogName"
    default-cascade="cascade_style"
    default-access="field|property|ClassName"
    default-lazy="true|false"
    auto-import="true|false"
    package="package.name"
/>
    
```

1
2
3
4
5
6
7

1	schema (optional): the name of a database schema.
2	catalog (optional): the name of a database catalog.
3	default-cascade (optional - defaults to none): a default cascade style.
4	default-access (optional - defaults to property): the strategy Hibernate should use for accessing all properties. It can be a custom implementation of PropertyAccessor .

5	default-lazy (optional - defaults to true): the default value for unspecified lazy attributes of class and collection mappings.
6	auto-import (optional - defaults to true): specifies whether we can use unqualified class names of classes in this mapping in the query language.
7	package (optional): specifies a package prefix to use for unqualified class names in the mapping document.

If you have two persistent classes with the same unqualified name, you should set **auto-import="false"**. An exception will result if you attempt to assign two classes to the same "imported" name.

The **hibernate-mapping** element allows you to nest several persistent **<class>** mappings, as shown above. It is, however, good practice (and expected by some tools) to map only a single persistent class, or a single class hierarchy, in one mapping file and name it after the persistent superclass. For example, **Cat.hbm.xml**, **Dog.hbm.xml**, or if using inheritance, **Animal.hbm.xml**.

5.1.3. Class

You can declare a persistent class using the **class** element. For example:

```

<class
    name="ClassName"
    table="tableName"
    discriminator-value="discriminator_value"
    mutable="true|false"
    schema="owner"
    catalog="catalog"
    proxy="ProxyInterface"
    dynamic-update="true|false"
    dynamic-insert="true|false"
    select-before-update="true|false"
    polymorphism="implicit|explicit"

```

1

2

3

4

5

6

7

8

9

10

11

```

        where="arbitrary sql where condition"

        persister="PersisterClass"

        batch-size="N"

        optimistic-lock="none|version|dirty|all"

        lazy="true|false"

        entity-name="EntityName"

        check="arbitrary sql check condition"

        rowid="rowid"

        subselect="SQL expression"

        abstract="true|false"
        node="element-name"
    />
    
```

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❶	name (optional): the fully qualified Java class name of the persistent class or interface. If this attribute is missing, it is assumed that the mapping is for a non-POJO entity.
❷	table (optional - defaults to the unqualified class name): the name of its database table.
❸	discriminator-value (optional - defaults to the class name): a value that distinguishes individual subclasses that is used for polymorphic behavior. Acceptable values include null and not null .
❹	mutable (optional - defaults to true): specifies that instances of the class are (not) mutable.
❺	schema (optional): overrides the schema name specified by the root <hibernate-mapping> element.
❻	catalog (optional): overrides the catalog name specified by the root <hibernate-mapping> element.
❼	proxy (optional): specifies an interface to use for lazy initializing proxies. You can specify the name of the class itself.
❽	dynamic-update (optional - defaults to false): specifies that UPDATE SQL should be generated at runtime and can contain only those columns whose values have changed.
❾	dynamic-insert (optional - defaults to false): specifies that INSERT SQL should be generated at runtime and contain only the columns whose values are not null.

10	select-before-update (optional - defaults to false): specifies that Hibernate should <i>never</i> perform an SQL UPDATE unless it is certain that an object is actually modified. Only when a transient object has been associated with a new session using update() , will Hibernate perform an extra SQL SELECT to determine if an UPDATE is actually required.
11	polymorphism (optional - defaults to implicit): determines whether implicit or explicit query polymorphism is used.
12	where (optional): specifies an arbitrary SQL WHERE condition to be used when retrieving objects of this class.
13	persister (optional): specifies a custom ClassPersister .
14	batch-size (optional - defaults to 1): specifies a "batch size" for fetching instances of this class by identifier.
15	optimistic-lock (optional - defaults to version): determines the optimistic locking strategy.
(16)	lazy (optional): lazy fetching can be disabled by setting lazy="false" .
(17)	entity-name (optional - defaults to the class name): Hibernate3 allows a class to be mapped multiple times, potentially to different tables. It also allows entity mappings that are represented by Maps or XML at the Java level. In these cases, you should provide an explicit arbitrary name for the entity. See Section 4.4, "Dynamic models" and Chapter 18, XML Mapping for more information.
(18)	check (optional): an SQL expression used to generate a multi-row <i>check</i> constraint for automatic schema generation.
(19)	rowid (optional): Hibernate can use ROWIDs on databases. On Oracle, for example, Hibernate can use the rowid extra column for fast updates once this option has been set to rowid . A ROWID is an implementation detail and represents the physical location of a stored tuple.
(20)	subselect (optional): maps an immutable and read-only entity to a database subselect. This is useful if you want to have a view instead of a base table. See below for more information.
(21)	abstract (optional): is used to mark abstract superclasses in <union-subclass> hierarchies.

It is acceptable for the named persistent class to be an interface. You can declare implementing classes of that interface using the **<subclass>** element. You can persist any *static* inner class. Specify the class name using the standard form i.e. **e.g. Foo\$Bar**.

Immutable classes, `mutable="false"`, cannot be updated or deleted by the application. This allows Hibernate to make some minor performance optimizations.

The optional `proxy` attribute enables lazy initialization of persistent instances of the class. Hibernate will initially return CGLIB proxies that implement the named interface. The persistent object will load when a method of the proxy is invoked. See "Initializing collections and proxies" below.

Implicit polymorphism means that instances of the class will be returned by a query that names any superclass or implemented interface or class, and that instances of any subclass of the class will be returned by a query that names the class itself. *Explicit* polymorphism means that class instances will be returned only by queries that explicitly name that class. Queries that name the class will return only instances of subclasses mapped inside this `<class>` declaration as a `<subclass>` or `<joined-subclass>`. For most purposes, the default `polymorphism="implicit"` is appropriate. Explicit polymorphism is useful when two different classes are mapped to the same table. This allows a "lightweight" class that contains a subset of the table columns.

The `persister` attribute lets you customize the persistence strategy used for the class. You can, for example, specify your own subclass of `org.hibernate.persister.EntityPersister`, or you can even provide a completely new implementation of the interface `org.hibernate.persister.ClassPersister` that implements, for example, persistence via stored procedure calls, serialization to flat files or LDAP. See `org.hibernate.test.CustomPersister` for a simple example of "persistence" to a `Hashtable`.

The `dynamic-update` and `dynamic-insert` settings are not inherited by subclasses, so they can also be specified on the `<subclass>` or `<joined-subclass>` elements. Although these settings can increase performance in some cases, they can actually decrease performance in others.

Use of `select-before-update` will usually decrease performance. It is useful to prevent a database update trigger being called unnecessarily if you reattach a graph of detached instances to a `Session`.

If you enable `dynamic-update`, you will have a choice of optimistic locking strategies:

- `version`: check the version/timestamp columns
- `all`: check all columns
- `dirty`: check the changed columns, allowing some concurrent updates
- `none`: do not use optimistic locking

It is *strongly* recommended that you use version/timestamp columns for optimistic locking with Hibernate. This strategy optimizes performance and correctly handles modifications made to detached instances (i.e. when `Session.merge()` is used).

There is no difference between a view and a base table for a Hibernate mapping. This is transparent at the database level, although some DBMS do not support views properly, especially with updates. Sometimes you want to use a view, but you cannot create one in the database (i.e. with a legacy schema). In this case, you can map an immutable and read-only entity to a given SQL subselect expression:

```
<class name="Summary">
  <subselect>
    select item.name, max(bid.amount), count(*)
    from item
    join bid on bid.item_id = item.id
    group by item.name
```

```

    </subselect>
    <synchronize table="item"/>
    <synchronize table="bid"/>
    <id name="name"/>
    ...
</class>

```

Declare the tables to synchronize this entity with, ensuring that auto-flush happens correctly and that queries against the derived entity do not return stale data. The `<subselect>` is available both as an attribute and a nested mapping element.

5.1.4. id

Mapped classes *must* declare the primary key column of the database table. Most classes will also have a JavaBeans-style property holding the unique identifier of an instance. The `<id>` element defines the mapping from that property to the primary key column.

```

<id
    name="propertyName"
    1
    type="typename"
    2
    column="column_name"
    3
    unsaved-value="null|any|none|undefined|id_value"
    4
    access="field|property|ClassName">
    5
    node="element-name|@attribute-name|element/@attribute|."
    <generator class="generatorClass"/>
</id>

```

1	name (optional): the name of the identifier property.
2	type (optional): a name that indicates the Hibernate type.
3	column (optional - defaults to the property name): the name of the primary key column.
4	unsaved-value (optional - defaults to a "sensible" value): an identifier property value that indicates an instance is newly instantiated (unsaved), distinguishing it from detached instances that were saved or loaded in a previous session.
5	access (optional - defaults to property): the strategy Hibernate should use for accessing the property value.

If the **name** attribute is missing, it is assumed that the class has no identifier property.

The **unsaved-value** attribute is almost never needed in Hibernate3.

There is an alternative **<composite-id>** declaration that allows access to legacy data with composite keys. Its use is strongly discouraged for anything else.

5.1.4.1. Generator

The optional **<generator>** child element names a Java class used to generate unique identifiers for instances of the persistent class. If any parameters are required to configure or initialize the generator instance, they are passed using the **<param>** element.

```
<id name="id" type="long" column="cat_id">
  <generator class="org.hibernate.id.TableHiLoGenerator">
    <param name="table">uid_table</param>
    <param name="column">next_hi_value_column</param>
  </generator>
</id>
```

All generators implement the interface **org.hibernate.id.IdentifierGenerator**. This is a very simple interface. Some applications can choose to provide their own specialized implementations, however, Hibernate provides a range of built-in implementations. The shortcut names for the built-in generators are as follows:

increment

generates identifiers of type **long**, **short** or **int** that are unique only when no other process is inserting data into the same table. *Do not use in a cluster.*

identity

supports identity columns in DB2, MySQL, MS SQL Server, Sybase and HypersonicSQL. The returned identifier is of type **long**, **short** or **int**.

sequence

uses a sequence in DB2, PostgreSQL, Oracle, SAP DB, McKoi or a generator in Interbase. The returned identifier is of type **long**, **short** or **int**

hilo

uses a hi/lo algorithm to efficiently generate identifiers of type **long**, **short** or **int**, given a table and column (by default **hibernate_unique_key** and **next_hi** respectively) as a source of hi values. The hi/lo algorithm generates identifiers that are unique only for a particular database.

seqhilo

uses a hi/lo algorithm to efficiently generate identifiers of type **long**, **short** or **int**, given a named database sequence.

uuid

uses a 128-bit UUID algorithm to generate identifiers of type string that are unique within a network (the IP address is used). The UUID is encoded as a string of 32 hexadecimal digits in length.

guid

uses a database-generated GUID string on MS SQL Server and MySQL.

native

selects **identity**, **sequence** or **hilo** depending upon the capabilities of the underlying database.

assigned

lets the application assign an identifier to the object before **save()** is called. This is the default strategy if no **<generator>** element is specified.

select

retrieves a primary key, assigned by a database trigger, by selecting the row by some unique key and retrieving the primary key value.

foreign

uses the identifier of another associated object. It is usually used in conjunction with a **<one-to-one>** primary key association.

sequence-identity

a specialized sequence generation strategy that utilizes a database sequence for the actual value generation, but combines this with JDBC3 `getGeneratedKeys` to return the generated identifier value as part of the insert statement execution. This strategy is only supported on Oracle 10g drivers targeted for JDK 1.4. Comments on these insert statements are disabled due to a bug in the Oracle drivers.

5.1.4.2. Hi/lo algorithm

The **hilo** and **seqhilo** generators provide two alternate implementations of the hi/lo algorithm. The first implementation requires a "special" database table to hold the next available "hi" value. Where supported, the second uses an Oracle-style sequence.

```
<id name="id" type="long" column="cat_id">
  <generator class="hilo">
    <param name="table">hi_value</param>
    <param name="column">next_value</param>
    <param name="max_lo">100</param>
  </generator>
</id>
```

```
<id name="id" type="long" column="cat_id">
  <generator class="seqhilo">
    <param name="sequence">hi_value</param>
    <param name="max_lo">100</param>
  </generator>
</id>
```

Unfortunately, you cannot use **hilo** when supplying your own **Connection** to Hibernate. When Hibernate uses an application server datasource to obtain connections enlisted with JTA, you must configure the **hibernate.transaction.manager_lookup_class**.

5.1.4.3. UUID algorithm

The UUID contains: IP address, start time of the JVM that is accurate to a quarter second, system time and a counter value that is unique within the JVM. It is not possible to obtain a MAC address or memory address from Java code, so this is the best option without using JNI.

5.1.4.4. Identity columns and sequences

For databases that support identity columns (DB2, MySQL, Sybase, MS SQL), you can use **identity** key generation. For databases that support sequences (DB2, Oracle, PostgreSQL, Interbase, McKoi, SAP DB) you can use **sequence** style key generation. Both of these strategies require two SQL queries to insert a new object. For example:

```
<id name="id" type="long" column="person_id">
  <generator class="sequence">
    <param name="sequence">person_id_sequence</param>
  </generator>
</id>
```

```
<id name="id" type="long" column="person_id" unsaved-value="0">
  <generator class="identity"/>
</id>
```

For cross-platform development, the **native** strategy will, depending on the capabilities of the underlying database, choose from the **identity**, **sequence** and **hilo** strategies.

5.1.4.5. Assigned identifiers

If you want the application to assign identifiers, as opposed to having Hibernate generate them, you can use the **assigned** generator. This special generator uses the identifier value already assigned to the object's identifier property. The generator is used when the primary key is a natural key instead of a surrogate key. This is the default behavior if you do not specify a **<generator>** element.

The **assigned** generator makes Hibernate use **unsaved-value="undefined"**. This forces Hibernate to go to the database to determine if an instance is transient or detached, unless there is a version or timestamp property, or you define **Interceptor.isUnsaved()**.

5.1.4.6. Primary keys assigned by triggers

Hibernate does not generate DDL with triggers. It is for legacy schemas only.

```
<id name="id" type="long" column="person_id">
  <generator class="select">
    <param name="key">socialSecurityNumber</param>
  </generator>
</id>
```

In the above example, there is a unique valued property named **socialSecurityNumber**. It is defined by the class, as a natural key and a surrogate key named **person_id**, whose value is generated by a trigger.

5.1.5. Enhanced identifier generators

Starting with release 3.2.3, there are 2 new generators which represent a re-thinking of 2 different aspects of identifier generation. The first aspect is database portability; the second is optimization. Optimization means that you do not have to query the database for every request for a new identifier value. These two new generators are intended to take the place of some of the named generators described above, starting in 3.3.x. However, they are included in the current releases and can be referenced by FQN.

The first of these new generators is **org.hibernate.id.enhanced.SequenceStyleGenerator** which is intended, firstly, as a replacement for the **sequence** generator and, secondly, as a better portability generator than **native**. This is because **native** generally chooses between **identity** and **sequence** which have largely different semantics that can cause subtle issues in applications eyeing portability. **org.hibernate.id.enhanced.SequenceStyleGenerator**, however, achieves portability in a different manner. It chooses between a table or a sequence in the database to store its incrementing values, depending on the capabilities of the dialect being used. The difference between this and **native** is that table-based and sequence-based storage have the same exact semantic. In fact, sequences are exactly what Hibernate tries to emulate with its table-based generators. This generator has a number of configuration parameters:

- **sequence_name** (optional, defaults to **hibernate_sequence**): the name of the sequence or table to be used.
- **initial_value** (optional, defaults to **1**): the initial value to be retrieved from the sequence/table. In sequence creation terms, this is analogous to the clause typically named "STARTS WITH".
- **increment_size** (optional - defaults to **1**): the value by which subsequent calls to the sequence/table should differ. In sequence creation terms, this is analogous to the clause typically named "INCREMENT BY".
- **force_table_use** (optional - defaults to **false**): should we force the use of a table as the backing structure even though the dialect might support sequence?
- **value_column** (optional - defaults to **next_val**): only relevant for table structures, it is the name of the column on the table which is used to hold the value.
- **optimizer** (optional - defaults to **none**): See [Section 5.1.6, "Identifier generator optimization"](#)

The second of these new generators is **org.hibernate.id.enhanced.TableGenerator**, which is intended, firstly, as a replacement for the **table** generator, even though it actually functions much more like **org.hibernate.id.MultipleHiLoPerTableGenerator**, and secondly, as a re-implementation of **org.hibernate.id.MultipleHiLoPerTableGenerator** that utilizes the notion of pluggable optimizers. Essentially this generator defines a table capable of holding a number of different increment values simultaneously by using multiple distinctly keyed rows. This generator has a number of configuration parameters:

- **table_name** (optional - defaults to **hibernate_sequences**): the name of the table to be used.
- **value_column_name** (optional - defaults to **next_val**): the name of the column on the table that is used to hold the value.
- **segment_column_name** (optional - defaults to **sequence_name**): the name of the column on the table that is used to hold the "segment key". This is the value which identifies which increment value to use.

- **segment_value** (optional - defaults to **default**): The "segment key" value for the segment from which we want to pull increment values for this generator.
- **segment_value_length** (optional - defaults to **255**): Used for schema generation; the column size to create this segment key column.
- **initial_value** (optional - defaults to **1**): The initial value to be retrieved from the table.
- **increment_size** (optional - defaults to **1**): The value by which subsequent calls to the table should differ.
- **optimizer** (optional - defaults to): See [Section 5.1.6, "Identifier generator optimization"](#)

5.1.6. Identifier generator optimization

For identifier generators that store values in the database, it is inefficient for them to hit the database on each and every call to generate a new identifier value. Instead, you can group a bunch of them in memory and only hit the database when you have exhausted your in-memory value group. This is the role of the pluggable optimizers. Currently only the two enhanced generators ([Section 5.1.5, "Enhanced identifier generators"](#)) support this operation.

- **none** (generally this is the default if no optimizer was specified): this will not perform any optimizations and hit the database for each and every request.
- **hilo**: applies a hi/lo algorithm around the database retrieved values. The values from the database for this optimizer are expected to be sequential. The values retrieved from the database structure for this optimizer indicates the "group number". The **increment_size** is multiplied by that value in memory to define a group "hi value".
- **pooled**: as with the case of **hilo**, this optimizer attempts to minimize the number of hits to the database. Here, however, we simply store the starting value for the "next group" into the database structure rather than a sequential value in combination with an in-memory grouping algorithm. Here, **increment_size** refers to the values coming from the database.

5.1.7. composite-id

```
<composite-id>
  name="propertyName"
  class="ClassName"
  mapped="true|false"
  access="field|property|ClassName">
  node="element-name"

  <key-property name="propertyName" type="typename"
column="column_name"/>
  <key-many-to-one name="propertyName" class="ClassName"
column="column_name"/>
  .....
</composite-id>
```

A table with a composite key can be mapped with multiple properties of the class as identifier properties. The **<composite-id>** element accepts **<key-property>** property mappings and **<key-many-to-one>** mappings as child elements.

```
<composite-id>
```



```

        <key-property name="medicareNumber"/>
        <key-property name="dependent"/>
    </composite-id>

```

The persistent class *must* override **equals()** and **hashCode()** to implement composite identifier equality. It must also implement **Serializable**.

Unfortunately, this approach means that a persistent object is its own identifier. There is no convenient "handle" other than the object itself. You must instantiate an instance of the persistent class itself and populate its identifier properties before you can **load()** the persistent state associated with a composite key. We call this approach an *embedded* composite identifier, and discourage it for serious applications.

A second approach is what we call a *mapped* composite identifier, where the identifier properties named inside the **<composite-id>** element are duplicated on both the persistent class and a separate identifier class.

```

<composite-id class="MedicareId" mapped="true">
    <key-property name="medicareNumber"/>
    <key-property name="dependent"/>
</composite-id>

```

In this example, both the composite identifier class, **MedicareId**, and the entity class itself have properties named **medicareNumber** and **dependent**. The identifier class must override **equals()** and **hashCode()** and implement **Serializable**. The main disadvantage of this approach is code duplication.

The following attributes are used to specify a mapped composite identifier:

- **mapped** (optional - defaults to **false**): indicates that a mapped composite identifier is used, and that the contained property mappings refer to both the entity class and the composite identifier class.
- **class** (optional - but required for a mapped composite identifier): the class used as a composite identifier.

We will describe a third, even more convenient approach, where the composite identifier is implemented as a component class in [Section 8.4, "Components as composite identifiers"](#). The attributes described below apply only to this alternative approach:

- **name** (optional - required for this approach): a property of component type that holds the composite identifier. Please see chapter 9 for more information.
- **access** (optional - defaults to **property**): the strategy Hibernate uses for accessing the property value.
- **class** (optional - defaults to the property type determined by reflection): the component class used as a composite identifier. Please see the next section for more information.

The third approach, an *identifier component*, is recommended for almost all applications.

5.1.8. Discriminator

The **<discriminator>** element is required for polymorphic persistence using the table-per-class-hierarchy mapping strategy. It declares a discriminator column of the table. The discriminator column contains marker values that tell the persistence layer what subclass to instantiate for a particular row. A

restricted set of types can be used: **string**, **character**, **integer**, **byte**, **short**, **boolean**, **yes_no**, **true_false**.

```
<discriminator
    column="discriminator_column"
    type="discriminator_type"
    force="true|false"
    insert="true|false"
    formula="arbitrary sql expression"
/>
```



❶	column (optional - defaults to class): the name of the discriminator column.
❷	type (optional - defaults to string): a name that indicates the Hibernate type
❸	force (optional - defaults to false): "forces" Hibernate to specify the allowed discriminator values, even when retrieving all instances of the root class.
❹	insert (optional - defaults to true): set this to false if your discriminator column is also part of a mapped composite identifier. It tells Hibernate not to include the column in SQL INSERTs .
❺	formula (optional): an arbitrary SQL expression that is executed when a type has to be evaluated. It allows content-based discrimination.

Actual values of the discriminator column are specified by the **discriminator-value** attribute of the **<class>** and **<subclass>** elements.

The **force** attribute is only useful if the table contains rows with "extra" discriminator values that are not mapped to a persistent class. This will not usually be the case.

The **formula** attribute allows you to declare an arbitrary SQL expression that will be used to evaluate the type of a row. For example:

```
<discriminator
    formula="case when CLASS_TYPE in ('a', 'b', 'c') then 0 else 1 end"
    type="integer"/>
```

5.1.9. Version (optional)

The **<version>** element is optional and indicates that the table contains versioned data. This is particularly useful if you plan to use *long transactions*. See below for more information:

```
<version
    column="version_column"
```

```

1 name="propertyName"
2 type="typename"
3 access="field|property|ClassName"
4 unsaved-value="null|negative|undefined"
5 generated="never|always"
6 insert="true|false"
7 node="element-name|@attribute-name|element/@attribute|."
/>

```

1	column (optional - defaults to the property name): the name of the column holding the version number.
2	name : the name of a property of the persistent class.
3	type (optional - defaults to integer): the type of the version number.
4	access (optional - defaults to property): the strategy Hibernate uses to access the property value.
5	unsaved-value (optional - defaults to undefined): a version property value that indicates that an instance is newly instantiated (unsaved), distinguishing it from detached instances that were saved or loaded in a previous session. Undefined specifies that the identifier property value should be used.
6	generated (optional - defaults to never): specifies that this version property value is generated by the database. See the discussion of Section 5.6, "Generated properties" for more information.
7	insert (optional - defaults to true): specifies whether the version column should be included in SQL insert statements. It can be set to false if the database column is defined with a default value of 0 .

Version numbers can be of Hibernate type **long**, **integer**, **short**, **timestamp** or **calendar**.

A version or timestamp property should never be null for a detached instance. Hibernate will detect any instance with a null version or timestamp as transient, irrespective of what other **unsaved-value** strategies are specified. *Declaring a nullable version or timestamp property is an easy way to avoid problems with transitive reattachment in Hibernate. It is especially useful for people using assigned identifiers or composite keys.*

5.1.10. Timestamp (optional)

The optional `<timestamp>` element indicates that the table contains timestamped data. This provides an alternative to versioning. Timestamps are a less safe implementation of optimistic locking. However, sometimes the application might use the timestamps in other ways.

```

<timestamp
  column="timestamp_column"
  1
  name="propertyName"
  2
  access="field|property|ClassName"
  3
  unsaved-value="null|undefined"
  4
  source="vm|db"
  5
  generated="never|always"
  6
  node="element-name|@attribute-name|element/@attribute|."
/>
    
```

1	column (optional - defaults to the property name): the name of a column holding the timestamp.
2	name : the name of a JavaBeans style property of Java type Date or Timestamp of the persistent class.
3	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
4	unsaved-value (optional - defaults to null): a version property value that indicates that an instance is newly instantiated (unsaved), distinguishing it from detached instances that were saved or loaded in a previous session. Undefined specifies that the identifier property value should be used.
5	source (optional - defaults to vm): Where should Hibernate retrieve the timestamp value from? From the database, or from the current JVM? Database-based timestamps incur an overhead because Hibernate must hit the database in order to determine the "next value". It is safer to use in clustered environments. Not all Dialects are known to support the retrieval of the database's current timestamp. Others may also be unsafe for usage in locking due to lack of precision (Oracle 8, for example).
6	generated (optional - defaults to never): specifies that this timestamp property value is actually generated by the database. See the discussion of Section 5.6, "Generated properties" for more information.

**NOTE**

<Timestamp> is equivalent to <version type="timestamp">. And <timestamp source="db"> is equivalent to <version type="dbtimestamp">

5.1.11. Property

The <property> element declares a persistent JavaBean style property of the class.

```

<property
  name="propertyName"
  1
  column="column_name"
  2
  type="typename"
  3
  update="true|false"
  4
  insert="true|false"
  4
  formula="arbitrary SQL expression"
  5
  access="field|property|ClassName"
  6
  lazy="true|false"
  7
  unique="true|false"
  8
  not-null="true|false"
  9
  optimistic-lock="true|false"
  10
  generated="never|insert|always"
  11
  node="element-name|@attribute-name|element/@attribute|."
  index="index_name"

```

```

        unique_key="unique_key_id"
        length="L"
        precision="P"
        scale="S"
    />

```

1	name : the name of the property, with an initial lowercase letter.
2	column (optional - defaults to the property name): the name of the mapped database table column. This can also be specified by nested <column> element(s).
3	type (optional): a name that indicates the Hibernate type.
4	update, insert (optional - defaults to true): specifies that the mapped columns should be included in SQL UPDATE and/or INSERT statements. Setting both to false allows a pure "derived" property whose value is initialized from some other property that maps to the same column(s), or by a trigger or other application.
5	formula (optional): an SQL expression that defines the value for a <i>computed</i> property. Computed properties do not have a column mapping of their own.
6	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
7	lazy (optional - defaults to false): specifies that this property should be fetched lazily when the instance variable is first accessed. It requires build-time bytecode instrumentation.
8	unique (optional): enables the DDL generation of a unique constraint for the columns. Also, allow this to be the target of a property-ref .
9	not-null (optional): enables the DDL generation of a nullability constraint for the columns.
10	optimistic-lock (optional - defaults to true): specifies that updates to this property do or do not require acquisition of the optimistic lock. In other words, it determines if a version increment should occur when this property is dirty.
11	generated (optional - defaults to never): specifies that this property value is actually generated by the database. See the discussion of Section 5.6 , "Generated properties" for more information.

typename could be:

1. The name of a Hibernate basic type: **integer, string, character, date, timestamp, float, binary, serializable, object, blob** etc.
2. The name of a Java class with a default basic type: **int, float, char, java.lang.String, java.util.Date, java.lang.Integer, java.sql.Clob** etc.
3. The name of a serializable Java class.
4. The class name of a custom type: **com.illflow.type.MyCustomType** etc.

If you do not specify a type, Hibernate will use reflection upon the named property and guess the correct Hibernate type. Hibernate will attempt to interpret the name of the return class of the property getter

using, in order, rules 2, 3, and 4. In certain cases you will need the **type** attribute. For example, to distinguish between **Hibernate.DATE** and **Hibernate.TIMESTAMP**, or to specify a custom type.

The **access** attribute allows you to control how Hibernate accesses the property at runtime. By default, Hibernate will call the property get/set pair. If you specify **access="field"**, Hibernate will bypass the get/set pair and access the field directly using reflection. You can specify your own strategy for property access by naming a class that implements the interface **org.hibernate.property.PropertyAccessor**.

A powerful feature is derived properties. These properties are by definition read-only. The property value is computed at load time. You declare the computation as an SQL expression. This then translates to a **SELECT** clause subquery in the SQL query that loads an instance:

```
<property name="totalPrice"
  formula="( SELECT SUM (li.quantity*p.price) FROM LineItem li, Product
p
          WHERE li.productId = p.productId
          AND li.customerId = customerId
          AND li.orderNumber = orderNumber )"/>
```

You can reference the entity table by not declaring an alias on a particular column. This would be **customerId** in the given example. You can also use the nested **<formula>** mapping element if you do not want to use the attribute.

5.1.12. Many-to-one

An ordinary association to another persistent class is declared using a **many-to-one** element. The relational model is a many-to-one association; a foreign key in one table is referencing the primary key column(s) of the target table.

```
<many-to-one
  name="propertyName"
  1
  column="column_name"
  2
  class="ClassName"
  3
  cascade="cascade_style"
  4
  fetch="join|select"
  5
  update="true|false"
  6
  insert="true|false"
```

6

```
property-ref="propertyNameFromAssociatedClass"
```

7

```
access="field|property|ClassName"
```

8

```
unique="true|false"
```

9

```
not-null="true|false"
```

10

```
optimistic-lock="true|false"
```

11

```
lazy="proxy|no-proxy|false"
```

12

```
not-found="ignore|exception"
```

13

```
entity-name="EntityName"
```

14

```
formula="arbitrary SQL expression"
```

15

```
node="element-name|@attribute-name|element/@attribute|."
```

```
embed-xml="true|false"
```

```
index="index_name"
```

```
unique_key="unique_key_id"
```

```
foreign-key="foreign_key_name"
```

```
/>
```

❶	name : the name of the property.
❷	column (optional): the name of the foreign key column. This can also be specified by nested <column> element(s).
❸	class (optional - defaults to the property type determined by reflection): the name of the associated class.
❹	cascade (optional): specifies which operations should be cascaded from the parent object to the associated object.

5	fetch (optional - defaults to select): chooses between outer-join fetching or sequential select fetching.
6	update, insert (optional - defaults to true): specifies that the mapped columns should be included in SQL UPDATE and/or INSERT statements. Setting both to false allows a pure "derived" association whose value is initialized from another property that maps to the same column(s), or by a trigger or other application.
7	property-ref (optional): the name of a property of the associated class that is joined to this foreign key. If not specified, the primary key of the associated class is used.
8	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
9	unique (optional): enables the DDL generation of a unique constraint for the foreign-key column. By allowing this to be the target of a property-ref , you can make the association multiplicity one-to-one.
10	not-null (optional): enables the DDL generation of a nullability constraint for the foreign key columns.
11	optimistic-lock (optional - defaults to true): specifies that updates to this property do or do not require acquisition of the optimistic lock. In other words, it determines if a version increment should occur when this property is dirty.
12	lazy (optional - defaults to proxy): by default, single point associations are proxied. lazy="no-proxy" specifies that the property should be fetched lazily when the instance variable is first accessed. This requires build-time bytecode instrumentation. lazy="false" specifies that the association will always be eagerly fetched.
13	not-found (optional - defaults to exception): specifies how foreign keys that reference missing rows will be handled. ignore will treat a missing row as a null association.
14	entity-name (optional): the entity name of the associated class.
15	formula (optional): an SQL expression that defines the value for a <i>computed</i> foreign key.

Setting a value of the **cascade** attribute to any meaningful value other than **none** will propagate certain operations to the associated object. The meaningful values are divided into three categories. First, basic operations, which include: **persist, merge, delete, save-update, evict, replicate, lock and refresh**; second, special values: **delete-orphan**; and third, all comma-separated combinations of operation names: **cascade="persist, merge, evict"** or **cascade="all, delete-orphan"**. See [Section 10.11, "Transitive persistence"](#) for a full explanation. Note that single valued, many-to-one and one-to-one, associations do not support orphan delete.

Here is an example of a typical **many-to-one** declaration:

```
<many-to-one name="product" class="Product" column="PRODUCT_ID"/>
```

The **property-ref** attribute should only be used for mapping legacy data where a foreign key refers to a unique key of the associated table other than the primary key. This is a complicated and confusing relational model. For example, if the **Product** class had a unique serial number that is not the primary key. The **unique** attribute controls Hibernate's DDL generation with the SchemaExport tool.

```
<property name="serialNumber" unique="true" type="string"
column="SERIAL_NUMBER"/>
```

Then the mapping for **OrderItem** might use:

```
<many-to-one name="product" property-ref="serialNumber"
column="PRODUCT_SERIAL_NUMBER"/>
```

This is not encouraged, however.

If the referenced unique key comprises multiple properties of the associated entity, you should map the referenced properties inside a named **<properties>** element.

If the referenced unique key is the property of a component, you can specify a property path:

```
<many-to-one name="owner" property-ref="identity.ssn" column="OWNER_SSN"/>
```

5.1.13. One-to-one

A one-to-one association to another persistent class is declared using a **one-to-one** element.

```
<one-to-one
    name="propertyName"
    1 class="ClassName"
    2 cascade="cascade_style"
    3 constrained="true|false"
    4 fetch="join|select"
    5 property-ref="propertyNameFromAssociatedClass"
    6 access="field|property|ClassName"
    7 formula="any SQL expression"
    8 lazy="proxy|no-proxy|false"
    9
```

10

```
entity-name="EntityName"
```

```
node="element-name|@attribute-name|element/@attribute|."
```

```
embed-xml="true|false"
```

```
foreign-key="foreign_key_name"
```

```
/>
```

1	name : the name of the property.
2	class (optional - defaults to the property type determined by reflection): the name of the associated class.
3	cascade (optional): specifies which operations should be cascaded from the parent object to the associated object.
4	constrained (optional): specifies that a foreign key constraint on the primary key of the mapped table and references the table of the associated class. This option affects the order in which save() and delete() are cascaded, and determines whether the association can be proxied. It is also used by the schema export tool.
5	fetch (optional - defaults to select): chooses between outer-join fetching or sequential select fetching.
6	property-ref (optional): the name of a property of the associated class that is joined to the primary key of this class. If not specified, the primary key of the associated class is used.
7	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
8	formula (optional): almost all one-to-one associations map to the primary key of the owning entity. If this is not the case, you can specify another column, columns or expression to join on using an SQL formula. See <code>org.hibernate.test.onetooneformula</code> for an example.
9	lazy (optional - defaults to proxy): by default, single point associations are proxied. lazy="no-proxy" specifies that the property should be fetched lazily when the instance variable is first accessed. It requires build-time bytecode instrumentation. lazy="false" specifies that the association will always be eagerly fetched. <i>Note that if constrained="false", proxying is impossible and Hibernate will eagerly fetch the association.</i>
10	entity-name (optional): the entity name of the associated class.

There are two varieties of one-to-one associations:

- primary key associations
- unique foreign key associations

Primary key associations do not need an extra table column. If two rows are related by the association, then the two table rows share the same primary key value. To relate two objects by a primary key association, ensure that they are assigned the same identifier value.

For a primary key association, add the following mappings to **Employee** and **Person** respectively:

```
<one-to-one name="person" class="Person"/>
```

```
<one-to-one name="employee" class="Employee" constrained="true"/>
```

Ensure that the primary keys of the related rows in the PERSON and EMPLOYEE tables are equal. You use a special Hibernate identifier generation strategy called **foreign**:

```
<class name="person" table="PERSON">
  <id name="id" column="PERSON_ID">
    <generator class="foreign">
      <param name="property">employee</param>
    </generator>
  </id>
  ...
  <one-to-one name="employee"
    class="Employee"
    constrained="true"/>
</class>
```

A newly saved instance of **Person** is assigned the same primary key value as the **Employee** instance referred with the **employee** property of that **Person**.

Alternatively, a foreign key with a unique constraint, from **Employee** to **Person**, can be expressed as:

```
<many-to-one name="person" class="Person" column="PERSON_ID"
  unique="true"/>
```

This association can be made bidirectional by adding the following to the **Person** mapping:

```
<one-to-one name="employee" class="Employee" property-ref="person"/>
```

5.1.14. Natural-id

```
<natural-id mutable="true|false"/>
  <property ... />
  <many-to-one ... />
  .....
</natural-id>
```

Although we recommend the use of surrogate keys as primary keys, you should try to identify natural keys for all entities. A natural key is a property or combination of properties that is unique and non-null. It is also immutable. Map the properties of the natural key inside the **<natural-id>** element. Hibernate will generate the necessary unique key and nullability constraints and, as a result, your mapping will be more self-documenting.

It is recommended that you implement **equals()** and **hashCode()** to compare the natural key properties of the entity.

This mapping is not intended for use with entities that have natural primary keys.

- **mutable** (optional - defaults to **false**): by default, natural identifier properties are assumed to be immutable (constant).

5.1.15. Component and dynamic-component

The `<component>` element maps properties of a child object to columns of the table of a parent class. Components can, in turn, declare their own properties, components or collections. See the "Component" examples below:

```

<component
    name="propertyName"
    class="className"
    insert="true|false"
    update="true|false"
    access="field|property|ClassName"
    lazy="true|false"
    optimistic-lock="true|false"
    unique="true|false"
    node="element-name|. "
>
    <property ...../>
    <many-to-one .... />
    .....
</component>

```

❶	name: the name of the property.
❷	class (optional - defaults to the property type determined by reflection): the name of the component (child) class.
❸	insert: do the mapped columns appear in SQL INSERTs ?
❹	update: do the mapped columns appear in SQL UPDATEs ?
❺	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
❻	lazy (optional - defaults to false): specifies that this component should be fetched lazily when the instance variable is first accessed. It requires build-time bytecode instrumentation.
❼	optimistic-lock (optional - defaults to true): specifies that updates to this component either do or do not require acquisition of the optimistic lock. It determines if a version increment should occur when this property is dirty.

- ④ **unique** (optional - defaults to **false**): specifies that a unique constraint exists upon all mapped columns of the component.

The child `<property>` tags map properties of the child class to table columns.

The `<component>` element allows a `<parent>` subelement that maps a property of the component class as a reference back to the containing entity.

The `<dynamic-component>` element allows a `Map` to be mapped as a component, where the property names refer to keys of the map. See [Section 8.5, “Dynamic components”](#) for more information.

5.1.16. Properties

The `<properties>` element allows the definition of a named, logical grouping of the properties of a class. The most important use of the construct is that it allows a combination of properties to be the target of a `property-ref`. It is also a convenient way to define a multi-column unique constraint. For example:

```

<properties
    name="logicalName"
    insert="true|false"
    update="true|false"
    optimistic-lock="true|false"
    unique="true|false"
>
    <property ...../>
    <many-to-one .... />
    .....
</properties>
    
```

- | | |
|---|---|
| ① | name : the logical name of the grouping. It is <i>not</i> an actual property name. |
| ② | insert : do the mapped columns appear in SQL INSERTs ? |
| ③ | update : do the mapped columns appear in SQL UPDATEs ? |
| ④ | optimistic-lock (optional - defaults to true): specifies that updates to these properties either do or do not require acquisition of the optimistic lock. It determines if a version increment should occur when these properties are dirty. |
| ⑤ | unique (optional - defaults to false): specifies that a unique constraint exists upon all mapped columns of the component. |

For example, if we have the following `<properties>` mapping:

```
<class name="Person">
  <id name="personNumber"/>

  ...
  <properties name="name"
    unique="true" update="false">
    <property name="firstName"/>
    <property name="initial"/>
    <property name="lastName"/>
  </properties>
</class>
```

You might have some legacy data association that refers to this unique key of the **Person** table, instead of to the primary key:

```
<many-to-one name="person"
  class="Person" property-ref="name">
  <column name="firstName"/>
  <column name="initial"/>
  <column name="lastName"/>
</many-to-one>
```

The use of this outside the context of mapping legacy data is not recommended.

5.1.17. Subclass

Polymorphic persistence requires the declaration of each subclass of the root persistent class. For the table-per-class-hierarchy mapping strategy, the `<subclass>` declaration is used. For example:

```
<subclass
  name="ClassName"
  discriminator-value="discriminator_value"
  proxy="ProxyInterface"
  lazy="true|false"
  dynamic-update="true|false"
  dynamic-insert="true|false"
  entity-name="EntityName"
  node="element-name"
  extends="SuperclassName">
  <property .... />
  .....
</subclass>
```

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❶ **name:** the fully qualified class name of the subclass.

2	discriminator-value (optional - defaults to the class name): a value that distinguishes individual subclasses.
3	proxy (optional): specifies a class or interface used for lazy initializing proxies.
4	lazy (optional - defaults to true): setting lazy="false" disables the use of lazy fetching.

Each subclass declares its own persistent properties and subclasses. **<version>** and **<id>** properties are assumed to be inherited from the root class. Each subclass in a hierarchy must define a unique **discriminator-value**. If this is not specified, the fully qualified Java class name is used.

For information about inheritance mappings see [Chapter 9, Inheritance mapping](#).

5.1.18. Joined-subclass

Each subclass can also be mapped to its own table. This is called the table-per-subclass mapping strategy. An inherited state is retrieved by joining with the table of the superclass. To do this you use the **<joined-subclass>** element. For example:

```

<joined-subclass
    name="ClassName"
    table="tablename"
    proxy="ProxyInterface"

    lazy="true|false"
    dynamic-update="true|false"
    dynamic-insert="true|false"
    schema="schema"
    catalog="catalog"
    extends="SuperclassName"
    persister="ClassName"
    subselect="SQL expression"
    entity-name="EntityName"
    node="element-name">

    <key .... >

    <property .... />
    .....
</joined-subclass>
    
```



1	name : the fully qualified class name of the subclass.
2	table : the name of the subclass table.
3	proxy (optional): specifies a class or interface to use for lazy initializing proxies.

- **lazy** (optional, defaults to **true**): setting **lazy="false"** disables the use of lazy fetching.

A discriminator column is not required for this mapping strategy. Each subclass must, however, declare a table column holding the object identifier using the **<key>** element. The mapping at the start of the chapter would then be re-written as:

```
<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
    "-//Hibernate/Hibernate Mapping DTD//EN"
    "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="eg">

    <class name="Cat" table="CATS">
        <id name="id" column="uid" type="long">
            <generator class="hilo"/>
        </id>
        <property name="birthdate" type="date"/>
        <property name="color" not-null="true"/>
        <property name="sex" not-null="true"/>
        <property name="weight"/>
        <many-to-one name="mate"/>
        <set name="kittens">
            <key column="MOTHER"/>
            <one-to-many class="Cat"/>
        </set>
        <joined-subclass name="DomesticCat"
table="DOMESTIC_CATS">
            <key column="CAT"/>
            <property name="name" type="string"/>
        </joined-subclass>
    </class>

    <class name="eg.Dog">
        <!-- mapping for Dog could go here -->
    </class>

</hibernate-mapping>
```

For information about inheritance mappings see [Chapter 9, Inheritance mapping](#).

5.1.19. Union-subclass

A third option is to map only the concrete classes of an inheritance hierarchy to tables. This is called the table-per-concrete-class strategy. Each table defines all persistent states of the class, including the inherited state. In Hibernate, it is not necessary to explicitly map such inheritance hierarchies. You can map each class with a separate **<class>** declaration. However, if you wish use polymorphic associations (e.g. an association to the superclass of your hierarchy), you need to use the **<union-subclass>** mapping. For example:

```
<union-subclass
    name="ClassName"
```

1

```

        table="tablename"

        proxy="ProxyInterface"

        lazy="true|false"
        dynamic-update="true|false"
        dynamic-insert="true|false"
        schema="schema"
        catalog="catalog"
        extends="SuperclassName"
        abstract="true|false"
        persister="ClassName"
        subselect="SQL expression"
        entity-name="EntityName"
        node="element-name">

        <property .... />
        .....
    </union-subclass>
    
```

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4

❶	name : the fully qualified class name of the subclass.
❷	table : the name of the subclass table.
❸	proxy (optional): specifies a class or interface to use for lazy initializing proxies.
❹	lazy (optional, defaults to true): setting lazy="false" disables the use of lazy fetching.

No discriminator column or key column is required for this mapping strategy.

For information about inheritance mappings see [Chapter 9, Inheritance mapping](#).

5.1.20. Join

Using the `<join>` element, it is possible to map properties of one class to several tables that have a one-to-one relationship. For example:

```

<join

    table="tablename"

    schema="owner"

    catalog="catalog"

    fetch="join|select"
    
```

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```

        inverse="true|false"

        optional="true|false">

        <key ... />

        <property ... />
        ...
    </join>

```

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❶	table : the name of the joined table.
❷	schema (optional): overrides the schema name specified by the root <hibernate-mapping> element.
❸	catalog (optional): overrides the catalog name specified by the root <hibernate-mapping> element.
❹	fetch (optional - defaults to join): if set to join , the default, Hibernate will use an inner join to retrieve a <join> defined by a class or its superclasses. It will use an outer join for a <join> defined by a subclass. If set to select then Hibernate will use a sequential select for a <join> defined on a subclass. This will be issued only if a row represents an instance of the subclass. Inner joins will still be used to retrieve a <join> defined by the class and its superclasses.
❺	inverse (optional - defaults to false): if enabled, Hibernate will not insert or update the properties defined by this join.
❻	optional (optional - defaults to false): if enabled, Hibernate will insert a row only if the properties defined by this join are non-null. It will always use an outer join to retrieve the properties.

