

Hibernate is an Object-Relational Mapping (ORM) solution for JAVA. It is an open source persistent framework created by Gavin King in 2001. It is a powerful, high performance Object-Relational Persistence and Query service for any Java Application.

Hibernate maps Java classes to database tables and from Java data types to SQL data types and relieves the developer from 95% of common data persistence related programming tasks.

Hibernate sits between traditional Java objects and database server to handle all the works in persisting those objects based on the appropriate O/R mechanisms and patterns.



Hibernate Advantages

- Hibernate takes care of mapping Java classes to database tables using XML files and without writing any line of code.
- Provides simple APIs for storing and retrieving Java objects directly to and from the database.
- If there is change in the database or in any table, then you need to change the XML file properties only.
- Abstracts away the unfamiliar SQL types and provides a way to work around familiar Java Objects.
- Hibernate does not require an application server to operate.
- Manipulates Complex associations of objects of your database.
- Minimizes database access with smart fetching strategies.
- Provides simple querying of data.

Supported Databases

Following is a list of few of the database engines supported by Hibernate –

- | | |
|------------------------|---------------------------------|
| ➤ HSQL Database Engine | ➤ Oracle |
| ➤ DB2/NT | ➤ Microsoft SQL Server Database |
| ➤ MySQL | ➤ Sybase SQL Server |
| ➤ PostgreSQL | ➤ Informix Dynamic Server |
| ➤ FrontBase | |

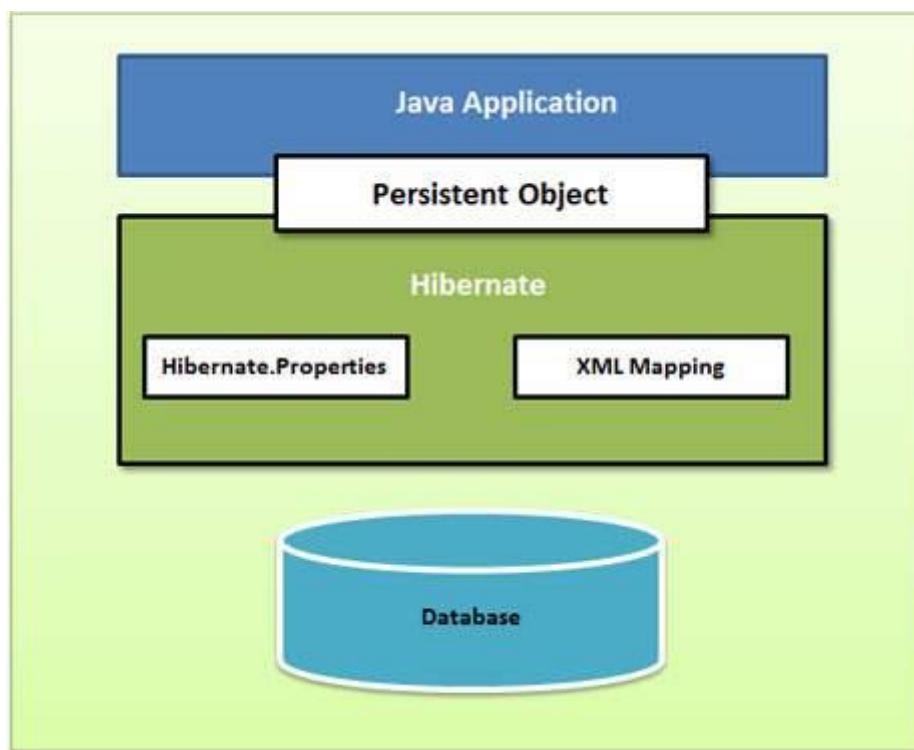
Supported Technologies

Hibernate supports a variety of other technologies, including –

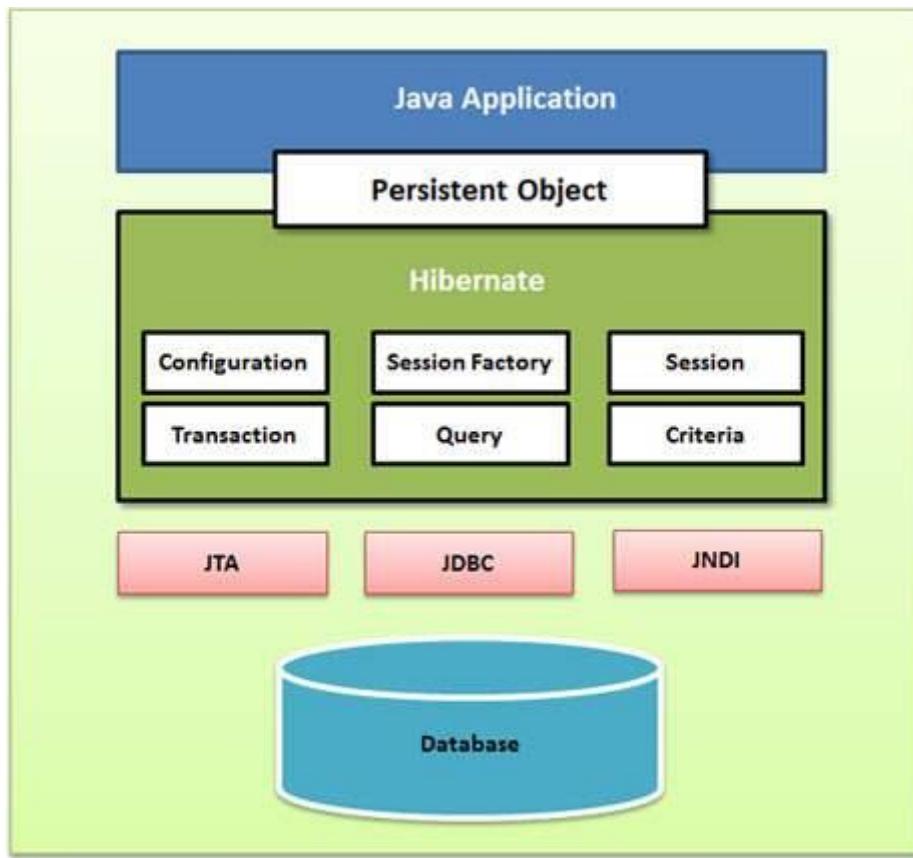
- XDoclet Spring
- J2EE
- Eclipse plug-ins
- Maven

Hibernate has a layered architecture which helps the user to operate without having to know the underlying APIs. Hibernate makes use of the database and configuration data to provide persistence