For example, address information for a person can be mapped to a separate table while preserving value type semantics for all properties:

```

<class name="Person"
    table="PERSON">

    <id name="id" column="PERSON_ID">...</id>

    <join table="ADDRESS">
        <key column="ADDRESS_ID"/>
        <property name="address"/>
        <property name="zip"/>
        <property name="country"/>
    </join>
    ...

```

This feature is often only useful for legacy data models. We recommend fewer tables than classes and a fine-grained domain model. However, it is useful for switching between inheritance mapping strategies in a single hierarchy, as explained later.

5.1.21. Key

The **<key>** element has featured a few times within this guide. It appears anywhere the parent mapping element defines a join to a new table that references the primary key of the original table. It also defines the foreign key in the joined table:

```

<key
    column="columnname"
    on-delete="noaction|cascade"
    property-ref="propertyName"
    not-null="true|false"
    update="true|false"
    unique="true|false"
/>
    
```



❶	column (optional): the name of the foreign key column. This can also be specified by nested <column> element(s).
❷	on-delete (optional - defaults to noaction): specifies whether the foreign key constraint has database-level cascade delete enabled.
❸	property-ref (optional): specifies that the foreign key refers to columns that are not the primary key of the original table. It is provided for legacy data.
❹	not-null (optional): specifies that the foreign key columns are not nullable. This is implied whenever the foreign key is also part of the primary key.
❺	update (optional): specifies that the foreign key should never be updated. This is implied whenever the foreign key is also part of the primary key.
❻	unique (optional): specifies that the foreign key should have a unique constraint. This is implied whenever the foreign key is also the primary key.

For systems where delete performance is important, we recommend that all keys should be defined **on-delete="cascade"**. Hibernate uses a database-level **ON CASCADE DELETE** constraint, instead of many individual **DELETE** statements. Be aware that this feature bypasses Hibernate's usual optimistic locking strategy for versioned data.

The **not-null** and **update** attributes are useful when mapping a unidirectional one-to-many association. If you map a unidirectional one-to-many association to a non-nullable foreign key, you *must* declare the key column using **<key not-null="true">**.

5.1.22. Column and formula elements

Mapping elements which accept a **column** attribute will alternatively accept a **<column>** subelement. Likewise, **<formula>** is an alternative to the **formula** attribute. For example:

```
<column
  name="column_name"
  length="N"
  precision="N"
  scale="N"
  not-null="true|false"
  unique="true|false"
  unique-key="multicolumn_unique_key_name"
  index="index_name"
  sql-type="sql_type_name"
  check="SQL expression"
  default="SQL expression"/>
```

```
<formula>SQL expression</formula>
```

column and **formula** attributes can even be combined within the same property or association mapping to express, for example, exotic join conditions.

```
<many-to-one name="homeAddress" class="Address"
  insert="false" update="false">
  <column name="person_id" not-null="true" length="10"/>
  <formula>'MAILING'</formula>
</many-to-one>
```

5.1.23. Import

If your application has two persistent classes with the same name, and you do not want to specify the fully qualified package name in Hibernate queries, classes can be "imported" explicitly, rather than relying upon **auto-import="true"**. You can also import classes and interfaces that are not explicitly mapped:

```
<import class="java.lang.Object" rename="Universe"/>
```

```
<import
  class="ClassName"
  rename="ShortName"
/>
```



- | | |
|---|---|
| ❶ | class : the fully qualified class name of any Java class. |
| ❷ | rename (optional - defaults to the unqualified class name): a name that can be used in the query language. |

5.1.24. Any

There is one more type of property mapping. The **<any>** mapping element defines a polymorphic association to classes from multiple tables. This type of mapping requires more than one column. The first column contains the type of the associated entity. The remaining columns contain the identifier. It is impossible to specify a foreign key constraint for this kind of association. This is not the usual way of mapping polymorphic associations and you should use this only in special cases. For example, for audit logs, user session data, etc.

The **meta-type** attribute allows the application to specify a custom type that maps database column values to persistent classes that have identifier properties of the type specified by **id-type**. You must specify the mapping from values of the meta-type to class names.

```
<any name="being" id-type="long" meta-type="string">
  <meta-value value="TBL_ANIMAL" class="Animal"/>
  <meta-value value="TBL_HUMAN" class="Human"/>
  <meta-value value="TBL_ALIEN" class="Alien"/>
  <column name="table_name"/>
  <column name="id"/>
</any>
```

```
<any
  name="propertyName"
  id-type="idtypename"
  meta-type="metatypename"
  cascade="cascade_style"
  access="field|property|ClassName"
  optimistic-lock="true|false"
  >
  <meta-value ... />
  <meta-value ... />
  .....
  <column .... />
  <column .... />
  .....
</any>
```

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1	name : the property name.
2	id-type : the identifier type.
3	meta-type (optional - defaults to string): any type that is allowed for a discriminator mapping.
4	cascade (optional- defaults to none): the cascade style.

5	access (optional - defaults to property): the strategy Hibernate uses for accessing the property value.
6	optimistic-lock (optional - defaults to true): specifies that updates to this property either do or do not require acquisition of the optimistic lock. It defines whether a version increment should occur if this property is dirty.

5.2. HIBERNATE TYPES

5.2.1. Entities and values

In relation to the persistence service, Java language-level objects are classified into two groups:

An *entity* exists independently of any other objects holding references to the entity. Contrast this with the usual Java model, where an unreferenced object is garbage collected. Entities must be explicitly saved and deleted. Saves and deletions, however, can be *cascaded* from a parent entity to its children. This is different from the ODMG model of object persistence by reachability and corresponds more closely to how application objects are usually used in large systems. Entities support circular and shared references. They can also be versioned.

An entity's persistent state consists of references to other entities and instances of *value* types. Values are primitives: collections (not what is inside a collection), components and certain immutable objects. Unlike entities, values in particular collections and components, *are* persisted and deleted by reachability. Since value objects and primitives are persisted and deleted along with their containing entity, they cannot be independently versioned. Values have no independent identity, so they cannot be shared by two entities or collections.

Until now, we have been using the term "persistent class" to refer to entities. We will continue to do that. Not all user-defined classes with a persistent state, however, are entities. A *component* is a user-defined class with value semantics. A Java property of type `java.lang.String` also has value semantics. Given this definition, all types (classes) provided by the JDK have value type semantics in Java, while user-defined types can be mapped with entity or value type semantics. This decision is up to the application developer. An entity class in a domain model will normally have shared references to a single instance of that class, while composition or aggregation usually translates to a value type.

We will revisit both concepts throughout this reference guide.

The challenge is to map the Java type system, and the developers' definition of entities and value types, to the SQL/database type system. The bridge between both systems is provided by Hibernate. For entities, `<class>`, `<subclass>` and so on are used. For value types we use `<property>`, `<component>` etc., that usually have a `type` attribute. The value of this attribute is the name of a Hibernate *mapping type*. Hibernate provides a range of mappings for standard JDK value types out of the box. You can write your own mapping types and implement your own custom conversion strategies.

With the exception of collections, all built-in Hibernate types support null semantics.

5.2.2. Basic value types

The built-in *basic mapping types* can be roughly categorized into the following:

integer, long, short, float, double, character, byte, boolean, yes_no, true_false

Type mappings from Java primitives or wrapper classes to appropriate (vendor-specific) SQL column types. **boolean**, **yes_no** and **true_false** are all alternative encodings for a Java **boolean** or **java.lang.Boolean**.

string

A type mapping from **java.lang.String** to **VARCHAR** (or Oracle **VARCHAR2**).

date, time, timestamp

Type mappings from **java.util.Date** and its subclasses to SQL types **DATE**, **TIME** and **TIMESTAMP** (or equivalent).

calendar, calendar_date

Type mappings from **java.util.Calendar** to SQL types **TIMESTAMP** and **DATE** (or equivalent).

big_decimal, big_integer

Type mappings from **java.math.BigDecimal** and **java.math.BigInteger** to **NUMERIC** (or Oracle **NUMBER**).

locale, timezone, currency

Type mappings from **java.util.Locale**, **java.util.TimeZone** and **java.util.Currency** to **VARCHAR** (or Oracle **VARCHAR2**). Instances of **Locale** and **Currency** are mapped to their ISO codes. Instances of **TimeZone** are mapped to their **ID**.

class

A type mapping from **java.lang.Class** to **VARCHAR** (or Oracle **VARCHAR2**). A **Class** is mapped to its fully qualified name.

binary

Maps byte arrays to an appropriate SQL binary type.

text

Maps long Java strings to a SQL **CLOB** or **TEXT** type.

serializable

Maps serializable Java types to an appropriate SQL binary type. You can also indicate the Hibernate type **serializable** with the name of a serializable Java class or interface that does not default to a basic type.

clob, blob

Type mappings for the JDBC classes **java.sql.Clob** and **java.sql.Blob**. These types can be inconvenient for some applications, since the blob or clob object cannot be reused outside of a transaction. Driver support is patchy and inconsistent.

imm_date, imm_time, imm_timestamp, imm_calendar, imm_calendar_date, imm_serializable, imm_binary

Type mappings for what are considered mutable Java types. This is where Hibernate makes certain optimizations appropriate only for immutable Java types, and the application treats the object as

immutable. For example, you should not call `Date.setTime()` for an instance mapped as `imm_timestamp`. To change the value of the property, and have that change made persistent, the application must assign a new, nonidentical, object to the property.

Unique identifiers of entities and collections can be of any basic type except `binary`, `blob` and `clob`. Composite identifiers are also allowed. See below for more information.

The basic value types have corresponding `Type` constants defined on `org.hibernate.Hibernate`. For example, `Hibernate.STRING` represents the `string` type.

5.2.3. Custom value types

It is relatively easy for developers to create their own value types. For example, you might want to persist properties of type `java.lang.BigInteger` to `VARCHAR` columns. Hibernate does not provide a built-in type for this. Custom types are not limited to mapping a property, or collection element, to a single table column. So, for example, you might have a Java property `getName()/setName()` of type `java.lang.String` that is persisted to the columns `FIRST_NAME`, `INITIAL`, `SURNAME`.

To implement a custom type, implement either `org.hibernate.UserType` or `org.hibernate.CompositeUserType` and declare properties using the fully qualified classname of the type. View `org.hibernate.test.DoubleStringType` to see the kind of things that are possible.

```
<property name="twoStrings" type="org.hibernate.test.DoubleStringType">
  <column name="first_string"/>
  <column name="second_string"/>
</property>
```

Notice the use of `<column>` tags to map a property to multiple columns.

The `CompositeUserType`, `EnhancedUserType`, `UserCollectionType`, and `UserVersionType` interfaces provide support for more specialized uses.

You can even supply parameters to a `UserType` in the mapping file. To do this, your `UserType` must implement the `org.hibernate.usertype.ParameterizedType` interface. To supply parameters to your custom type, you can use the `<type>` element in your mapping files.

```
<property name="priority">
  <type name="com.mycompany.usertypes.DefaultValueIntegerType">
    <param name="default">0</param>
  </type>
</property>
```

The `UserType` can now retrieve the value for the parameter named `default` from the `Properties` object passed to it.

If you regularly use a certain `UserType`, it is useful to define a shorter name for it. You can do this using the `<typedef>` element. Typedefs assign a name to a custom type, and can also contain a list of default parameter values if the type is parameterized.

```
<typedef class="com.mycompany.usertypes.DefaultValueIntegerType"
name="default_zero">
  <param name="default">0</param>
</typedef>
```

```
<property name="priority" type="default_zero"/>
```

It is also possible to override the parameters supplied in a typedef on a case-by-case basis by using type parameters on the property mapping.

Even though Hibernate's rich range of built-in types and support for components means you will rarely need to use a custom type, it is considered good practice to use custom types for non-entity classes that occur frequently in your application. For example, a **MonetaryAmount** class is a good candidate for a **CompositeUserType**, even though it could be mapped as a component. One reason for this is abstraction. With a custom type, your mapping documents would be protected against changes to the way monetary values are represented.

5.3. MAPPING A CLASS MORE THAN ONCE

It is possible to provide more than one mapping for a particular persistent class. In this case, you must specify an *entity name* to disambiguate between instances of the two mapped entities. By default, the entity name is the same as the class name. Hibernate lets you specify the entity name when working with persistent objects, when writing queries, or when mapping associations to the named entity.

```
<class name="Contract" table="Contracts"
    entity-name="CurrentContract">
    ...
    <set name="history" inverse="true"
        order-by="effectiveEndDate desc">
        <key column="currentContractId"/>
        <one-to-many entity-name="HistoricalContract"/>
    </set>
</class>

<class name="Contract" table="ContractHistory"
    entity-name="HistoricalContract">
    ...
    <many-to-one name="currentContract"
        column="currentContractId"
        entity-name="CurrentContract"/>
</class>
```

Associations are now specified using **entity-name** instead of **class**.

5.4. SQL QUOTED IDENTIFIERS

You can force Hibernate to quote an identifier in the generated SQL by enclosing the table or column name in backticks in the mapping document. Hibernate will use the correct quotation style for the SQL **Dialect**. This is usually double quotes, but the SQL Server uses brackets and MySQL uses backticks.

```
<class name="LineItem" table="`Line Item`">
    <id name="id" column="`Item Id`"/><generator class="assigned"/></id>
    <property name="itemNumber" column="`Item #`"/>
    ...
</class>
```

5.5. METADATA ALTERNATIVES

XML does not suit all users so there are some alternative ways to define O/R mapping metadata in Hibernate.

5.5.1. Using XDoclet markup

Many Hibernate users prefer to embed mapping information directly in source code using XDoclet `@hibernate.tags`. We do not cover this approach in this reference guide since it is considered part of XDoclet. However, we include the following example of the `Cat` class with XDoclet mappings:

```
package eg;
import java.util.Set;
import java.util.Date;

/**
 * @hibernate.class
 * table="CATS"
 */
public class Cat {
    private Long id; // identifier
    private Date birthdate;
    private Cat mother;
    private Set kittens;
    private Color color;
    private char sex;
    private float weight;

    /*
     * @hibernate.id
     * generator-class="native"
     * column="CAT_ID"
     */
    public Long getId() {
        return id;
    }
    private void setId(Long id) {
        this.id=id;
    }

    /**
     * @hibernate.many-to-one
     * column="PARENT_ID"
     */
    public Cat getMother() {
        return mother;
    }
    void setMother(Cat mother) {
        this.mother = mother;
    }

    /**
     * @hibernate.property
     * column="BIRTH_DATE"
     */
    public Date getBirthdate() {
        return birthdate;
    }
}
```

```

void setBirthdate(Date date) {
    birthdate = date;
}
/**
 * @hibernate.property
 * column="WEIGHT"
 */
public float getWeight() {
    return weight;
}
void setWeight(float weight) {
    this.weight = weight;
}

/**
 * @hibernate.property
 * column="COLOR"
 * not-null="true"
 */
public Color getColor() {
    return color;
}
void setColor(Color color) {
    this.color = color;
}
/**
 * @hibernate.set
 * inverse="true"
 * order-by="BIRTH_DATE"
 * @hibernate.collection-key
 * column="PARENT_ID"
 * @hibernate.collection-one-to-many
 */
public Set getKittens() {
    return kittens;
}
void setKittens(Set kittens) {
    this.kittens = kittens;
}
// addKitten not needed by Hibernate
public void addKitten(Cat kitten) {
    kittens.add(kitten);
}

/**
 * @hibernate.property
 * column="SEX"
 * not-null="true"
 * update="false"
 */
public char getSex() {
    return sex;
}
void setSex(char sex) {

```

```

        this.sex=sex;
    }
}

```

See the Hibernate website for more examples of XDoclet and Hibernate.

5.5.2. Using JDK 5.0 Annotations

JDK 5.0 introduced XDoclet-style annotations at the language level that are type-safe and checked at compile time. This mechanism is more powerful than XDoclet annotations and better supported by tools and IDEs. IntelliJ IDEA, for example, supports auto-completion and syntax highlighting of JDK 5.0 annotations. The new revision of the EJB specification (JSR-220) uses JDK 5.0 annotations as the primary metadata mechanism for entity beans. Hibernate3 implements the **EntityManager** of JSR-220 (the persistence API). Support for mapping metadata is available via the *Hibernate Annotations* package as a separate download. Both EJB3 (JSR-220) and Hibernate3 metadata is supported.

This is an example of a POJO class annotated as an EJB entity bean:

```

@Entity
public class Customer implements Serializable {

    @Id
    Long id;

    String firstName;
    String lastName;
    Date birthday;

    @Transient
    Integer age;

    @Embedded
    private Address homeAddress;

    @OneToMany(cascade=CascadeType.ALL)
    @JoinColumn(name="CUSTOMER_ID")
    Set<Order> orders;

    // Getter/setter and business methods
}

```

5.6. GENERATED PROPERTIES

Generated properties are properties that have their values generated by the database. Typically, Hibernate applications needed to **refresh** objects that contain any properties for which the database was generating values. Marking properties as generated, however, lets the application delegate this responsibility to Hibernate. When Hibernate issues an SQL INSERT or UPDATE for an entity that has defined generated properties, it immediately issues a select afterwards to retrieve the generated values.

Properties marked as generated must additionally be non-insertable and non-updateable. Only [Section 5.1.9, “Version \(optional\)”](#), [Section 5.1.10, “Timestamp \(optional\)”](#), and [Section 5.1.11, “Property”](#), can be marked as generated.

never (the default): the given property value is not generated within the database.

insert: the given property value is generated on insert, but is not regenerated on subsequent updates. Properties like created-date fall into this category. Even though [Section 5.1.9, “Version \(optional\)”](#) and [Section 5.1.10, “Timestamp \(optional\)”](#) properties can be marked as generated, this option is not available.

always: the property value is generated both on insert and on update.

5.7. AUXILIARY DATABASE OBJECTS

Auxiliary database objects allow for the CREATE and DROP of arbitrary database objects. In conjunction with Hibernate's schema evolution tools, they have the ability to fully define a user schema within the Hibernate mapping files. Although designed specifically for creating and dropping things like triggers or stored procedures, any SQL command that can be run via a `java.sql.Statement.execute()` method is valid (for example, ALTERs, INSERTS, etc.). There are essentially two modes for defining auxiliary database objects:

The first mode is to explicitly list the CREATE and DROP commands in the mapping file:

```
<hibernate-mapping>
    ...
    <database-object>
        <create>CREATE TRIGGER my_trigger ...</create>
        <drop>DROP TRIGGER my_trigger</drop>
    </database-object>
</hibernate-mapping>
```

The second mode is to supply a custom class that constructs the CREATE and DROP commands. This custom class must implement the `org.hibernate.mapping.AuxiliaryDatabaseObject` interface.

```
<hibernate-mapping>
    ...
    <database-object>
        <definition class="MyTriggerDefinition"/>
    </database-object>
</hibernate-mapping>
```

Additionally, these database objects can be optionally scoped so that they only apply when certain dialects are used.

```
<hibernate-mapping>
    ...
    <database-object>
        <definition class="MyTriggerDefinition"/>
        <dialect-scope name="org.hibernate.dialect.Oracle9iDialect"/>
        <dialect-scope name="org.hibernate.dialect.Oracle10gDialect"/>
    </database-object>
</hibernate-mapping>
```

CHAPTER 6. COLLECTION MAPPING

6.1. PERSISTENT COLLECTIONS

Hibernate requires that persistent collection-valued fields be declared as an interface type. For example:

```
public class Product {
    private String serialNumber;
    private Set parts = new HashSet();

    public Set getParts() { return parts; }
    void setParts(Set parts) { this.parts = parts; }
    public String getSerialNumber() { return serialNumber; }
    void setSerialNumber(String sn) { serialNumber = sn; }
}
```

The actual interface might be `java.util.Set`, `java.util.Collection`, `java.util.List`, `java.util.Map`, `java.util.SortedSet`, `java.util.SortedMap` or anything you like ("anything you like" means you will have to write an implementation of `org.hibernate.usertype.UserCollectionType`.)

Notice how the instance variable was initialized with an instance of `HashSet`. This is the best way to initialize collection valued properties of newly instantiated (non-persistent) instances. When you make the instance persistent, by calling `persist()` for example, Hibernate will actually replace the `HashSet` with an instance of Hibernate's own implementation of `Set`. Be aware of the following errors:

```
Cat cat = new DomesticCat();
Cat kitten = new DomesticCat();
....
Set kittens = new HashSet();
kittens.add(kitten);
cat.setKittens(kittens);
session.persist(cat);
kittens = cat.getKittens(); // Okay, kittens collection is a Set
(HashSet) cat.getKittens(); // Error!
```

The persistent collections injected by Hibernate behave like `HashMap`, `HashSet`, `TreeMap`, `TreeSet` or `ArrayList`, depending on the interface type.

Collections instances have the usual behavior of value types. They are automatically persisted when referenced by a persistent object and are automatically deleted when unreferenced. If a collection is passed from one persistent object to another, its elements might be moved from one table to another. Two entities cannot share a reference to the same collection instance. Due to the underlying relational model, collection-valued properties do not support null value semantics. Hibernate does not distinguish between a null collection reference and an empty collection.

Use persistent collections the same way you use ordinary Java collections. However, please ensure you understand the semantics of bidirectional associations (these are discussed later).

6.2. COLLECTION MAPPINGS



NOTE

There are quite a range of mappings that can be generated for collections that cover many common relational models. We suggest you experiment with the schema generation tool so that you understand how various mapping declarations translate to database tables.

The Hibernate mapping element used for mapping a collection depends upon the type of interface. For example, a `<set>` element is used for mapping properties of type `Set`.

```
<class name="Product">
  <id name="serialNumber" column="productSerialNumber"/>
  <set name="parts">
    <key column="productSerialNumber" not-null="true"/>
    <one-to-many class="Part"/>
  </set>
</class>
```

Apart from `<set>`, there is also `<list>`, `<map>`, `<bag>`, `<array>` and `<primitive-array>` mapping elements. The `<map>` element is representative:

```
<map
  name="propertyName"
  table="table_name"
  schema="schema_name"
  lazy="true|extra|false"
  inverse="true|false"
  cascade="all|none|save-update|delete|all-delete-orphan|delete-orphan"
  sort="unsorted|natural|comparatorClass"
  order-by="column_name asc|desc"
  where="arbitrary sql where condition"
  fetch="join|select|subselect"
  batch-size="N"
  access="field|property|ClassName"
```

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```

    optimistic-lock="true|false"

    mutable="true|false"
    node="element-name|."
    embed-xml="true|false"
>

    <key .... />
    <map-key .... />
    <element .... />
</map>

```

13

14

1	name : the collection property name
2	table (optional - defaults to property name): the name of the collection table. It is not used for one-to-many associations.
3	schema (optional): the name of a table schema to override the schema declared on the root element
4	lazy (optional - defaults to true): disables lazy fetching and specifies that the association is always eagerly fetched. It can also be used to enable "extra-lazy" fetching where most operations do not initialize the collection. This is suitable for large collections.
5	inverse (optional - defaults to false): marks this collection as the "inverse" end of a bidirectional association.
6	cascade (optional - defaults to none): enables operations to cascade to child entities.
7	sort (optional): specifies a sorted collection with natural sort order or a given comparator class.
8	order-by (optional, JDK1.4 only): specifies a table column or columns that define the iteration order of the Map , Set or bag, together with an optional asc or desc .
9	where (optional): specifies an arbitrary SQL WHERE condition that is used when retrieving or removing the collection. This is useful if the collection needs to contain only a subset of the available data.
10	fetch (optional, defaults to select): chooses between outer-join fetching, fetching by sequential select, and fetching by sequential subselect.
11	batch-size (optional, defaults to 1): specifies a "batch size" for lazily fetching instances of this collection.
12	access (optional - defaults to property): the strategy Hibernate uses for accessing the collection property value.
13	optimistic-lock (optional - defaults to true): specifies that changes to the state of the collection results in increments of the owning entity's version. For one-to-many associations you may want to disable this setting.

14

mutable (optional - defaults to **true**): a value of **false** specifies that the elements of the collection never change. This allows for minor performance optimization in some cases.

6.2.1. Collection foreign keys

Collection instances are distinguished in the database by the foreign key of the entity that owns the collection. This foreign key is referred to as the *collection key column*, or columns, of the collection table. The collection key column is mapped by the **<key>** element.

There can be a nullability constraint on the foreign key column. For most collections, this is implied. For unidirectional one-to-many associations, the foreign key column is nullable by default, so you may need to specify **not-null="true"**.

```
<key column="productSerialNumber" not-null="true"/>
```

The foreign key constraint can use **ON DELETE CASCADE**.

```
<key column="productSerialNumber" on-delete="cascade"/>
```

See the previous chapter for a full definition of the **<key>** element.

6.2.2. Collection elements

Collections can contain almost any other Hibernate type, including: basic types, custom types, components and references to other entities. This is an important distinction. An object in a collection might be handled with "value" semantics (its life cycle fully depends on the collection owner), or it might be a reference to another entity with its own life cycle. In the latter case, only the "link" between the two objects is considered to be a state held by the collection.

The contained type is referred to as the *collection element type*. Collection elements are mapped by **<element>** or **<composite-element>**, or in the case of entity references, with **<one-to-many>** or **<many-to-many>**. The first two map elements with value semantics, the next two are used to map entity associations.

6.2.3. Indexed collections

All collection mappings, except those with set and bag semantics, need an *index column* in the collection table. An index column is a column that maps to an array index, or **List** index, or **Map** key. The index of a **Map** may be of any basic type, mapped with **<map-key>**. It can be an entity reference mapped with **<map-key-many-to-many>**, or it can be a composite type mapped with **<composite-map-key>**. The index of an array or list is always of type **integer** and is mapped using the **<list-index>** element. The mapped column contains sequential integers that are numbered from zero by default.

```
<list-index
    column="column_name"
    base="0|1|..."
/>
```

1

2

❶	column_name (required): the name of the column holding the collection index values.
❷	base (optional - defaults to 0): the value of the index column that corresponds to the first element of the list or array.

```

<map-key
    column="column_name"
    formula="any SQL expression"
    type="type_name"
    node="@attribute-name"
    length="N"/>

```

❶	column (optional): the name of the column holding the collection index values.
❷	formula (optional): a SQL formula used to evaluate the key of the map.
❸	type (required): the type of the map keys.

```

<map-key-many-to-many
    column="column_name"
    formula="any SQL expression"
    class="ClassName"
/>

```

❶	column (optional): the name of the foreign key column for the collection index values.
❷	formula (optional): a SQ formula used to evaluate the foreign key of the map key.
❸	class (required): the entity class used as the map key.

If your table does not have an index column, and you still wish to use **List** as the property type, you can map the property as a Hibernate `<bag>`. A bag does not retain its order when it is persisted to the database, but it can be optionally sorted or ordered when it is retrieved from the database.

6.2.4. Collections of values and many-to-many associations

Any collection of values or many-to-many associations requires a dedicated *collection table* with a foreign key column or columns, *collection element column* or columns, and possibly an index column or columns.

For a collection of values use the `<element>` tag. For example:

```

<element
    column="column_name"
    formula="any SQL expression"
    type="typename"
    length="L"
    precision="P"
    scale="S"
    not-null="true|false"
    unique="true|false"
    node="element-name"
/>
    
```

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1	column (optional): the name of the column holding the collection element values.
2	formula (optional): an SQL formula used to evaluate the element.
3	type (required): the type of the collection element.

A *many-to-many* association is specified using the `<many-to-many>` element.

```

<many-to-many
    column="column_name"
    formula="any SQL expression"
    class="ClassName"
    fetch="select|join"
    unique="true|false"
    not-found="ignore|exception"
    entity-name="EntityName"
    property-ref="propertyNameFromAssociatedClass"
    node="element-name"
    embed-xml="true|false"
/>
    
```

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1	column (optional): the name of the element foreign key column.
2	formula (optional): an SQL formula used to evaluate the element foreign key value.
3	class (required): the name of the associated class.
4	fetch (optional - defaults to join): enables outer-join or sequential select fetching for this association. This is a special case; for full eager fetching in a single SELECT of an entity and its many-to-many relationships to other entities, you would enable join fetching, not only of the collection itself, but also with this attribute on the <many-to-many> nested element.
5	unique (optional): enables the DDL generation of a unique constraint for the foreign-key column. This makes the association multiplicity effectively one-to-many.
6	not-found (optional - defaults to exception): specifies how foreign keys that reference missing rows will be handled: ignore will treat a missing row as a null association.
7	entity-name (optional): the entity name of the associated class, as an alternative to class .
8	property-ref (optional): the name of a property of the associated class that is joined to this foreign key. If not specified, the primary key of the associated class is used.

Here are some examples.

A set of strings:

```
<set name="names" table="person_names">
  <key column="person_id"/>
  <element column="person_name" type="string"/>
</set>
```

A bag containing integers with an iteration order determined by the **order-by** attribute:

```
<bag name="sizes"
  table="item_sizes"
  order-by="size asc">
  <key column="item_id"/>
  <element column="size" type="integer"/>
</bag>
```

An array of entities, in this case, a many-to-many association:

```
<array name="addresses"
  table="PersonAddress"
  cascade="persist">
  <key column="personId"/>
  <list-index column="sortOrder"/>
  <many-to-many column="addressId" class="Address"/>
</array>
```

A map from string indices to dates:

```

<map name="holidays"
      table="holidays"
      schema="dbo"
      order-by="hol_name asc">
  <key column="id"/>
  <map-key column="hol_name" type="string"/>
  <element column="hol_date" type="date"/>
</map>
    
```

A list of components (this is discussed in the next chapter):

```

<list name="carComponents"
      table="CarComponents">
  <key column="carId"/>
  <list-index column="sortOrder"/>
  <composite-element class="CarComponent">
    <property name="price"/>
    <property name="type"/>
    <property name="serialNumber" column="serialNum"/>
  </composite-element>
</list>
    
```

6.2.5. One-to-many associations

A *one-to-many association* links the tables of two classes via a foreign key with no intervening collection table. This mapping loses certain semantics of normal Java collections:

- An instance of the contained entity class cannot belong to more than one instance of the collection.
- An instance of the contained entity class cannot appear at more than one value of the collection index.

An association from **Product** to **Part** requires the existence of a foreign key column and possibly an index column to the **Part** table. A **<one-to-many>** tag indicates that this is a one-to-many association.

```

<one-to-many

  class="ClassName"

  not-found="ignore|exception"

  entity-name="EntityName"
  node="element-name"
  embed-xml="true|false"
/>
    
```



1	class (required): the name of the associated class.
2	not-found (optional - defaults to exception): specifies how cached identifiers that reference missing rows will be handled. ignore will treat a missing row as a null association.

④ **entity-name** (optional): the entity name of the associated class, as an alternative to **class**.

The **<one-to-many>** element does not need to declare any columns. Nor is it necessary to specify the **table** name anywhere.



WARNING

If the foreign key column of a **<one-to-many>** association is declared **NOT NULL**, you must declare the **<key>** mapping **not-null="true"** or use a *bidirectional association* with the collection mapping marked **inverse="true"**. See the discussion of bidirectional associations later in this chapter for more information.

The following example shows a map of **Part** entities by name, where **partName** is a persistent property of **Part**. Notice the use of a formula-based index:

```
<map name="parts"
      cascade="all">
  <key column="productId" not-null="true"/>
  <map-key formula="partName"/>
  <one-to-many class="Part"/>
</map>
```

6.3. ADVANCED COLLECTION MAPPINGS

6.3.1. Sorted collections

Hibernate supports collections implementing `java.util.SortedMap` and `java.util.SortedSet`. You must specify a comparator in the mapping file:

```
<set name="aliases"
      table="person_aliases"
      sort="natural">
  <key column="person"/>
  <element column="name" type="string"/>
</set>

<map name="holidays" sort="my.custom.HolidayComparator">
  <key column="year_id"/>
  <map-key column="hol_name" type="string"/>
  <element column="hol_date" type="date"/>
</map>
```

Allowed values of the **sort** attribute are **unsorted**, **natural** and the name of a class implementing `java.util.Comparator`.

Sorted collections actually behave like `java.util.TreeSet` or `java.util.TreeMap`.

If you want the database itself to order the collection elements, use the **order-by** attribute of **set**, **bag** or **map** mappings. This solution is only available under JDK 1.4 or higher and is implemented using **LinkedHashSet** or **LinkedHashMap**. This performs the ordering in the SQL query and not in the memory.

```
<set name="aliases" table="person_aliases" order-by="lower(name) asc">
  <key column="person"/>
  <element column="name" type="string"/>
</set>

<map name="holidays" order-by="hol_date, hol_name">
  <key column="year_id"/>
  <map-key column="hol_name" type="string"/>
  <element column="hol_date" type="date"/>
</map>
```



NOTE

The value of the **order-by** attribute is an SQL ordering, not an HQL ordering.

Associations can even be sorted by arbitrary criteria at runtime using a collection **filter()**:

```
sortedUsers = s.createFilter( group.getUsers(), "order by this.name"
).list();
```

6.3.2. Bidirectional associations

A *bidirectional association* allows navigation from both "ends" of the association. Two kinds of bidirectional association are supported:

one-to-many

set or bag valued at one end and single-valued at the other

many-to-many

set or bag valued at both ends

You can specify a bidirectional many-to-many association by mapping two many-to-many associations to the same database table and declaring one end as *inverse*. You cannot select an indexed collection.

Here is an example of a bidirectional many-to-many association that illustrates how each category can have many items and each item can be in many categories:

```
<class name="Category">
  <id name="id" column="CATEGORY_ID"/>
  ...
  <bag name="items" table="CATEGORY_ITEM">
    <key column="CATEGORY_ID"/>
    <many-to-many class="Item" column="ITEM_ID"/>
  </bag>
</class>
```



```

<class name="Item">
  <id name="id" column="ITEM_ID"/>
  ...

  <!-- inverse end -->
  <bag name="categories" table="CATEGORY_ITEM" inverse="true">
    <key column="ITEM_ID"/>
    <many-to-many class="Category" column="CATEGORY_ID"/>
  </bag>
</class>

```

Changes made only to the inverse end of the association are *not* persisted. This means that Hibernate has two representations in memory for every bidirectional association: one link from A to B and another link from B to A. This is easier to understand if you think about the Java object model and how a many-to-many relationship in Javais created:

```

category.getItems().add(item);           // The category now "knows" about
the relationship
item.getCategories().add(category);     // The item now "knows" about the
relationship

session.persist(item);                   // The relationship will not be
saved!
session.persist(category);               // The relationship will be
saved

```

The non-inverse side is used to save the in-memory representation to the database.

You can define a bidirectional one-to-many association by mapping a one-to-many association to the same table column(s) as a many-to-one association and declaring the many-valued end **inverse="true"**.

```

<class name="Parent">
  <id name="id" column="parent_id"/>
  ....
  <set name="children" inverse="true">
    <key column="parent_id"/>
    <one-to-many class="Child"/>
  </set>
</class>

<class name="Child">
  <id name="id" column="child_id"/>
  ....
  <many-to-one name="parent"
    class="Parent"
    column="parent_id"
    not-null="true"/>
</class>

```

Mapping one end of an association with **inverse="true"** does not affect the operation of cascades as these are orthogonal concepts.

6.3.3. Bidirectional associations with indexed collections

A bidirectional association where one end is represented as a **<list>** or **<map>**, requires special consideration. If there is a property of the child class that maps to the index column you can use **inverse="true"** on the collection mapping:

```

<class name="Parent">
  <id name="id" column="parent_id"/>
  ....
  <map name="children" inverse="true">
    <key column="parent_id"/>
    <map-key column="name"
      type="string"/>
    <one-to-many class="Child"/>
  </map>
</class>

<class name="Child">
  <id name="id" column="child_id"/>
  ....
  <property name="name"
    not-null="true"/>
  <many-to-one name="parent"
    class="Parent"
    column="parent_id"
    not-null="true"/>
</class>
    
```

If there is no such property on the child class, the association cannot be considered truly bidirectional. That is, there is information available at one end of the association that is not available at the other end. In this case, you cannot map the collection **inverse="true"**. Instead, you could use the following mapping:

```

<class name="Parent">
  <id name="id" column="parent_id"/>
  ....
  <map name="children">
    <key column="parent_id"
      not-null="true"/>
    <map-key column="name"
      type="string"/>
    <one-to-many class="Child"/>
  </map>
</class>

<class name="Child">
  <id name="id" column="child_id"/>
  ....
  <many-to-one name="parent"
    class="Parent"
    column="parent_id"
    insert="false"
    update="false"
    not-null="true"/>
</class>
    
```

Note that in this mapping, the collection-valued end of the association is responsible for updates to the foreign key.

6.3.4. Ternary associations

There are three possible approaches to mapping a ternary association. One approach is to use a **Map** with an association as its index:

```
<map name="contracts">
  <key column="employer_id" not-null="true"/>
  <map-key-many-to-many column="employee_id" class="Employee"/>
  <one-to-many class="Contract"/>
</map>
```

```
<map name="connections">
  <key column="incoming_node_id"/>
  <map-key-many-to-many column="outgoing_node_id" class="Node"/>
  <many-to-many column="connection_id" class="Connection"/>
</map>
```

A second approach is to remodel the association as an entity class. This is the most common approach.

A final alternative is to use composite elements, which will be discussed later.

6.3.5. Using an `<idbag>`

The majority of the many-to-many associations and collections of values shown previously all map to tables with composite keys, even though it has been suggested that entities should have synthetic identifiers (surrogate keys). A pure association table does not seem to benefit much from a surrogate key, although a collection of composite values *might*. It is for this reason that Hibernate provides a feature that allows you to map many-to-many associations and collections of values to a table with a surrogate key.

The `<idbag>` element lets you map a **List** (or **Collection**) with bag semantics. For example:

```
<idbag name="lovers" table="LOVERS">
  <collection-id column="ID" type="long">
    <generator class="sequence"/>
  </collection-id>
  <key column="PERSON1"/>
  <many-to-many column="PERSON2" class="Person" fetch="join"/>
</idbag>
```

An `<idbag>` has a synthetic id generator, just like an entity class. A different surrogate key is assigned to each collection row. Hibernate does not, however, provide any mechanism for discovering the surrogate key value of a particular row.

The update performance of an `<idbag>` supersedes a regular `<bag>`. Hibernate can locate individual rows efficiently and update or delete them individually, similar to a list, map or set.

In the current implementation, the **native** identifier generation strategy is not supported for `<idbag>` collection identifiers.

6.4. COLLECTION EXAMPLES

This section covers collection examples.

The following class has a collection of **Child** instances:

```
package eg;
import java.util.Set;

public class Parent {
    private long id;
    private Set children;

    public long getId() { return id; }
    private void setId(long id) { this.id=id; }

    private Set getChildren() { return children; }
    private void setChildren(Set children) { this.children=children; }

    ....
    ....
}
```

If each child has, at most, one parent, the most natural mapping is a one-to-many association:

```
<hibernate-mapping>

    <class name="Parent">
        <id name="id">
            <generator class="sequence"/>
        </id>
        <set name="children">
            <key column="parent_id"/>
            <one-to-many class="Child"/>
        </set>
    </class>

    <class name="Child">
        <id name="id">
            <generator class="sequence"/>
        </id>
        <property name="name"/>
    </class>

</hibernate-mapping>
```

This maps to the following table definitions:

```
create table parent ( id bigint not null primary key )
create table child ( id bigint not null primary key, name varchar(255),
parent_id bigint )
alter table child add constraint childfk0 (parent_id) references parent
```

If the parent is *required*, use a bidirectional one-to-many association:

■

```

<hibernate-mapping>

  <class name="Parent">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <set name="children" inverse="true">
      <key column="parent_id"/>
      <one-to-many class="Child"/>
    </set>
  </class>

  <class name="Child">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <property name="name"/>
    <many-to-one name="parent" class="Parent" column="parent_id" not-
null="true"/>
  </class>

</hibernate-mapping>

```

Notice the **NOT NULL** constraint:

```

create table parent ( id bigint not null primary key )
create table child ( id bigint not null
                    primary key,
                    name varchar(255),
                    parent_id bigint not null )
alter table child add constraint childfk0 (parent_id) references parent

```

Alternatively, if this association must be unidirectional you can declare the **NOT NULL** constraint on the **<key>** mapping:

```

<hibernate-mapping>

  <class name="Parent">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <set name="children">
      <key column="parent_id" not-null="true"/>
      <one-to-many class="Child"/>
    </set>
  </class>

  <class name="Child">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <property name="name"/>
  </class>

</hibernate-mapping>

```

On the other hand, if a child has multiple parents, a many-to-many association is appropriate:

```

<hibernate-mapping>

  <class name="Parent">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <set name="children" table="childset">
      <key column="parent_id"/>
      <many-to-many class="Child" column="child_id"/>
    </set>
  </class>

  <class name="Child">
    <id name="id">
      <generator class="sequence"/>
    </id>
    <property name="name"/>
  </class>

</hibernate-mapping>
    
```

Table definitions:

```

create table parent ( id bigint not null primary key )
create table child ( id bigint not null primary key, name varchar(255) )
create table childset ( parent_id bigint not null,
                        child_id bigint not null,
                        primary key ( parent_id, child_id ) )
alter table childset add constraint childsetfk0 (parent_id) references
parent
alter table childset add constraint childsetfk1 (child_id) references
child
    
```

For more examples and a complete explanation of a parent/child relationship mapping, see [Chapter 21](#), *Example: Parent/Child* for more information.

Even more complex association mappings are covered in the next chapter.

CHAPTER 7. ASSOCIATION MAPPINGS

7.1. INTRODUCTION

Association mappings are often the most difficult thing to implement correctly. In this section we examine some canonical cases one by one, starting with unidirectional mappings and then bidirectional cases. We will use **Person** and **Address** in all the examples.

Associations will be classified by multiplicity and whether or not they map to an intervening join table.

Nullable foreign keys are not considered to be good practice in traditional data modelling, so our examples do not use nullable foreign keys. This is not a requirement of Hibernate, and the mappings will work if you drop the nullability constraints.

7.2. UNIDIRECTIONAL ASSOCIATIONS

7.2.1. Many-to-one

A *unidirectional many-to-one association* is the most common kind of unidirectional association.

```
<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <many-to-one name="address"
    column="addressId"
    not-null="true"/>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>
```

```
create table Person ( personId bigint not null primary key, addressId
bigint not null )
create table Address ( addressId bigint not null primary key )
```

7.2.2. One-to-one

A *unidirectional one-to-one association on a foreign key* is almost identical. The only difference is the column unique constraint.

```
<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <many-to-one name="address"
    column="addressId"
    unique="true"
    not-null="true"/>
</class>
```

```

</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>

```

```

create table Person ( personId bigint not null primary key, addressId
bigint not null unique )
create table Address ( addressId bigint not null primary key )

```

A *unidirectional one-to-one association on a primary key* usually uses a special id generator. In this example, however, we have reversed the direction of the association:

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
</class>

<class name="Address">
  <id name="id" column="personId">
    <generator class="foreign">
      <param name="property">person</param>
    </generator>
  </id>
  <one-to-one name="person" constrained="true"/>
</class>

```

```

create table Person ( personId bigint not null primary key )
create table Address ( personId bigint not null primary key )

```

7.2.3. One-to-many

A *unidirectional one-to-many association on a foreign key* is an unusual case, and is not recommended.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <set name="addresses">
    <key column="personId"
      not-null="true"/>
    <one-to-many class="Address"/>
  </set>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>

```



```
create table Person ( personId bigint not null primary key )
create table Address ( addressId bigint not null primary key, personId
bigint not null )
```

You should instead use a join table for this kind of association.

7.3. UNIDIRECTIONAL ASSOCIATIONS WITH JOIN TABLES

7.3.1. One-to-many

A *unidirectional one-to-many association on a join table* is the preferred option. Specifying `unique="true"`, changes the multiplicity from many-to-many to one-to-many.

```
<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <set name="addresses" table="PersonAddress">
    <key column="personId"/>
    <many-to-many column="addressId"
      unique="true"
      class="Address"/>
  </set>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>
```

```
create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId not null, addressId bigint not null
primary key )
create table Address ( addressId bigint not null primary key )
```

7.3.2. Many-to-one

A *unidirectional many-to-one association on a join table* is common when the association is optional. For example:

```
<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <join table="PersonAddress"
    optional="true">
    <key column="personId" unique="true"/>
    <many-to-one name="address"
      column="addressId"
      not-null="true"/>
  </join>
</class>
```

```

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>
    
```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null primary key,
addressId bigint not null )
create table Address ( addressId bigint not null primary key )
    
```

7.3.3. One-to-one

A *unidirectional one-to-one association on a join table* is possible, but extremely unusual.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <join table="PersonAddress"
    optional="true">
    <key column="personId"
      unique="true"/>
    <many-to-one name="address"
      column="addressId"
      not-null="true"
      unique="true"/>
  </join>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
</class>
    
```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null primary key,
addressId bigint not null unique )
create table Address ( addressId bigint not null primary key )
    
```

7.3.4. Many-to-many

Finally, here is an example of a *unidirectional many-to-many association*.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <set name="addresses" table="PersonAddress">
    <key column="personId"/>
    <many-to-many column="addressId"
    
```

```

        class="Address"/>
    </set>
</class>

<class name="Address">
    <id name="id" column="addressId">
        <generator class="native"/>
    </id>
</class>

```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null, addressId bigint
not null, primary key (personId, addressId) )
create table Address ( addressId bigint not null primary key )

```

7.4. BIDIRECTIONAL ASSOCIATIONS

7.4.1. one-to-many / many-to-one

A *bidirectional many-to-one association* is the most common kind of association. The following example illustrates the standard parent/child relationship.

```

<class name="Person">
    <id name="id" column="personId">
        <generator class="native"/>
    </id>
    <many-to-one name="address"
        column="addressId"
        not-null="true"/>
</class>

<class name="Address">
    <id name="id" column="addressId">
        <generator class="native"/>
    </id>
    <set name="people" inverse="true">
        <key column="addressId"/>
        <one-to-many class="Person"/>
    </set>
</class>

```

```

create table Person ( personId bigint not null primary key, addressId
bigint not null )
create table Address ( addressId bigint not null primary key )

```

If you use a **List**, or other indexed collection, set the **key** column of the foreign key to **not null**. Hibernate will manage the association from the collections side to maintain the index of each element, making the other side virtually inverse by setting **update="false"** and **insert="false"**:

```

<class name="Person">
    <id name="id"/>
    ...
    <many-to-one name="address"

```

```

        column="addressId"
        not-null="true"
        insert="false"
        update="false"/>
</class>

<class name="Address">
    <id name="id"/>
    ...
    <list name="people">
        <key column="addressId" not-null="true"/>
        <list-index column="peopleIdx"/>
        <one-to-many class="Person"/>
    </list>
</class>

```

If the underlying foreign key column is **NOT NULL**, it is important that you define `not-null="true"` on the `<key>` element of the collection mapping. Do not only declare `not-null="true"` on a possible nested `<column>` element, but on the `<key>` element.

7.4.2. One-to-one

A *bidirectional one-to-one association on a foreign key* is common:

```

<class name="Person">
    <id name="id" column="personId">
        <generator class="native"/>
    </id>
    <many-to-one name="address"
        column="addressId"
        unique="true"
        not-null="true"/>
</class>

<class name="Address">
    <id name="id" column="addressId">
        <generator class="native"/>
    </id>
    <one-to-one name="person"
        property-ref="address"/>
</class>

```

```

create table Person ( personId bigint not null primary key, addressId
bigint not null unique )
create table Address ( addressId bigint not null primary key )

```

A *bidirectional one-to-one association on a primary key* uses the special id generator:

```

<class name="Person">
    <id name="id" column="personId">
        <generator class="native"/>
    </id>
    <one-to-one name="address"/>
</class>

```

```

<class name="Address">
  <id name="id" column="personId">
    <generator class="foreign">
      <param name="property">person</param>
    </generator>
  </id>
  <one-to-one name="person"
    constrained="true"/>
</class>

```

```

create table Person ( personId bigint not null primary key )
create table Address ( personId bigint not null primary key )

```

7.5. BIDIRECTIONAL ASSOCIATIONS WITH JOIN TABLES

7.5.1. one-to-many / many-to-one

The following is an example of a *bidirectional one-to-many association on a join table*. The `inverse="true"` can go on either end of the association, on the collection, or on the join.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <set name="addresses"
    table="PersonAddress">
    <key column="personId"/>
    <many-to-many column="addressId"
      unique="true"
      class="Address"/>
  </set>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
  <join table="PersonAddress"
    inverse="true"
    optional="true">
    <key column="addressId"/>
    <many-to-one name="person"
      column="personId"
      not-null="true"/>
  </join>
</class>

```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null, addressId bigint
not null primary key )
create table Address ( addressId bigint not null primary key )

```

7.5.2. one to one

A *bidirectional one-to-one association on a join table* is possible, but extremely unusual.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <join table="PersonAddress"
    optional="true">
    <key column="personId"
      unique="true"/>
    <many-to-one name="address"
      column="addressId"
      not-null="true"
      unique="true"/>
  </join>
</class>

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
  <join table="PersonAddress"
    optional="true"
    inverse="true">
    <key column="addressId"
      unique="true"/>
    <many-to-one name="person"
      column="personId"
      not-null="true"
      unique="true"/>
  </join>
</class>
    
```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null primary key,
addressId bigint not null unique )
create table Address ( addressId bigint not null primary key )
    
```

7.5.3. Many-to-many

Here is an example of a *bidirectional many-to-many association*.

```

<class name="Person">
  <id name="id" column="personId">
    <generator class="native"/>
  </id>
  <set name="addresses" table="PersonAddress">
    <key column="personId"/>
    <many-to-many column="addressId"
      class="Address"/>
  </set>
</class>
    
```

```

<class name="Address">
  <id name="id" column="addressId">
    <generator class="native"/>
  </id>
  <set name="people" inverse="true" table="PersonAddress">
    <key column="addressId"/>
    <many-to-many column="personId"
      class="Person"/>
  </set>
</class>

```

```

create table Person ( personId bigint not null primary key )
create table PersonAddress ( personId bigint not null, addressId bigint
not null, primary key (personId, addressId) )
create table Address ( addressId bigint not null primary key )

```

7.6. MORE COMPLEX ASSOCIATION MAPPINGS

More complex association joins are *extremely* rare. Hibernate handles more complex situations by using SQL fragments embedded in the mapping document. For example, if a table with historical account information data defines **accountNumber**, **effectiveEndDate** and **effectiveStartDate** columns, it would be mapped as follows:

```

<properties name="currentAccountKey">
  <property name="accountNumber" type="string" not-null="true"/>
  <property name="currentAccount" type="boolean">
    <formula>case when effectiveEndDate is null then 1 else 0
end</formula>
  </property>
</properties>
<property name="effectiveEndDate" type="date"/>
<property name="effectiveStateDate" type="date" not-null="true"/>

```

You can then map an association to the *current* instance, the one with null **effectiveEndDate**, by using:

```

<many-to-one name="currentAccountInfo"
  property-ref="currentAccountKey"
  class="AccountInfo">
  <column name="accountNumber"/>
  <formula>'1'</formula>
</many-to-one>

```

In a more complex example, imagine that the association between **Employee** and **Organization** is maintained in an **Employment** table full of historical employment data. An association to the employee's *most recent* employer, the one with the most recent **startDate**, could be mapped in the following way:

```

<join>
  <key column="employeeId"/>
  <subselect>
    select employeeId, orgId
    from Employments
    group by orgId
  </subselect>
</join>

```

```
        having startDate = max(startDate)
    </subselect>
    <many-to-one name="mostRecentEmployer"
        class="Organization"
        column="orgId"/>
</join>
```

This functionality allows a degree of creativity and flexibility, but it is more practical to handle these kinds of cases using HQL or a criteria query.

CHAPTER 8. COMPONENT MAPPING

The notion of a *component* is re-used in several different contexts and purposes throughout Hibernate.

8.1. DEPENDENT OBJECTS

A component is a contained object that is persisted as a value type and not an entity reference. The term "component" refers to the object-oriented notion of composition and not to architecture-level components. For example, you can model a person like this:

```
public class Person {
    private java.util.Date birthday;
    private Name name;
    private String key;
    public String getKey() {
        return key;
    }
    private void setKey(String key) {
        this.key=key;
    }
    public java.util.Date getBirthday() {
        return birthday;
    }
    public void setBirthday(java.util.Date birthday) {
        this.birthday = birthday;
    }
    public Name getName() {
        return name;
    }
    public void setName(Name name) {
        this.name = name;
    }
    .....
    .....
}
```

```
public class Name {
    char initial;
    String first;
    String last;
    public String getFirst() {
        return first;
    }
    void setFirst(String first) {
        this.first = first;
    }
    public String getLast() {
        return last;
    }
    void setLast(String last) {
        this.last = last;
    }
    public char getInitial() {
        return initial;
    }
}
```

```

        void setInitial(char initial) {
            this.initial = initial;
        }
    }

```

Now **Name** can be persisted as a component of **Person**. **Name** defines getter and setter methods for its persistent properties, but it does not need to declare any interfaces or identifier properties.

Our Hibernate mapping would look like this:

```

<class name="eg.Person" table="person">
    <id name="Key" column="pid" type="string">
        <generator class="uuid"/>
    </id>
    <property name="birthday" type="date"/>
    <component name="Name" class="eg.Name"> <!-- class attribute optional
-->
        <property name="initial"/>
        <property name="first"/>
        <property name="last"/>
    </component>
</class>

```

The person table would have the columns **pid**, **birthday**, **initial**, **first** and **last**.

Like value types, components do not support shared references. In other words, two persons could have the same name, but the two person objects would contain two independent name objects that were only "the same" by value. The null value semantics of a component are *ad hoc*. When reloading the containing object, Hibernate will assume that if all component columns are null, then the entire component is null. This is suitable for most purposes.

The properties of a component can be of any Hibernate type (collections, many-to-one associations, other components, etc). Nested components should *not* be considered an exotic usage. Hibernate is intended to support a fine-grained object model.

The **<component>** element allows a **<parent>** subelement that maps a property of the component class as a reference back to the containing entity.

```

<class name="eg.Person" table="person">
    <id name="Key" column="pid" type="string">
        <generator class="uuid"/>
    </id>
    <property name="birthday" type="date"/>
    <component name="Name" class="eg.Name" unique="true">
        <parent name="namedPerson"/> <!-- reference back to the Person --
>
        <property name="initial"/>
        <property name="first"/>
        <property name="last"/>
    </component>
</class>

```

8.2. COLLECTIONS OF DEPENDENT OBJECTS

Collections of components are supported (e.g. an array of type **Name**). Declare your component collection by replacing the `<element>` tag with a `<composite-element>` tag:

```
<set name="someNames" table="some_names" lazy="true">
  <key column="id"/>
  <composite-element class="eg.Name"> <!-- class attribute required -->
    <property name="initial"/>
    <property name="first"/>
    <property name="last"/>
  </composite-element>
</set>
```



IMPORTANT

If you define a **Set** of composite elements, it is important to implement `equals()` and `hashCode()` correctly.

Composite elements can contain components but not collections. If your composite element contains components, use the `<nested-composite-element>` tag. This case is a collection of components which themselves have components. You may want to consider if a one-to-many association is more appropriate. Remodel the composite element as an entity, but be aware that even though the Java model is the same, the relational model and persistence semantics are still slightly different.

A composite element mapping does not support null-able properties if you are using a `<set>`. There is no separate primary key column in the composite element table. Hibernate uses each column's value to identify a record when deleting objects, which is not possible with null values. You have to either use only not-null properties in a composite-element or choose a `<list>`, `<map>`, `<bag>` or `<idbag>`.

A special case of a composite element is a composite element with a nested `<many-to-one>` element. This mapping allows you to map extra columns of a many-to-many association table to the composite element class. The following is a many-to-many association from **Order** to **Item**, where **purchaseDate**, **price** and **quantity** are properties of the association:

```
<class name="eg.Order" .... >
  ....
  <set name="purchasedItems" table="purchase_items" lazy="true">
    <key column="order_id">
      <composite-element class="eg.Purchase">
        <property name="purchaseDate"/>
        <property name="price"/>
        <property name="quantity"/>
        <many-to-one name="item" class="eg.Item"/> <!-- class
attribute is optional -->
      </composite-element>
    </set>
  </class>
```

There cannot be a reference to the purchase on the other side for bidirectional association navigation. Components are value types and do not allow shared references. A single **Purchase** can be in the set of an **Order**, but it cannot be referenced by the **Item** at the same time.

Even ternary (or quaternary, etc) associations are possible:

```

<class name="eg.Order" .... >
    ....
    <set name="purchasedItems" table="purchase_items" lazy="true">
        <key column="order_id">
            <composite-element class="eg.OrderLine">
                <many-to-one name="purchaseDetails class="eg.Purchase"/>
                <many-to-one name="item" class="eg.Item"/>
            </composite-element>
        </set>
    </class>
    
```

Composite elements can appear in queries using the same syntax as associations to other entities.

8.3. COMPONENTS AS MAP INDICES

The `<composite-map-key>` element allows you to map a component class as the key of a `Map`. Ensure that you override `hashCode()` and `equals()` correctly on the component class.

8.4. COMPONENTS AS COMPOSITE IDENTIFIERS

You can use a component as an identifier of an entity class. Your component class must satisfy certain requirements:

- It must implement `java.io.Serializable`.
- It must re-implement `equals()` and `hashCode()` consistently with the database's notion of composite key equality.



NOTE

In Hibernate3, although the second requirement is not an absolutely hard requirement of Hibernate, it is recommended.

You cannot use an `IdentifierGenerator` to generate composite keys. Instead the application must assign its own identifiers.

Use the `<composite-id>` tag, with nested `<key-property>` elements, in place of the usual `<id>` declaration. For example, the `OrderLine` class has a primary key that depends upon the (composite) primary key of `Order`.

```

<class name="OrderLine">

    <composite-id name="id" class="OrderLineId">
        <key-property name="lineId"/>
        <key-property name="orderId"/>
        <key-property name="customerId"/>
    </composite-id>

    <property name="name"/>

    <many-to-one name="order" class="Order"
        insert="false" update="false">
        <column name="orderId"/>
    
```

```

        <column name="customerId"/>
    </many-to-one>
    ....
</class>

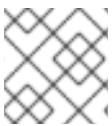
```

Any foreign keys referencing the **OrderLine** table are now composite. Declare this in your mappings for other classes. An association to **OrderLine** is mapped like this:

```

<many-to-one name="orderLine" class="OrderLine">
  <!-- the "class" attribute is optional, as usual -->
  <column name="lineId"/>
  <column name="orderId"/>
  <column name="customerId"/>
</many-to-one>

```



NOTE

The **<column>** tag is an alternative to the **column** attribute everywhere.

A **many-to-many** association to **OrderLine** also uses the composite foreign key:

```

<set name="undeliveredOrderLines">
  <key column name="warehouseId"/>
  <many-to-many class="OrderLine">
    <column name="lineId"/>
    <column name="orderId"/>
    <column name="customerId"/>
  </many-to-many>
</set>

```

The collection of **OrderLines** in **Order** would use:

```

<set name="orderLines" inverse="true">
  <key>
    <column name="orderId"/>
    <column name="customerId"/>
  </key>
  <one-to-many class="OrderLine"/>
</set>

```

The **<one-to-many>** element declares no columns.

If **OrderLine** itself owns a collection, it also has a composite foreign key.

```

<class name="OrderLine">
  ....
  ....
  <list name="deliveryAttempts">
    <key> <!-- a collection inherits the composite key type -->
      <column name="lineId"/>
      <column name="orderId"/>
      <column name="customerId"/>

```

```

        </key>
        <list-index column="attemptId" base="1"/>
        <composite-element class="DeliveryAttempt">
            ...
        </composite-element>
    </set>
</class>

```

8.5. DYNAMIC COMPONENTS

You can also map a property of type **Map**:

```

<dynamic-component name="userAttributes">
    <property name="foo" column="FOO" type="string"/>
    <property name="bar" column="BAR" type="integer"/>
    <many-to-one name="baz" class="Baz" column="BAZ_ID"/>
</dynamic-component>

```

The semantics of a **<dynamic-component>** mapping are identical to **<component>**. The advantage of this kind of mapping is the ability to determine the actual properties of the bean at deployment time just by editing the mapping document. Runtime manipulation of the mapping document is also possible, using a DOM parser. You can also access, and change, Hibernate's configuration-time metamodel via the **Configuration** object.

CHAPTER 9. INHERITANCE MAPPING

9.1. THE THREE STRATEGIES

Hibernate supports the three basic inheritance mapping strategies:

- table per class hierarchy
- table per subclass
- table per concrete class

In addition, Hibernate supports a fourth, slightly different kind of polymorphism:

- implicit polymorphism

It is possible to use different mapping strategies for different branches of the same inheritance hierarchy. You can then make use of implicit polymorphism to achieve polymorphism across the whole hierarchy. However, Hibernate does not support mixing **<subclass>**, **<joined-subclass>** and **<union-subclass>** mappings under the same root **<class>** element. It is possible to mix together the table per class hierarchy and table per subclass strategies under the same **<class>** element, by combining the **<subclass>** and **<join>** elements (see below for an example).

It is possible to define **subclass**, **union-subclass**, and **joined-subclass** mappings in separate mapping documents directly beneath **hibernate-mapping**. This allows you to extend a class hierarchy by adding a new mapping file. You must specify an **extends** attribute in the subclass mapping, naming a previously mapped superclass. Previously this feature made the ordering of the mapping documents important. Since Hibernate3, the ordering of mapping files is irrelevant when using the **extends** keyword. The ordering inside a single mapping file still needs to be defined as superclasses before subclasses.

```
<hibernate-mapping>
  <subclass name="DomesticCat" extends="Cat" discriminator-value="D">
    <property name="name" type="string"/>
  </subclass>
</hibernate-mapping>
```

9.1.1. Table per class hierarchy

Suppose we have an interface **Payment** with the implementors **CreditCardPayment**, **CashPayment**, and **ChequePayment**. The table per class hierarchy mapping would display in the following way:

```
<class name="Payment" table="PAYMENT">
  <id name="id" type="long" column="PAYMENT_ID">
    <generator class="native"/>
  </id>
  <discriminator column="PAYMENT_TYPE" type="string"/>
  <property name="amount" column="AMOUNT"/>
  ...
  <subclass name="CreditCardPayment" discriminator-value="CREDIT">
    <property name="creditCardType" column="CCTYPE"/>
    ...
  </subclass>
  <subclass name="CashPayment" discriminator-value="CASH">
```

```

        ...
    </subclass>
    <subclass name="ChequePayment" discriminator-value="CHEQUE">
        ...
    </subclass>
</class>

```

Exactly one table is required. There is a limitation of this mapping strategy: columns declared by the subclasses, such as **CCTYPE**, cannot have **NOT NULL** constraints.

9.1.2. Table per subclass

A table per subclass mapping looks like this:

```

<class name="Payment" table="PAYMENT">
    <id name="id" type="long" column="PAYMENT_ID">
        <generator class="native"/>
    </id>
    <property name="amount" column="AMOUNT"/>
    ...
    <joined-subclass name="CreditCardPayment" table="CREDIT_PAYMENT">
        <key column="PAYMENT_ID"/>
        <property name="creditCardType" column="CCTYPE"/>
        ...
    </joined-subclass>
    <joined-subclass name="CashPayment" table="CASH_PAYMENT">
        <key column="PAYMENT_ID"/>
        ...
    </joined-subclass>
    <joined-subclass name="ChequePayment" table="CHEQUE_PAYMENT">
        <key column="PAYMENT_ID"/>
        ...
    </joined-subclass>
</class>

```

Four tables are required. The three subclass tables have primary key associations to the superclass table so the relational model is actually a one-to-one association.

9.1.3. Table per subclass: using a discriminator

Hibernate's implementation of table per subclass does not require a discriminator column. Other object/relational mappers use a different implementation of table per subclass that requires a type discriminator column in the superclass table. The approach taken by Hibernate is much more difficult to implement, but arguably more correct from a relational point of view. If you want to use a discriminator column with the table per subclass strategy, you can combine the use of **<subclass>** and **<join>**, as follows:

```

<class name="Payment" table="PAYMENT">
    <id name="id" type="long" column="PAYMENT_ID">
        <generator class="native"/>
    </id>
    <discriminator column="PAYMENT_TYPE" type="string"/>
    <property name="amount" column="AMOUNT"/>
    ...
    <subclass name="CreditCardPayment" discriminator-value="CREDIT">

```



```

        <join table="CREDIT_PAYMENT">
            <key column="PAYMENT_ID"/>
            <property name="creditCardType" column="CCTYPE"/>
            ...
        </join>
    </subclass>
    <subclass name="CashPayment" discriminator-value="CASH">
        <join table="CASH_PAYMENT">
            <key column="PAYMENT_ID"/>
            ...
        </join>
    </subclass>
    <subclass name="ChequePayment" discriminator-value="CHEQUE">
        <join table="CHEQUE_PAYMENT" fetch="select">
            <key column="PAYMENT_ID"/>
            ...
        </join>
    </subclass>
</class>

```

The optional **fetch="select"** declaration tells Hibernate not to fetch the **ChequePayment** subclass data using an outer join when querying the superclass.

9.1.4. Mixing table per class hierarchy with table per subclass

You can even mix the table per class hierarchy and table per subclass strategies using the following approach:

```

<class name="Payment" table="PAYMENT">
    <id name="id" type="long" column="PAYMENT_ID">
        <generator class="native"/>
    </id>
    <discriminator column="PAYMENT_TYPE" type="string"/>
    <property name="amount" column="AMOUNT"/>
    ...
    <subclass name="CreditCardPayment" discriminator-value="CREDIT">
        <join table="CREDIT_PAYMENT">
            <property name="creditCardType" column="CCTYPE"/>
            ...
        </join>
    </subclass>
    <subclass name="CashPayment" discriminator-value="CASH">
        ...
    </subclass>
    <subclass name="ChequePayment" discriminator-value="CHEQUE">
        ...
    </subclass>
</class>

```

For any of these mapping strategies, a polymorphic association to the root **Payment** class is mapped using **<many-to-one>**.

```

<many-to-one name="payment" column="PAYMENT_ID" class="Payment"/>

```

9.1.5. Table per concrete class

There are two ways we can map the table per concrete class strategy. First, you can use `<union-subclass>`.

```
<class name="Payment">
  <id name="id" type="long" column="PAYMENT_ID">
    <generator class="sequence"/>
  </id>
  <property name="amount" column="AMOUNT"/>
  ...
  <union-subclass name="CreditCardPayment" table="CREDIT_PAYMENT">
    <property name="creditCardType" column="CCTYPE"/>
    ...
  </union-subclass>
  <union-subclass name="CashPayment" table="CASH_PAYMENT">
    ...
  </union-subclass>
  <union-subclass name="ChequePayment" table="CHEQUE_PAYMENT">
    ...
  </union-subclass>
</class>
```

Three tables are involved for the subclasses. Each table defines columns for all properties of the class, including inherited properties.

The limitation of this approach is that if a property is mapped on the superclass, the column name must be the same on all subclass tables. The identity generator strategy is not allowed in union subclass inheritance. The primary key seed has to be shared across all unioned subclasses of a hierarchy.

If your superclass is abstract, map it with `abstract="true"`. If it is not abstract, an additional table (it defaults to `PAYMENT` in the example above), is needed to hold instances of the superclass.

9.1.6. Table per concrete class using implicit polymorphism

An alternative approach is to make use of implicit polymorphism:

```
<class name="CreditCardPayment" table="CREDIT_PAYMENT">
  <id name="id" type="long" column="CREDIT_PAYMENT_ID">
    <generator class="native"/>
  </id>
  <property name="amount" column="CREDIT_AMOUNT"/>
  ...
</class>

<class name="CashPayment" table="CASH_PAYMENT">
  <id name="id" type="long" column="CASH_PAYMENT_ID">
    <generator class="native"/>
  </id>
  <property name="amount" column="CASH_AMOUNT"/>
  ...
</class>

<class name="ChequePayment" table="CHEQUE_PAYMENT">
  <id name="id" type="long" column="CHEQUE_PAYMENT_ID">
```

```

        <generator class="native"/>
    </id>
    <property name="amount" column="CHEQUE_AMOUNT"/>
    ...
</class>

```

Notice that the **Payment** interface is not mentioned explicitly. Also notice that properties of **Payment** are mapped in each of the subclasses. If you want to avoid duplication, consider using XML entities (for example, [`<!ENTITY allproperties SYSTEM "allproperties.xml">`] in the **DOCTYPE** declaration and `&allproperties;` in the mapping).

The disadvantage of this approach is that Hibernate does not generate SQL **UNIONS** when performing polymorphic queries.

For this mapping strategy, a polymorphic association to **Payment** is usually mapped using `<any>`.

```

<any name="payment" meta-type="string" id-type="long">
    <meta-value value="CREDIT" class="CreditCardPayment"/>
    <meta-value value="CASH" class="CashPayment"/>
    <meta-value value="CHEQUE" class="ChequePayment"/>
    <column name="PAYMENT_CLASS"/>
    <column name="PAYMENT_ID"/>
</any>

```

9.1.7. Mixing implicit polymorphism with other inheritance mappings

Since the subclasses are each mapped in their own `<class>` element, and since **Payment** is just an interface), each of the subclasses could easily be part of another inheritance hierarchy. You can still use polymorphic queries against the **Payment** interface.

```

<class name="CreditCardPayment" table="CREDIT_PAYMENT">
    <id name="id" type="long" column="CREDIT_PAYMENT_ID">
        <generator class="native"/>
    </id>
    <discriminator column="CREDIT_CARD" type="string"/>
    <property name="amount" column="CREDIT_AMOUNT"/>
    ...
    <subclass name="MasterCardPayment" discriminator-value="MDC"/>
    <subclass name="VisaPayment" discriminator-value="VISA"/>
</class>

<class name="NonelectronicTransaction" table="NONELECTRONIC_TXN">
    <id name="id" type="long" column="TXN_ID">
        <generator class="native"/>
    </id>
    ...
    <joined-subclass name="CashPayment" table="CASH_PAYMENT">
        <key column="PAYMENT_ID"/>
        <property name="amount" column="CASH_AMOUNT"/>
        ...
    </joined-subclass>
    <joined-subclass name="ChequePayment" table="CHEQUE_PAYMENT">
        <key column="PAYMENT_ID"/>
        <property name="amount" column="CHEQUE_AMOUNT"/>
        ...
    </joined-subclass>

```

```

        </joined-subclass>
    </class>
    
```

Once again, **Payment** is not mentioned explicitly. If we execute a query against the **Payment** interface, for example **from Payment**, Hibernate automatically returns instances of **CreditCardPayment** (and its subclasses, since they also implement **Payment**), **CashPayment** and **ChequePayment**, but not instances of **NonelectronicTransaction**.

9.2. LIMITATIONS

There are limitations to the "implicit polymorphism" approach to the table per concrete-class mapping strategy. There are somewhat less restrictive limitations to **<union-subclass>** mappings.

The following list shows the limitations of table per concrete-class mappings, and of implicit polymorphism, in Hibernate.

table per class-hierarchy, table per subclass

- Polymorphic many-to-one: **<many-to-one>**
- Polymorphic one-to-one: **<one-to-one>**
- Polymorphic one-to-many: **<one-to-many>**
- Polymorphic many-to-many: **<many-to-many>**
- Polymorphic **load()** or **get()**: **s.get(Payment.class, id)**
- Polymorphic queries: **from Payment p**
- Polymorphic joins: **from Order o join o.payment p**

Outer join fetching is supported.

table per concrete-class (union-subclass)

- Polymorphic many-to-one: **<many-to-one>**
- Polymorphic one-to-one: **<one-to-one>**
- Polymorphic one-to-many: **<one-to-many>** (for **inverse="true"** only)
- Polymorphic many-to-many: **<many-to-many>**
- Polymorphic **load()** or **get()**: **s.get(Payment.class, id)**
- Polymorphic queries: **from Payment p**
- Polymorphic joins: **from Order o join o.payment p**

Outer join fetching is supported.

table per concrete class (implicit polymorphism)

- Polymorphic many-to-one: **<any>**

- Polymorphic many-to-many: `<many-to-many>`
- Polymorphic `load()` or `get()`: `s.createCriteria(Payment.class).add(Restrictions.idEq(id)).uniqueResult()`
- Polymorphic queries: `from Payment p`

Polymorphic one-to-one, polymorphic one-to-many, polymorphic joins, and outer join fetching are not supported.

CHAPTER 10. WORKING WITH OBJECTS

Hibernate is a full object/relational mapping solution that not only shields the developer from the details of the underlying database management system, but also offers *state management* of objects. This is, contrary to the management of SQL **statements** in common JDBC/SQL persistence layers, a natural object-oriented view of persistence in Java applications.

In other words, Hibernate application developers should always think about the *state* of their objects, and not necessarily about the execution of SQL statements. This part is taken care of by Hibernate and is only relevant for the application developer when tuning the performance of the system.

10.1. HIBERNATE OBJECT STATES

Hibernate defines and supports the following object states:

- *Transient* - an object is transient if it has just been instantiated using the **new** operator, and it is not associated with a Hibernate **Session**. It has no persistent representation in the database and no identifier value has been assigned. Transient instances will be destroyed by the garbage collector if the application does not hold a reference anymore. Use the Hibernate **Session** to make an object persistent (and let Hibernate take care of the SQL statements that need to be executed for this transition).
- *Persistent* - a persistent instance has a representation in the database and an identifier value. It might just have been saved or loaded, however, it is by definition in the scope of a **Session**. Hibernate will detect any changes made to an object in persistent state and synchronize the state with the database when the unit of work completes. Developers do not execute manual **UPDATE** statements, or **DELETE** statements when an object should be made transient.
- *Detached* - a detached instance is an object that has been persistent, but its **Session** has been closed. The reference to the object is still valid, of course, and the detached instance might even be modified in this state. A detached instance can be reattached to a new **Session** at a later point in time, making it (and all the modifications) persistent again. This feature enables a programming model for long running units of work that require user think-time. We call them *application transactions*, i.e., a unit of work from the point of view of the user.

We will now discuss the states and state transitions (and the Hibernate methods that trigger a transition) in more detail.

10.2. MAKING OBJECTS PERSISTENT

Newly instantiated instances of a persistent class are considered *transient* by Hibernate. We can make a transient instance *persistent* by associating it with a session:

```
DomesticCat fritz = new DomesticCat();
fritz.setColor(Color.GINGER);
fritz.setSex('M');
fritz.setName("Fritz");
Long generatedId = (Long) sess.save(fritz);
```

If **Cat** has a generated identifier, the identifier is generated and assigned to the **cat** when **save()** is called. If **Cat** has an **assigned** identifier, or a composite key, the identifier should be assigned to the **cat** instance before calling **save()**. You can also use **persist()** instead of **save()**, with the semantics defined in the EJB3 early draft.

- **persist()** makes a transient instance persistent. However, it does not guarantee that the identifier value will be assigned to the persistent instance immediately, the assignment might happen at flush time. **persist()** also guarantees that it will not execute an **INSERT** statement if it is called outside of transaction boundaries. This is useful in long-running conversations with an extended Session/persistence context.
- **save()** does guarantee to return an identifier. If an **INSERT** has to be executed to get the identifier (e.g. "identity" generator, not "sequence"), this **INSERT** happens immediately, no matter if you are inside or outside of a transaction. This is problematic in a long-running conversation with an extended Session/persistence context.

Alternatively, you can assign the identifier using an overloaded version of **save()**.

```
DomesticCat pk = new DomesticCat();
pk.setColor(Color.TABBY);
pk.setSex('F');
pk.setName("PK");
pk.setKittens( new HashSet() );
pk.addKitten(fritz);
```

If the object you make persistent has associated objects (e.g. the **kittens** collection in the previous example), these objects can be made persistent in any order you like unless you have a **NOT NULL** constraint upon a foreign key column. There is never a risk of violating foreign key constraints. However, you might violate a **NOT NULL** constraint if you **save()** the objects in the wrong order.

Usually you do not bother with this detail, as you will normally use Hibernate's *transitive persistence* feature to save the associated objects automatically. Then, even **NOT NULL** constraint violations do not occur - Hibernate will take care of everything. Transitive persistence is discussed later in this chapter.

10.3. LOADING AN OBJECT

The **load()** methods of **Session** provide a way of retrieving a persistent instance if you know its identifier. **load()** takes a class object and loads the state into a newly instantiated instance of that class in a persistent state.

```
Cat fritz = (Cat) sess.load(Cat.class, generatedId);
```

```
// you need to wrap primitive identifiers
long id = 1234;
DomesticCat pk = (DomesticCat) sess.load( DomesticCat.class, new Long(id)
);
```

Alternatively, you can load state into a given instance:

```
Cat cat = new DomesticCat();
// load pk's state into cat
sess.load( cat, new Long(pkId) );
Set kittens = cat.getKittens();
```

Be aware that **load()** will throw an unrecoverable exception if there is no matching database row. If the class is mapped with a proxy, **load()** just returns an uninitialized proxy and does not actually hit the database until you invoke a method of the proxy. This is useful if you wish to create an association to an

object without actually loading it from the database. It also allows multiple instances to be loaded as a batch if **batch-size** is defined for the class mapping.

If you are not certain that a matching row exists, you should use the **get()** method which hits the database immediately and returns null if there is no matching row.

```
Cat cat = (Cat) sess.get(Cat.class, id);
if (cat==null) {
    cat = new Cat();
}
return cat;
```

You can even load an object using an SQL **SELECT . . . FOR UPDATE**, using a **LockMode**. See the API documentation for more information.

```
Cat cat = (Cat) sess.get(Cat.class, id, LockMode.UPGRADE);
```

Any associated instances or contained collections will *not* be selected **FOR UPDATE**, unless you decide to specify **lock** or **all** as a cascade style for the association.

It is possible to re-load an object and all its collections at any time, using the **refresh()** method. This is useful when database triggers are used to initialize some of the properties of the object.

```
sess.save(cat);
sess.flush(); //force the SQL INSERT
sess.refresh(cat); //re-read the state (after the trigger executes)
```

How much does Hibernate load from the database and how many SQL **SELECT**s will it use? This depends on the *fetching strategy*. This is explained in [Section 19.1, "Fetching strategies"](#).

10.4. QUERYING

If you do not know the identifiers of the objects you are looking for, you need a query. Hibernate supports an easy-to-use but powerful object oriented query language (HQL). For programmatic query creation, Hibernate supports a sophisticated Criteria and Example query feature (QBC and QBE). You can also express your query in the native SQL of your database, with optional support from Hibernate for result set conversion into objects.

10.4.1. Executing queries

HQL and native SQL queries are represented with an instance of **org.hibernate.Query**. This interface offers methods for parameter binding, result set handling, and for the execution of the actual query. You always obtain a **Query** using the current **Session**:

```
List cats = session.createQuery(
    "from Cat as cat where cat.birthdate < ?")
    .setDate(0, date)
    .list();

List mothers = session.createQuery(
    "select mother from Cat as cat join cat.mother as mother where
    cat.name = ?")
    .setString(0, name)
```



```

        .list();

List kittens = session.createQuery(
    "from Cat as cat where cat.mother = ?")
    .setEntity(0, pk)
    .list();

Cat mother = (Cat) session.createQuery(
    "select cat.mother from Cat as cat where cat = ?")
    .setEntity(0, izi)
    .uniqueResult();

Query mothersWithKittens = session.createQuery(
    "select mother from Cat as mother left join fetch mother.kittens");
Set uniqueMothers = new HashSet(mothersWithKittens.list());

```

A query is usually executed by invoking `list()`. The result of the query will be loaded completely into a collection in memory. Entity instances retrieved by a query are in a persistent state. The `uniqueResult()` method offers a shortcut if you know your query will only return a single object. Queries that make use of eager fetching of collections usually return duplicates of the root objects, but with their collections initialized. You can filter these duplicates through a `Set`.

10.4.1.1. Iterating results

Occasionally, you might be able to achieve better performance by executing the query using the `iterate()` method. This will usually be the case if you expect that the actual entity instances returned by the query will already be in the session or second-level cache. If they are not already cached, `iterate()` will be slower than `list()` and might require many database hits for a simple query, usually 1 for the initial select which only returns identifiers, and n additional selects to initialize the actual instances.

```

// fetch ids
Iterator iter = sess.createQuery("from eg.Qux q order by
q.likeliness").iterate();
while ( iter.hasNext() ) {
    Qux qux = (Qux) iter.next(); // fetch the object
    // something we could not express in the query
    if ( qux.calculateComplicatedAlgorithm() ) {
        // delete the current instance
        iter.remove();
        // do not need to process the rest
        break;
    }
}

```

10.4.1.2. Queries that return tuples

Hibernate queries sometimes return tuples of objects. Each tuple is returned as an array:

```

Iterator kittensAndMothers = sess.createQuery(
    "select kitten, mother from Cat kitten join kitten.mother
mother")
    .list()
    .iterator();

```

```

while ( kittensAndMothers.hasNext() ) {
    Object[] tuple = (Object[]) kittensAndMothers.next();
    Cat kitten = (Cat) tuple[0];
    Cat mother = (Cat) tuple[1];
    ....
}
    
```

10.4.1.3. Scalar results

Queries can specify a property of a class in the **select** clause. They can even call SQL aggregate functions. Properties or aggregates are considered "scalar" results and not entities in persistent state.

```

Iterator results = sess.createQuery(
    "select cat.color, min(cat.birthdate), count(cat) from Cat cat " +
    "group by cat.color")
    .list()
    .iterator();

while ( results.hasNext() ) {
    Object[] row = (Object[]) results.next();
    Color type = (Color) row[0];
    Date oldest = (Date) row[1];
    Integer count = (Integer) row[2];
    .....
}
    
```

10.4.1.4. Bind parameters

Methods on **Query** are provided for binding values to named parameters or JDBC-style **?** parameters. *Contrary to JDBC, Hibernate numbers parameters from zero.* Named parameters are identifiers of the form **:name** in the query string. The advantages of named parameters are as follows:

- named parameters are insensitive to the order they occur in the query string
- they can occur multiple times in the same query
- they are self-documenting

```

//named parameter (preferred)
Query q = sess.createQuery("from DomesticCat cat where cat.name = :name");
q.setString("name", "Fritz");
Iterator cats = q.iterate();
    
```

```

//positional parameter
Query q = sess.createQuery("from DomesticCat cat where cat.name = ?");
q.setString(0, "Izi");
Iterator cats = q.iterate();
    
```

```

//named parameter list
List names = new ArrayList();
names.add("Izi");
names.add("Fritz");
Query q = sess.createQuery("from DomesticCat cat where cat.name in
    
```

```
(:namesList)");
q.setParameterList("namesList", names);
List cats = q.list();
```

10.4.1.5. Pagination

If you need to specify bounds upon your result set, that is, the maximum number of rows you want to retrieve and/or the first row you want to retrieve, you can use methods of the **Query** interface:

```
Query q = sess.createQuery("from DomesticCat cat");
q.setFirstResult(20);
q.setMaxResults(10);
List cats = q.list();
```

Hibernate knows how to translate this limit query into the native SQL of your DBMS.

10.4.1.6. Scrollable iteration

If your JDBC driver supports scrollable **ResultSets**, the **Query** interface can be used to obtain a **ScrollableResults** object that allows flexible navigation of the query results.

```
Query q = sess.createQuery("select cat.name, cat from DomesticCat cat " +
                          "order by cat.name");
ScrollableResults cats = q.scroll();
if ( cats.first() ) {

    // find the first name on each page of an alphabetical list of cats by
    name
    firstNamesOfPages = new ArrayList();
    do {
        String name = cats.getString(0);
        firstNamesOfPages.add(name);
    }
    while ( cats.scroll(PAGE_SIZE) );

    // Now get the first page of cats
    pageOfCats = new ArrayList();
    cats.beforeFirst();
    int i=0;
    while( ( PAGE_SIZE > i++ ) && cats.next() ) pageOfCats.add(
cats.get(1) );
}
cats.close();
```

Note that an open database connection and cursor is required for this functionality. Use **setMaxResult()/setFirstResult()** if you need offline pagination functionality.

10.4.1.7. Externalizing named queries

You can also define named queries in the mapping document. Remember to use a **CDATA** section if your query contains characters that could be interpreted as markup.

```
<query name="ByNameAndMaximumWeight"><![CDATA[
```

```

        from eg.DomesticCat as cat
            where cat.name = ?
            and cat.weight > ?
    ] ]></query>

```

Parameter binding and executing is done programmatically:

```

Query q = sess.getNamedQuery("ByNameAndMaximumWeight");
q.setString(0, name);
q.setInteger(1, minWeight);
List cats = q.list();

```

The actual program code is independent of the query language that is used. You can also define native SQL queries in metadata, or migrate existing queries to Hibernate by placing them in mapping files.

Also note that a query declaration inside a **<hibernate-mapping>** element requires a global unique name for the query, while a query declaration inside a **<class>** element is made unique automatically by prepending the fully qualified name of the class. For example **eg.Cat.ByNameAndMaximumWeight**.

10.4.2. Filtering collections

A collection *filter* is a special type of query that can be applied to a persistent collection or array. The query string can refer to **this**, meaning the current collection element.

```

Collection blackKittens = session.createFilter(
    pk.getKittens(),
    "where this.color = ?")
    .setParameter( Color.BLACK, Hibernate.custom(ColorUserType.class) )
    .list()

```

The returned collection is considered a bag that is a copy of the given collection. The original collection is not modified. This is contrary to the implication of the name "filter", but consistent with expected behavior.

Observe that filters do not require a **from** clause, although they can have one if required. Filters are not limited to returning the collection elements themselves.

```

Collection blackKittenMates = session.createFilter(
    pk.getKittens(),
    "select this.mate where this.color = eg.Color.BLACK.intValue")
    .list();

```

Even an empty filter query is useful, e.g. to load a subset of elements in a large collection:

```

Collection tenKittens = session.createFilter(
    mother.getKittens(), "")
    .setFirstResult(0).setMaxResults(10)
    .list();

```

10.4.3. Criteria queries

HQL is extremely powerful, but some developers prefer to build queries dynamically using an object-oriented API, rather than building query strings. Hibernate provides an intuitive **Criteria** query API for these cases:

```
Criteria crit = session.createCriteria(Cat.class);
crit.add( Restrictions.eq( "color", eg.Color.BLACK ) );
crit.setMaxResults(10);
List cats = crit.list();
```

The **Criteria** and the associated **Example** API are discussed in more detail in [Chapter 15, Criteria Queries](#).

10.4.4. Queries in native SQL

You can express a query in SQL, using **createSQLQuery()** and let Hibernate manage the mapping from result sets to objects. You can at any time call **session.connection()** and use the JDBC **Connection** directly. If you choose to use the Hibernate API, you must enclose SQL aliases in braces:

```
List cats = session.createSQLQuery("SELECT {cat.*} FROM CAT {cat} WHERE
ROWNUM<10")
    .addEntity("cat", Cat.class)
    .list();
```

```
List cats = session.createSQLQuery(
    "SELECT {cat}.ID AS {cat.id}, {cat}.SEX AS {cat.sex}, " +
    "{cat}.MATE AS {cat.mate}, {cat}.SUBCLASS AS {cat.class}, ... "
+
    "FROM CAT {cat} WHERE ROWNUM<10")
    .addEntity("cat", Cat.class)
    .list();
```

SQL queries can contain named and positional parameters, just like Hibernate queries. More information about native SQL queries in Hibernate can be found in [Chapter 16, Native SQL](#).

10.5. MODIFYING PERSISTENT OBJECTS

Transactional persistent instances (i.e. objects loaded, saved, created or queried by the **Session**) can be manipulated by the application, and any changes to persistent state will be persisted when the **Session** is *flushed*. This is discussed later in this chapter. There is no need to call a particular method (like **update()**, which has a different purpose) to make your modifications persistent. The most straightforward way to update the state of an object is to **load()** it and then manipulate it directly while the **Session** is open:

```
DomesticCat cat = (DomesticCat) sess.load( Cat.class, new Long(69) );
cat.setName("PK");
sess.flush(); // changes to cat are automatically detected and persisted
```

Sometimes this programming model is inefficient, as it requires in the same session both an SQL **SELECT** to load an object and an SQL **UPDATE** to persist its updated state. Hibernate offers an alternate approach by using detached instances.



IMPORTANT

Hibernate does not offer its own API for direct execution of **UPDATE** or **DELETE** statements. Hibernate is a *state management* service, you do not have to think in *statements* to use it. JDBC is a perfect API for executing SQL statements, you can get a JDBC **Connection** at any time by calling `session.connection()`. Furthermore, the notion of mass operations conflicts with object/relational mapping for online transaction processing-oriented applications. Future versions of Hibernate can, however, provide special mass operation functions. See [Chapter 13, Batch processing](#) for some possible batch operation tricks.

10.6. MODIFYING DETACHED OBJECTS

Many applications need to retrieve an object in one transaction, send it to the UI layer for manipulation, then save the changes in a new transaction. Applications that use this kind of approach in a high-concurrency environment usually use versioned data to ensure isolation for the "long" unit of work.

Hibernate supports this model by providing for reattachment of detached instances using the `Session.update()` or `Session.merge()` methods:

```
// in the first session
Cat cat = (Cat) firstSession.load(Cat.class, catId);
Cat potentialMate = new Cat();
firstSession.save(potentialMate);

// in a higher layer of the application
cat.setMate(potentialMate);

// later, in a new session
secondSession.update(cat); // update cat
secondSession.update(mate); // update mate
```

If the **Cat** with identifier `catId` had already been loaded by `secondSession` when the application tried to reattach it, an exception would have been thrown.

Use `update()` if you are certain that the session does not contain an already persistent instance with the same identifier. Use `merge()` if you want to merge your modifications at any time without consideration of the state of the session. In other words, `update()` is usually the first method you would call in a fresh session, ensuring that the reattachment of your detached instances is the first operation that is executed.

The application should individually `update()` detached instances that are reachable from the given detached instance *only* if it wants their state to be updated. This can be automated using *transitive persistence*. See [Section 10.11, "Transitive persistence"](#) for more information.

The `lock()` method also allows an application to reassociate an object with a new session. However, the detached instance has to be unmodified.

```
//just reassociate:
sess.lock(fritz, LockMode.NONE);
//do a version check, then reassociate:
sess.lock(izi, LockMode.READ);
//do a version check, using SELECT ... FOR UPDATE, then reassociate:
sess.lock(pk, LockMode.UPGRADE);
```

Note that `lock()` can be used with various `LockModes`. See the API documentation and the chapter on transaction handling for more information. Reattachment is not the only usecase for `lock()`.

Other models for long units of work are discussed in [Section 11.3, “Optimistic concurrency control”](#).

10.7. AUTOMATIC STATE DETECTION

Hibernate users have requested a general purpose method that either saves a transient instance by generating a new identifier or updates/reattaches the detached instances associated with its current identifier. The `saveOrUpdate()` method implements this functionality.

```
// in the first session
Cat cat = (Cat) firstSession.load(Cat.class, catID);

// in a higher tier of the application
Cat mate = new Cat();
cat.setMate(mate);

// later, in a new session
secondSession.saveOrUpdate(cat); // update existing state (cat has a
non-null id)
secondSession.saveOrUpdate(mate); // save the new instance (mate has a
null id)
```

The usage and semantics of `saveOrUpdate()` seems to be confusing for new users. Firstly, so long as you are not trying to use instances from one session in another new session, you should not need to use `update()`, `saveOrUpdate()`, or `merge()`. Some whole applications will never use either of these methods.

Usually `update()` or `saveOrUpdate()` are used in the following scenario:

- the application loads an object in the first session
- the object is passed up to the UI tier
- some modifications are made to the object
- the object is passed back down to the business logic tier
- the application persists these modifications by calling `update()` in a second session

`saveOrUpdate()` does the following:

- if the object is already persistent in this session, do nothing
- if another object associated with the session has the same identifier, throw an exception
- if the object has no identifier property, `save()` it
- if the object's identifier has the value assigned to a newly instantiated object, `save()` it
- if the object is versioned by a `<version>` or `<timestamp>`, and the version property value is the same value assigned to a newly instantiated object, `save()` it
- otherwise `update()` the object

and `merge()` is very different:

- if there is a persistent instance with the same identifier currently associated with the session, copy the state of the given object onto the persistent instance
- if there is no persistent instance currently associated with the session, try to load it from the database, or create a new persistent instance
- the persistent instance is returned
- the given instance does not become associated with the session, it remains detached

10.8. DELETING PERSISTENT OBJECTS

`Session.delete()` will remove an object's state from the database. Your application, however, can still hold a reference to a deleted object. It is best to think of `delete()` as making a persistent instance, transient.

```
sess.delete(cat);
```

You can delete objects in any order, without risk of foreign key constraint violations. It is still possible to violate a **NOT NULL** constraint on a foreign key column by deleting objects in the wrong order, e.g. if you delete the parent, but forget to delete the children.

10.9. REPLICATING OBJECT BETWEEN TWO DIFFERENT DATASTORES

It is sometimes useful to be able to take a graph of persistent instances and make them persistent in a different datastore, without regenerating identifier values.

```
//retrieve a cat from one database
Session session1 = factory1.openSession();
Transaction tx1 = session1.beginTransaction();
Cat cat = (Cat) session1.get(Cat.class, catId);
tx1.commit();
session1.close();

//reconcile with a second database
Session session2 = factory2.openSession();
Transaction tx2 = session2.beginTransaction();
session2.replicate(cat, ReplicationMode.LATEST_VERSION);
tx2.commit();
session2.close();
```

The `ReplicationMode` determines how `replicate()` will deal with conflicts with existing rows in the database:

- **ReplicationMode.IGNORE**: ignores the object when there is an existing database row with the same identifier
- **ReplicationMode.OVERWRITE**: overwrites any existing database row with the same identifier
- **ReplicationMode.EXCEPTION**: throws an exception if there is an existing database row with the same identifier

- **ReplicationMode.LATEST_VERSION**: overwrites the row if its version number is earlier than the version number of the object, or ignore the object otherwise

Use cases for this feature include reconciling data entered into different database instances, upgrading system configuration information during product upgrades, rolling back changes made during non-ACID transactions and more.

10.10. FLUSHING THE SESSION

Sometimes the **Session** will execute the SQL statements needed to synchronize the JDBC connection's state with the state of objects held in memory. This process, called *flush*, occurs by default at the following points:

- before some query executions
- from `org.hibernate.Transaction.commit()`
- from `Session.flush()`

The SQL statements are issued in the following order:

1. all entity insertions in the same order the corresponding objects were saved using `Session.save()`
2. all entity updates
3. all collection deletions
4. all collection element deletions, updates and insertions
5. all collection insertions
6. all entity deletions in the same order the corresponding objects were deleted using `Session.delete()`

An exception is that objects using **native** ID generation are inserted when they are saved.

Except when you explicitly `flush()`, there are absolutely no guarantees about *when* the **Session** executes the JDBC calls, only the *order* in which they are executed. However, Hibernate does guarantee that the `Query.list(..)` will never return stale or incorrect data.

It is possible to change the default behavior so that flush occurs less frequently. The **FlushMode** class defines three different modes: only flush at commit time when the Hibernate **Transaction** API is used, flush automatically using the explained routine, or never flush unless `flush()` is called explicitly. The last mode is useful for long running units of work, where a **Session** is kept open and disconnected for a long time (see [Section 11.3.2, "Extended session and automatic versioning"](#)).

```
sess = sf.openSession();
Transaction tx = sess.beginTransaction();
sess.setFlushMode(FlushMode.COMMIT); // allow queries to return stale
state

Cat izi = (Cat) sess.load(Cat.class, id);
izi.setName(iznizi);

// might return stale data
```

```

sess.createQuery("from Cat as cat left outer join cat.kittens kitten");

// change to izi is not flushed!
...
tx.commit(); // flush occurs
sess.close();

```

During flush, an exception might occur (e.g. if a DML operation violates a constraint). Since handling exceptions involves some understanding of Hibernate's transactional behavior, we discuss it in [Chapter 11, Transactions and Concurrency](#).

10.11. TRANSITIVE PERSISTENCE

It is quite cumbersome to save, delete, or reattach individual objects, especially if you deal with a graph of associated objects. A common case is a parent/child relationship. Consider the following example:

If the children in a parent/child relationship would be value typed (e.g. a collection of addresses or strings), their life cycle would depend on the parent and no further action would be required for convenient "cascading" of state changes. When the parent is saved, the value-typed child objects are saved and when the parent is deleted, the children will be deleted, etc. This works for operations such as the removal of a child from the collection. Since value-typed objects cannot have shared references, Hibernate will detect this and delete the child from the database.

Now consider the same scenario with parent and child objects being entities, not value-types (e.g. categories and items, or parent and child cats). Entities have their own life cycle and support shared references. Removing an entity from the collection does not mean it can be deleted, and there is by default no cascading of state from one entity to any other associated entities. Hibernate does not implement *persistence by reachability* by default.

For each basic operation of the Hibernate session - including `persist()`, `merge()`, `saveOrUpdate()`, `delete()`, `lock()`, `refresh()`, `evict()`, `replicate()` - there is a corresponding cascade style. Respectively, the cascade styles are named **create**, **merge**, **save-update**, **delete**, **lock**, **refresh**, **evict**, **replicate**. If you want an operation to be cascaded along an association, you must indicate that in the mapping document. For example:

```
<one-to-one name="person" cascade="persist"/>
```

Cascade styles may be combined:

```
<one-to-one name="person" cascade="persist,delete,lock"/>
```

You can even use **cascade="all"** to specify that *all* operations should be cascaded along the association. The default **cascade="none"** specifies that no operations are to be cascaded.

A special cascade style, **delete-orphan**, applies only to one-to-many associations, and indicates that the `delete()` operation should be applied to any child object that is removed from the association.

Recommendations:

- It does not usually make sense to enable cascade on a **<many-to-one>** or **<many-to-many>** association. Cascade is often useful for **<one-to-one>** and **<one-to-many>** associations.
- If the child object's lifespan is bounded by the lifespan of the parent object, make it a *life cycle object* by specifying **cascade="all,delete-orphan"**.

- Otherwise, you might not need cascade at all. But if you think that you will often be working with the parent and children together in the same transaction, and you want to save yourself some typing, consider using **`cascade="persist, merge, save-update"`**.

Mapping an association (either a single valued association, or a collection) with **`cascade="all"`** marks the association as a *parent/child* style relationship where *save/update/delete* of the parent results in *save/update/delete* of the child or children.

Furthermore, a mere reference to a child from a persistent parent will result in *save/update* of the child. This metaphor is incomplete, however. A child which becomes unreferenced by its parent is *not* automatically deleted, except in the case of a **<one-to-many>** association mapped with **`cascade="delete-orphan"`**. The precise semantics of cascading operations for a parent/child relationship are as follows:

- If a parent is passed to **`persist()`**, all children are passed to **`persist()`**
- If a parent is passed to **`merge()`**, all children are passed to **`merge()`**
- If a parent is passed to **`save()`**, **`update()`** or **`saveOrUpdate()`**, all children are passed to **`saveOrUpdate()`**
- If a transient or detached child becomes referenced by a persistent parent, it is passed to **`saveOrUpdate()`**
- If a parent is deleted, all children are passed to **`delete()`**
- If a child is dereferenced by a persistent parent, *nothing special happens* - the application should explicitly delete the child if necessary - unless **`cascade="delete-orphan"`**, in which case the "orphaned" child is deleted.

Finally, note that cascading of operations can be applied to an object graph at *call time* or at *flush time*. All operations, if enabled, are cascaded to associated entities reachable when the operation is executed. However, **`save-update`** and **`delete-orphan`** are transitive for all associated entities reachable during flush of the **Session**.

10.12. USING METADATA

Hibernate requires a rich meta-level model of all entity and value types. This model can be useful to the application itself. For example, the application might use Hibernate's metadata to implement a "smart" deep-copy algorithm that understands which objects should be copied (eg. mutable value types) and which objects that should not (e.g. immutable value types and, possibly, associated entities).

Hibernate exposes metadata via the **ClassMetadata** and **CollectionMetadata** interfaces and the **Type** hierarchy. Instances of the metadata interfaces can be obtained from the **SessionFactory**.

```
Cat fritz = .....;
ClassMetadata catMeta = sessionFactory.getClassMetadata(Cat.class);

Object[] propertyValues = catMeta.getPropertyValues(fritz,
EntityMode.POJO);
String[] propertyNames = catMeta.getPropertyNames();
Type[] propertyTypes = catMeta.getPropertyTypes();

// get a Map of all properties which are not collections or associations
Map namedValues = new HashMap();
```

```
for ( int i=0; i<propertyNames.length; i++ ) {  
    if ( !propertyTypes[i].isEntityType() &&  
        !propertyTypes[i].isCollectionType() ) {  
        namedValues.put( propertyNames[i], propertyValues[i] );  
    }  
}
```

CHAPTER 11. TRANSACTIONS AND CONCURRENCY

The most important point about Hibernate and concurrency control is that it is easy to understand. Hibernate directly uses JDBC connections and JTA resources without adding any additional locking behavior. It is recommended that you spend some time with the JDBC, ANSI, and transaction isolation specification of your database management system.

Hibernate does not lock objects in memory. Your application can expect the behavior as defined by the isolation level of your database transactions. Through **Session**, which is also a transaction-scoped cache, Hibernate provides repeatable reads for lookup by identifier and entity queries and not reporting queries that return scalar values.

In addition to versioning for automatic optimistic concurrency control, Hibernate also offers, using the **SELECT FOR UPDATE** syntax, a (minor) API for pessimistic locking of rows. Optimistic concurrency control and this API are discussed later in this chapter.

The discussion of concurrency control in Hibernate begins with the granularity of **Configuration**, **SessionFactory**, and **Session**, as well as database transactions and long conversations.

11.1. SESSION AND TRANSACTION SCOPES

A **SessionFactory** is an expensive-to-create, threadsafe object, intended to be shared by all application threads. It is created once, usually on application start, from a **Configuration** instance.

A **Session** is an inexpensive, non-threadsafe object that should be used once and then discarded for: a single request, a conversation or a single unit of work. A **Session** will not obtain a JDBC **Connection**, or a **Datasource**, unless it is needed. It will not consume any resources until used.

In order to reduce lock contention in the database, a database transaction has to be as short as possible. Long database transactions will prevent your application from scaling to a highly concurrent load. It is not recommended that you hold a database transaction open during user think time until the unit of work is complete.

What is the scope of a unit of work? Can a single Hibernate **Session** span several database transactions, or is this a one-to-one relationship of scopes? When should you open and close a **Session** and how do you demarcate the database transaction boundaries? These questions are addressed in the following sections.

11.1.1. Unit of work

First, let us define a unit of work. A unit of work is a design pattern described by Martin Fowler as “[maintaining] a list of objects affected by a business transaction and coordinates the writing out of changes and the resolution of concurrency problems.” [PoEAA] In other words, it's a series of operations we wish to carry out against the database together. Basically, it is a transaction, though fulfilling a unit of work will often span multiple physical database transactions (see [Section 11.1.2, “Long conversations”](#)). So really we are talking about a more abstract notion of a transaction. The term “business transaction” is also sometimes used in lieu of unit of work.

Do not use the *session-per-operation* antipattern: do not open and close a **Session** for every simple database call in a single thread. The same is true for database transactions. Database calls in an application are made using a planned sequence; they are grouped into atomic units of work. This also means that auto-commit after every single SQL statement is useless in an application as this mode is intended for ad-hoc SQL console work. Hibernate disables, or expects the application server to disable, auto-commit mode immediately. Database transactions are never optional. All communication with a

database has to occur inside a transaction. Auto-commit behavior for reading data should be avoided, as many small transactions are unlikely to perform better than one clearly defined unit of work. The latter is also more maintainable and extensible.

The most common pattern in a multi-user client/server application is *session-per-request*. In this model, a request from the client is sent to the server, where the Hibernate persistence layer runs. A new Hibernate **Session** is opened, and all database operations are executed in this unit of work. On completion of the work, and once the response for the client has been prepared, the session is flushed and closed. Use a single database transaction to serve the clients request, starting and committing it when you open and close the **Session**. The relationship between the two is one-to-one and this model is a perfect fit for many applications.

The challenge lies in the implementation. Hibernate provides built-in management of the "current session" to simplify this pattern. Start a transaction when a server request has to be processed, and end the transaction before the response is sent to the client. Common solutions are **ServletFilter**, AOP interceptor with a pointcut on the service methods, or a proxy/interception container. An EJB container is a standardized way to implement cross-cutting aspects such as transaction demarcation on EJB session beans, declaratively with CMT. If you use programmatic transaction demarcation, for ease of use and code portability use the Hibernate **Transaction** API shown later in this chapter.

Your application code can access a "current session" to process the request by calling **SessionFactory.getCurrentSession()**. You will always get a **Session** scoped to the current database transaction. This has to be configured for either resource-local or JTA environments, see [Section 2.5, "Contextual sessions"](#).

You can extend the scope of a **Session** and database transaction until the "view has been rendered". This is especially useful in servlet applications that utilize a separate rendering phase after the request has been processed. Extending the database transaction until view rendering, is achieved by implementing your own interceptor. However, this will be difficult if you rely on EJBs with container-managed transactions. A transaction will be completed when an EJB method returns, before rendering of any view can start. See the Hibernate website and forum for tips and examples relating to this *Open Session in View* pattern.

11.1.2. Long conversations

The session-per-request pattern is not the only way of designing units of work. Many business processes require a whole series of interactions with the user that are interleaved with database accesses. In web and enterprise applications, it is not acceptable for a database transaction to span a user interaction. Consider the following example:

- The first screen of a dialog opens. The data seen by the user has been loaded in a particular **Session** and database transaction. The user is free to modify the objects.
- The user clicks "Save" after 5 minutes and expects their modifications to be made persistent. The user also expects that they were the only person editing this information and that no conflicting modification has occurred.

From the point of view of the user, we call this unit of work a long-running *conversation* or *application transaction*. There are many ways to implement this in your application.

A first naive implementation might keep the **Session** and database transaction open during user think time, with locks held in the database to prevent concurrent modification and to guarantee isolation and atomicity. This is an anti-pattern, since lock contention would not allow the application to scale with the number of concurrent users.

You have to use several database transactions to implement the conversation. In this case, maintaining

isolation of business processes becomes the partial responsibility of the application tier. A single conversation usually spans several database transactions. It will be atomic if only one of these database transactions (the last one) stores the updated data. All others simply read data (for example, in a wizard-style dialog spanning several request/response cycles). This is easier to implement than it might sound, especially if you utilize some of Hibernate's features:

- *Automatic Versioning*: Hibernate can perform automatic optimistic concurrency control for you. It can automatically detect if a concurrent modification occurred during user think time. Check for this at the end of the conversation.
- *Detached Objects*: if you decide to use the *session-per-request* pattern, all loaded instances will be in the detached state during user think time. Hibernate allows you to reattach the objects and persist the modifications. The pattern is called *session-per-request-with-detached-objects*. Automatic versioning is used to isolate concurrent modifications.
- *Extended (or Long) Session*: the Hibernate **Session** can be disconnected from the underlying JDBC connection after the database transaction has been committed and reconnected when a new client request occurs. This pattern is known as *session-per-conversation* and makes even reattachment unnecessary. Automatic versioning is used to isolate concurrent modifications and the **Session** will not be allowed to be flushed automatically, but explicitly.

Both *session-per-request-with-detached-objects* and *session-per-conversation* have advantages and disadvantages. These disadvantages are discussed later in this chapter in the context of optimistic concurrency control.

11.1.3. Considering object identity

An application can concurrently access the same persistent state in two different **Sessions**. However, an instance of a persistent class is never shared between two **Session** instances. It is for this reason that there are two different notions of identity:

Database Identity

```
foo.getId().equals( bar.getId() )
```

JVM Identity

```
foo==bar
```

For objects attached to a *particular Session* (i.e., in the scope of a **Session**), the two notions are equivalent and JVM identity for database identity is guaranteed by Hibernate. While the application might concurrently access the "same" (persistent identity) business object in two different sessions, the two instances will actually be "different" (JVM identity). Conflicts are resolved using an optimistic approach and automatic versioning at flush/commit time.

This approach leaves Hibernate and the database to worry about concurrency. It also provides the best scalability, since guaranteeing identity in single-threaded units of work means that it does not need expensive locking or other means of synchronization. The application does not need to synchronize on any business object, as long as it maintains a single thread per **Session**. Within a **Session** the application can safely use `==` to compare objects.

However, an application that uses `==` outside of a **Session** might produce unexpected results. This might occur even in some unexpected places. For example, if you put two detached instances into the same **Set**, both might have the same database identity (i.e., they represent the same row). JVM identity, however, is by definition not guaranteed for instances in a detached state. The developer has to override the `equals()` and `hashCode()` methods in persistent classes and implement their own notion of object

equality. There is one caveat: never use the database identifier to implement equality. Use a business key that is a combination of unique, usually immutable, attributes. The database identifier will change if a transient object is made persistent. If the transient instance (usually together with detached instances) is held in a **Set**, changing the hashcode breaks the contract of the **Set**. Attributes for business keys do not have to be as stable as database primary keys; you only have to guarantee stability as long as the objects are in the same **Set**. See the Hibernate website for a more thorough discussion of this issue. Please note that this is not a Hibernate issue, but simply how Java object identity and equality has to be implemented.

11.1.4. Common issues

Do not use the anti-patterns *session-per-user-session* or *session-per-application* (there are, however, rare exceptions to this rule). Some of the following issues might also arise within the recommended patterns, so ensure that you understand the implications before making a design decision:

- A **Session** is not thread-safe. Things that work concurrently, like HTTP requests, session beans, or Swing workers, will cause race conditions if a **Session** instance is shared. If you keep your Hibernate **Session** in your **HttpSession** (this is discussed later in the chapter), you should consider synchronizing access to your Http session. Otherwise, a user that clicks reload fast enough can use the same **Session** in two concurrently running threads.
- An exception thrown by Hibernate means you have to rollback your database transaction and close the **Session** immediately (this is discussed in more detail later in the chapter). If your **Session** is bound to the application, you have to stop the application. Rolling back the database transaction does not put your business objects back into the state they were at the start of the transaction. This means that the database state and the business objects will be out of sync. Usually this is not a problem, because exceptions are not recoverable and you will have to start over after rollback anyway.
- The **Session** caches every object that is in a persistent state (watched and checked for dirty state by Hibernate). If you keep it open for a long time or simply load too much data, it will grow endlessly until you get an `OutOfMemoryException`. One solution is to call `clear()` and `evict()` to manage the **Session** cache, but you should consider a Stored Procedure if you need mass data operations. Some solutions are shown in [Chapter 13, Batch processing](#). Keeping a **Session** open for the duration of a user session also means a higher probability of stale data.

11.2. DATABASE TRANSACTION DEMARCATION

Database, or system, transaction boundaries are always necessary. No communication with the database can occur outside of a database transaction (this seems to confuse many developers who are used to the auto-commit mode). Always use clear transaction boundaries, even for read-only operations. Depending on your isolation level and database capabilities this might not be required, but there is no downside if you always demarcate transactions explicitly. Certainly, a single database transaction is going to perform better than many small transactions, even for reading data.

A Hibernate application can run in non-managed (i.e., standalone, simple Web- or Swing applications) and managed J2EE environments. In a non-managed environment, Hibernate is usually responsible for its own database connection pool. The application developer has to manually set transaction boundaries (begin, commit, or rollback database transactions) themselves. A managed environment usually provides container-managed transactions (CMT), with the transaction assembly defined declaratively (in deployment descriptors of EJB session beans, for example). Programmatic transaction demarcation is then no longer necessary.

However, it is often desirable to keep your persistence layer portable between non-managed resource-

local environments, and systems that can rely on JTA but use BMT instead of CMT. In both cases use programmatic transaction demarcation. Hibernate offers a wrapper API called **Transaction** that translates into the native transaction system of your deployment environment. This API is actually optional, but we strongly encourage its use unless you are in a CMT session bean.

Ending a **Session** usually involves four distinct phases:

- flush the session
- commit the transaction
- close the session
- handle exceptions

We discussed Flushing the session earlier, so we will now have a closer look at transaction demarcation and exception handling in both managed and non-managed environments.

11.2.1. Non-managed environment

If a Hibernate persistence layer runs in a non-managed environment, database connections are usually handled by simple (i.e., non-DataSource) connection pools from which Hibernate obtains connections as needed. The session/transaction handling idiom looks like this:

```
// Non-managed environment idiom
Session sess = factory.openSession();
Transaction tx = null;
try {
    tx = sess.beginTransaction();

    // do some work
    ...

    tx.commit();
}
catch (RuntimeException e) {
    if (tx != null) tx.rollback();
    throw e; // or display error message
}
finally {
    sess.close();
}
```

You do not have to **flush()** the **Session** explicitly: the call to **commit()** automatically triggers the synchronization depending on the [Section 10.10, “Flushing the Session”](#) for the session. A call to **close()** marks the end of a session. The main implication of **close()** is that the JDBC connection will be relinquished by the session. This Java code is portable and runs in both non-managed and JTA environments.

As outlined earlier, a much more flexible solution is Hibernate's built-in "current session" context management:

```
// Non-managed environment idiom with getCurrentSession()
try {
    factory.getCurrentSession().beginTransaction();
```

```

        // do some work
        ...

        factory.getCurrentSession().getTransaction().commit();
    }
    catch (RuntimeException e) {
        factory.getCurrentSession().getTransaction().rollback();
        throw e; // or display error message
    }

```

You will not see these code snippets in a regular application; fatal (system) exceptions should always be caught at the "top". In other words, the code that executes Hibernate calls in the persistence layer, and the code that handles **RuntimeException** (and usually can only clean up and exit), are in different layers. The current context management by Hibernate can significantly simplify this design by accessing a **SessionFactory**. Exception handling is discussed later in this chapter.

You should select **org.hibernate.transaction.JDBCTransactionFactory**, which is the default, and for the second example select **"thread"** as your **hibernate.current_session_context_class**.

11.2.2. Using JTA

If your persistence layer runs in an application server (for example, behind EJB session beans), every datasource connection obtained by Hibernate will automatically be part of the global JTA transaction. You can also install a standalone JTA implementation and use it without EJB. Hibernate offers two strategies for JTA integration.

If you use bean-managed transactions (BMT), Hibernate will tell the application server to start and end a BMT transaction if you use the **Transaction** API. The transaction management code is identical to the non-managed environment.

```

// BMT idiom
Session sess = factory.openSession();
Transaction tx = null;
try {
    tx = sess.beginTransaction();

    // do some work
    ...

    tx.commit();
}
catch (RuntimeException e) {
    if (tx != null) tx.rollback();
    throw e; // or display error message
}
finally {
    sess.close();
}

```

If you want to use a transaction-bound **Session**, that is, the **getCurrentSession()** functionality for easy context propagation, use the JTA **UserTransaction** API directly:

```

// BMT idiom with getCurrentSession()

```

```

try {
    UserTransaction tx = (UserTransaction)new InitialContext()
        .lookup("java:comp/UserTransaction");

    tx.begin();

    // Do some work on Session bound to transaction
    factory.getCurrentSession().load(...);
    factory.getCurrentSession().persist(...);

    tx.commit();
}
catch (RuntimeException e) {
    tx.rollback();
    throw e; // or display error message
}

```

With CMT, transaction demarcation is completed in session bean deployment descriptors, not programmatically. The code is reduced to:

```

// CMT idiom
Session sess = factory.getCurrentSession();

// do some work
...

```

In a CMT/EJB, even rollback happens automatically. An unhandled **RuntimeException** thrown by a session bean method tells the container to set the global transaction to rollback. *You do not need to use the Hibernate **Transaction** API at all with BMT or CMT, and you get automatic propagation of the "current" Session bound to the transaction.*

When configuring Hibernate's transaction factory, choose **org.hibernate.transaction.JTATransactionFactory** if you use JTA directly (BMT), and **org.hibernate.transaction.CMTTransactionFactory** in a CMT session bean. Remember to also set **hibernate.transaction.manager_lookup_class**. Ensure that your **hibernate.current_session_context_class** is either unset (backwards compatibility), or is set to "jta".

The **getCurrentSession()** operation has one downside in a JTA environment. There is one caveat to the use of **after_statement** connection release mode, which is then used by default. Due to a limitation of the JTA spec, it is not possible for Hibernate to automatically clean up any unclosed **ScrollableResults** or **Iterator** instances returned by **scroll()** or **iterate()**. You *must* release the underlying database cursor by calling **ScrollableResults.close()** or **Hibernate.close(Iterator)** explicitly from a **finally** block. Most applications can easily avoid using **scroll()** or **iterate()** from the JTA or CMT code.)

11.2.3. Exception handling

If the **Session** throws an exception, including any **SQLException**, immediately rollback the database transaction, call **Session.close()** and discard the **Session** instance. Certain methods of **Session** will *not* leave the session in a consistent state. No exception thrown by Hibernate can be treated as recoverable. Ensure that the **Session** will be closed by calling **close()** in a **finally** block.

The **HibernateException**, which wraps most of the errors that can occur in a Hibernate persistence

layer, is an unchecked exception. It was not in older versions of Hibernate. In our opinion, we should not force the application developer to catch an unrecoverable exception at a low layer. In most systems, unchecked and fatal exceptions are handled in one of the first frames of the method call stack (i.e., in higher layers) and either an error message is presented to the application user or some other appropriate action is taken. Note that Hibernate might also throw other unchecked exceptions that are not a **HibernateException**. These are not recoverable and appropriate action should be taken.

Hibernate wraps **SQLExceptions** thrown while interacting with the database in a **JDBCException**. In fact, Hibernate will attempt to convert the exception into a more meaningful subclass of **JDBCException**. The underlying **SQLException** is always available via **JDBCException.getCause()**. Hibernate converts the **SQLException** into an appropriate **JDBCException** subclass using the **SQLExceptionConverter** attached to the **SessionFactory**. By default, the **SQLExceptionConverter** is defined by the configured dialect. However, it is also possible to plug in a custom implementation. See the javadocs for the **SQLExceptionConverterFactory** class for details. The standard **JDBCException** subtypes are:

- **JDBCConnectionException**: indicates an error with the underlying JDBC communication.
- **SQLGrammarException**: indicates a grammar or syntax problem with the issued SQL.
- **ConstraintViolationException**: indicates some form of integrity constraint violation.
- **LockAcquisitionException**: indicates an error acquiring a lock level necessary to perform the requested operation.
- **GenericJDBCException**: a generic exception which did not fall into any of the other categories.

11.2.4. Transaction timeout

An important feature provided by a managed environment like EJB is transaction timeout, which is never provided in non-managed code. Transaction timeouts ensure that no misbehaving transaction can indefinitely tie up resources while returning no response to the user. Outside a managed (JTA) environment, Hibernate cannot fully provide this functionality. However, Hibernate can at least control data access operations, ensuring that database level deadlocks and queries with huge result sets are limited by a defined timeout. In a managed environment, Hibernate can delegate transaction timeout to JTA. This functionality is abstracted by the Hibernate **Transaction** object.

```
Session sess = factory.openSession();
try {
    //set transaction timeout to 3 seconds
    sess.getTransaction().setTimeout(3);
    sess.getTransaction().begin();

    // do some work
    ...

    sess.getTransaction().commit();
}
catch (RuntimeException e) {
    sess.getTransaction().rollback();
    throw e; // or display error message
}
```

```
finally {
    sess.close();
}
```

`setTimeout()` cannot be called in a CMT bean, where transaction timeouts must be defined declaratively.

11.3. OPTIMISTIC CONCURRENCY CONTROL

The only approach that is consistent with high concurrency and high scalability, is optimistic concurrency control with versioning. Version checking uses version numbers, or timestamps, to detect conflicting updates and to prevent lost updates. Hibernate provides three possible approaches to writing application code that uses optimistic concurrency. The use cases we discuss are in the context of long conversations, but version checking also has the benefit of preventing lost updates in single database transactions.

11.3.1. Application version checking

In an implementation without much help from Hibernate, each interaction with the database occurs in a new **Session** and the developer is responsible for reloading all persistent instances from the database before manipulating them. The application is forced to carry out its own version checking to ensure conversation transaction isolation. This approach is the least efficient in terms of database access. It is the approach most similar to entity EJBs.

```
// foo is an instance loaded by a previous Session
session = factory.openSession();
Transaction t = session.beginTransaction();

int oldVersion = foo.getVersion();
session.load( foo, foo.getKey() ); // load the current state
if ( oldVersion != foo.getVersion() ) throw new
StaleObjectStateException("Message", foo.getId());
foo.setProperty("bar");

t.commit();
session.close();
```

The **version** property is mapped using `<version>`, and Hibernate will automatically increment it during flush if the entity is dirty.

If you are operating in a low-data-concurrency environment, and do not require version checking, you can use this approach and skip the version check. In this case, *last commit wins* is the default strategy for long conversations. Be aware that this might confuse the users of the application, as they might experience lost updates without error messages or a chance to merge conflicting changes.

Manual version checking is only feasible in trivial circumstances and not practical for most applications. Often not only single instances, but complete graphs of modified objects, have to be checked. Hibernate offers automatic version checking with either an extended **Session** or detached instances as the design paradigm.

11.3.2. Extended session and automatic versioning

A single **Session** instance and its persistent instances that are used for the whole conversation are known as *session-per-conversation*. Hibernate checks instance versions at flush time, throwing an

exception if concurrent modification is detected. It is up to the developer to catch and handle this exception. Common options are the opportunity for the user to merge changes or to restart the business conversation with non-stale data.

The **Session** is disconnected from any underlying JDBC connection when waiting for user interaction. This approach is the most efficient in terms of database access. The application does not version check or reattach detached instances, nor does it have to reload instances in every database transaction.

```
// foo is an instance loaded earlier by the old session
Transaction t = session.beginTransaction(); // Obtain a new JDBC
connection, start transaction

foo.setProperty("bar");

session.flush(); // Only for last transaction in conversation
t.commit(); // Also return JDBC connection
session.close(); // Only for last transaction in conversation
```

The **foo** object knows which **Session** it was loaded in. Beginning a new database transaction on an old session obtains a new connection and resumes the session. Committing a database transaction disconnects a session from the JDBC connection and returns the connection to the pool. After reconnection, to force a version check on data you are not updating, you can call **Session.lock()** with **LockMode.READ** on any objects that might have been updated by another transaction. You do not need to lock any data that you *are* updating. Usually you would set **FlushMode.MANUAL** on an extended **Session**, so that only the last database transaction cycle is allowed to actually persist all modifications made in this conversation. Only this last database transaction will include the **flush()** operation, and then **close()** the session to end the conversation.

This pattern is problematic if the **Session** is too big to be stored during user think time (for example, an **HttpSession** should be kept as small as possible). As the **Session** is also the first-level cache and contains all loaded objects, we can probably use this strategy only for a few request/response cycles. Use a **Session** only for a single conversation as it will soon have stale data.



NOTE

Earlier versions of Hibernate required explicit disconnection and reconnection of a **Session**. These methods are deprecated, as beginning and ending a transaction has the same effect.

Keep the disconnected **Session** close to the persistence layer. Use an EJB stateful session bean to hold the **Session** in a three-tier environment. Do not transfer it to the web layer, or even serialize it to a separate tier, to store it in the **HttpSession**.

The extended session pattern, or *session-per-conversation*, is more difficult to implement with automatic current session context management. You need to supply your own implementation of the **CurrentSessionContext** for this. See the Hibernate Wiki for examples.

11.3.3. Detached objects and automatic versioning

Each interaction with the persistent store occurs in a new **Session**. However, the same persistent instances are reused for each interaction with the database. The application manipulates the state of detached instances originally loaded in another **Session** and then reattaches them using **Session.update()**, **Session.saveOrUpdate()**, or **Session.merge()**.

```
// foo is an instance loaded by a previous Session
foo.setProperty("bar");
session = factory.openSession();
Transaction t = session.beginTransaction();
session.saveOrUpdate(foo); // Use merge() if "foo" might have been loaded
already
t.commit();
session.close();
```

Again, Hibernate will check instance versions during flush, throwing an exception if conflicting updates occurred.

You can also call `lock()` instead of `update()`, and use `LockMode.READ` (performing a version check and bypassing all caches) if you are sure that the object has not been modified.

11.3.4. Customizing automatic versioning

You can disable Hibernate's automatic version increment for particular properties and collections by setting the `optimistic-lock` mapping attribute to `false`. Hibernate will then no longer increment versions if the property is dirty.

Legacy database schemas are often static and cannot be modified. Or, other applications might access the same database and will not know how to handle version numbers or even timestamps. In both cases, versioning cannot rely on a particular column in a table. To force a version check with a comparison of the state of all fields in a row but without a version or timestamp property mapping, turn on `optimistic-lock="all"` in the `<class>` mapping. This conceptually only works if Hibernate can compare the old and the new state (i.e., if you use a single long `Session` and not session-per-request-with-detached-objects).

Concurrent modification can be permitted in instances where the changes that have been made do not overlap. If you set `optimistic-lock="dirty"` when mapping the `<class>`, Hibernate will only compare dirty fields during flush.

In both cases, with dedicated version/timestamp columns or with a full/dirty field comparison, Hibernate uses a single `UPDATE` statement, with an appropriate `WHERE` clause, per entity to execute the version check and update the information. If you use transitive persistence to cascade reattachment to associated entities, Hibernate may execute unnecessary updates. This is usually not a problem, but *on update* triggers in the database might be executed even when no changes have been made to detached instances. You can customize this behavior by setting `select-before-update="true"` in the `<class>` mapping, forcing Hibernate to `SELECT` the instance to ensure that changes did occur before updating the row.

11.4. PESSIMISTIC LOCKING

It is not intended that users spend much time worrying about locking strategies. It is usually enough to specify an isolation level for the JDBC connections and then simply let the database do all the work. However, advanced users may wish to obtain exclusive pessimistic locks or re-obtain locks at the start of a new transaction.

Hibernate will always use the locking mechanism of the database; it never lock objects in memory.

The `LockMode` class defines the different lock levels that can be acquired by Hibernate. A lock is obtained by the following mechanisms:

- `LockMode.WRITE` is acquired automatically when Hibernate updates or inserts a row.

- **LockMode.UPGRADE** can be acquired upon explicit user request using **SELECT ... FOR UPDATE** on databases which support that syntax.
- **LockMode.UPGRADE_NOWAIT** can be acquired upon explicit user request using a **SELECT ... FOR UPDATE NOWAIT** under Oracle.
- **LockMode.READ** is acquired automatically when Hibernate reads data under Repeatable Read or Serializable isolation level. It can be re-acquired by explicit user request.
- **LockMode.NONE** represents the absence of a lock. All objects switch to this lock mode at the end of a **Transaction**. Objects associated with the session via a call to **update()** or **saveOrUpdate()** also start out in this lock mode.

The "explicit user request" is expressed in one of the following ways:

- A call to **Session.load()**, specifying a **LockMode**.
- A call to **Session.lock()**.
- A call to **Query.setLockMode()**.

If **Session.load()** is called with **UPGRADE** or **UPGRADE_NOWAIT**, and the requested object was not yet loaded by the session, the object is loaded using **SELECT ... FOR UPDATE**. If **load()** is called for an object that is already loaded with a less restrictive lock than the one requested, Hibernate calls **lock()** for that object.

Session.lock() performs a version number check if the specified lock mode is **READ**, **UPGRADE** or **UPGRADE_NOWAIT**. In the case of **UPGRADE** or **UPGRADE_NOWAIT**, **SELECT ... FOR UPDATE** is used.

If the requested lock mode is not supported by the database, Hibernate uses an appropriate alternate mode instead of throwing an exception. This ensures that applications are portable.

11.5. CONNECTION RELEASE MODES

One of the legacies of Hibernate 2.x JDBC connection management meant that a **Session** would obtain a connection when it was first required and then maintain that connection until the session was closed. Hibernate 3.x introduced the notion of connection release modes that would instruct a session how to handle its JDBC connections. The following discussion is pertinent only to connections provided through a configured **ConnectionProvider**. User-supplied connections are outside the breadth of this discussion. The different release modes are identified by the enumerated values of **org.hibernate.ConnectionReleaseMode**:

- **ON_CLOSE**: is the legacy behavior described above. The Hibernate session obtains a connection when it first needs to perform some JDBC access and maintains that connection until the session is closed.
- **AFTER_TRANSACTION**: releases connections after a **org.hibernate.Transaction** has been completed.
- **AFTER_STATEMENT** (also referred to as aggressive release): releases connections after every statement execution. This aggressive releasing is skipped if that statement leaves open resources associated with the given session. Currently the only situation where this occurs is through the use of **org.hibernate.ScrollableResults**.

The configuration parameter `hibernate.connection.release_mode` is used to specify which release mode to use. The possible values are as follows:

- **auto** (the default): this choice delegates to the release mode returned by the `org.hibernate.transaction.TransactionFactory.getDefaultReleaseMode()` method. For `JTATransactionFactory`, this returns `ConnectionReleaseMode.AFTER_STATEMENT`; for `JDBCTransactionFactory`, this returns `ConnectionReleaseMode.AFTER_TRANSACTION`. Do not change this default behavior as failures due to the value of this setting tend to indicate bugs and/or invalid assumptions in user code.
- **on_close**: uses `ConnectionReleaseMode.ON_CLOSE`. This setting is left for backwards compatibility, but its use is discouraged.
- **after_transaction**: uses `ConnectionReleaseMode.AFTER_TRANSACTION`. This setting should not be used in JTA environments. Also note that with `ConnectionReleaseMode.AFTER_TRANSACTION`, if a session is considered to be in auto-commit mode, connections will be released as if the release mode were `AFTER_STATEMENT`.
- **after_statement**: uses `ConnectionReleaseMode.AFTER_STATEMENT`. Additionally, the configured `ConnectionProvider` is consulted to see if it supports this setting (`supportsAggressiveRelease()`). If not, the release mode is reset to `ConnectionReleaseMode.AFTER_TRANSACTION`. This setting is only safe in environments where we can either re-acquire the same underlying JDBC connection each time you make a call into `ConnectionProvider.getConnection()` or in auto-commit environments where it does not matter if we re-establish the same connection.

CHAPTER 12. INTERCEPTORS AND EVENTS

It is useful for the application to react to certain events that occur inside Hibernate. This allows for the implementation of generic functionality and the extension of Hibernate functionality.

12.1. INTERCEPTORS

The **Interceptor** interface provides callbacks from the session to the application, allowing the application to inspect and/or manipulate properties of a persistent object before it is saved, updated, deleted or loaded. One possible use for this is to track auditing information. For example, the following **Interceptor** automatically sets the **createTimestamp** when an **Auditable** is created and updates the **lastUpdateTimestamp** property when an **Auditable** is updated.

You can either implement **Interceptor** directly or extend **EmptyInterceptor**.

```
package org.hibernate.test;

import java.io.Serializable;
import java.util.Date;
import java.util.Iterator;

import org.hibernate.EmptyInterceptor;
import org.hibernate.Transaction;
import org.hibernate.type.Type;

public class AuditInterceptor extends EmptyInterceptor {

    private int updates;
    private int creates;
    private int loads;

    public void onDelete(Object entity,
                        Serializable id,
                        Object[] state,
                        String[] propertyNames,
                        Type[] types) {
        // do nothing
    }

    public boolean onFlushDirty(Object entity,
                               Serializable id,
                               Object[] currentState,
                               Object[] previousState,
                               String[] propertyNames,
                               Type[] types) {

        if ( entity instanceof Auditable ) {
            updates++;
            for ( int i=0; i < propertyNames.length; i++ ) {
                if ( "lastUpdateTimestamp".equals( propertyNames[i] ) ) {
                    currentState[i] = new Date();
                    return true;
                }
            }
        }
    }
}
```

```

        return false;
    }

    public boolean onLoad(Object entity,
        Serializable id,
        Object[] state,
        String[] propertyNames,
        Type[] types) {
        if ( entity instanceof Auditable ) {
            loads++;
        }
        return false;
    }

    public boolean onSave(Object entity,
        Serializable id,
        Object[] state,
        String[] propertyNames,
        Type[] types) {

        if ( entity instanceof Auditable ) {
            creates++;
            for ( int i=0; i<propertyNames.length; i++ ) {
                if ( "createTimestamp".equals( propertyNames[i] ) ) {
                    state[i] = new Date();
                    return true;
                }
            }
        }
        return false;
    }

    public void afterTransactionCompletion(Transaction tx) {
        if ( tx.wasCommitted() ) {
            System.out.println("Creations: " + creates + ", Updates: " +
updates + "Loads: " + loads);
        }
        updates=0;
        creates=0;
        loads=0;
    }
}

```

There are two kinds of interceptors: **Session**-scoped and **SessionFactory**-scoped.

A **Session**-scoped interceptor is specified when a session is opened using one of the overloaded `SessionFactory.openSession()` methods accepting an **Interceptor**.

```
Session session = sf.openSession( new AuditInterceptor() );
```

A **SessionFactory**-scoped interceptor is registered with the **Configuration** object prior to building the **SessionFactory**. Unless a session is opened explicitly specifying the interceptor to use, the supplied interceptor will be applied to all sessions opened from that **SessionFactory**.

SessionFactory-scoped interceptors must be thread safe. Ensure that you do not store session-specific states, since multiple sessions will use this interceptor potentially concurrently.

```
new Configuration().setInterceptor( new AuditInterceptor() );
```

12.2. EVENT SYSTEM

If you have to react to particular events in your persistence layer, you can also use the Hibernate3 *event* architecture. The event system can be used in addition, or as a replacement, for interceptors.

All the methods of the **Session** interface correlate to an event. You have a **LoadEvent**, a **FlushEvent**, etc. Consult the XML configuration-file DTD or the **org.hibernate.event** package for the full list of defined event types. When a request is made of one of these methods, the Hibernate **Session** generates an appropriate event and passes it to the configured event listeners for that type. Out-of-the-box, these listeners implement the same processing in which those methods always resulted. However, you are free to implement a customization of one of the listener interfaces (i.e., the **LoadEvent** is processed by the registered implementation of the **LoadEventListener** interface), in which case their implementation would be responsible for processing any **load()** requests made of the **Session**.

The listeners should be considered singletons. This means they are shared between requests, and should not save any state as instance variables.

A custom listener implements the appropriate interface for the event it wants to process and/or extend one of the convenience base classes (or even the default event listeners used by Hibernate out-of-the-box as these are declared non-final for this purpose). Custom listeners can either be registered programmatically through the **Configuration** object, or specified in the Hibernate configuration XML. Declarative configuration through the properties file is not supported. Here is an example of a custom load event listener:

```
public class MyLoadListener implements LoadEventListener {
    // this is the single method defined by the LoadEventListener
    // interface
    public void onLoad(LoadEvent event, LoadEventListener.LoadType
loadType)
        throws HibernateException {
        if ( !MySecurity.isAuthorized( event.getEntityClassName(),
event.getEntityId() ) ) {
            throw new MySecurityException("Unauthorized access");
        }
    }
}
```

You also need a configuration entry telling Hibernate to use the listener in addition to the default listener:

```
<hibernate-configuration>
  <session-factory>
    ...
    <event type="load">
      <listener class="com.eg.MyLoadListener"/>
      <listener
class="org.hibernate.event.def.DefaultLoadEventListener"/>
    </event>
  </session-factory>
</hibernate-configuration>
```

Instead, you can register it programmatically:

```
Configuration cfg = new Configuration();
LoadEventListener[] stack = { new MyLoadListener(), new
DefaultLoadEventListener() };
cfg.getEventListeners().setLoadEventListeners(stack);
```

Listeners registered declaratively cannot share instances. If the same class name is used in multiple `<listener/>` elements, each reference will result in a separate instance of that class. If you need to share listener instances between listener types you must use the programmatic registration approach.

Why implement an interface and define the specific type during configuration? A listener implementation could implement multiple event listener interfaces. Having the type additionally defined during registration makes it easier to turn custom listeners on or off during configuration.

12.3. HIBERNATE DECLARATIVE SECURITY

Usually, declarative security in Hibernate applications is managed in a session facade layer. Hibernate3 allows certain actions to be permissioned via JACC, and authorized via JAAS. This is an optional functionality that is built on top of the event architecture.

First, you must configure the appropriate event listeners, to enable the use of JAAS authorization.

```
<listener type="pre-delete"
class="org.hibernate.secure.JACCPreDeleteEventListener"/>
<listener type="pre-update"
class="org.hibernate.secure.JACCPreUpdateEventListener"/>
<listener type="pre-insert"
class="org.hibernate.secure.JACCPreInsertEventListener"/>
<listener type="pre-load"
class="org.hibernate.secure.JACCPreLoadEventListener"/>
```

Note that `<listener type="..." class="...">` is shorthand for `<event type="..."><listener class="..."></event>` when there is exactly one listener for a particular event type.

Next, while still in `hibernate.cfg.xml`, bind the permissions to roles:

```
<grant role="admin" entity-name="User" actions="insert,update,read"/>
<grant role="su" entity-name="User" actions="*">
```

The role names are the roles understood by your JACC provider.

CHAPTER 13. BATCH PROCESSING

A naive approach to inserting 100,000 rows in the database using Hibernate might look like this:

```
Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();
for ( int i=0; i<100000; i++ ) {
    Customer customer = new Customer(.....);
    session.save(customer);
}
tx.commit();
session.close();
```

This would fall over with an **OutOfMemoryException** somewhere around the 50,000th row. That is because Hibernate caches all the newly inserted **Customer** instances in the session-level cache. In this chapter we will show you how to avoid this problem.

If you are undertaking batch processing you will need to enable the use of JDBC batching. This is absolutely essential if you want to achieve optimal performance. Set the JDBC batch size to a reasonable number (10-50, for example):

```
hibernate.jdbc.batch_size 20
```

Hibernate disables insert batching at the JDBC level transparently if you use an **identity** identifier generator.

You can also do this kind of work in a process where interaction with the second-level cache is completely disabled:

```
hibernate.cache.use_second_level_cache false
```

However, this is not absolutely necessary, since we can explicitly set the **CacheMode** to disable interaction with the second-level cache.

13.1. BATCH INSERTS

When making new objects persistent **flush()** and then **clear()** the session regularly in order to control the size of the first-level cache.

```
Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

for ( int i=0; i<100000; i++ ) {
    Customer customer = new Customer(.....);
    session.save(customer);
    if ( i % 20 == 0 ) { //20, same as the JDBC batch size
        //flush a batch of inserts and release memory:
        session.flush();
        session.clear();
    }
}

tx.commit();
session.close();
```

13.2. BATCH UPDATES

For retrieving and updating data, the same ideas apply. In addition, you need to use `scroll()` to take advantage of server-side cursors for queries that return many rows of data.

```

Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

ScrollableResults customers = session.getNamedQuery("GetCustomers")
    .setCacheMode(CacheMode.IGNORE)
    .scroll(ScrollMode.FORWARD_ONLY);
int count=0;
while ( customers.next() ) {
    Customer customer = (Customer) customers.get(0);
    customer.updateStuff(...);
    if ( ++count % 20 == 0 ) {
        //flush a batch of updates and release memory:
        session.flush();
        session.clear();
    }
}

tx.commit();
session.close();

```

13.3. THE STATELESSSESSION INTERFACE

Alternatively, Hibernate provides a command-oriented API that can be used for streaming data to and from the database in the form of detached objects. A **StatelessSession** has no persistence context associated with it and does not provide many of the higher-level life cycle semantics. In particular, a stateless session does not implement a first-level cache nor interact with any second-level or query cache. It does not implement transactional write-behind or automatic dirty checking. Operations performed using a stateless session never cascade to associated instances. Collections are ignored by a stateless session. Operations performed via a stateless session bypass Hibernate's event model and interceptors. Due to the lack of a first-level cache, Stateless sessions are vulnerable to data aliasing effects. A stateless session is a lower-level abstraction that is much closer to the underlying JDBC.

```

StatelessSession session = sessionFactory.openStatelessSession();
Transaction tx = session.beginTransaction();

ScrollableResults customers = session.getNamedQuery("GetCustomers")
    .scroll(ScrollMode.FORWARD_ONLY);
while ( customers.next() ) {
    Customer customer = (Customer) customers.get(0);
    customer.updateStuff(...);
    session.update(customer);
}

tx.commit();
session.close();

```

In this code example, the **Customer** instances returned by the query are immediately detached. They are never associated with any persistence context.

The **insert()**, **update()** and **delete()** operations defined by the **StatelessSession** interface are considered to be direct database row-level operations. They result in the immediate execution of a SQL **INSERT**, **UPDATE** or **DELETE** respectively. They have different semantics to the **save()**, **saveOrUpdate()** and **delete()** operations defined by the **Session** interface.

13.4. DML-STYLE OPERATIONS

As already discussed, automatic and transparent object/relational mapping is concerned with the management of the object state. The object state is available in memory. This means that manipulating data directly in the database (using the SQL **Data Manipulation Language** (DML) the statements: **INSERT**, **UPDATE**, **DELETE**) will not affect in-memory state. However, Hibernate provides methods for bulk SQL-style DML statement execution that is performed through the Hibernate Query Language ([Chapter 14, HQL: The Hibernate Query Language](#)).

The pseudo-syntax for **UPDATE** and **DELETE** statements is: **(UPDATE | DELETE) FROM? EntityName (WHERE where_conditions)?**.

Some points to note:

- In the from-clause, the FROM keyword is optional
- There can only be a single entity named in the from-clause. It can, however, be aliased. If the entity name is aliased, then any property references must be qualified using that alias. If the entity name is not aliased, then it is illegal for any property references to be qualified.
- No [Section 14.4, “Forms of join syntax”](#), either implicit or explicit, can be specified in a bulk HQL query. Sub-queries can be used in the where-clause, where the subqueries themselves may contain joins.
- The where-clause is also optional.

As an example, to execute an HQL **UPDATE**, use the **Query.executeUpdate()** method. The method is named for those familiar with JDBC's **PreparedStatement.executeUpdate()**:

```
Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

String hqlUpdate = "update Customer c set c.name = :newName where c.name = :oldName";
// or String hqlUpdate = "update Customer set name = :newName where name = :oldName";
int updatedEntities = session.createQuery( hqlUpdate )
    .setString( "newName", newName )
    .setString( "oldName", oldName )
    .executeUpdate();
tx.commit();
session.close();
```

In keeping with the EJB3 specification, HQL **UPDATE** statements, by default, do not effect the [Section 5.1.9, “Version \(optional\)”](#) or the [Section 5.1.10, “Timestamp \(optional\)”](#) property values for the affected entities. However, you can force Hibernate to reset the **version** or **timestamp** property values

through the use of a **versioned update**. This is achieved by adding the **VERSIONED** keyword after the **UPDATE** keyword.

```

Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();
String hqlVersionedUpdate = "update versioned Customer set name = :newName
where name = :oldName";
int updatedEntities = session.createQuery( hqlVersionedUpdate )
    .setString( "newName", newName )
    .setString( "oldName", oldName )
    .executeUpdate();
tx.commit();
session.close();

```

Custom version types, `org.hibernate.usertype.UserVersionType`, are not allowed in conjunction with a **update versioned** statement.

To execute an HQL **DELETE**, use the same `Query.executeUpdate()` method:

```

Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

String hqlDelete = "delete Customer c where c.name = :oldName";
// or String hqlDelete = "delete Customer where name = :oldName";
int deletedEntities = session.createQuery( hqlDelete )
    .setString( "oldName", oldName )
    .executeUpdate();
tx.commit();
session.close();

```

The `int` value returned by the `Query.executeUpdate()` method indicates the number of entities effected by the operation. This may or may not correlate to the number of rows effected in the database. An HQL bulk operation might result in multiple actual SQL statements being executed (for joined-subclass, for example). The returned number indicates the number of actual entities affected by the statement. Going back to the example of joined-subclass, a delete against one of the subclasses may actually result in deletes against not just the table to which that subclass is mapped, but also the "root" table and potentially joined-subclass tables further down the inheritance hierarchy.

The pseudo-syntax for **INSERT** statements is: **INSERT INTO EntityName properties_list select_statement**. Some points to note:

- Only the **INSERT INTO ... SELECT ...** form is supported; not the **INSERT INTO ... VALUES ...** form.

The `properties_list` is analogous to the **column specification** in the SQL **INSERT** statement. For entities involved in mapped inheritance, only properties directly defined on that given class-level can be used in the `properties_list`. Superclass properties are not allowed and subclass properties do not make sense. In other words, **INSERT** statements are inherently non-polymorphic.

- `select_statement` can be any valid HQL select query, with the caveat that the return types must match the types expected by the insert. Currently, this is checked during query compilation rather than allowing the check to delegate to the database. This might, however, cause problems between Hibernate **Types** which are *equivalent* as opposed to *equal*. This might cause issues

with mismatches between a property defined as a `org.hibernate.type.DateType` and a property defined as a `org.hibernate.type.TimestampType`, even though the database might not make a distinction or might be able to handle the conversion.

- For the id property, the insert statement gives you two options. You can either explicitly specify the id property in the `properties_list`, in which case its value is taken from the corresponding select expression, or omit it from the `properties_list`, in which case a generated value is used. This latter option is only available when using id generators that operate in the database; attempting to use this option with any "in memory" type generators will cause an exception during parsing. For the purposes of this discussion, in-database generators are considered to be `org.hibernate.id.SequenceGenerator` (and its subclasses) and any implementers of `org.hibernate.id.PostInsertIdentifierGenerator`. The most notable exception here is `org.hibernate.id.TableHiLoGenerator`, which cannot be used because it does not expose a selectable way to get its values.
- For properties mapped as either `version` or `timestamp`, the insert statement gives you two options. You can either specify the property in the `properties_list`, in which case its value is taken from the corresponding select expressions, or omit it from the `properties_list`, in which case the `seed value` defined by the `org.hibernate.type.VersionType` is used.

The following is an example of an HQL **INSERT** statement execution:

```
Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

String hqlInsert = "insert into DelinquentAccount (id, name) select c.id,
c.name from Customer c where ...";
int createdEntities = session.createQuery( hqlInsert )
    .executeUpdate();
tx.commit();
session.close();
```

CHAPTER 14. HQL: THE HIBERNATE QUERY LANGUAGE

Hibernate uses a powerful query language (HQL) that is similar in appearance to SQL. Compared with SQL, however, HQL is fully object-oriented and understands notions like inheritance, polymorphism and association.

14.1. CASE SENSITIVITY

With the exception of names of Java classes and properties, queries are case-insensitive. So **SeLeCT** is the same as **sELEct** is the same as **SELECT**, but **org.hibernate.eg.FOO** is not **org.hibernate.eg.Foo**, and **foo.barSet** is not **foo.BARSET**.

This manual uses lowercase HQL keywords. Some users find queries with uppercase keywords more readable, but this convention is unsuitable for queries embedded in Java code.

14.2. THE FROM CLAUSE

The simplest possible Hibernate query is of the form:

```
from eg.Cat
```

This returns all instances of the class **eg.Cat**. You do not usually need to qualify the class name, since **auto-import** is the default. For example:

```
from Cat
```

In order to refer to the **Cat** in other parts of the query, you will need to assign an *alias*. For example:

```
from Cat as cat
```

This query assigns the alias **cat** to **Cat** instances, so you can use that alias later in the query. The **as** keyword is optional. You could also write:

```
from Cat cat
```

Multiple classes can appear, resulting in a cartesian product or "cross" join.

```
from Formula, Parameter
```

```
from Formula as form, Parameter as param
```

It is good practice to name query aliases using an initial lowercase as this is consistent with Java naming standards for local variables (e.g. **domesticCat**).

14.3. ASSOCIATIONS AND JOINS

You can also assign aliases to associated entities or to elements of a collection of values using a **join**. For example:

```

from Cat as cat
    inner join cat.mate as mate
    left outer join cat.kittens as kitten
    
```

```

from Cat as cat left join cat.mate.kittens as kittens
    
```

```

from Formula form full join form.parameter param
    
```

The supported join types are borrowed from ANSI SQL:

- **inner join**
- **left outer join**
- **right outer join**
- **full join** (not usually useful)

The **inner join**, **left outer join** and **right outer join** constructs may be abbreviated.

```

from Cat as cat
    join cat.mate as mate
    left join cat.kittens as kitten
    
```

You may supply extra join conditions using the HQL **with** keyword.

```

from Cat as cat
    left join cat.kittens as kitten
        with kitten.bodyWeight > 10.0
    
```

A "fetch" join allows associations or collections of values to be initialized along with their parent objects using a single select. This is particularly useful in the case of a collection. It effectively overrides the outer join and lazy declarations of the mapping file for associations and collections. See [Section 19.1, "Fetching strategies"](#) for more information.

```

from Cat as cat
    inner join fetch cat.mate
    left join fetch cat.kittens
    
```

A fetch join does not usually need to assign an alias, because the associated objects should not be used in the **where** clause (or any other clause). The associated objects are also not returned directly in the query results. Instead, they may be accessed via the parent object. The only reason you might need an alias is if you are recursively join fetching a further collection:

```

from Cat as cat
    inner join fetch cat.mate
    left join fetch cat.kittens child
    left join fetch child.kittens
    
```

IMPORTANT

The **fetch** construct cannot be used in queries called using **iterate()** (though **scroll()** can be used). **Fetch** should not be used together with **setMaxResults()** or **setFirstResult()**, as these operations are based on the result rows which usually contain duplicates for eager collection fetching, hence, the number of rows is not what you would expect. **Fetch** should also not be used together with impromptu **with** condition. It is possible to create a cartesian product by join fetching more than one collection in a query, so take care in this case. Join fetching multiple collection roles can produce unexpected results for bag mappings, so user discretion is advised when formulating queries in this case. Finally, note that **full join fetch** and **right join fetch** are not meaningful.

If you are using property-level lazy fetching (with bytecode instrumentation), it is possible to force Hibernate to fetch the lazy properties in the first query immediately using **fetch all properties**.

```
from Document fetch all properties order by name
```

```
from Document doc fetch all properties where lower(doc.name)
like '%cats%'
```

14.4. FORMS OF JOIN SYNTAX

HQL supports two forms of association joining: **implicit** and **explicit**.

The queries shown in the previous section all use the **explicit** form, that is, where the join keyword is explicitly used in the from clause. This is the recommended form.

The **implicit** form does not use the join keyword. Instead, the associations are "dereferenced" using dot-notation. **implicit** joins can appear in any of the HQL clauses. **implicit** join result in inner joins in the resulting SQL statement.

```
from Cat as cat where cat.mate.name like '%s%'
```

14.5. REFERRING TO IDENTIFIER PROPERTY

There are 2 ways to refer to an entity's identifier property:

- The special property (lowercase) **id** may be used to reference the identifier property of an entity *provided that the entity does not define a non-identifier property named id*.
- If the entity defines a named identifier property, you can use that property name.

References to composite identifier properties follow the same naming rules. If the entity has a non-identifier property named **id**, the composite identifier property can only be referenced by its defined name. Otherwise, the special **id** property can be used to reference the identifier property.



IMPORTANT

Please note that, starting in version 3.2.2, this has changed significantly. In previous versions, `id` *always* referred to the identifier property regardless of its actual name. A ramification of that decision was that non-identifier properties named `id` could never be referenced in Hibernate queries.

14.6. THE SELECT CLAUSE

The `select` clause picks which objects and properties to return in the query result set. Consider the following:

```
select mate
from Cat as cat
     inner join cat.mate as mate
```

The query will select `mates` of other `Cats`. You can express this query more compactly as:

```
select cat.mate from Cat cat
```

Queries can return properties of any value type including properties of component type:

```
select cat.name from DomesticCat cat
where cat.name like 'fri%'
```

```
select cust.name.firstName from Customer as cust
```

Queries can return multiple objects and/or properties as an array of type `Object[]`:

```
select mother, offspr, mate.name
from DomesticCat as mother
     inner join mother.mate as mate
     left outer join mother.kittens as offspr
```

Or as a `List`:

```
select new list(mother, offspr, mate.name)
from DomesticCat as mother
     inner join mother.mate as mate
     left outer join mother.kittens as offspr
```

Or - assuming that the class `Family` has an appropriate constructor - as an actual typesafe Java object:

```
select new Family(mother, mate, offspr)
from DomesticCat as mother
     join mother.mate as mate
     left join mother.kittens as offspr
```

You can assign aliases to selected expressions using `as`:

```
select max(bodyWeight) as max, min(bodyWeight) as min, count(*) as n
from Cat cat
```

This is most useful when used together with **select new map**:

```
select new map( max(bodyWeight) as max, min(bodyWeight) as min, count(*)
as n )
from Cat cat
```

This query returns a **Map** from aliases to selected values.

14.7. AGGREGATE FUNCTIONS

HQL queries can even return the results of aggregate functions on properties:

```
select avg(cat.weight), sum(cat.weight), max(cat.weight), count(cat)
from Cat cat
```

The supported aggregate functions are:

- **avg(...), sum(...), min(...), max(...)**
- **count(*)**
- **count(...), count(distinct ...), count(all...)**

You can use arithmetic operators, concatenation, and recognized SQL functions in the select clause:

```
select cat.weight + sum(kitten.weight)
from Cat cat
    join cat.kittens kitten
group by cat.id, cat.weight
```

```
select firstName||' '||initial||' '||upper(lastName) from Person
```

The **distinct** and **all** keywords can be used and have the same semantics as in SQL.

```
select distinct cat.name from Cat cat
select count(distinct cat.name), count(cat) from Cat cat
```

14.8. POLYMORPHIC QUERIES

A query like:

```
from Cat as cat
```

returns instances not only of **Cat**, but also of subclasses like **DomesticCat**. Hibernate queries can name *any* Java class or interface in the **from** clause. The query will return instances of all persistent classes that extend that class or implement the interface. The following query would return all persistent objects:

```
from java.lang.Object o
```

The interface **Named** might be implemented by various persistent classes:

```
from Named n, Named m where n.name = m.name
```

These last two queries will require more than one SQL **SELECT**. This means that the **order by** clause does not correctly order the whole result set. It also means you cannot call these queries using `Query.scroll()`.

14.9. THE WHERE CLAUSE

The **where** clause allows you to refine the list of instances returned. If no alias exists, you can refer to properties by name:

```
from Cat where name='Fritz'
```

If there is an alias, use a qualified property name:

```
from Cat as cat where cat.name='Fritz'
```

This returns instances of **Cat** named 'Fritz'.

The following query:

```
select foo
from Foo foo, Bar bar
where foo.startDate = bar.date
```

returns all instances of **Foo** with an instance of **bar** with a **date** property equal to the **startDate** property of the **Foo**. Compound path expressions make the **where** clause extremely powerful. Consider the following:

```
from Cat cat where cat.mate.name is not null
```

This query translates to an SQL query with a table (inner) join. For example:

```
from Foo foo
where foo.bar.baz.customer.address.city is not null
```

would result in a query that would require four table joins in SQL.

The **=** operator can be used to compare not only properties, but also instances:

```
from Cat cat, Cat rival where cat.mate = rival.mate
```

```
select cat, mate
from Cat cat, Cat mate
where cat.mate = mate
```

The special property (lowercase) **id** can be used to reference the unique identifier of an object. See [Section 14.5, “Referring to identifier property”](#) for more information.


```

from Cat as cat where cat.id = 123

from Cat as cat where cat.mate.id = 69

```

The second query is efficient and does not require a table join.

Properties of composite identifiers can also be used. Consider the following example where **Person** has composite identifiers consisting of **country** and **medicareNumber**:

```

from bank.Person person
where person.id.country = 'AU'
      and person.id.medicareNumber = 123456

from bank.Account account
where account.owner.id.country = 'AU'
      and account.owner.id.medicareNumber = 123456

```

Once again, the second query does not require a table join.

See [Section 14.5, “Referring to identifier property”](#) for more information regarding referencing identifier properties)

The special property **class** accesses the discriminator value of an instance in the case of polymorphic persistence. A Java class name embedded in the where clause will be translated to its discriminator value.

```

from Cat cat where cat.class = DomesticCat

```

You can also use components or composite user types, or properties of said component types. See [Section 14.17, “Components”](#) for more information.

An "any" type has the special properties **id** and **class** that allows you to express a join in the following way (where **AuditLog.item** is a property mapped with **<any>**):

```

from AuditLog log, Payment payment
where log.item.class = 'Payment' and log.item.id = payment.id

```

The **log.item.class** and **payment.class** would refer to the values of completely different database columns in the above query.

14.10. EXPRESSIONS

Expressions used in the **where** clause include the following:

- mathematical operators: **+**, **-**, *****, **/**
- binary comparison operators: **=**, **>=**, **<=**, **<>**, **!=**, **like**
- logical operations **and**, **or**, **not**
- Parentheses () that indicates grouping

- **in**, **not in**, **between**, **is null**, **is not null**, **is empty**, **is not empty**, **member of** and **not member of**
- "Simple" case, **case ... when ... then ... else ... end**, and "searched" case, **case when ... then ... else ... end**
- string concatenation **... || ...** or **concat(..., ...)**
- **current_date()**, **current_time()**, and **current_timestamp()**
- **second(...)**, **minute(...)**, **hour(...)**, **day(...)**, **month(...)**, and **year(...)**
- Any function or operator defined by EJB-QL 3.0: **substring()**, **trim()**, **lower()**, **upper()**, **length()**, **locate()**, **abs()**, **sqrt()**, **bit_length()**, **mod()**
- **coalesce()** and **nullif()**
- **str()** for converting numeric or temporal values to a readable string
- **cast(... as ...)**, where the second argument is the name of a Hibernate type, and **extract(... from ...)** if ANSI **cast()** and **extract()** is supported by the underlying database
- the HQL **index()** function, that applies to aliases of a joined indexed collection
- HQL functions that take collection-valued path expressions: **size()**, **minelement()**, **maxelement()**, **minindex()**, **maxindex()**, along with the special **elements()** and **indices** functions that can be quantified using **some**, **all**, **exists**, **any**, **in**.
- Any database-supported SQL scalar function like **sign()**, **trunc()**, **rtrim()**, and **sin()**
- JDBC-style positional parameters ?
- named parameters **:name**, **:start_date**, and **:x1**
- SQL literals **'foo'**, **69**, **6.66E+2**, **'1970-01-01 10:00:01.0'**
- Java **public static final** constants eg. **Color.TABBY**

in and **between** can be used as follows:

```
from DomesticCat cat where cat.name between 'A' and 'B'
```

```
from DomesticCat cat where cat.name in ( 'Foo', 'Bar', 'Baz' )
```

The negated forms can be written as follows:

```
from DomesticCat cat where cat.name not between 'A' and 'B'
```

```
from DomesticCat cat where cat.name not in ( 'Foo', 'Bar', 'Baz' )
```

Similarly, **is null** and **is not null** can be used to test for null values.

Booleans can be easily used in expressions by declaring HQL query substitutions in Hibernate configuration:

```
<property name="hibernate.query.substitutions">true 1, false 0</property>
```

This will replace the keywords **true** and **false** with the literals **1** and **0** in the translated SQL from this HQL:

```
from Cat cat where cat.alive = true
```

You can test the size of a collection with the special property **size** or the special **size()** function.

```
from Cat cat where cat.kittens.size > 0
```

```
from Cat cat where size(cat.kittens) > 0
```

For indexed collections, you can refer to the minimum and maximum indices using **minindex** and **maxindex** functions. Similarly, you can refer to the minimum and maximum elements of a collection of basic type using the **minelement** and **maxelement** functions. For example:

```
from Calendar cal where maxelement(cal.holidays) > current_date
```

```
from Order order where maxindex(order.items) > 100
```

```
from Order order where minelement(order.items) > 10000
```

The SQL functions **any**, **some**, **all**, **exists**, **in** are supported when passed the element or index set of a collection (**elements** and **indices** functions) or the result of a subquery (see below):

```
select mother from Cat as mother, Cat as kit
where kit in elements(foo.kittens)
```

```
select p from NameList list, Person p
where p.name = some elements(list.names)
```

```
from Cat cat where exists elements(cat.kittens)
```

```
from Player p where 3 > all elements(p.scores)
```

```
from Show show where 'fizard' in indices(show.acts)
```

Note that these constructs - **size**, **elements**, **indices**, **minindex**, **maxindex**, **minelement**, **maxelement** - can only be used in the where clause in Hibernate3.

Elements of indexed collections (arrays, lists, and maps) can be referred to by index in a where clause only:

```
from Order order where order.items[0].id = 1234
```

```
select person from Person person, Calendar calendar
where calendar.holidays['national day'] = person.birthDay
    and person.nationality.calendar = calendar
```

```
select item from Item item, Order order
where order.items[ order.deliveredItemIndices[0] ] = item and order.id =
11
```

```
select item from Item item, Order order
where order.items[ maxindex(order.items) ] = item and order.id = 11
```

The expression inside [] can even be an arithmetic expression:

```
select item from Item item, Order order
where order.items[ size(order.items) - 1 ] = item
```

HQL also provides the built-in **index()** function for elements of a one-to-many association or collection of values.

```
select item, index(item) from Order order
    join order.items item
where index(item) < 5
```

Scalar SQL functions supported by the underlying database can be used:

```
from DomesticCat cat where upper(cat.name) like 'FRI%'
```

Consider how much longer and less readable the following query would be in SQL:

```
select cust
from Product prod,
    Store store
    inner join store.customers cust
where prod.name = 'widget'
    and store.location.name in ( 'Melbourne', 'Sydney' )
    and prod = all elements(cust.currentOrder.lineItems)
```

Hint: something like

```
SELECT cust.name, cust.address, cust.phone, cust.id, cust.current_order
FROM customers cust,
    stores store,
    locations loc,
    store_customers sc,
    product prod
WHERE prod.name = 'widget'
    AND store.loc_id = loc.id
    AND loc.name IN ( 'Melbourne', 'Sydney' )
    AND sc.store_id = store.id
    AND sc.cust_id = cust.id
    AND prod.id = ALL(
        SELECT item.prod_id
        FROM line_items item, orders o
```

```

        WHERE item.order_id = o.id
            AND cust.current_order = o.id
    )

```

14.11. THE ORDER BY CLAUSE

The list returned by a query can be ordered by any property of a returned class or components:

```

from DomesticCat cat
order by cat.name asc, cat.weight desc, cat.birthdate

```

The optional **asc** or **desc** indicate ascending or descending order respectively.

14.12. THE GROUP BY CLAUSE

A query that returns aggregate values can be grouped by any property of a returned class or components:

```

select cat.color, sum(cat.weight), count(cat)
from Cat cat
group by cat.color

```

```

select foo.id, avg(name), max(name)
from Foo foo join foo.names name
group by foo.id

```

A **having** clause is also allowed.

```

select cat.color, sum(cat.weight), count(cat)
from Cat cat
group by cat.color
having cat.color in (eg.Color.TABBY, eg.Color.BLACK)

```

SQL functions and aggregate functions are allowed in the **having** and **order by** clauses if they are supported by the underlying database (i.e., not in MySQL).

```

select cat
from Cat cat
    join cat.kittens kitten
group by cat.id, cat.name, cat.other, cat.properties
having avg(kitten.weight) > 100
order by count(kitten) asc, sum(kitten.weight) desc

```

Neither the **group by** clause nor the **order by** clause can contain arithmetic expressions. Hibernate also does not currently expand a grouped entity, so you cannot write **group by cat** if all properties of **cat** are non-aggregated. You have to list all non-aggregated properties explicitly.

14.13. SUBQUERIES

For databases that support subselects, Hibernate supports subqueries within queries. A subquery must be surrounded by parentheses (often by an SQL aggregate function call). Even correlated subqueries (subqueries that refer to an alias in the outer query) are allowed.

```

from Cat as fatcat
where fatcat.weight > (
    select avg(cat.weight) from DomesticCat cat
)
    
```

```

from DomesticCat as cat
where cat.name = some (
    select name.nickName from Name as name
)
    
```

```

from Cat as cat
where not exists (
    from Cat as mate where mate.mate = cat
)
    
```

```

from DomesticCat as cat
where cat.name not in (
    select name.nickName from Name as name
)
    
```

```

select cat.id, (select max(kit.weight) from cat.kitten kit)
from Cat as cat
    
```

Note that HQL subqueries can occur only in the select or where clauses.

Note that subqueries can also utilize **row value constructor** syntax. See [Section 14.18, “Row value constructor syntax”](#) for more information.

14.14. HQL EXAMPLES

Hibernate queries can be quite powerful and complex. In fact, the power of the query language is one of Hibernate's main strengths. The following example queries are similar to queries that have been used on recent projects. Please note that most queries you will write will be much simpler than the following examples.

The following query returns the order id, number of items, the given minimum total value and the total value of the order for all unpaid orders for a particular customer. The results are ordered by total value. In determining the prices, it uses the current catalog. The resulting SQL query, against the **ORDER**, **ORDER_LINE**, **PRODUCT**, **CATALOG** and **PRICE** tables has four inner joins and an (uncorrelated) subselect.

```

select order.id, sum(price.amount), count(item)
from Order as order
    join order.lineItems as item
    join item.product as product,
    Catalog as catalog
    join catalog.prices as price
where order.paid = false
    and order.customer = :customer
    and price.product = product
    and catalog.effectiveDate < sysdate
    and catalog.effectiveDate >= all (
        select cat.effectiveDate
    )
    
```

```

        from Catalog as cat
        where cat.effectiveDate < sysdate
    )
group by order
having sum(price.amount) > :minAmount
order by sum(price.amount) desc

```

What a monster! Actually, in real life, I'm not very keen on subqueries, so my query was really more like this:

```

select order.id, sum(price.amount), count(item)
from Order as order
    join order.lineItems as item
    join item.product as product,
    Catalog as catalog
    join catalog.prices as price
where order.paid = false
    and order.customer = :customer
    and price.product = product
    and catalog = :currentCatalog
group by order
having sum(price.amount) > :minAmount
order by sum(price.amount) desc

```

The next query counts the number of payments in each status, excluding all payments in the **AWAITING_APPROVAL** status where the most recent status change was made by the current user. It translates to an SQL query with two inner joins and a correlated subselect against the **PAYMENT**, **PAYMENT_STATUS** and **PAYMENT_STATUS_CHANGE** tables.

```

select count(payment), status.name
from Payment as payment
    join payment.currentStatus as status
    join payment.statusChanges as statusChange
where payment.status.name <> PaymentStatus.AWAITING_APPROVAL
    or (
        statusChange.timeStamp = (
            select max(change.timeStamp)
            from PaymentStatusChange change
            where change.payment = payment
        )
        and statusChange.user <> :currentUser
    )
group by status.name, status.sortOrder
order by status.sortOrder

```

If the **statusChanges** collection was mapped as a list, instead of a set, the query would have been much simpler to write.

```

select count(payment), status.name
from Payment as payment
    join payment.currentStatus as status
where payment.status.name <> PaymentStatus.AWAITING_APPROVAL
    or payment.statusChanges[ maxIndex(payment.statusChanges) ].user <>

```

```

:currentUser
group by status.name, status.sortOrder
order by status.sortOrder
    
```

The next query uses the MS SQL Server `isNull()` function to return all the accounts and unpaid payments for the organization to which the current user belongs. It translates to an SQL query with three inner joins, an outer join and a subselect against the **ACCOUNT**, **PAYMENT**, **PAYMENT_STATUS**, **ACCOUNT_TYPE**, **ORGANIZATION** and **ORG_USER** tables.

```

select account, payment
from Account as account
    left outer join account.payments as payment
where :currentUser in elements(account.holder.users)
    and PaymentStatus.UNPAID = isNull(payment.currentStatus.name,
PaymentStatus.UNPAID)
order by account.type.sortOrder, account.accountNumber, payment.dueDate
    
```

For some databases, we would need to do away with the (correlated) subselect.

```

select account, payment
from Account as account
    join account.holder.users as user
    left outer join account.payments as payment
where :currentUser = user
    and PaymentStatus.UNPAID = isNull(payment.currentStatus.name,
PaymentStatus.UNPAID)
order by account.type.sortOrder, account.accountNumber, payment.dueDate
    
```

14.15. BULK UPDATE AND DELETE

HQL now supports **update**, **delete** and **insert ... select ...** statements. See [Section 13.4](#), “DML-style operations” for more information.

14.16. TIPS & TRICKS

You can count the number of query results without returning them:

```

( (Integer) session.createQuery("select count(*) from
...").iterate().next() ).intValue()
    
```

To order a result by the size of a collection, use the following query:

```

select usr.id, usr.name
from User as usr
    left join usr.messages as msg
group by usr.id, usr.name
order by count(msg)
    
```

If your database supports subselects, you can place a condition upon selection size in the where clause of your query:

```

from User usr where size(usr.messages) >= 1
    
```


If your database does not support subselects, use the following query:

```
select usr.id, usr.name
from User usr
     join usr.messages msg
group by usr.id, usr.name
having count(msg) >= 1
```

As this solution cannot return a **User** with zero messages because of the inner join, the following form is also useful:

```
select usr.id, usr.name
from User as usr
     left join usr.messages as msg
group by usr.id, usr.name
having count(msg) = 0
```

Properties of a JavaBean can be bound to named query parameters:

```
Query q = s.createQuery("from foo Foo as foo where foo.name=:name and
foo.size=:size");
q.setProperties(fooBean); // fooBean has getName() and getSize()
List foos = q.list();
```

Collections are pageable by using the **Query** interface with a filter:

```
Query q = s.createFilter( collection, "" ); // the trivial filter
q.setMaxResults(PAGE_SIZE);
q.setFirstResult(PAGE_SIZE * pageNumber);
List page = q.list();
```

Collection elements can be ordered or grouped using a query filter:

```
Collection orderedCollection = s.createFilter( collection, "order by
this.amount" ).list();
Collection counts = s.createFilter( collection, "select this.type,
count(this) group by this.type" ).list();
```

You can find the size of a collection without initializing it:

```
( (Integer) session.createQuery("select count(*) from
...").iterate().next() ).intValue();
```

14.17. COMPONENTS

Components can be used similarly to the simple value types that are used in HQL queries. They can appear in the **select** clause as follows:

```
select p.name from Person p
```

```
select p.name.first from Person p
```

where the Person's name property is a component. Components can also be used in the **where** clause:

```
from Person p where p.name = :name
```

```
from Person p where p.name.first = :firstName
```

Components can also be used in the **order by** clause:

```
from Person p order by p.name
```

```
from Person p order by p.name.first
```

Another common use of components is in [Section 14.18](#), “Row value constructor syntax”.

14.18. ROW VALUE CONSTRUCTOR SYNTAX

HQL supports the use of ANSI SQL **row value constructor** syntax, sometimes referred to as **tuple** syntax, even though the underlying database may not support that notion. Here, we are generally referring to multi-valued comparisons, typically associated with components. Consider an entity Person which defines a name component:

```
from Person p where p.name.first='John' and p.name.last='Jingleheimer-Schmidt'
```

That is valid syntax although it is a little verbose. You can make this more concise by using **row value constructor** syntax:

```
from Person p where p.name=('John', 'Jingleheimer-Schmidt')
```

It can also be useful to specify this in the **select** clause:

```
select p.name from Person p
```

Using **row value constructor** syntax can also be beneficial when using subqueries that need to compare against multiple values:

```
from Cat as cat
where not ( cat.name, cat.color ) in (
    select cat.name, cat.color from DomesticCat cat
)
```

One thing to consider when deciding if you want to use this syntax, is that the query will be dependent upon the ordering of the component sub-properties in the metadata.

CHAPTER 15. CRITERIA QUERIES

Hibernate features an intuitive, extensible criteria query API.

15.1. CREATING A CRITERIA INSTANCE

The interface `org.hibernate.Criteria` represents a query against a particular persistent class. The `Session` is a factory for `Criteria` instances.

```
Criteria crit = sess.createCriteria(Cat.class);
crit.setMaxResults(50);
List cats = crit.list();
```

15.2. NARROWING THE RESULT SET

An individual query criterion is an instance of the interface `org.hibernate.criterion.Criterion`. The class `org.hibernate.criterion.Restrictions` defines factory methods for obtaining certain built-in `Criterion` types.

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.like("name", "Fritz%") )
    .add( Restrictions.between("weight", minWeight, maxWeight) )
    .list();
```

Restrictions can be grouped logically.

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.like("name", "Fritz%") )
    .add( Restrictions.or(
        Restrictions.eq( "age", new Integer(0) ),
        Restrictions.isNull("age")
    ) )
    .list();
```

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.in( "name", new String[] { "Fritz", "Izi", "Pk" } ) )
    .add( Restrictions.disjunction()
        .add( Restrictions.isNull("age") )
        .add( Restrictions.eq("age", new Integer(0) ) )
        .add( Restrictions.eq("age", new Integer(1) ) )
        .add( Restrictions.eq("age", new Integer(2) ) )
    )
    .list();
```

There are a range of built-in criterion types (`Restrictions` subclasses). One of the most useful allows you to specify SQL directly.

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.sqlRestriction("lower({alias}.name) like lower(?)",
    "Fritz%", Hibernate.STRING) )
    .list();
```

The `{alias}` placeholder will be replaced by the row alias of the queried entity.

You can also obtain a criterion from a **Property** instance. You can create a **Property** by calling **Property.forName()**:

```
Property age = Property.forName("age");
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.disjunction()
        .add( age.isNull() )
        .add( age.eq( new Integer(0) ) )
        .add( age.eq( new Integer(1) ) )
        .add( age.eq( new Integer(2) ) )
    )
    .add( Property.forName("name").in( new String[] { "Fritz", "Izi", "Pk"
} ) )
    .list();
```

15.3. ORDERING THE RESULTS

You can order the results using **org.hibernate.criterion.Order**.

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.like("name", "F%") )
    .addOrder( Order.asc("name") )
    .addOrder( Order.desc("age") )
    .setMaxResults(50)
    .list();
```

```
List cats = sess.createCriteria(Cat.class)
    .add( Property.forName("name").like("F%") )
    .addOrder( Property.forName("name").asc() )
    .addOrder( Property.forName("age").desc() )
    .setMaxResults(50)
    .list();
```

15.4. ASSOCIATIONS

By navigating associations using **createCriteria()** you can specify constraints upon related entities:

```
List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.like("name", "F%") )
    .createCriteria("kittens")
        .add( Restrictions.like("name", "F%") )
    .list();
```

The second **createCriteria()** returns a new instance of **Criteria** that refers to the elements of the **kittens** collection.

There is also an alternate form that is useful in certain circumstances:

```
List cats = sess.createCriteria(Cat.class)
```

```

.createAlias("kittens", "kt")
.createAlias("mate", "mt")
.add( Restrictions.eqProperty("kt.name", "mt.name") )
.list();

```

(**createAlias()** does not create a new instance of **Criteria**.)

The kittens collections held by the **Cat** instances returned by the previous two queries are *not* pre-filtered by the criteria. If you want to retrieve just the kittens that match the criteria, you must use a **ResultTransformer**.

```

List cats = sess.createCriteria(Cat.class)
    .createCriteria("kittens", "kt")
        .add( Restrictions.eq("name", "F%") )
    .setResultTransformer(Criteria.ALIAS_TO_ENTITY_MAP)
    .list();
Iterator iter = cats.iterator();
while ( iter.hasNext() ) {
    Map map = (Map) iter.next();
    Cat cat = (Cat) map.get(Criteria.ROOT_ALIAS);
    Cat kitten = (Cat) map.get("kt");
}

```

15.5. DYNAMIC ASSOCIATION FETCHING

You can specify association fetching semantics at runtime using **setFetchMode()**.

```

List cats = sess.createCriteria(Cat.class)
    .add( Restrictions.like("name", "Fritz%") )
    .setFetchMode("mate", FetchMode.EAGER)
    .setFetchMode("kittens", FetchMode.EAGER)
    .list();

```

This query will fetch both **mate** and **kittens** by outer join. See [Section 19.1, “Fetching strategies”](#) for more information.

15.6. EXAMPLE QUERIES

The class **org.hibernate.criterion.Example** allows you to construct a query criterion from a given instance.

```

Cat cat = new Cat();
cat.setSex('F');
cat.setColor(Color.BLACK);
List results = session.createCriteria(Cat.class)
    .add( Example.create(cat) )
    .list();

```

Version properties, identifiers and associations are ignored. By default, null valued properties are excluded.

You can adjust how the **Example** is applied.

```

Example example = Example.create(cat)
    .excludeZeroes()           //exclude zero valued properties
    .excludeProperty("color") //exclude the property named "color"
    .ignoreCase()             //perform case insensitive string
comparisons
    .enableLike();            //use like for string comparisons
List results = session.createCriteria(Cat.class)
    .add(example)
    .list();
    
```

You can even use examples to place criteria upon associated objects.

```

List results = session.createCriteria(Cat.class)
    .add( Example.create(cat) )
    .createCriteria("mate")
        .add( Example.create( cat.getMate() ) )
    .list();
    
```

15.7. PROJECTIONS, AGGREGATION AND GROUPING

The class `org.hibernate.criterion.Projections` is a factory for `Projection` instances. You can apply a projection to a query by calling `setProjection()`.

```

List results = session.createCriteria(Cat.class)
    .setProjection( Projections.rowCount() )
    .add( Restrictions.eq("color", Color.BLACK) )
    .list();
    
```

```

List results = session.createCriteria(Cat.class)
    .setProjection( Projections.projectionList()
        .add( Projections.rowCount() )
        .add( Projections.avg("weight" ) )
        .add( Projections.max("weight" ) )
        .add( Projections.groupProperty("color" ) )
    )
    .list();
    
```

There is no explicit "group by" necessary in a criteria query. Certain projection types are defined to be *grouping projections*, which also appear in the SQL **group by** clause.

An alias can be assigned to a projection so that the projected value can be referred to in restrictions or orderings. Here are two different ways to do this:

```

List results = session.createCriteria(Cat.class)
    .setProjection( Projections.alias( Projections.groupProperty("color"),
"colr" ) )
    .addOrder( Order.asc("colr" ) )
    .list();
    
```

```

List results = session.createCriteria(Cat.class)
    .setProjection( Projections.groupProperty("color").as("colr" ) )
    .addOrder( Order.asc("colr" ) )
    .list();
    
```

The `alias()` and `as()` methods simply wrap a projection instance in another, aliased, instance of **Projection**. As a shortcut, you can assign an alias when you add the projection to a projection list:

```
List results = session.createCriteria(Cat.class)
    .setProjection( Projections.projectionList()
        .add( Projections.rowCount(), "catCountByColor" )
        .add( Projections.avg("weight"), "avgWeight" )
        .add( Projections.max("weight"), "maxWeight" )
        .add( Projections.groupProperty("color"), "color" )
    )
    .addOrder( Order.desc("catCountByColor") )
    .addOrder( Order.desc("avgWeight") )
    .list();
```

```
List results = session.createCriteria(Domestic.class, "cat")
    .createAlias("kittens", "kit")
    .setProjection( Projections.projectionList()
        .add( Projections.property("cat.name"), "catName" )
        .add( Projections.property("kit.name"), "kitName" )
    )
    .addOrder( Order.asc("catName") )
    .addOrder( Order.asc("kitName") )
    .list();
```

You can also use **Property.forName()** to express projections:

```
List results = session.createCriteria(Cat.class)
    .setProjection( Property.forName("name") )
    .add( Property.forName("color").eq(Color.BLACK) )
    .list();
```

```
List results = session.createCriteria(Cat.class)
    .setProjection( Projections.projectionList()
        .add( Projections.rowCount() )
        .add( Property.forName("weight").avg().as("avgWeight") )
        .add( Property.forName("weight").max().as("maxWeight") )
        .add( Property.forName("color").group().as("color" )
    ) )
    .addOrder( Order.desc("catCountByColor") )
    .addOrder( Order.desc("avgWeight") )
    .list();
```

15.8. DETACHED QUERIES AND SUBQUERIES

The **DetachedCriteria** class allows you to create a query outside the scope of a session and then execute it using an arbitrary **Session**.

```
DetachedCriteria query = DetachedCriteria.forClass(Cat.class)
    .add( Property.forName("sex").eq('F') );

Session session = ....;
Transaction txn = session.beginTransaction();
```

```
List results =
query.getExecutableCriteria(session).setMaxResults(100).list();
txn.commit();
session.close();
```

A **DetachedCriteria** can also be used to express a subquery. Criterion instances involving subqueries can be obtained via **Subqueries** or **Property**.

```
DetachedCriteria avgWeight = DetachedCriteria.forClass(Cat.class)
    .setProjection( Property.forName("weight").avg() );
session.createCriteria(Cat.class)
    .add( Property.forName("weight").gt(avgWeight) )
    .list();
```

```
DetachedCriteria weights = DetachedCriteria.forClass(Cat.class)
    .setProjection( Property.forName("weight") );
session.createCriteria(Cat.class)
    .add( Subqueries.geAll("weight", weights) )
    .list();
```

Correlated subqueries are also possible:

```
DetachedCriteria avgWeightForSex = DetachedCriteria.forClass(Cat.class,
"cat2")
    .setProjection( Property.forName("weight").avg() )
    .add( Property.forName("cat2.sex").eqProperty("cat.sex") );
session.createCriteria(Cat.class, "cat")
    .add( Property.forName("weight").gt(avgWeightForSex) )
    .list();
```

15.9. QUERIES BY NATURAL IDENTIFIER

For most queries, including criteria queries, the query cache is not efficient because query cache invalidation occurs too frequently. However, there is a special kind of query where you can optimize the cache invalidation algorithm: lookups by a constant natural key. In some applications, this kind of query occurs frequently. The criteria API provides special provision for this use case.

First, map the natural key of your entity using **<natural-id>** and enable use of the second-level cache.

```
<class name="User">
  <cache usage="read-write"/>
  <id name="id">
    <generator class="increment"/>
  </id>
  <natural-id>
    <property name="name"/>
    <property name="org"/>
  </natural-id>
  <property name="password"/>
</class>
```

This functionality is not intended for use with entities with *mutable* natural keys.

Once you have enabled the Hibernate query cache, the `Restrictions.naturalId()` allows you to make use of the more efficient cache algorithm.

```
session.createCriteria(User.class)
    .add( Restrictions.naturalId()
        .set("name", "gavin")
        .set("org", "hb")
    ).setCacheable(true)
    .uniqueResult();
```

CHAPTER 16. NATIVE SQL

You can also express queries in the native SQL dialect of your database. This is useful if you want to utilize database-specific features such as query hints or the **CONNECT** keyword in Oracle. It also provides a clean migration path from a direct SQL/JDBC based application to Hibernate.

Hibernate3 allows you to specify handwritten SQL, including stored procedures, for all create, update, delete, and load operations.

16.1. USING A SQLQUERY

Execution of native SQL queries is controlled via the **SQLQuery** interface, which is obtained by calling **Session.createSQLQuery()**. The following sections describe how to use this API for querying.

16.1.1. Scalar queries

The most basic SQL query is to get a list of scalars (values).

```
sess.createSQLQuery("SELECT * FROM CATS").list();
sess.createSQLQuery("SELECT ID, NAME, BIRTHDATE FROM CATS").list();
```

These will return a List of Object arrays (Object[]) with scalar values for each column in the CATS table. Hibernate will use **ResultSetMetadata** to deduce the actual order and types of the returned scalar values.

To avoid the overhead of using **ResultSetMetadata**, or simply to be more explicit in what is returned, one can use **addScalar()**:

```
sess.createSQLQuery("SELECT * FROM CATS")
    .addScalar("ID", Hibernate.LONG)
    .addScalar("NAME", Hibernate.STRING)
    .addScalar("BIRTHDATE", Hibernate.DATE);
```

This query specified:

- the SQL query string
- the columns and types to return

This will return Object arrays, but now it will not use **ResultSetMetadata** but will instead explicitly get the ID, NAME and BIRTHDATE column as respectively a Long, String and a Short from the underlying resultset. This also means that only these three columns will be returned, even though the query is using ***** and could return more than the three listed columns.

It is possible to leave out the type information for all or some of the scalars.

```
sess.createSQLQuery("SELECT * FROM CATS")
    .addScalar("ID", Hibernate.LONG)
    .addScalar("NAME")
    .addScalar("BIRTHDATE");
```

This is essentially the same query as before, but now **ResultSetMetadata** is used to determine the type of NAME and BIRTHDATE, where as the type of ID is explicitly specified.

How the `java.sql.Types` returned from `ResultSetMetaData` is mapped to Hibernate types is controlled by the `Dialect`. If a specific type is not mapped, or does not result in the expected type, it is possible to customize it via calls to `registerHibernateType` in the `Dialect`.

16.1.2. Entity queries

The above queries were all about returning scalar values, basically returning the "raw" values from the resultset. The following shows how to get entity objects from a native sql query via `addEntity()`.

```
sess.createSQLQuery("SELECT * FROM CATS").addEntity(Cat.class);
sess.createSQLQuery("SELECT ID, NAME, BIRTHDATE FROM
CATS").addEntity(Cat.class);
```

This query specified:

- the SQL query string
- the entity returned by the query

Assuming that `Cat` is mapped as a class with the columns `ID`, `NAME` and `BIRTHDATE` the above queries will both return a `List` where each element is a `Cat` entity.

If the entity is mapped with a **many-to-one** to another entity it is required to also return this when performing the native query, otherwise a database specific "column not found" error will occur. The additional columns will automatically be returned when using the `*` notation, but we prefer to be explicit as in the following example for a **many-to-one** to a **Dog**:

```
sess.createSQLQuery("SELECT ID, NAME, BIRTHDATE, DOG_ID FROM
CATS").addEntity(Cat.class);
```

This will allow `cat.getDog()` to function properly.

16.1.3. Handling associations and collections

It is possible to eagerly join in the **Dog** to avoid the possible extra roundtrip for initializing the proxy. This is done via the `addJoin()` method, which allows you to join in an association or collection.

```
sess.createSQLQuery("SELECT c.ID, NAME, BIRTHDATE, DOG_ID, D_ID, D_NAME
FROM CATS c, DOGS d WHERE c.DOG_ID = d.D_ID")
    .addEntity("cat", Cat.class)
    .addJoin("dog", "cat.dog");
```

In this example, the returned `Cat`'s will have their `dog` property fully initialized without any extra roundtrip to the database. Notice that you added an alias name ("cat") to be able to specify the target property path of the join. It is possible to do the same eager joining for collections, e.g. if the `Cat` had a one-to-many to `Dog` instead.

```
sess.createSQLQuery("SELECT ID, NAME, BIRTHDATE, D_ID, D_NAME, CAT_ID FROM
CATS c, DOGS d WHERE c.ID = d.CAT_ID")
    .addEntity("cat", Cat.class)
    .addJoin("dog", "cat.dogs");
```

At this stage you are reaching the limits of what is possible with native queries, without starting to enhance the sql queries to make them usable in Hibernate. Problems can arise when returning multiple entities of the same type or when the default alias/column names are not enough.

16.1.4. Returning multiple entities

Until now, the result set column names are assumed to be the same as the column names specified in the mapping document. This can be problematic for SQL queries that join multiple tables, since the same column names can appear in more than one table.

Column alias injection is needed in the following query (which most likely will fail):

```
sess.createSQLQuery("SELECT c.*, m.* FROM CATS c, CATS m WHERE
c.MOTHER_ID = c.ID")
    .addEntity("cat", Cat.class)
    .addEntity("mother", Cat.class)
```

The query was intended to return two Cat instances per row: a cat and its mother. The query will, however, fail because there is a conflict of names; the instances are mapped to the same column names. Also, on some databases the returned column aliases will most likely be on the form "c.ID", "c.NAME", etc. which are not equal to the columns specified in the mappings ("ID" and "NAME").

The following form is not vulnerable to column name duplication:

```
sess.createSQLQuery("SELECT {cat.*}, {mother.*} FROM CATS c, CATS m WHERE
c.MOTHER_ID = c.ID")
    .addEntity("cat", Cat.class)
    .addEntity("mother", Cat.class)
```

This query specified:

- the SQL query string, with placeholders for Hibernate to inject column aliases
- the entities returned by the query

The {cat.*} and {mother.*} notation used above is a shorthand for "all properties". Alternatively, you can list the columns explicitly, but even in this case Hibernate injects the SQL column aliases for each property. The placeholder for a column alias is just the property name qualified by the table alias. In the following example, you retrieve Cats and their mothers from a different table (cat_log) to the one declared in the mapping metadata. You can even use the property aliases in the where clause.

```
String sql = "SELECT ID as {c.id}, NAME as {c.name}, " +
    "BIRTHDATE as {c.birthDate}, MOTHER_ID as {c.mother}, {mother.*}
" +
    "FROM CAT_LOG c, CAT_LOG m WHERE {c.mother} = c.ID";

List loggedCats = sess.createSQLQuery(sql)
    .addEntity("cat", Cat.class)
    .addEntity("mother", Cat.class).list()
```

16.1.4.1. Alias and property references

In most cases the above alias injection is needed. For queries relating to more complex mappings, like composite properties, inheritance discriminators, collections etc., you can use specific aliases that allow Hibernate to inject the proper aliases.

The following table shows the different ways you can use the alias injection. Please note that the alias names in the result are simply examples; each alias will have a unique and probably different name when used.

Table 16.1. Alias injection names

Description	Syntax	Example
A simple property	<code>{[aliasname]}. [propertyname]</code>	<code>A_NAME as {item.name}</code>
A composite property	<code>{[aliasname]}. [componentname]. [propertyname]}</code>	<code>CURRENCY as {item.amount.currency}, VALUE as {item.amount.value}</code>
Discriminator of an entity	<code>{[aliasname].class}</code>	<code>DISC as {item.class}</code>
All properties of an entity	<code>{[aliasname].*}</code>	<code>{item.*}</code>
A collection key	<code>{[aliasname].key}</code>	<code>ORGID as {coll.key}</code>
The id of an collection	<code>{[aliasname].id}</code>	<code>EMPID as {coll.id}</code>
The element of an collection	<code>{[aliasname].element}</code>	<code>XID as {coll.element}</code>
property of the element in the collection	<code>{[aliasname].element. [propertyname]}</code>	<code>NAME as {coll.element.name}</code>
All properties of the element in the collection	<code>{[aliasname].element.*}</code>	<code>{coll.element.*}</code>
All properties of the collection	<code>{[aliasname].*}</code>	<code>{coll.*}</code>

16.1.5. Returning non-managed entities

It is possible to apply a ResultTransformer to native SQL queries, allowing it to return non-managed entities.

```
sess.createSQLQuery("SELECT NAME, BIRTHDATE FROM CATS")
    .setResultTransformer(Transformers.aliasToBean(CatDTO.class))
```

This query specified:

- the SQL query string
- a result transformer

The above query will return a list of **CatDTO** which has been instantiated and injected the values of NAME and BIRTHNAME into its corresponding properties or fields.

16.1.6. Handling inheritance

Native SQL queries which query for entities that are mapped as part of an inheritance must include all properties for the baseclass and all its subclasses.

16.1.7. Parameters

Native SQL queries support positional as well as named parameters:

```
Query query = sess.createSQLQuery("SELECT * FROM CATS WHERE NAME like
?").addEntity(Cat.class);
List pusList = query.setString(0, "Pus%").list();

query = sess.createSQLQuery("SELECT * FROM CATS WHERE NAME like
:name").addEntity(Cat.class);
List pusList = query.setString("name", "Pus%").list();
```

16.2. NAMED SQL QUERIES

Named SQL queries can be defined in the mapping document and called in exactly the same way as a named HQL query. In this case, you do *not* need to call **addEntity()**.

```
<sql-query name="persons">
  <return alias="person" class="eg.Person"/>
  SELECT person.NAME AS {person.name},
         person.AGE AS {person.age},
         person.SEX AS {person.sex}
  FROM PERSON person
  WHERE person.NAME LIKE :namePattern
</sql-query>
```

```
List people = sess.getNamedQuery("persons")
    .setString("namePattern", namePattern)
    .setMaxResults(50)
    .list();
```

The **<return-join>** element is use to join associations and the **<load-collection>** element is used to define queries which initialize collections,

```
<sql-query name="personsWith">
  <return alias="person" class="eg.Person"/>
  <return-join alias="address" property="person.mailingAddress"/>
  SELECT person.NAME AS {person.name},
         person.AGE AS {person.age},
         person.SEX AS {person.sex},
         address.STREET AS {address.street},
         address.CITY AS {address.city},
         address.STATE AS {address.state},
         address.ZIP AS {address.zip}
  FROM PERSON person
```

```

    JOIN ADDRESS address
      ON person.ID = address.PERSON_ID AND address.TYPE='MAILING'
    WHERE person.NAME LIKE :namePattern
</sql-query>

```

A named SQL query may return a scalar value. You must declare the column alias and Hibernate type using the `<return-scalar>` element:

```

<sql-query name="mySqlQuery">
  <return-scalar column="name" type="string"/>
  <return-scalar column="age" type="long"/>
  SELECT p.NAME AS name,
         p.AGE AS age,
  FROM PERSON p WHERE p.NAME LIKE 'Hiber%'
</sql-query>

```

You can externalize the resultset mapping information in a `<resultset>` element which will allow you to either reuse them across several named queries or through the `setResultSetMapping()` API.

```

<resultset name="personAddress">
  <return alias="person" class="eg.Person"/>
  <return-join alias="address" property="person.mailingAddress"/>
</resultset>

<sql-query name="personsWith" resultset-ref="personAddress">
  SELECT person.NAME AS {person.name},
         person.AGE AS {person.age},
         person.SEX AS {person.sex},
         address.STREET AS {address.street},
         address.CITY AS {address.city},
         address.STATE AS {address.state},
         address.ZIP AS {address.zip}
  FROM PERSON person
  JOIN ADDRESS address
    ON person.ID = address.PERSON_ID AND address.TYPE='MAILING'
  WHERE person.NAME LIKE :namePattern
</sql-query>

```

You can, alternatively, use the resultset mapping information in your hbm files directly in java code.

```

List cats = sess.createSQLQuery(
    "select {cat.*}, {kitten.*} from cats cat, cats kitten where
kitten.mother = cat.id"
)
.setResultSetMapping("catAndKitten")
.list();

```

16.2.1. Using return-property to explicitly specify column/alias names

You can explicitly tell Hibernate what column aliases to use with `<return-property>`, instead of using the `{}`-syntax to let Hibernate inject its own aliases. For example:

```

<sql-query name="mySqlQuery">
  <return alias="person" class="eg.Person">

```

```

        <return-property name="name" column="myName"/>
        <return-property name="age" column="myAge"/>
        <return-property name="sex" column="mySex"/>
    </return>
    SELECT person.NAME AS myName,
           person.AGE AS myAge,
           person.SEX AS mySex,
    FROM PERSON person WHERE person.NAME LIKE :name
</sql-query>

```

<return-property> also works with multiple columns. This solves a limitation with the **{}**-syntax which cannot allow fine grained control of multi-column properties.

```

<sql-query name="organizationCurrentEmployments">
    <return alias="emp" class="Employment">
        <return-property name="salary">
            <return-column name="VALUE"/>
            <return-column name="CURRENCY"/>
        </return-property>
        <return-property name="endDate" column="myEndDate"/>
    </return>
    SELECT EMPLOYEE AS {emp.employee}, EMPLOYER AS {emp.employer},
    STARTDATE AS {emp.startDate}, ENDDATE AS {emp.endDate},
    REGIONCODE as {emp.regionCode}, EID AS {emp.id}, VALUE, CURRENCY
    FROM EMPLOYMENT
    WHERE EMPLOYER = :id AND ENDDATE IS NULL
    ORDER BY STARTDATE ASC
</sql-query>

```

In this example **<return-property>** was used in combination with the **{}**-syntax for injection. This allows users to choose how they want to refer column and properties.

If your mapping has a discriminator you must use **<return-discriminator>** to specify the discriminator column.

16.2.2. Using stored procedures for querying

Hibernate3 provides support for queries via stored procedures and functions. Most of the following documentation is equivalent for both. The stored procedure/function must return a resultset as the first out-parameter to be able to work with Hibernate. An example of such a stored function in Oracle 9 and higher is as follows:

```

CREATE OR REPLACE FUNCTION selectAllEmployments
    RETURN SYS_REFCURSOR
AS
    st_cursor SYS_REFCURSOR;
BEGIN
    OPEN st_cursor FOR
    SELECT EMPLOYEE, EMPLOYER,
    STARTDATE, ENDDATE,
    REGIONCODE, EID, VALUE, CURRENCY
    FROM EMPLOYMENT;
    RETURN st_cursor;
END;

```


To use this query in Hibernate you need to map it via a named query.

```
<sql-query name="selectAllEmployees_SP" callable="true">
  <return alias="emp" class="Employment">
    <return-property name="employee" column="EMPLOYEE"/>
    <return-property name="employer" column="EMPLOYER"/>
    <return-property name="startDate" column="STARTDATE"/>
    <return-property name="endDate" column="ENDDATE"/>
    <return-property name="regionCode" column="REGIONCODE"/>
    <return-property name="id" column="EID"/>
    <return-property name="salary">
      <return-column name="VALUE"/>
      <return-column name="CURRENCY"/>
    </return-property>
  </return>
  { ? = call selectAllEmployments() }
</sql-query>
```

Stored procedures currently only return scalars and entities. **<return-join>** and **<load-collection>** are not supported.

16.2.2.1. Rules/limitations for using stored procedures

You cannot use stored procedures with Hibernate unless you follow some procedure/function rules. If they do not follow those rules they are not usable with Hibernate. If you still want to use these procedures you have to execute them via `session.connection()`. The rules are different for each database, since database vendors have different stored procedure semantics/syntax.

Stored procedure queries cannot be paged with `setFirstResult()/setMaxResults()`.

The recommended call form is standard SQL92: `{ ? = call functionName(<parameters>) }` or `{ ? = call procedureName(<parameters>}`. Native call syntax is not supported.

For Oracle the following rules apply:

- A function must return a result set. The first parameter of a procedure must be an **OUT** that returns a result set. This is done by using a **SYS_REFCURSOR** type in Oracle 9 or 10. In Oracle you need to define a **REF CURSOR** type. See Oracle literature for further information.

For Sybase or MS SQL server the following rules apply:

- The procedure must return a result set. Note that since these servers can return multiple result sets and update counts, Hibernate will iterate the results and take the first result that is a result set as its return value. Everything else will be discarded.
- If you can enable **SET NOCOUNT ON** in your procedure it will probably be more efficient, but this is not a requirement.

16.3. CUSTOM SQL FOR CREATE, UPDATE AND DELETE

Hibernate3 can use custom SQL statements for create, update, and delete operations. The class and collection persisters in Hibernate already contain a set of configuration time generated strings (insertsql, deletesql, updatesql etc.). The mapping tags **<sql-insert>**, **<sql-delete>**, and **<sql-update>** override these strings:

■

```

<class name="Person">
  <id name="id">
    <generator class="increment"/>
  </id>
  <property name="name" not-null="true"/>
  <sql-insert>INSERT INTO PERSON (NAME, ID) VALUES ( UPPER(?), ? )</sql-
insert>
  <sql-update>UPDATE PERSON SET NAME=UPPER(?) WHERE ID=?</sql-update>
  <sql-delete>DELETE FROM PERSON WHERE ID=?</sql-delete>
</class>
    
```

The SQL is directly executed in your database, so you can use any dialect you like. This will reduce the portability of your mapping if you use database specific SQL.

Stored procedures are supported if the **callable** attribute is set:

```

<class name="Person">
  <id name="id">
    <generator class="increment"/>
  </id>
  <property name="name" not-null="true"/>
  <sql-insert callable="true">{call createPerson (?, ?)}</sql-insert>
  <sql-delete callable="true">{? = call deletePerson (?)}</sql-delete>
  <sql-update callable="true">{? = call updatePerson (?, ?)}</sql-
update>
</class>
    
```

The order of the positional parameters is vital, as they must be in the same sequence as Hibernate expects them.

You can view the expected order by enabling debug logging for the **org.hibernate.persister.entity** level. With this level enabled, Hibernate will print out the static SQL that is used to create, update, delete etc. entities. To view the expected sequence, do not include your custom SQL in the mapping files, as this will override the Hibernate generated static SQL.

The stored procedures are in most cases required to return the number of rows inserted, updated and deleted, as Hibernate has some runtime checks for the success of the statement. Hibernate always registers the first statement parameter as a numeric output parameter for the CRUD operations:

```

CREATE OR REPLACE FUNCTION updatePerson (uid IN NUMBER, uname IN VARCHAR2)
  RETURN NUMBER IS
BEGIN
  update PERSON
  set
    NAME = uname,
  where
    ID = uid;

  return SQL%ROWCOUNT;
END updatePerson;
    
```

16.4. CUSTOM SQL FOR LOADING

You can also declare your own SQL (or HQL) queries for entity loading:

```
<sql-query name="person">
  <return alias="pers" class="Person" lock-mode="upgrade"/>
  SELECT NAME AS {pers.name}, ID AS {pers.id}
  FROM PERSON
  WHERE ID=?
  FOR UPDATE
</sql-query>
```

This is just a named query declaration, as discussed earlier. You can reference this named query in a class mapping:

```
<class name="Person">
  <id name="id">
    <generator class="increment"/>
  </id>
  <property name="name" not-null="true"/>
  <loader query-ref="person"/>
</class>
```

This even works with stored procedures.

You can even define a query for collection loading:

```
<set name="employments" inverse="true">
  <key/>
  <one-to-many class="Employment"/>
  <loader query-ref="employments"/>
</set>
```

```
<sql-query name="employments">
  <load-collection alias="emp" role="Person.employments"/>
  SELECT {emp.*}
  FROM EMPLOYMENT emp
  WHERE EMPLOYER = :id
  ORDER BY STARTDATE ASC, EMPLOYEE ASC
</sql-query>
```

You can also define an entity loader that loads a collection by join fetching:

```
<sql-query name="person">
  <return alias="pers" class="Person"/>
  <return-join alias="emp" property="pers.employments"/>
  SELECT NAME AS {pers.*}, {emp.*}
  FROM PERSON pers
  LEFT OUTER JOIN EMPLOYMENT emp
    ON pers.ID = emp.PERSON_ID
  WHERE ID=?
</sql-query>
```

CHAPTER 17. FILTERING DATA

Hibernate3 provides an innovative new approach to handling data with "visibility" rules. A *Hibernate filter* is a global, named, parameterized filter that can be enabled or disabled for a particular Hibernate session.

17.1. HIBERNATE FILTERS

Hibernate3 has the ability to pre-define filter criteria and attach those filters at both a class level and a collection level. A filter criteria allows you to define a restriction clause similar to the existing "where" attribute available on the class and various collection elements. These filter conditions, however, can be parameterized. The application can then decide at runtime whether certain filters should be enabled and what their parameter values should be. Filters can be used like database views, but they are parameterized inside the application.

In order to use filters, they must first be defined and then attached to the appropriate mapping elements. To define a filter, use the `<filter-def/>` element within a `<hibernate-mapping/>` element:

```
<filter-def name="myFilter">
    <filter-param name="myFilterParam" type="string"/>
</filter-def>
```

This filter can then be attached to a class:

```
<class name="myClass" ...>
    ...
    <filter name="myFilter" condition=":myFilterParam =
MY_FILTERED_COLUMN"/>
</class>
```

Or, to a collection:

```
<set ...>
    <filter name="myFilter" condition=":myFilterParam =
MY_FILTERED_COLUMN"/>
</set>
```

Or, to both or multiples of each at the same time.

The methods on `Session` are: `enableFilter(String filterName)`, `getEnabledFilter(String filterName)`, and `disableFilter(String filterName)`. By default, filters are *not* enabled for a given session. Filters must be enabled through use of the `Session.enableFilter()` method, which returns an instance of the `Filter` interface. If you used the simple filter defined above, it would look like this:

```
session.enableFilter("myFilter").setParameter("myFilterParam", "some-
value");
```

Methods on the `org.hibernate.Filter` interface do allow the method-chaining common to much of Hibernate.

The following is a full example, using temporal data with an effective record date pattern:

```

<filter-def name="effectiveDate">
  <filter-param name="asOfDate" type="date"/>
</filter-def>

<class name="Employee" ...>
  ...
  <many-to-one name="department" column="dept_id" class="Department"/>
  <property name="effectiveStartDate" type="date"
column="eff_start_dt"/>
  <property name="effectiveEndDate" type="date" column="eff_end_dt"/>
  ...
  <!--
    Note that this assumes non-terminal records have an eff_end_dt set
to
    a max db date for simplicity-sake
  -->
  <filter name="effectiveDate"
    condition=":asOfDate BETWEEN eff_start_dt and eff_end_dt"/>
</class>

<class name="Department" ...>
  ...
  <set name="employees" lazy="true">
    <key column="dept_id"/>
    <one-to-many class="Employee"/>
    <filter name="effectiveDate"
      condition=":asOfDate BETWEEN eff_start_dt and
eff_end_dt"/>
  </set>
</class>

```

In order to ensure that you are provided with currently effective records, enable the filter on the session prior to retrieving employee data:

```

Session session = ...;
session.enableFilter("effectiveDate").setParameter("asOfDate", new
Date());
List results = session.createQuery("from Employee as e where e.salary >
:targetSalary")
    .setLong("targetSalary", new Long(1000000))
    .list();

```

Even though a salary constraint was mentioned explicitly on the results in the above HQL, because of the enabled filter, the query will return only currently active employees who have a salary greater than one million dollars.

If you want to use filters with outer joining, either through HQL or load fetching, be careful of the direction of the condition expression. It is safest to set this up for left outer joining. Place the parameter first followed by the column name(s) after the operator.

After being defined, a filter might be attached to multiple entities and/or collections each with its own condition. This can be problematic when the conditions are the same each time. Using **<filter-def/>** allows you to define a default condition, either as an attribute or CDATA:

```
<filter-def name="myFilter" condition="abc > xyz">...</filter-def>  
<filter-def name="myOtherFilter">abc=xyz</filter-def>
```

This default condition will be used whenever the filter is attached to something without specifying a condition. This means you can give a specific condition as part of the attachment of the filter that overrides the default condition in that particular case.

CHAPTER 18. XML MAPPING

XML Mapping is an experimental feature in Hibernate 3.0 and is currently under active development.

18.1. WORKING WITH XML DATA

Hibernate allows you to work with persistent XML data in much the same way you work with persistent POJOs. A parsed XML tree can be thought of as another way of representing the relational data at the object level, instead of POJOs.

Hibernate supports dom4j as API for manipulating XML trees. You can write queries that retrieve dom4j trees from the database and have any modification you make to the tree automatically synchronized to the database. You can even take an XML document, parse it using dom4j, and write it to the database with any of Hibernate's basic operations: **persist()**, **saveOrUpdate()**, **merge()**, **delete()**, **replicate()** (merging is not yet supported).

This feature has many applications including data import/export, externalization of entity data via JMS or SOAP and XSLT-based reporting.

A single mapping can be used to simultaneously map properties of a class and nodes of an XML document to the database, or, if there is no class to map, it can be used to map just the XML.

18.1.1. Specifying XML and class mapping together

Here is an example of mapping a POJO and XML simultaneously:

```
<class name="Account"
      table="ACCOUNTS"
      node="account">

  <id name="accountId"
      column="ACCOUNT_ID"
      node="@id"/>

  <many-to-one name="customer"
      column="CUSTOMER_ID"
      node="customer/@id"
      embed-xml="false"/>

  <property name="balance"
      column="BALANCE"
      node="balance"/>

  ...

</class>
```

18.1.2. Specifying only an XML mapping

Here is an example where there is no POJO class:

```
<class entity-name="Account"
      table="ACCOUNTS"
      node="account">
```

```

<id name="id"
    column="ACCOUNT_ID"
    node="@id"
    type="string"/>

<many-to-one name="customerId"
    column="CUSTOMER_ID"
    node="customer/@id"
    embed-xml="false"
    entity-name="Customer"/>

<property name="balance"
    column="BALANCE"
    node="balance"
    type="big_decimal"/>

...

</class>
    
```

This mapping allows you to access the data as a dom4j tree, or as a graph of property name/value pairs or java **Maps**. The property names are purely logical constructs that can be referred to in HQL queries.

18.2. XML MAPPING METADATA

A range of Hibernate mapping elements accept the **node** attribute. This lets you specify the name of an XML attribute or element that holds the property or entity data. The format of the **node** attribute must be one of the following:

- **"element-name"**: map to the named XML element
- **"@attribute-name"**: map to the named XML attribute
- **"."**: map to the parent element
- **"element-name/@attribute-name"**: map to the named attribute of the named element

For collections and single valued associations, there is an additional **embed-xml** attribute. If **embed-xml="true"**, the default, the XML tree for the associated entity (or collection of value type) will be embedded directly in the XML tree for the entity that owns the association. Otherwise, if **embed-xml="false"**, then only the referenced identifier value will appear in the XML for single point associations and collections will not appear at all.

Do not leave **embed-xml="true"** for too many associations, since XML does not deal well with circularity.

```

<class name="Customer"
    table="CUSTOMER"
    node="customer">

    <id name="id"
        column="CUST_ID"
        node="@id"/>
    
```



```

<map name="accounts"
      node="."
      embed-xml="true">
  <key column="CUSTOMER_ID"
        not-null="true"/>
  <map-key column="SHORT_DESC"
           node="@short-desc"
           type="string"/>
  <one-to-many entity-name="Account"
               embed-xml="false"
               node="account"/>
</map>

<component name="name"
           node="name">
  <property name="firstName"
            node="first-name"/>
  <property name="initial"
            node="initial"/>
  <property name="lastName"
            node="last-name"/>
</component>

...
</class>

```

In this case, the collection of account ids is embedded, but not the actual account data. The following HQL query:

```
from Customer c left join fetch c.accounts where c.lastName like :lastName
```

would return datasets such as this:

```

<customer id="123456789">
  <account short-desc="Savings">987632567</account>
  <account short-desc="Credit Card">985612323</account>
  <name>
    <first-name>Gavin</first-name>
    <initial>A</initial>
    <last-name>King</last-name>
  </name>
  ...
</customer>

```

If you set `embed-xml="true"` on the `<one-to-many>` mapping, the data might look more like this:

```

<customer id="123456789">
  <account id="987632567" short-desc="Savings">
    <customer id="123456789"/>
    <balance>100.29</balance>
  </account>
  <account id="985612323" short-desc="Credit Card">
    <customer id="123456789"/>
    <balance>-2370.34</balance>

```

```

        </account>
        <name>
            <first-name>Gavin</first-name>
            <initial>A</initial>
            <last-name>King</last-name>
        </name>
        ...
    </customer>

```

18.3. MANIPULATING XML DATA

You can also re-read and update XML documents in the application. You can do this by obtaining a dom4j session:

```

Document doc = ....;

Session session = factory.openSession();
Session dom4jSession = session.getSession(EntityMode.DOM4J);
Transaction tx = session.beginTransaction();

List results = dom4jSession
    .createQuery("from Customer c left join fetch c.accounts where
c.lastName like :lastName")
    .list();
for ( int i=0; i<results.size(); i++ ) {
    //add the customer data to the XML document
    Element customer = (Element) results.get(i);
    doc.add(customer);
}

tx.commit();
session.close();

```

```

Session session = factory.openSession();
Session dom4jSession = session.getSession(EntityMode.DOM4J);
Transaction tx = session.beginTransaction();

Element cust = (Element) dom4jSession.get("Customer", customerId);
for ( int i=0; i<results.size(); i++ ) {
    Element customer = (Element) results.get(i);
    //change the customer name in the XML and database
    Element name = customer.element("name");
    name.element("first-name").setText(firstName);
    name.element("initial").setText(initial);
    name.element("last-name").setText(lastName);
}

tx.commit();
session.close();

```

When implementing XML-based data import/export, it is useful to combine this feature with Hibernate's **replicate()** operation.

CHAPTER 19. IMPROVING PERFORMANCE

19.1. FETCHING STRATEGIES

Hibernate uses a *fetching strategy* to retrieve associated objects if the application needs to navigate the association. Fetch strategies can be declared in the O/R mapping metadata, or over-ridden by a particular HQL or **Criteria** query.

Hibernate3 defines the following fetching strategies:

- *Join fetching*: Hibernate retrieves the associated instance or collection in the same **SELECT**, using an **OUTER JOIN**.
- *Select fetching*: a second **SELECT** is used to retrieve the associated entity or collection. Unless you explicitly disable lazy fetching by specifying **lazy="false"**, this second select will only be executed when you access the association.
- *Subselect fetching*: a second **SELECT** is used to retrieve the associated collections for all entities retrieved in a previous query or fetch. Unless you explicitly disable lazy fetching by specifying **lazy="false"**, this second select will only be executed when you access the association.
- *Batch fetching*: an optimization strategy for select fetching. Hibernate retrieves a batch of entity instances or collections in a single **SELECT** by specifying a list of primary or foreign keys.

Hibernate also distinguishes between:

- *Immediate fetching*: an association, collection or attribute is fetched immediately when the owner is loaded.
- *Lazy collection fetching*: a collection is fetched when the application invokes an operation upon that collection. This is the default for collections.
- *"Extra-lazy" collection fetching*: individual elements of the collection are accessed from the database as needed. Hibernate tries not to fetch the whole collection into memory unless absolutely needed. It is suitable for large collections.
- *Proxy fetching*: a single-valued association is fetched when a method other than the identifier getter is invoked upon the associated object.
- *"No-proxy" fetching*: a single-valued association is fetched when the instance variable is accessed. Compared to proxy fetching, this approach is less lazy; the association is fetched even when only the identifier is accessed. It is also more transparent, since no proxy is visible to the application. This approach requires buildtime bytecode instrumentation and is rarely necessary.
- *Lazy attribute fetching*: an attribute or single valued association is fetched when the instance variable is accessed. This approach requires buildtime bytecode instrumentation and is rarely necessary.

We have two orthogonal notions here: *when* is the association fetched and *how* is it fetched. It is important that you do not confuse them. We use **fetch** to tune performance. We can use **lazy** to define a contract for what data is always available in any detached instance of a particular class.

19.1.1. Working with lazy associations

By default, Hibernate3 uses lazy select fetching for collections and lazy proxy fetching for single-valued associations. These defaults make sense for most associations in the majority of applications.

If you set `hibernate.default_batch_fetch_size`, Hibernate will use the batch fetch optimization for lazy fetching. This optimization can also be enabled at a more granular level.

Please be aware that access to a lazy association outside of the context of an open Hibernate session will result in an exception. For example:

```
s = sessions.openSession();
Transaction tx = s.beginTransaction();

User u = (User) s.createQuery("from User u where u.name=:userName")
    .setString("userName", userName).uniqueResult();
Map permissions = u.getPermissions();

tx.commit();
s.close();

Integer accessLevel = (Integer) permissions.get("accounts"); // Error!
```

Since the permissions collection was not initialized when the **Session** was closed, the collection will not be able to load its state. *Hibernate does not support lazy initialization for detached objects*. This can be fixed by moving the code that reads from the collection to just before the transaction is committed.

Alternatively, you can use a non-lazy collection or association, by specifying `lazy="false"` for the association mapping. However, it is intended that lazy initialization be used for almost all collections and associations. If you define too many non-lazy associations in your object model, Hibernate will fetch the entire database into memory in every transaction.

On the other hand, you can use join fetching, which is non-lazy by nature, instead of select fetching in a particular transaction. We will now explain how to customize the fetching strategy. In Hibernate3, the mechanisms for choosing a fetch strategy are identical for single-valued associations and collections.

19.1.2. Tuning fetch strategies

Select fetching (the default) is extremely vulnerable to N+1 selects problems, so we might want to enable join fetching in the mapping document:

```
<set name="permissions"
    fetch="join">
    <key column="userId"/>
    <one-to-many class="Permission"/>
</set

<many-to-one name="mother" class="Cat" fetch="join"/>
```

The **fetch** strategy defined in the mapping document affects:

- retrieval via `get()` or `load()`
- retrieval that happens implicitly when an association is navigated
- **Criteria** queries

- HQL queries if **subselect** fetching is used

Irrespective of the fetching strategy you use, the defined non-lazy graph is guaranteed to be loaded into memory. This might, however, result in several immediate selects being used to execute a particular HQL query.

Usually, the mapping document is not used to customize fetching. Instead, we keep the default behavior, and override it for a particular transaction, using **left join fetch** in HQL. This tells Hibernate to fetch the association eagerly in the first select, using an outer join. In the **Criteria** query API, you would use **setFetchMode(FetchMode.JOIN)**.

If you want to change the fetching strategy used by **get()** or **load()**, you can use a **Criteria** query. For example:

```
User user = (User) session.createCriteria(User.class)
    .setFetchMode("permissions", FetchMode.JOIN)
    .add( Restrictions.idEq(userId) )
    .uniqueResult();
```

This is Hibernate's equivalent of what some ORM solutions call a "fetch plan".

A completely different approach to problems with N+1 selects is to use the second-level cache.

19.1.3. Single-ended association proxies

Lazy fetching for collections is implemented using Hibernate's own implementation of persistent collections. However, a different mechanism is needed for lazy behavior in single-ended associations. The target entity of the association must be proxied. Hibernate implements lazy initializing proxies for persistent objects using runtime bytecode enhancement which is accessed via the CGLIB library.

At start up, Hibernate3 generates proxies by default for all persistent classes and uses them to enable lazy fetching of **many-to-one** and **one-to-one** associations.

The mapping file may declare an interface to use as the proxy interface for that class, with the **proxy** attribute. By default, Hibernate uses a subclass of the class. *The proxied class must implement a default constructor with at least package visibility. This constructor is recommended for all persistent classes.*

There are potential problems to note when extending this approach to polymorphic classes. For example:

```
<class name="Cat" proxy="Cat">
    .....
    <subclass name="DomesticCat">
        .....
    </subclass>
</class>
```

Firstly, instances of **Cat** will never be castable to **DomesticCat**, even if the underlying instance is an instance of **DomesticCat**:

```
Cat cat = (Cat) session.load(Cat.class, id); // instantiate a proxy (does
not hit the db)
if ( cat.isDomesticCat() ) { // hit the db to initialize
the proxy
```

```

        DomesticCat dc = (DomesticCat) cat;          // Error!
        ....
    }

```

Secondly, it is possible to break proxy ==:

```

Cat cat = (Cat) session.load(Cat.class, id);          // instantiate a
Cat proxy
DomesticCat dc =
    (DomesticCat) session.load(DomesticCat.class, id); // acquire new
DomesticCat proxy!
System.out.println(cat==dc);                          // false

```

However, the situation is not quite as bad as it looks. Even though we now have two references to different proxy objects, the underlying instance will still be the same object:

```

cat.setWeight(11.0); // hit the db to initialize the proxy
System.out.println( dc.getWeight() ); // 11.0

```

Third, you cannot use a CGLIB proxy for a **final** class or a class with any **final** methods.

Finally, if your persistent object acquires any resources upon instantiation (e.g. in initializers or default constructor), then those resources will also be acquired by the proxy. The proxy class is an actual subclass of the persistent class.

These problems are all due to fundamental limitations in Java's single inheritance model. To avoid these problems your persistent classes must each implement an interface that declares its business methods. You should specify these interfaces in the mapping file where **CatImpl** implements the interface **Cat** and **DomesticCatImpl** implements the interface **DomesticCat**. For example:

```

<class name="CatImpl" proxy="Cat">
    .....
    <subclass name="DomesticCatImpl" proxy="DomesticCat">
        .....
    </subclass>
</class>

```

Then proxies for instances of **Cat** and **DomesticCat** can be returned by **load()** or **iterate()**.

```

Cat cat = (Cat) session.load(CatImpl.class, catid);
Iterator iter = session.createQuery("from CatImpl as cat where
cat.name='fritz'").iterate();
Cat fritz = (Cat) iter.next();

```



NOTE

list() does not usually return proxies.

Relationships are also lazily initialized. This means you must declare any properties to be of type **Cat**, not **CatImpl**.

Certain operations do *not* require proxy initialization:

- `equals()`: if the persistent class does not override `equals()`
- `hashCode()`: if the persistent class does not override `hashCode()`
- The identifier getter method

Hibernate will detect persistent classes that override `equals()` or `hashCode()`.

By choosing `lazy="no-proxy"` instead of the default `lazy="proxy"`, you can avoid problems associated with typecasting. However, buildtime bytecode instrumentation is required, and all operations will result in immediate proxy initialization.

19.1.4. Initializing collections and proxies

A `LazyInitializationException` will be thrown by Hibernate if an uninitialized collection or proxy is accessed outside of the scope of the `Session`, i.e., when the entity owning the collection or having the reference to the proxy is in the detached state.

Sometimes a proxy or collection needs to be initialized before closing the `Session`. You can force initialization by calling `cat.getSex()` or `cat.getKittens().size()`, for example. However, this can be confusing to readers of the code and it is not convenient for generic code.

The static methods `Hibernate.initialize()` and `Hibernate.isInitialized()`, provide the application with a convenient way of working with lazily initialized collections or proxies. `Hibernate.initialize(cat)` will force the initialization of a proxy, `cat`, as long as its `Session` is still open. `Hibernate.initialize(cat.getKittens())` has a similar effect for the collection of kittens.

Another option is to keep the `Session` open until all required collections and proxies have been loaded. In some application architectures, particularly where the code that accesses data using Hibernate, and the code that uses it are in different application layers or different physical processes, it can be a problem to ensure that the `Session` is open when a collection is initialized. There are two basic ways to deal with this issue:

- In a web-based application, a servlet filter can be used to close the `Session` only at the end of a user request, once the rendering of the view is complete (the *Open Session in View* pattern). Of course, this places heavy demands on the correctness of the exception handling of your application infrastructure. It is vitally important that the `Session` is closed and the transaction ended before returning to the user, even when an exception occurs during rendering of the view. See the Hibernate Wiki for examples of this "Open Session in View" pattern.
- In an application with a separate business tier, the business logic must "prepare" all collections that the web tier needs before returning. This means that the business tier should load all the data and return all the data already initialized to the presentation/web tier that is required for a particular use case. Usually, the application calls `Hibernate.initialize()` for each collection that will be needed in the web tier (this call must occur before the session is closed) or retrieves the collection eagerly using a Hibernate query with a `FETCH` clause or a `FetchMode.JOIN` in `Criteria`. This is usually easier if you adopt the *Command* pattern instead of a *Session Facade*.
- You can also attach a previously loaded object to a new `Session` with `merge()` or `lock()` before accessing uninitialized collections or other proxies. Hibernate does not, and certainly *should not*, do this automatically since it would introduce impromptu transaction semantics.

Sometimes you do not want to initialize a large collection, but still need some information about it, like its size, for example, or a subset of the data.

You can use a collection filter to get the size of a collection without initializing it:

```
( (Integer) s.createFilter( collection, "select count(*)" ).list().get(0)
).intValue()
```

The `createFilter()` method is also used to efficiently retrieve subsets of a collection without needing to initialize the whole collection:

```
s.createFilter( lazyCollection,
    "").setFirstResult(0).setMaxResults(10).list();
```

19.1.5. Using batch fetching

Using batch fetching, Hibernate can load several uninitialized proxies if one proxy is accessed. Batch fetching is an optimization of the lazy select fetching strategy. There are two ways you can configure batch fetching: on the class level and the collection level.

Batch fetching for classes/entities is easier to understand. Consider the following example: at runtime you have 25 `Cat` instances loaded in a `Session`, and each `Cat` has a reference to its `owner`, a `Person`. The `Person` class is mapped with a proxy, `lazy="true"`. If you now iterate through all cats and call `getOwner()` on each, Hibernate will, by default, execute 25 `SELECT` statements to retrieve the proxied owners. You can tune this behavior by specifying a `batch-size` in the mapping of `Person`:

```
<class name="Person" batch-size="10">...</class>
```

Hibernate will now execute only three queries: the pattern is 10, 10, 5.

You can also enable batch fetching of collections. For example, if each `Person` has a lazy collection of `Cats`, and 10 persons are currently loaded in the `Session`, iterating through all persons will generate 10 `SELECTs`, one for every call to `getCats()`. If you enable batch fetching for the `cats` collection in the mapping of `Person`, Hibernate can pre-fetch collections:

```
<class name="Person">
    <set name="cats" batch-size="3">
        ...
    </set>
</class>
```

With a `batch-size` of 3, Hibernate will load 3, 3, 3, 1 collections in four `SELECTs`. Again, the value of the attribute depends on the expected number of uninitialized collections in a particular `Session`.

Batch fetching of collections is particularly useful if you have a nested tree of items, i.e. the typical bill-of-materials pattern. However, a *nested set* or a *materialized path* might be a better option for read-mostly trees.

19.1.6. Using subselect fetching

If one lazy collection or single-valued proxy has to be fetched, Hibernate will load all of them, re-running the original query in a subselect. This works in the same way as batch-fetching but without the piecemeal loading.

19.1.7. Using lazy property fetching

Hibernate3 supports the lazy fetching of individual properties. This optimization technique is also known as *fetch groups*. Please note that this is mostly a marketing feature; optimizing row reads is much more important than optimization of column reads. However, only loading some properties of a class could be useful in extreme cases. For example, when legacy tables have hundreds of columns and the data model cannot be improved.

To enable lazy property loading, set the **lazy** attribute on your particular property mappings:

```
<class name="Document">
  <id name="id">
    <generator class="native"/>
  </id>
  <property name="name" not-null="true" length="50"/>
  <property name="summary" not-null="true" length="200" lazy="true"/>
  <property name="text" not-null="true" length="2000" lazy="true"/>
</class>
```

Lazy property loading requires buildtime bytecode instrumentation. If your persistent classes are not enhanced, Hibernate will ignore lazy property settings and return to immediate fetching.

For bytecode instrumentation, use the following Ant task:

```
<target name="instrument" depends="compile">
  <taskdef name="instrument"
    classname="org.hibernate.tool.instrument.InstrumentTask">
    <classpath path="${jar.path}"/>
    <classpath path="${classes.dir}"/>
    <classpath refid="lib.class.path"/>
  </taskdef>

  <instrument verbose="true">
    <fileset dir="${testclasses.dir}/org/hibernate/auction/model">
      <include name="*.class"/>
    </fileset>
  </instrument>
</target>
```

A different way of avoiding unnecessary column reads, at least for read-only transactions, is to use the projection features of HQL or Criteria queries. This avoids the need for buildtime bytecode processing and is certainly a preferred solution.

You can force the usual eager fetching of properties using **fetch all properties** in HQL.

19.2. THE SECOND LEVEL CACHE

A Hibernate **Session** is a transaction-level cache of persistent data. It is possible to configure a cluster or JVM-level (**SessionFactory**-level) cache on a class-by-class and collection-by-collection basis. You can even plug in a clustered cache. Be aware that caches are not aware of changes made to the persistent store by another application. They can, however, be configured to regularly expire cached data.

You have the option to tell Hibernate which caching implementation to use by specifying the name of a class that implements **org.hibernate.cache.CacheProvider** using the property

hibernate.cache.provider_class. Hibernate is bundled with a number of built-in integrations with the open-source cache providers that are listed below. You can also implement your own and plug it in as outlined above.

Table 19.1. Cache Providers

Cache	Provider class	Type	Cluster Safe	Query Cache Supported
Hashtable (not intended for production use)	org.hibernate.cache.HashtableCacheProvider	memory		yes
EHCache	org.hibernate.cache.EhCacheProvider	memory, disk		yes
OSCache	org.hibernate.cache.OSCacheProvider	memory, disk		yes
SwarmCache	org.hibernate.cache.SwarmCacheProvider	clustered (ip multicast)	yes (clustered invalidation)	
JBoss Cache 1.x	org.hibernate.cache.TreeCacheProvider	clustered (ip multicast), transactional	yes (replication)	yes (clock sync req.)
JBoss Cache 2	org.hibernate.cache.jbc2.JBossCacheRegionFactory	clustered (ip multicast), transactional	yes (replication or invalidation)	yes (clock sync req.)

19.2.1. Cache mappings

The `<cache>` element of a class or collection mapping has the following form:

```

<cache
  usage="transactional|read-write|nonstrict-read-write|read-only"
  1
  region="RegionName"
  2
  include="all|non-lazy"
  3
/>
    
```

❶	usage (required) specifies the caching strategy: transactional , read-write , nonstrict-read-write or read-only
❷	region (optional: defaults to the class or collection role name): specifies the name of the second level cache region
❸	include (optional: defaults to all) non-lazy : specifies that properties of the entity mapped with lazy="true" cannot be cached when attribute-level lazy fetching is enabled

Alternatively, you can specify `<class-cache>` and `<collection-cache>` elements in `hibernate.cfg.xml`.

The **usage** attribute specifies a *cache concurrency strategy*.

19.2.2. Strategy: read only

If your application needs to read, but not modify, instances of a persistent class, a **read-only** cache can be used. This is the simplest and optimal performing strategy. It is even safe for use in a cluster.

```
<class name="eg.Immutable" mutable="false">
  <cache usage="read-only"/>
  ....
</class>
```

19.2.3. Strategy: read/write

If the application needs to update data, a **read-write** cache might be appropriate. This cache strategy should never be used if serializable transaction isolation level is required. If the cache is used in a JTA environment, you must specify the property `hibernate.transaction.manager_lookup_class` and naming a strategy for obtaining the JTA `TransactionManager`. In other environments, you should ensure that the transaction is completed when `Session.close()` or `Session.disconnect()` is called. If you want to use this strategy in a cluster, you should ensure that the underlying cache implementation supports locking. The built-in cache providers *do not* support locking.

```
<class name="eg.Cat" .... >
  <cache usage="read-write"/>
  ....
  <set name="kittens" ... >
    <cache usage="read-write"/>
    ....
  </set>
</class>
```

19.2.4. Strategy: nonstrict read/write

If the application only occasionally needs to update data (i.e. if it is extremely unlikely that two transactions would try to update the same item simultaneously), and strict transaction isolation is not required, a **nonstrict-read-write** cache might be appropriate. If the cache is used in a JTA

environment, you must specify `hibernate.transaction.manager_lookup_class`. In other environments, you should ensure that the transaction is completed when `Session.close()` or `Session.disconnect()` is called.

19.2.5. Strategy: transactional

The `transactional` cache strategy provides support for fully transactional cache providers such as JBoss TreeCache. Such a cache can only be used in a JTA environment and you must specify `hibernate.transaction.manager_lookup_class`.

19.2.6. Cache-provider/concurrency-strategy compatibility



IMPORTANT

None of the cache providers support all of the cache concurrency strategies.

The following table shows which providers are compatible with which concurrency strategies.

Table 19.2. Cache Concurrency Strategy Support

Cache	read-only	nonstrict-read-write	read-write	transactional
Hashtable (not intended for production use)	yes	yes	yes	
EHCache	yes	yes	yes	
OSCache	yes	yes	yes	
SwarmCache	yes	yes		
JBoss Cache 1.x	yes			yes
JBoss Cache 2	yes			yes

19.3. MANAGING THE CACHES

Whenever you pass an object to `save()`, `update()` or `saveOrUpdate()`, and whenever you retrieve an object using `load()`, `get()`, `list()`, `iterate()` or `scroll()`, that object is added to the internal cache of the `Session`.

When `flush()` is subsequently called, the state of that object will be synchronized with the database. If you do not want this synchronization to occur, or if you are processing a huge number of objects and need to manage memory efficiently, the `evict()` method can be used to remove the object and its collections from the first-level cache.

```
ScrollableResults cats = sess.createQuery("from Cat as cat").scroll(); //a
huge result set
```

```
while ( cats.next() ) {
    Cat cat = (Cat) cats.get(0);
    doSomethingWithACat(cat);
    sess.evict(cat);
}
```

The **Session** also provides a **contains()** method to determine if an instance belongs to the session cache.

To evict all objects from the session cache, call **Session.clear()**

For the second-level cache, there are methods defined on **SessionFactory** for evicting the cached state of an instance, entire class, collection instance or entire collection role.

```
sessionFactory.evict(Cat.class, catId); //evict a particular Cat
sessionFactory.evict(Cat.class); //evict all Cats
sessionFactory.evictCollection("Cat.kittens", catId); //evict a particular
collection of kittens
sessionFactory.evictCollection("Cat.kittens"); //evict all kitten
collections
```



NOTE

This method is invoked as a result of the application using the `SessionFactory.evictXXX(..., Serializable id)` API. Applications using this API should recognize that calls to it may block waiting for other transactions to complete with a JBoss Cache based Second Level Cache.

Further, such calls that occur in the middle of a transaction will hold locks until the transaction commits and will not update other nodes until the transaction commits. If this is a problem, it may be helpful to do the eviction before the transaction begins or after it commits.

The **CacheMode** controls how a particular session interacts with the second-level cache:

- **CacheMode.NORMAL**: will read items from and write items to the second-level cache
- **CacheMode.GET**: will read items from the second-level cache. Do not write to the second-level cache except when updating data
- **CacheMode.PUT**: will write items to the second-level cache. Do not read from the second-level cache
- **CacheMode.REFRESH**: will write items to the second-level cache. Do not read from the second-level cache. Bypass the effect of `hibernate.cache.use_minimal_puts` forcing a refresh of the second-level cache for all items read from the database

To browse the contents of a second-level or query cache region, use the **Statistics** API:

```
Map cacheEntries = sessionFactory.getStatistics()
    .getSecondLevelCacheStatistics(regionName)
    .getEntries();
```

You will need to enable statistics and, optionally, force Hibernate to keep the cache entries in a more readable format:

```
hibernate.generate_statistics true
hibernate.cache.use_structured_entries true
```

19.4. THE QUERY CACHE

Query result sets can also be cached. This is only useful for queries that are run frequently with the same parameters. You will first need to enable the query cache:

```
hibernate.cache.use_query_cache true
```

This setting creates two new cache regions: one holding cached query result sets (**org.hibernate.cache.StandardQueryCache**), the other holding timestamps of the most recent updates to queryable tables (**org.hibernate.cache.UpdateTimestampsCache**). Note that the query cache does not cache the state of the actual entities in the result set; it caches only identifier values and results of value type. The query cache should always be used in conjunction with the second-level cache.

Most queries do not benefit from caching, so by default, queries are not cached. To enable caching, call **Query.setCacheable(true)**. This call allows the query to look for existing cache results or add its results to the cache when it is executed.

If you require fine-grained control over query cache expiration policies, you can specify a named cache region for a particular query by calling **Query.setCacheRegion()**.

```
List blogs = sess.createQuery("from Blog blog where blog.blogger =
:blogger")
    .setEntity("blogger", blogger)
    .setMaxResults(15)
    .setCacheable(true)
    .setCacheRegion("frontpages")
    .list();
```

If the query should force a refresh of its query cache region, you should call **Query.setCacheMode(CacheMode.REFRESH)**. This is particularly useful in cases where underlying data may have been updated via a separate process (i.e., not modified through Hibernate) and allows the application to selectively refresh particular query result sets. This is a more efficient alternative to eviction of a query cache region via **SessionFactory.evictQueries()**.

19.5. UNDERSTANDING COLLECTION PERFORMANCE

In the previous sections we have covered collections and their applications. In this section we explore some more issues in relation to collections at runtime.

19.5.1. Taxonomy

Hibernate defines three basic kinds of collections:

- collections of values
- one-to-many associations

- many-to-many associations

This classification distinguishes the various table and foreign key relationships but does not tell us quite everything we need to know about the relational model. To fully understand the relational structure and performance characteristics, we must also consider the structure of the primary key that is used by Hibernate to update or delete collection rows. This suggests the following classification:

- indexed collections
- sets
- bags

All indexed collections (maps, lists, and arrays) have a primary key consisting of the `<key>` and `<index>` columns. In this case, collection updates are extremely efficient. The primary key can be efficiently indexed and a particular row can be efficiently located when Hibernate tries to update or delete it.

Sets have a primary key consisting of `<key>` and element columns. This can be less efficient for some types of collection element, particularly composite elements or large text or binary fields, as the database may not be able to index a complex primary key as efficiently. However, for one-to-many or many-to-many associations, particularly in the case of synthetic identifiers, it is likely to be just as efficient. If you want `SchemaExport` to actually create the primary key of a `<set>`, you must declare all columns as `not-null="true"`.

`<idbag>` mappings define a surrogate key, so they are efficient to update. In fact, they are the best case.

Bags are the worst case since they permit duplicate element values and, as they have no index column, no primary key can be defined. Hibernate has no way of distinguishing between duplicate rows. Hibernate resolves this problem by completely removing in a single `DELETE` and recreating the collection whenever it changes. This can be inefficient.

For a one-to-many association, the "primary key" may not be the physical primary key of the database table. Even in this case, the above classification is still useful. It reflects how Hibernate "locates" individual rows of the collection.

19.5.2. Lists, maps, idbags and sets are the most efficient collections to update

From the discussion above, it should be clear that indexed collections and sets allow the most efficient operation in terms of adding, removing and updating elements.

There is, arguably, one more advantage that indexed collections have over sets for many-to-many associations or collections of values. Because of the structure of a `Set`, Hibernate does not `UPDATE` a row when an element is "changed". Changes to a `Set` always work via `INSERT` and `DELETE` of individual rows. Once again, this consideration does not apply to one-to-many associations.

After observing that arrays cannot be lazy, you can conclude that lists, maps and idbags are the most performant (non-inverse) collection types, with sets not far behind. You can expect sets to be the most common kind of collection in Hibernate applications. This is because the "set" semantics are most natural in the relational model.

However, in well-designed Hibernate domain models, most collections are in fact one-to-many associations with `inverse="true"`. For these associations, the update is handled by the many-to-one end of the association, and so considerations of collection update performance simply do not apply.

19.5.3. Bags and lists are the most efficient inverse collections

There is a particular case, however, in which bags, and also lists, are much more performant than sets. For a collection with `inverse="true"`, the standard bidirectional one-to-many relationship idiom, for example, we can add elements to a bag or list without needing to initialize (fetch) the bag elements. This is because, unlike a `set`, `Collection.add()` or `Collection.addAll()` must always return true for a bag or `List`. This can make the following common code much faster:

```
Parent p = (Parent) sess.load(Parent.class, id);
Child c = new Child();
c.setParent(p);
p.getChildren().add(c); //no need to fetch the collection!
sess.flush();
```

19.5.4. One shot delete

Deleting collection elements one by one can sometimes be extremely inefficient. Hibernate knows not to do that in the case of an newly-empty collection (if you called `list.clear()`, for example). In this case, Hibernate will issue a single **DELETE**.

Suppose you added a single element to a collection of size twenty and then remove two elements. Hibernate will issue one **INSERT** statement and two **DELETE** statements, unless the collection is a bag. This is certainly desirable.

However, suppose that we remove eighteen elements, leaving two and then add three new elements. There are two possible ways to proceed

- delete eighteen rows one by one and then insert three rows
- remove the whole collection in one SQL **DELETE** and insert all five current elements one by one

Hibernate cannot know that the second option is probably quicker. It would probably be undesirable for Hibernate to be that intuitive as such behavior might confuse database triggers, etc.

Fortunately, you can force this behavior (i.e. the second strategy) at any time by discarding (i.e. dereferencing) the original collection and returning a newly instantiated collection with all the current elements.

One-shot-delete does not apply to collections mapped `inverse="true"`.

19.6. MONITORING PERFORMANCE

Optimization is not much use without monitoring and access to performance numbers. Hibernate provides a full range of figures about its internal operations. Statistics in Hibernate are available per **SessionFactory**.

19.6.1. Monitoring a SessionFactory

You can access **SessionFactory** metrics in two ways. Your first option is to call `sessionFactory.getStatistics()` and read or display the **Statistics** yourself.

Hibernate can also use JMX to publish metrics if you enable the **StatisticsService** MBean. You can enable a single MBean for all your **SessionFactory** or one per factory. See the following code for minimalistic configuration examples:


```
// MBean service registration for a specific SessionFactory
Hashtable tb = new Hashtable();
tb.put("type", "statistics");
tb.put("sessionFactory", "myFinancialApp");
ObjectName on = new ObjectName("hibernate", tb); // MBean object name

StatisticsService stats = new StatisticsService(); // MBean implementation
stats.setSessionFactory(sessionFactory); // Bind the stats to a
SessionFactory
server.registerMBean(stats, on); // Register the Mbean on the server

// MBean service registration for all SessionFactory's
Hashtable tb = new Hashtable();
tb.put("type", "statistics");
tb.put("sessionFactory", "all");
ObjectName on = new ObjectName("hibernate", tb); // MBean object name

StatisticsService stats = new StatisticsService(); // MBean implementation
server.registerMBean(stats, on); // Register the MBean on the server
```

You can activate and deactivate the monitoring for a **SessionFactory**:

- at configuration time, set **hibernate.generate_statistics** to **false**
- at runtime: **sf.getStatistics().setStatisticsEnabled(true)** or **hibernateStatsBean.setStatisticsEnabled(true)**

Statistics can be reset programmatically using the **clear()** method. A summary can be sent to a logger (info level) using the **logSummary()** method.

19.6.2. Metrics

Hibernate provides a number of metrics, from basic information to more specialized information that is only relevant in certain scenarios. All available counters are described in the **Statistics** interface API, in three categories:

- Metrics related to the general **Session** usage, such as number of open sessions, retrieved JDBC connections, etc.
- Metrics related to the entities, collections, queries, and caches as a whole (aka global metrics).
- Detailed metrics related to a particular entity, collection, query or cache region.

For example, you can check the cache hit, miss, and put ratio of entities, collections and queries, and the average time a query needs. Be aware that the number of milliseconds is subject to approximation in Java. Hibernate is tied to the JVM precision and on some platforms this might only be accurate to 10 seconds.

Simple getters are used to access the global metrics (i.e. not tied to a particular entity, collection, cache region, etc.). You can access the metrics of a particular entity, collection or cache region through its name, and through its HQL or SQL representation for queries. Please refer to the **Statistics**, **EntityStatistics**, **CollectionStatistics**, **SecondLevelCacheStatistics**, and **QueryStatistics** API Javadoc for more information. The following code is a simple example:

```
Statistics stats = HibernateUtil.sessionFactory.getStatistics();

double queryCacheHitCount = stats.getQueryCacheHitCount();
double queryCacheMissCount = stats.getQueryCacheMissCount();
double queryCacheHitRatio =
    queryCacheHitCount / (queryCacheHitCount + queryCacheMissCount);

log.info("Query Hit ratio:" + queryCacheHitRatio);

EntityStatistics entityStats =
    stats.getEntityStatistics( Cat.class.getName() );
long changes =
    entityStats.getInsertCount()
    + entityStats.getUpdateCount()
    + entityStats.getDeleteCount();
log.info(Cat.class.getName() + " changed " + changes + "times" );
```

You can work on all entities, collections, queries and region caches, by retrieving the list of names of entities, collections, queries and region caches using the following methods: **getQueries()**, **getEntityNames()**, **getCollectionRoleNames()**, and **getSecondLevelCacheRegionNames()**.

CHAPTER 20. TOOLSET GUIDE

Roundtrip engineering with Hibernate is possible using a set of Eclipse plug-ins, command line tools, and Ant tasks.

Hibernate Tools currently include plug-ins for the Eclipse IDE as well as Ant tasks for reverse engineering of existing databases:

- *Mapping Editor*: an editor for Hibernate XML mapping files that supports auto-completion and syntax highlighting. It also supports semantic auto-completion for class names and property/field names, making it more versatile than a normal XML editor.
- *Console*: the console is a new view in Eclipse. In addition to a tree overview of your console configurations, you are also provided with an interactive view of your persistent classes and their relationships. The console allows you to execute HQL queries against your database and browse the result directly in Eclipse.
- *Development Wizards*: several wizards are provided with the Hibernate Eclipse tools. You can use a wizard to quickly generate Hibernate configuration (cfg.xml) files, or to reverse engineer an existing database schema into POJO source files and Hibernate mapping files. The reverse engineering wizard supports customizable templates.
-

Please refer to the *Hibernate Tools* package documentation for more information.

However, the Hibernate main package comes bundled with an integrated tool: *SchemaExport* aka **hbm2ddl**. It can even be used from "inside" Hibernate.

20.1. AUTOMATIC SCHEMA GENERATION

DDL can be generated from your mapping files by a Hibernate utility. The generated schema includes referential integrity constraints, primary and foreign keys, for entity and collection tables. Tables and sequences are also created for mapped identifier generators.

You *must* specify a SQL **Dialect** via the **hibernate.dialect** property when using this tool, as DDL is highly vendor-specific.

First, you must customize your mapping files to improve the generated schema. The next section covers schema customization.

20.1.1. Customizing the schema

Many Hibernate mapping elements define optional attributes named **length**, **precision** and **scale**. You can set the length, precision and scale of a column with this attribute.

```
<property name="zip" length="5"/>
```

```
<property name="balance" precision="12" scale="2"/>
```

Some tags also accept a **not-null** attribute for generating a **NOT NULL** constraint on table columns, and a **unique** attribute for generating **UNIQUE** constraint on table columns.

```
<many-to-one name="bar" column="barId" not-null="true"/>
```

```
<element column="serialNumber" type="long" not-null="true" unique="true"/>
```

A **unique-key** attribute can be used to group columns in a single, unique key constraint. Currently, the specified value of the **unique-key** attribute is *not* used to name the constraint in the generated DDL. It is only used to group the columns in the mapping file.

```
<many-to-one name="org" column="orgId" unique-key="OrgEmployeeId"/>
<property name="employeeId" unique-key="OrgEmployee"/>
```

An **index** attribute specifies the name of an index that will be created using the mapped column or columns. Multiple columns can be grouped into the same index by simply specifying the same index name.

```
<property name="lastName" index="CustName"/>
<property name="firstName" index="CustName"/>
```

A **foreign-key** attribute can be used to override the name of any generated foreign key constraint.

```
<many-to-one name="bar" column="barId" foreign-key="FKFooBar"/>
```

Many mapping elements also accept a child **<column>** element. This is particularly useful for mapping multi-column types:

```
<property name="name" type="my.customtypes.Name"/>
  <column name="last" not-null="true" index="bar_idx" length="30"/>
  <column name="first" not-null="true" index="bar_idx" length="20"/>
  <column name="initial"/>
</property>
```

The **default** attribute allows you to specify a default value for a column. You should assign the same value to the mapped property before saving a new instance of the mapped class.

```
<property name="credits" type="integer" insert="false">
  <column name="credits" default="10"/>
</property>
```

```
<version name="version" type="integer" insert="false">
  <column name="version" default="0"/>
</property>
```

The **sql-type** attribute allows the user to override the default mapping of a Hibernate type to SQL datatype.

```
<property name="balance" type="float">
  <column name="balance" sql-type="decimal(13,3)"/>
</property>
```

The **check** attribute allows you to specify a check constraint.

```
<property name="foo" type="integer">
  <column name="foo" check="foo > 10"/>
</property>
```

```

<class name="Foo" table="foos" check="bar < 100.0">
  ...
  <property name="bar" type="float"/>
</class>

```

The following table summarizes these optional attributes.

Table 20.1. Summary

Attribute	Values	Interpretation
length	number	column length
precision	number	column decimal precision
scale	number	column decimal scale
not-null	true false	specifies that the column should be non-nullable
unique	true false	specifies that the column should have a unique constraint
index	index_name	specifies the name of a (multi-column) index
unique-key	unique_key_name	specifies the name of a multi-column unique constraint
foreign-key	foreign_key_name	specifies the name of the foreign key constraint generated for an association, for a <one-to-one> , <many-to-one> , <key> , or <many-to-many> mapping element. Note that inverse="true" sides will not be considered by SchemaExport .
sql-type	SQL column type	overrides the default column type (attribute of <column> element only)
default	SQL expression	specify a default value for the column
check	SQL expression	create an SQL check constraint on either column or table

The **<comment>** element allows you to specify comments for the generated schema.

```

<class name="Customer" table="CurCust">
  <comment>Current customers only</comment>
  ...
</class>
    
```

```

<property name="balance">
  <column name="bal">
    <comment>Balance in USD</comment>
  </column>
</property>
    
```

This results in a **comment on table** or **comment on column** statement in the generated DDL where supported.

20.1.2. Running the tool

The **SchemaExport** tool writes a DDL script to standard out and/or executes the DDL statements.

The following table displays the **SchemaExport** command line options

```

java -cp hibernate_classpaths org.hibernate.tool.hbm2ddl.SchemaExport options
mapping_files
    
```

Table 20.2. SchemaExport Command Line Options

Option	Description
--quiet	do not output the script to stdout
--drop	only drop the tables
--create	only create the tables
--text	do not export to the database
--output=my_schema.ddl	output the ddl script to a file
--naming=eg.MyNamingStrategy	select a NamingStrategy
--config=hibernate.cfg.xml	read Hibernate configuration from an XML file
--properties=hibernate.properties	read database properties from a file
--format	format the generated SQL nicely in the script

Option	Description
<code>--delimiter=;</code>	set an end of line delimiter for the script

You can even embed **SchemaExport** in your application:

```
Configuration cfg = ....;
new SchemaExport(cfg).create(false, true);
```

20.1.3. Properties

Database properties can be specified:

- as system properties with `-D<property>`
- in `hibernate.properties`
- in a named properties file with `--properties`

The needed properties are:

Table 20.3. SchemaExport Connection Properties

Property Name	Description
<code>hibernate.connection.driver_class</code>	jdbc driver class
<code>hibernate.connection.url</code>	jdbc url
<code>hibernate.connection.username</code>	database user
<code>hibernate.connection.password</code>	user password
<code>hibernate.dialect</code>	dialect

20.1.4. Using Ant

You can call **SchemaExport** from your Ant build script:

```
<target name="schemaexport">
  <taskdef name="schemaexport"
    classname="org.hibernate.tool.hbm2ddl.SchemaExportTask"
    classpathref="class.path"/>

  <schemaexport
    properties="hibernate.properties"
```

```

        quiet="no"
        text="no"
        drop="no"
        delimiter=";"
        output="schema-export.sql">
        <fileset dir="src">
            <include name="**/*.hbm.xml"/>
        </fileset>
    </schemaexport>
</target>

```

20.1.5. Incremental schema updates

The **SchemaUpdate** tool will update an existing schema with "incremental" changes. The **SchemaUpdate** depends upon the JDBC metadata API and, as such, will not work with all JDBC drivers.

```

java -cp hibernate_classpaths org.hibernate.tool.hbm2ddl.SchemaUpdate options
mapping_files

```

Table 20.4. SchemaUpdate Command Line Options

Option	Description
--quiet	do not output the script to stdout
--text	do not export the script to the database
--naming=eg.MyNamingStrategy	select a NamingStrategy
--properties=hibernate.properties	read database properties from a file
--config=hibernate.cfg.xml	specify a .cfg.xml file

You can embed **SchemaUpdate** in your application:

```

Configuration cfg = ....;
new SchemaUpdate(cfg).execute(false);

```

20.1.6. Using Ant for incremental schema updates

You can call **SchemaUpdate** from the Ant script:

```

<target name="schemaupdate">
    <taskdef name="schemaupdate"
        classname="org.hibernate.tool.hbm2ddl.SchemaUpdateTask"

```



```

        classpathref="class.path"/>
    <schemaupdate
        properties="hibernate.properties"
        quiet="no">
        <fileset dir="src">
            <include name="**/*.hbm.xml"/>
        </fileset>
    </schemaupdate>
</target>

```

20.1.7. Schema validation

The **SchemaValidator** tool will validate that the existing database schema "matches" your mapping documents. The **SchemaValidator** depends heavily upon the JDBC metadata API and, as such, will not work with all JDBC drivers. This tool is extremely useful for testing.

```
java -cp hibernate_classpaths org.hibernate.tool.hbm2ddl.SchemaValidator options
mapping_files
```

The following table displays the **SchemaValidator** command line options:

Table 20.5. SchemaValidator Command Line Options

Option	Description
-- naming=eg.MyNamingStrategy	select a NamingStrategy
-- properties=hibernate.properties	read database properties from a file
-- config=hibernate.cfg.xml	specify a .cfg.xml file

You can embed **SchemaValidator** in your application:

```

Configuration cfg = ....;
new SchemaValidator(cfg).validate();

```

20.1.8. Using Ant for schema validation

You can call **SchemaValidator** from the Ant script:

```

<target name="schemavalidate">
    <taskdef name="schemavalidator"
        classname="org.hibernate.tool.hbm2ddl.SchemaValidatorTask"
        classpathref="class.path"/>

```

```
<schemavalidator
  properties="hibernate.properties">
  <fileset dir="src">
    <include name="**/*.hbm.xml"/>
  </fileset>
</schemavalidator>
</target>
```

CHAPTER 21. EXAMPLE: PARENT/CHILD

One of the first things that new users want to do with Hibernate is to model a parent/child type relationship. There are two different approaches to this. The most convenient approach, especially for new users, is to model both **Parent** and **Child** as entity classes with a **<one-to-many>** association from **Parent** to **Child**. The alternative approach is to declare the **Child** as a **<composite-element>**. The default semantics of a one-to-many association in Hibernate are much less close to the usual semantics of a parent/child relationship than those of a composite element mapping. We will explain how to use a *bidirectional one-to-many association with cascades* to model a parent/child relationship efficiently and elegantly.

21.1. A NOTE ABOUT COLLECTIONS

Hibernate collections are considered to be a logical part of their owning entity and not of the contained entities. Be aware that this is a critical distinction that has the following consequences:

- When you remove/add an object from/to a collection, the version number of the collection owner is incremented.
- If an object that was removed from a collection is an instance of a value type (e.g. a composite element), that object will cease to be persistent and its state will be completely removed from the database. Likewise, adding a value type instance to the collection will cause its state to be immediately persistent.
- Conversely, if an entity is removed from a collection (a one-to-many or many-to-many association), it will not be deleted by default. This behavior is completely consistent; a change to the internal state of another entity should not cause the associated entity to vanish. Likewise, adding an entity to a collection does not cause that entity to become persistent, by default.

Adding an entity to a collection, by default, merely creates a link between the two entities. Removing the entity will remove the link. This is appropriate for all sorts of cases. However, it is not appropriate in the case of a parent/child relationship. In this case, the life of the child is bound to the life cycle of the parent.

21.2. BIDIRECTIONAL ONE-TO-MANY

Suppose we start with a simple **<one-to-many>** association from **Parent** to **Child**.

```
<set name="children">
  <key column="parent_id"/>
  <one-to-many class="Child"/>
</set>
```

If we were to execute the following code:

```
Parent p = .....;
Child c = new Child();
p.getChildren().add(c);
session.save(c);
session.flush();
```

Hibernate would issue two SQL statements:

- an **INSERT** to create the record for **c**

- an **UPDATE** to create the link from **p** to **c**

This is not only inefficient, but also violates any **NOT NULL** constraint on the **parent_id** column. You can fix the nullability constraint violation by specifying **not-null="true"** in the collection mapping:

```
<set name="children">
  <key column="parent_id" not-null="true"/>
  <one-to-many class="Child"/>
</set>
```

However, this is not the recommended solution.

The underlying cause of this behavior is that the link (the foreign key **parent_id**) from **p** to **c** is not considered part of the state of the **Child** object and is therefore not created in the **INSERT**. The solution is to make the link part of the **Child** mapping.

```
<many-to-one name="parent" column="parent_id" not-null="true"/>
```

You also need to add the **parent** property to the **Child** class.

Now that the **Child** entity is managing the state of the link, we tell the collection not to update the link. We use the **inverse** attribute to do this:

```
<set name="children" inverse="true">
  <key column="parent_id"/>
  <one-to-many class="Child"/>
</set>
```

The following code would be used to add a new **Child**:

```
Parent p = (Parent) session.load(Parent.class, pid);
Child c = new Child();
c.setParent(p);
p.getChildren().add(c);
session.save(c);
session.flush();
```

Only one SQL **INSERT** would now be issued.

You could also create an **addChild()** method of **Parent**.

```
public void addChild(Child c) {
    c.setParent(this);
    children.add(c);
}
```

The code to add a **Child** looks like this:

```
Parent p = (Parent) session.load(Parent.class, pid);
Child c = new Child();
p.addChild(c);
session.save(c);
session.flush();
```

21.3. CASCADING LIFE CYCLE

You can address the frustrations of the explicit call to `save()` by using cascades.

```
<set name="children" inverse="true" cascade="all">
  <key column="parent_id"/>
  <one-to-many class="Child"/>
</set>
```

This simplifies the code above to:

```
Parent p = (Parent) session.load(Parent.class, pid);
Child c = new Child();
p.addChild(c);
session.flush();
```

Similarly, we do not need to iterate over the children when saving or deleting a **Parent**. The following removes **p** and all its children from the database.

```
Parent p = (Parent) session.load(Parent.class, pid);
session.delete(p);
session.flush();
```

However, the following code:

```
Parent p = (Parent) session.load(Parent.class, pid);
Child c = (Child) p.getChildren().iterator().next();
p.getChildren().remove(c);
c.setParent(null);
session.flush();
```

will not remove **c** from the database. In this case, it will only remove the link to **p** and cause a **NOT NULL** constraint violation. You need to explicitly `delete()` the **Child**.

```
Parent p = (Parent) session.load(Parent.class, pid);
Child c = (Child) p.getChildren().iterator().next();
p.getChildren().remove(c);
session.delete(c);
session.flush();
```

In our case, a **Child** cannot exist without its parent. So if we remove a **Child** from the collection, we do want it to be deleted. To do this, we must use `cascade="all-delete-orphan"`.

```
<set name="children" inverse="true" cascade="all-delete-orphan">
  <key column="parent_id"/>
  <one-to-many class="Child"/>
</set>
```

Even though the collection mapping specifies `inverse="true"`, cascades are still processed by iterating the collection elements. If you need an object be saved, deleted or updated by cascade, you must add it to the collection. It is not enough to simply call `setParent()`.

21.4. CASCADES AND UNSAVED-VALUE

Suppose we loaded up a **Parent** in one **Session**, made some changes in a UI action and wanted to persist these changes in a new session by calling `update()`. The **Parent** will contain a collection of children and, since the cascading update is enabled, Hibernate needs to know which children are newly instantiated and which represent existing rows in the database. We will also assume that both **Parent** and **Child** have generated identifier properties of type **Long**. Hibernate will use the identifier and version/timestamp property value to determine which of the children are new. (See [Section 10.7, “Automatic state detection”](#).) *In Hibernate3, it is no longer necessary to specify an **unsaved-value** explicitly.*

The following code will update **parent** and **child** and insert **newChild**:

```
//parent and child were both loaded in a previous session
parent.addChild(child);
Child newChild = new Child();
parent.addChild(newChild);
session.update(parent);
session.flush();
```

This may be suitable for the case of a generated identifier, but what about assigned identifiers and composite identifiers? This is more difficult, since Hibernate cannot use the identifier property to distinguish between a newly instantiated object, with an identifier assigned by the user, and an object loaded in a previous session. In this case, Hibernate will either use the timestamp or version property, or will actually query the second-level cache or, worst case, the database, to see if the row exists.

21.5. CONCLUSION

The sections we have just covered can be a bit confusing. However, in practice, it all works out nicely. Most Hibernate applications use the parent/child pattern in many places.

We mentioned an alternative in the first paragraph. None of the above issues exist in the case of **<composite-element>** mappings, which have exactly the semantics of a parent/child relationship. Unfortunately, there are two big limitations with composite element classes: composite elements cannot own collections and they should not be the child of any entity other than the unique parent.

CHAPTER 22. EXAMPLE: WEBLOG APPLICATION

22.1. PERSISTENT CLASSES

The persistent classes here represent a weblog and an item posted in a weblog. They are to be modelled as a standard parent/child relationship, but we will use an ordered bag, instead of a set:

```
package eg;

import java.util.List;

public class Blog {
    private Long _id;
    private String _name;
    private List _items;

    public Long getId() {
        return _id;
    }
    public List getItems() {
        return _items;
    }
    public String getName() {
        return _name;
    }
    public void setId(Long long1) {
        _id = long1;
    }
    public void setItems(List list) {
        _items = list;
    }
    public void setName(String string) {
        _name = string;
    }
}
```

```
package eg;

import java.text.DateFormat;
import java.util.Calendar;

public class BlogItem {
    private Long _id;
    private Calendar _datetime;
    private String _text;
    private String _title;
    private Blog _blog;

    public Blog getBlog() {
        return _blog;
    }
    public Calendar getDatetime() {
        return _datetime;
    }
}
```

```

public Long getId() {
    return _id;
}
public String getText() {
    return _text;
}
public String getTitle() {
    return _title;
}
public void setBlog(Blog blog) {
    _blog = blog;
}
public void setDatetime(Calendar calendar) {
    _datetime = calendar;
}
public void setId(Long long1) {
    _id = long1;
}
public void setText(String string) {
    _text = string;
}
public void setTitle(String string) {
    _title = string;
}
}
    
```

22.2. HIBERNATE MAPPINGS

The XML mappings are now straightforward. For example:

```

<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
    "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
    "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="eg">

    <class
        name="Blog"
        table="BLOGS">

        <id
            name="id"
            column="BLOG_ID">

            <generator class="native"/>

        </id>

        <property
            name="name"
            column="NAME"
            not-null="true"
            unique="true"/>
    
```



```

    <bag
      name="items"
      inverse="true"
      order-by="DATE_TIME"
      cascade="all">

      <key column="BLOG_ID"/>
      <one-to-many class="BlogItem"/>

    </bag>

  </class>
</hibernate-mapping>

<?xml version="1.0"?>
<!DOCTYPE hibernate-mapping PUBLIC
  "-//Hibernate/Hibernate Mapping DTD 3.0//EN"
  "http://hibernate.sourceforge.net/hibernate-mapping-3.0.dtd">

<hibernate-mapping package="eg">

  <class
    name="BlogItem"
    table="BLOG_ITEMS"
    dynamic-update="true">

    <id
      name="id"
      column="BLOG_ITEM_ID">

      <generator class="native"/>

    </id>

    <property
      name="title"
      column="TITLE"
      not-null="true"/>

    <property
      name="text"
      column="TEXT"
      not-null="true"/>

    <property
      name="datetime"
      column="DATE_TIME"
      not-null="true"/>

    <many-to-one
      name="blog"
      column="BLOG_ID"
      not-null="true"/>
  </class>
</hibernate-mapping>

```

```
</class>
```

```
</hibernate-mapping>
```

22.3. HIBERNATE CODE

The following class demonstrates some of the kinds of things we can do with these classes using Hibernate:

```
package eg;

import java.util.ArrayList;
import java.util.Calendar;
import java.util.Iterator;
import java.util.List;

import org.hibernate.HibernateException;
import org.hibernate.Query;
import org.hibernate.Session;
import org.hibernate.SessionFactory;
import org.hibernate.Transaction;
import org.hibernate.cfg.Configuration;
import org.hibernate.tool.hbm2ddl.SchemaExport;

public class BlogMain {

    private SessionFactory _sessions;

    public void configure() throws HibernateException {
        _sessions = new Configuration()
            .addClass(Blog.class)
            .addClass(BlogItem.class)
            .buildSessionFactory();
    }

    public void exportTables() throws HibernateException {
        Configuration cfg = new Configuration()
            .addClass(Blog.class)
            .addClass(BlogItem.class);
        new SchemaExport(cfg).create(true, true);
    }

    public Blog createBlog(String name) throws HibernateException {

        Blog blog = new Blog();
        blog.setName(name);
        blog.setItems( new ArrayList() );

        Session session = _sessions.openSession();
        Transaction tx = null;
        try {
            tx = session.beginTransaction();
            session.persist(blog);
            tx.commit();
        }
    }
}
```

```

        catch (HibernateException he) {
            if (tx!=null) tx.rollback();
            throw he;
        }
        finally {
            session.close();
        }
        return blog;
    }
}

public BlogItem createBlogItem(Blog blog, String title, String text)
    throws HibernateException {

    BlogItem item = new BlogItem();
    item.setTitle(title);
    item.setText(text);
    item.setBlog(blog);
    item.setDatetime( Calendar.getInstance() );
    blog.getItems().add(item);

    Session session = _sessions.openSession();
    Transaction tx = null;
    try {
        tx = session.beginTransaction();
        session.update(blog);
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
        throw he;
    }
    finally {
        session.close();
    }
    return item;
}

public BlogItem createBlogItem(Long blogid, String title, String text)
    throws HibernateException {

    BlogItem item = new BlogItem();
    item.setTitle(title);
    item.setText(text);
    item.setDatetime( Calendar.getInstance() );

    Session session = _sessions.openSession();
    Transaction tx = null;
    try {
        tx = session.beginTransaction();
        Blog blog = (Blog) session.load(Blog.class, blogid);
        item.setBlog(blog);
        blog.getItems().add(item);
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
    }
}

```

```

        throw he;
    }
    finally {
        session.close();
    }
    return item;
}

public void updateBlogItem(BlogItem item, String text)
    throws HibernateException {

    item.setText(text);

    Session session = _sessions.openSession();
    Transaction tx = null;
    try {
        tx = session.beginTransaction();
        session.update(item);
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
        throw he;
    }
    finally {
        session.close();
    }
}

public void updateBlogItem(Long itemid, String text)
    throws HibernateException {

    Session session = _sessions.openSession();
    Transaction tx = null;
    try {
        tx = session.beginTransaction();
        BlogItem item = (BlogItem) session.load(BlogItem.class,
itemid);
        item.setText(text);
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
        throw he;
    }
    finally {
        session.close();
    }
}

public List listAllBlogNamesAndItemCounts(int max)
    throws HibernateException {

    Session session = _sessions.openSession();
    Transaction tx = null;
    List result = null;

```

```

try {
    tx = session.beginTransaction();
    Query q = session.createQuery(
        "select blog.id, blog.name, count(blogItem) " +
        "from Blog as blog " +
        "left outer join blog.items as blogItem " +
        "group by blog.name, blog.id " +
        "order by max(blogItem.datetime)"
    );
    q.setMaxResults(max);
    result = q.list();
    tx.commit();
}
catch (HibernateException he) {
    if (tx!=null) tx.rollback();
    throw he;
}
finally {
    session.close();
}
return result;
}

public Blog getBlogAndAllItems(Long blogid)
    throws HibernateException {

    Session session = _sessions.openSession();
    Transaction tx = null;
    Blog blog = null;
    try {
        tx = session.beginTransaction();
        Query q = session.createQuery(
            "from Blog as blog " +
            "left outer join fetch blog.items " +
            "where blog.id = :blogid"
        );
        q.setParameter("blogid", blogid);
        blog = (Blog) q.uniqueResult();
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
        throw he;
    }
    finally {
        session.close();
    }
    return blog;
}

public List listBlogsAndRecentItems() throws HibernateException {

    Session session = _sessions.openSession();
    Transaction tx = null;
    List result = null;
    try {

```

```
        tx = session.beginTransaction();
        Query q = session.createQuery(
            "from Blog as blog " +
            "inner join blog.items as blogItem " +
            "where blogItem.datetime > :minDate"
        );

        Calendar cal = Calendar.getInstance();
        cal.roll(Calendar.MONTH, false);
        q.setCalendar("minDate", cal);

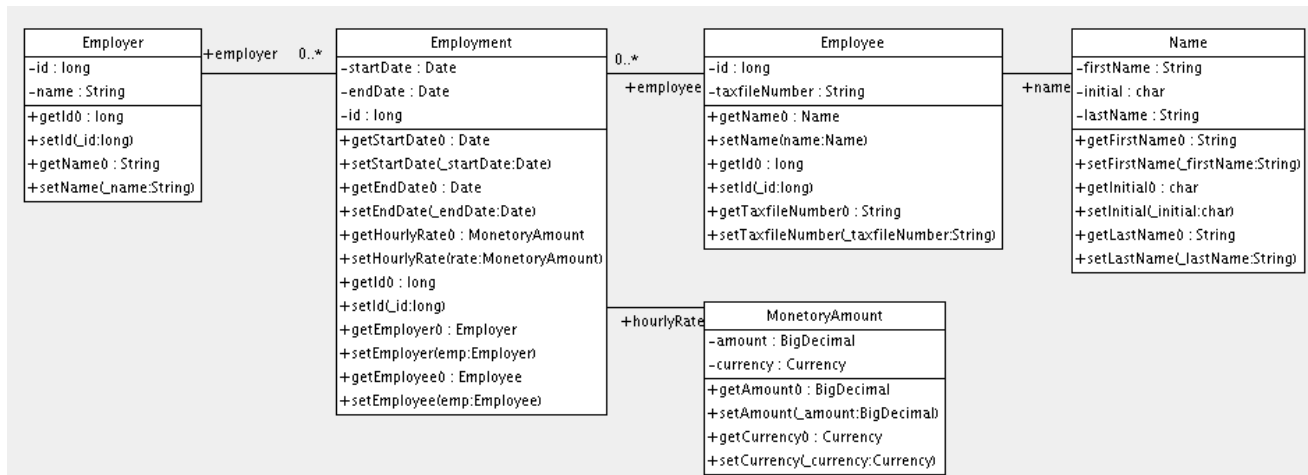
        result = q.list();
        tx.commit();
    }
    catch (HibernateException he) {
        if (tx!=null) tx.rollback();
        throw he;
    }
    finally {
        session.close();
    }
    return result;
}
}
```

CHAPTER 23. EXAMPLE: VARIOUS MAPPINGS

This chapters explores some more complex association mappings.

23.1. EMPLOYER/EMPLOYEE

The following model of the relationship between **Employer** and **Employee** uses an entity class (**Employment**) to represent the association. You can do this when there might be more than one period of employment for the same two parties. Components are used to model monetary values and employee names.



Here is a possible mapping document:

```

<hibernate-mapping>

  <class name="Employer" table="employers">
    <id name="id">
      <generator class="sequence">
        <param name="sequence">employer_id_seq</param>
      </generator>
    </id>
    <property name="name" />
  </class>

  <class name="Employment" table="employment_periods">

    <id name="id">
      <generator class="sequence">
        <param name="sequence">employment_id_seq</param>
      </generator>
    </id>
    <property name="startDate" column="start_date" />
    <property name="endDate" column="end_date" />

    <component name="hourlyRate" class="MonetaryAmount">
      <property name="amount">
        <column name="hourly_rate" sql-type="NUMERIC(12, 2)" />
      </property>
      <property name="currency" length="12" />
    </component>
  </class>

```

```

        <many-to-one name="employer" column="employer_id" not-
        null="true"/>
        <many-to-one name="employee" column="employee_id" not-
        null="true"/>

    </class>

    <class name="Employee" table="employees">
        <id name="id">
            <generator class="sequence">
                <param name="sequence">employee_id_seq</param>
            </generator>
        </id>
        <property name="taxfileNumber"/>
        <component name="name" class="Name">
            <property name="firstName"/>
            <property name="initial"/>
            <property name="lastName"/>
        </component>
    </class>

</hibernate-mapping>

```

Here is the table schema generated by **SchemaExport**.

```

create table employers (
    id BIGINT not null,
    name VARCHAR(255),
    primary key (id)
)

create table employment_periods (
    id BIGINT not null,
    hourly_rate NUMERIC(12, 2),
    currency VARCHAR(12),
    employee_id BIGINT not null,
    employer_id BIGINT not null,
    end_date TIMESTAMP,
    start_date TIMESTAMP,
    primary key (id)
)

create table employees (
    id BIGINT not null,
    firstName VARCHAR(255),
    initial CHAR(1),
    lastName VARCHAR(255),
    taxfileNumber VARCHAR(255),
    primary key (id)
)

alter table employment_periods
    add constraint employment_periodsFK0 foreign key (employer_id)
    references employers
alter table employment_periods
    add constraint employment_periodsFK1 foreign key (employee_id)

```



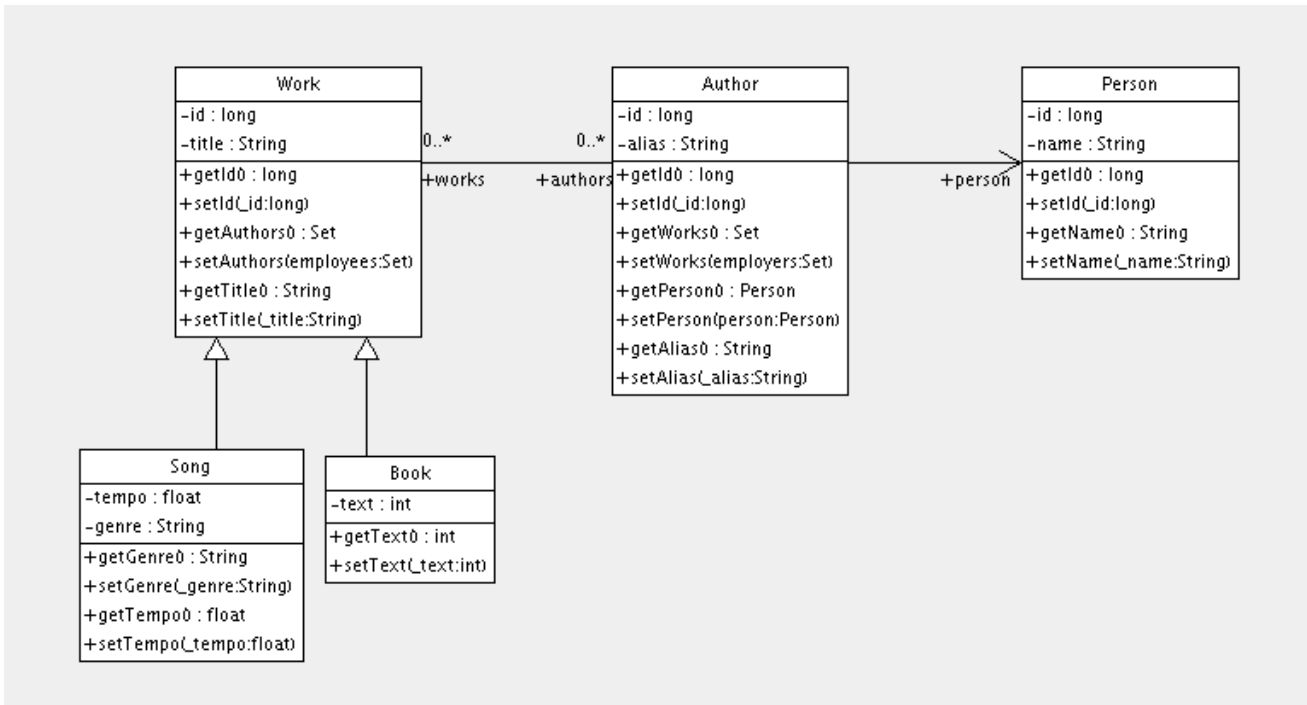
```

references employees
create sequence employee_id_seq
create sequence employment_id_seq
create sequence employer_id_seq

```

23.2. AUTHOR/WORK

Consider the following model of the relationships between **Work**, **Author** and **Person**. In the example, the relationship between **Work** and **Author** is represented as a many-to-many association and the relationship between **Author** and **Person** is represented as one-to-one association. Another possibility would be to have **Author** extend **Person**.



The following mapping document correctly represents these relationships:

```

<hibernate-mapping>

  <class name="Work" table="works" discriminator-value="W">

    <id name="id" column="id">
      <generator class="native"/>
    </id>
    <discriminator column="type" type="character"/>

    <property name="title"/>
    <set name="authors" table="author_work">
      <key column name="work_id"/>
      <many-to-many class="Author" column name="author_id"/>
    </set>

    <subclass name="Book" discriminator-value="B">
      <property name="text"/>
    </subclass>

    <subclass name="Song" discriminator-value="S">

```

```

        <property name="tempo"/>
        <property name="genre"/>
    </subclass>

</class>

<class name="Author" table="authors">

    <id name="id" column="id">
        <!-- The Author must have the same identifier as the Person --
    >
        <generator class="assigned"/>
    </id>

    <property name="alias"/>
    <one-to-one name="person" constrained="true"/>

    <set name="works" table="author_work" inverse="true">
        <key column="author_id"/>
        <many-to-many class="Work" column="work_id"/>
    </set>

</class>

<class name="Person" table="persons">
    <id name="id" column="id">
        <generator class="native"/>
    </id>
    <property name="name"/>
</class>

</hibernate-mapping>

```

There are four tables in this mapping: **works**, **authors** and **persons** hold work, author and person data respectively. **author_work** is an association table linking authors to works. Here is the table schema, as generated by **SchemaExport**:

```

create table works (
    id BIGINT not null generated by default as identity,
    tempo FLOAT,
    genre VARCHAR(255),
    text INTEGER,
    title VARCHAR(255),
    type CHAR(1) not null,
    primary key (id)
)

create table author_work (
    author_id BIGINT not null,
    work_id BIGINT not null,
    primary key (work_id, author_id)
)

create table authors (
    id BIGINT not null generated by default as identity,
    alias VARCHAR(255),

```

```

        primary key (id)
    )

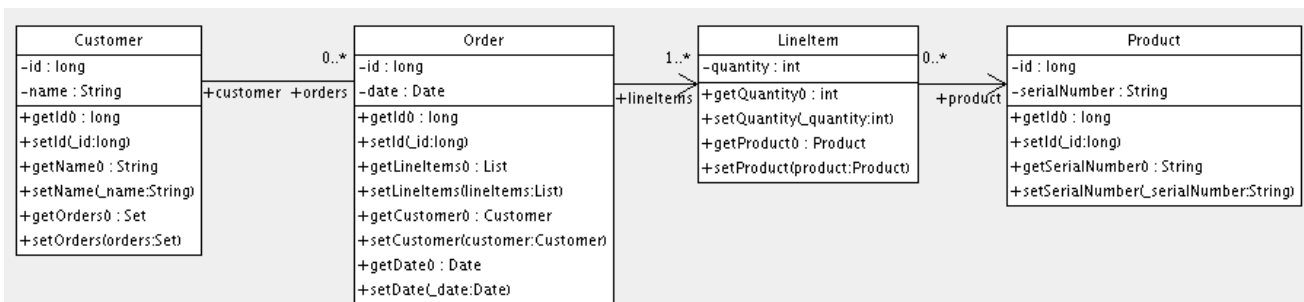
create table persons (
    id BIGINT not null generated by default as identity,
    name VARCHAR(255),
    primary key (id)
)

alter table authors
    add constraint authorsFK0 foreign key (id) references persons
alter table author_work
    add constraint author_workFK0 foreign key (author_id) references
authors
alter table author_work
    add constraint author_workFK1 foreign key (work_id) references works

```

23.3. CUSTOMER/ORDER/PRODUCT

In this section we consider a model of the relationships between **Customer**, **Order**, **Line Item** and **Product**. There is a one-to-many association between **Customer** and **Order**, but how can you represent **Order** / **LineItem** / **Product**? In the example, **LineItem** is mapped as an association class representing the many-to-many association between **Order** and **Product**. In Hibernate this is called a composite element.



The mapping document will look like this:

```

<hibernate-mapping>

    <class name="Customer" table="customers">
        <id name="id">
            <generator class="native"/>
        </id>
        <property name="name"/>
        <set name="orders" inverse="true">
            <key column="customer_id"/>
            <one-to-many class="Order"/>
        </set>
    </class>

    <class name="Order" table="orders">
        <id name="id">
            <generator class="native"/>
        </id>
        <property name="date"/>
        <many-to-one name="customer" column="customer_id"/>

```

```

        <list name="lineItems" table="line_items">
            <key column="order_id"/>
            <list-index column="line_number"/>
            <composite-element class="LineItem">
                <property name="quantity"/>
                <many-to-one name="product" column="product_id"/>
            </composite-element>
        </list>
    </class>

    <class name="Product" table="products">
        <id name="id">
            <generator class="native"/>
        </id>
        <property name="serialNumber"/>
    </class>

</hibernate-mapping>

```

customers, **orders**, **line_items** and **products** hold customer, order, order line item and product data respectively. **line_items** also acts as an association table linking orders with products.

```

create table customers (
    id BIGINT not null generated by default as identity,
    name VARCHAR(255),
    primary key (id)
)

create table orders (
    id BIGINT not null generated by default as identity,
    customer_id BIGINT,
    date TIMESTAMP,
    primary key (id)
)

create table line_items (
    line_number INTEGER not null,
    order_id BIGINT not null,
    product_id BIGINT,
    quantity INTEGER,
    primary key (order_id, line_number)
)

create table products (
    id BIGINT not null generated by default as identity,
    serialNumber VARCHAR(255),
    primary key (id)
)

alter table orders
    add constraint ordersFK0 foreign key (customer_id) references
customers
alter table line_items
    add constraint line_itemsFK0 foreign key (product_id) references

```

```

products
alter table line_items
    add constraint line_itemsFK1 foreign key (order_id) references orders

```

23.4. MISCELLANEOUS EXAMPLE MAPPINGS

These examples are available from the Hibernate test suite. You will find many other useful example mappings there by searching in the `test` folder of the Hibernate distribution.

23.4.1. "Typed" one-to-one association

```

<class name="Person">
  <id name="name"/>
  <one-to-one name="address"
    cascade="all">
    <formula>name</formula>
    <formula>'HOME'</formula>
  </one-to-one>
  <one-to-one name="mailingAddress"
    cascade="all">
    <formula>name</formula>
    <formula>'MAILING'</formula>
  </one-to-one>
</class>

<class name="Address" batch-size="2"
  check="addressType in ('MAILING', 'HOME', 'BUSINESS')">
  <composite-id>
    <key-many-to-one name="person"
      column="personName"/>
    <key-property name="type"
      column="addressType"/>
  </composite-id>
  <property name="street" type="text"/>
  <property name="state"/>
  <property name="zip"/>
</class>

```

23.4.2. Composite key example

```

<class name="Customer">
  <id name="customerId"
    length="10">
    <generator class="assigned"/>
  </id>

  <property name="name" not-null="true" length="100"/>
  <property name="address" not-null="true" length="200"/>

  <list name="orders"
    inverse="true"
    cascade="save-update">
    <key column="customerId"/>
  </list>

```

```

        <index column="orderNumber"/>
        <one-to-many class="Order"/>
    </list>

</class>

<class name="Order" table="CustomerOrder" lazy="true">
    <synchronize table="LineItem"/>
    <synchronize table="Product"/>

    <composite-id name="id"
        class="Order$Id">
        <key-property name="customerId" length="10"/>
        <key-property name="orderNumber"/>
    </composite-id>

    <property name="orderDate"
        type="calendar_date"
        not-null="true"/>

    <property name="total">
        <formula>
            ( select sum(li.quantity*p.price)
              from LineItem li, Product p
              where li.productId = p.productId
                  and li.customerId = customerId
                  and li.orderNumber = orderNumber )
        </formula>
    </property>

    <many-to-one name="customer"
        column="customerId"
        insert="false"
        update="false"
        not-null="true"/>

    <bag name="lineItems"
        fetch="join"
        inverse="true"
        cascade="save-update">
        <key>
            <column name="customerId"/>
            <column name="orderNumber"/>
        </key>
        <one-to-many class="LineItem"/>
    </bag>

</class>

<class name="LineItem">

    <composite-id name="id"
        class="LineItem$Id">
        <key-property name="customerId" length="10"/>
        <key-property name="orderNumber"/>
        <key-property name="productId" length="10"/>

```

```

</composite-id>

<property name="quantity"/>

<many-to-one name="order"
    insert="false"
    update="false"
    not-null="true">
    <column name="customerId"/>
    <column name="orderNumber"/>
</many-to-one>

<many-to-one name="product"
    insert="false"
    update="false"
    not-null="true"
    column="productId"/>

</class>

<class name="Product">
    <synchronize table="LineItem"/>

    <id name="productId"
        length="10">
        <generator class="assigned"/>
    </id>

    <property name="description"
        not-null="true"
        length="200"/>
    <property name="price" length="3"/>
    <property name="numberAvailable"/>

    <property name="numberOrdered">
        <formula>
            ( select sum(li.quantity)
              from LineItem li
              where li.productId = productId )
        </formula>
    </property>

</class>

```

23.4.3. Many-to-many with shared composite key attribute

```

<class name="User" table="`User`">
    <composite-id>
        <key-property name="name"/>
        <key-property name="org"/>
    </composite-id>
    <set name="groups" table="UserGroup">
        <key>
            <column name="userName"/>
            <column name="org"/>

```

```

        </key>
        <many-to-many class="Group">
            <column name="groupName"/>
            <formula>org</formula>
        </many-to-many>
    </set>
</class>

<class name="Group" table="`Group`">
    <composite-id>
        <key-property name="name"/>
        <key-property name="org"/>
    </composite-id>
    <property name="description"/>
    <set name="users" table="UserGroup" inverse="true">
        <key>
            <column name="groupName"/>
            <column name="org"/>
        </key>
        <many-to-many class="User">
            <column name="userName"/>
            <formula>org</formula>
        </many-to-many>
    </set>
</class>

```

23.4.4. Content based discrimination

```

<class name="Person"
    discriminator-value="P">

    <id name="id"
        column="person_id"
        unsaved-value="0">
        <generator class="native"/>
    </id>

    <discriminator
        type="character">
        <formula>
            case
                when title is not null then 'E'
                when salesperson is not null then 'C'
                else 'P'
            end
        </formula>
    </discriminator>

    <property name="name"
        not-null="true"
        length="80"/>

    <property name="sex"
        not-null="true"

```



```

        update="false"/>

    <component name="address">
        <property name="address"/>
        <property name="zip"/>
        <property name="country"/>
    </component>

    <subclass name="Employee"
        discriminator-value="E">
        <property name="title"
            length="20"/>
        <property name="salary"/>
        <many-to-one name="manager"/>
    </subclass>

    <subclass name="Customer"
        discriminator-value="C">
        <property name="comments"/>
        <many-to-one name="salesperson"/>
    </subclass>

</class>

```

23.4.5. Associations on alternate keys

```

<class name="Person">

    <id name="id">
        <generator class="hilo"/>
    </id>

    <property name="name" length="100"/>

    <one-to-one name="address"
        property-ref="person"
        cascade="all"
        fetch="join"/>

    <set name="accounts"
        inverse="true">
        <key column="userId"
            property-ref="userId"/>
        <one-to-many class="Account"/>
    </set>

    <property name="userId" length="8"/>

</class>

<class name="Address">

    <id name="id">
        <generator class="hilo"/>
    </id>

```

```
<property name="address" length="300"/>
<property name="zip" length="5"/>
<property name="country" length="25"/>
<many-to-one name="person" unique="true" not-null="true"/>
```

```
</class>
```

```
<class name="Account">
  <id name="accountId" length="32">
    <generator class="uuid"/>
  </id>

  <many-to-one name="user"
    column="userId"
    property-ref="userId"/>

  <property name="type" not-null="true"/>
</class>
```

CHAPTER 24. BEST PRACTICES

Write fine-grained classes and map them using `<component>`:

Use an **Address** class to encapsulate **street**, **suburb**, **state**, **postcode**. This encourages code reuse and simplifies refactoring.

Declare identifier properties on persistent classes:

Hibernate makes identifier properties optional. There are a range of reasons why you should use them. We recommend that identifiers be 'synthetic', that is, generated with no business meaning.

Identify natural keys:

Identify natural keys for all entities, and map them using `<natural-id>`. Implement `equals()` and `hashCode()` to compare the properties that make up the natural key.

Place each class mapping in its own file:

Do not use a single monolithic mapping document. Map `com.eg.Foo` in the file `com/eg/Foo.hbm.xml`. This makes sense, particularly in a team environment.

Load mappings as resources:

Deploy the mappings along with the classes they map.

Consider externalizing query strings:

This is recommended if your queries call non-ANSI-standard SQL functions. Externalizing the query strings to mapping files will make the application more portable.

Use bind variables.

As in JDBC, always replace non-constant values by "?". Do not use string manipulation to bind a non-constant value in a query. You should also consider using named parameters in queries.

Do not manage your own JDBC connections:

Hibernate allows the application to manage JDBC connections, but this approach should be considered a last-resort. If you cannot use the built-in connection providers, consider providing your own implementation of `org.hibernate.connection.ConnectionProvider`.

Consider using a custom type:

Suppose you have a Java type from a library that needs to be persisted but does not provide the accessors needed to map it as a component. You should consider implementing `org.hibernate.UserType`. This approach frees the application code from implementing transformations to/from a Hibernate type.

Use hand-coded JDBC in bottlenecks:

In performance-critical areas of the system, some kinds of operations might benefit from direct JDBC. Do not assume, however, that JDBC is necessarily faster. Please wait until you *know* something is a bottleneck. If you need to use direct JDBC, you can open a Hibernate Session and wrap your JDBC operation as a Work object with `session.doWork(work)`. This way you can still use the same transaction strategy and underlying connection provider.

Understand Session flushing:

Sometimes the Session synchronizes its persistent state with the database. Performance will be affected if this process occurs too often. You can sometimes minimize unnecessary flushing by disabling automatic flushing, or even by changing the order of queries and other operations within a particular transaction.

In a three tiered architecture, consider using detached objects:

When using a servlet/session bean architecture, you can pass persistent objects loaded in the session bean to and from the servlet/JSP layer. Use a new session to service each request. Use `Session.merge()` or `Session.saveOrUpdate()` to synchronize objects with the database.

In a two tiered architecture, consider using long persistence contexts:

Database Transactions have to be as short as possible for best scalability. However, it is often necessary to implement long running *application transactions*, a single unit-of-work from the point of view of a user. An application transaction might span several client request/response cycles. It is common to use detached objects to implement application transactions. An appropriate alternative in a two tiered architecture, is to maintain a single open persistence contact session for the whole life cycle of the application transaction. Then simply disconnect from the JDBC connection at the end of each request and reconnect at the beginning of the subsequent request. Never share a single session across more than one application transaction or you will be working with stale data.

Do not treat exceptions as recoverable:

This is more of a necessary practice than a "best" practice. When an exception occurs, roll back the **Transaction** and close the **Session**. If you do not do this, Hibernate cannot guarantee that in-memory state accurately represents the persistent state. For example, do not use `Session.load()` to determine if an instance with the given identifier exists on the database; use `Session.get()` or a query instead.

Prefer lazy fetching for associations:

Use eager fetching sparingly. Use proxies and lazy collections for most associations to classes that are not likely to be completely held in the second-level cache. For associations to cached classes, where there is an extremely high probability of a cache hit, explicitly disable eager fetching using `lazy="false"`. When join fetching is appropriate to a particular use case, use a query with a `left join fetch`.

Use the *open session in view* pattern, or a disciplined *assembly phase* to avoid problems with unfetched data:

Hibernate frees the developer from writing tedious *Data Transfer Objects* (DTO). In a traditional EJB architecture, DTOs serve dual purposes: first, they work around the problem that entity beans are not serializable; second, they implicitly define an assembly phase where all data to be used by the view is fetched and marshaled into the DTOs before returning control to the presentation tier. Hibernate eliminates the first purpose. Unless you are prepared to hold the persistence context (the session) open across the view rendering process, you will still need an assembly phase. Think of your business methods as having a strict contract with the presentation tier about what data is available in the detached objects. This is not a limitation of Hibernate. It is a fundamental requirement of safe transactional data access.

Consider abstracting your business logic from Hibernate:

Hide Hibernate data-access code behind an interface. Combine the *DAO* and *Thread Local Session* patterns. You can even have some classes persisted by hand coded JDBC associated to Hibernate via a **UserType**. This advice is, however, intended for "sufficiently large" applications. It is not appropriate for an application with five tables.

Do not use exotic association mappings:

Practical test cases for real many-to-many associations are rare. Most of the time you need additional information stored in the "link table". In this case, it is much better to use two one-to-many associations to an intermediate link class. In fact, most associations are one-to-many and many-to-one. For this reason, you should proceed cautiously when using any other association style.

Prefer bidirectional associations:

Unidirectional associations are more difficult to query. In a large application, almost all associations must be navigable in both directions in queries.

CHAPTER 25. DATABASE PORTABILITY CONSIDERATIONS

25.1. PORTABILITY BASICS

One of the selling points of Hibernate (and really Object/Relational Mapping as a whole) is the notion of database portability. This could mean an internal IT user migrating from one database vendor to another, or it could mean a framework or deployable application consuming Hibernate to simultaneously target multiple database products by their users. Regardless of the exact scenario, the basic idea is that you want Hibernate to help you run against any number of databases without changes to your code, and ideally without any changes to the mapping metadata.

25.2. DIALECT

The first line of portability for Hibernate is the dialect, which is a specialization of the `org.hibernate.dialect.Dialect` contract. A dialect encapsulates all the differences in how Hibernate must communicate with a particular database to accomplish some task like getting a sequence value or structuring a SELECT query. Hibernate bundles a wide range of dialects for many of the most popular databases. If you find that your particular database is not among them, it is not terribly difficult to write your own.

25.3. DIALECT RESOLUTION

Originally, Hibernate would always require that users specify which dialect to use. In the case of users looking to simultaneously target multiple databases with their build that was problematic. Generally this required their users to configure the Hibernate dialect or defining their own method of setting that value.

Starting with version 3.2, Hibernate introduced the notion of automatically detecting the dialect to use based on the `java.sql.DatabaseMetaData` obtained from a `java.sql.Connection` to that database. This was much better, except that this resolution was limited to databases Hibernate know about ahead of time and was in no way configurable or overridable.

Starting with version 3.3, Hibernate has a far more powerful way to automatically determine which dialect to should be used by relying on a series of delegates which implement the `org.hibernate.dialect.resolver.DialectResolver` which defines only a single method:

```
public Dialect resolveDialect(DatabaseMetaData metaData) throws  
JDBCConnectionException
```

. The basic contract here is that if the resolver 'understands' the given database metadata then it returns the corresponding Dialect; if not it returns null and the process continues to the next resolver. The signature also identifies `org.hibernate.exception.JDBCConnectionException` as possibly being thrown. A `JDBCConnectionException` here is interpreted to imply a "non transient" (aka non-recoverable) connection problem and is used to indicate an immediate stop to resolution attempts. All other exceptions result in a warning and continuing on to the next resolver.

The cool part about these resolvers is that users can also register their own custom resolvers which will be processed ahead of the built-in Hibernate ones. This might be useful in a number of different situations: it allows easy integration for auto-detection of dialects beyond those shipped with Hibernate itself; it allows you to specify to use a custom dialect when a particular database is recognized; etc. To register one or more resolvers, simply specify them (separated by commas, tabs or spaces) using the 'hibernate.dialect_resolvers' configuration setting (see the `DIALECT_RESOLVERS` constant on `org.hibernate.cfg.Environment`).

25.4. IDENTIFIER GENERATION

When considering portability between databases, another important decision is selecting the identifier generation strategy you want to use. Originally Hibernate provided the *native* generator for this purpose, which was intended to select between a *sequence*, *identity*, or *table* strategy depending on the capability of the underlying database. However, an insidious implication of this approach comes about when targeting some databases which support *identity* generation and some which do not. *identity* generation relies on the SQL definition of an IDENTITY (or auto-increment) column to manage the identifier value; it is what is known as a post-insert generation strategy because the insert must actually happen before we can know the identifier value. Because Hibernate relies on this identifier value to uniquely reference entities within a persistence context it must then issue the insert immediately when the users requests the entity be associated with the session (like via `save()` e.g.) regardless of current transactional semantics. The underlying issue is that the semantics of the application itself changes in these cases.



NOTE

Hibernate has been improved so that the insert is delayed in cases where that is feasible.

Starting with version 3.2.3, Hibernate comes with a set of [enhanced](#) identifier generators targeting portability in a much different way.



NOTE

There are specifically 2 bundled *enhanced* generators:

- `org.hibernate.id.enhanced.SequenceStyleGenerator`
- `org.hibernate.id.enhanced.TableGenerator`

The idea behind these generators is to port the actual semantics of the identifier value generation to the different databases. For example, the `org.hibernate.id.enhanced.SequenceStyleGenerator` mimics the behavior of a sequence on databases which do not support sequences by using a table.

25.5. DATABASE FUNCTIONS



WARNING

This is a new area in Hibernate and as such it is not as mature as the overall Hibernate experience.

SQL functions can be referenced in many ways by users. However, not all databases support the same set of functions. Hibernate, provides a means of mapping a *logical* function name to a delegate which knows how to render that particular function, perhaps even using a totally different physical function call.



IMPORTANT

Technically this function registration is handled through the **`org.hibernate.dialect.function.SQLFunctionRegistry`** class which is intended to allow users to provide custom function definitions without having to provide a custom dialect. This specific behavior is not fully completed as of yet.

It is sort of implemented such that users can programmatically register functions with the **`org.hibernate.cfg.Configuration`** and those functions will be recognized for HQL.

APPENDIX A. REVISION HISTORY

Revision 5.2.0-100.400**2013-10-30****Rüdiger Landmann**

Rebuild with publican 4.0.0

Revision 5.2.0-100**Wed 23 Jan 2013****Russell Dickenson**

Incorporated changes for JBoss Enterprise Application Platform 5.2.0 GA. For information about documentation changes to this guide, refer to *Release Notes 5.2.0*.

Revision 5.1.2-100**Thu Dec 8 2011****Jared Morgan**

Incorporated changes for JBoss Enterprise Application Platform 5.1.2 GA. For information about documentation changes to this guide, refer to *Release Notes 5.1.2*.

Revision 5.1.1-100**Mon Jul 18 2011****Jared Morgan**

Incorporated changes for JBoss Enterprise Application Platform 5.1.1 GA. For information about documentation changes to this guide, refer to *Release Notes 5.1.1*.

Revision 5.1.0-100**Wed Sep 15 2010****Laura Bailey**

Changed version number in line with new versioning requirements.

Revised for JBoss Enterprise Application Platform 5.1.0.GA, including:
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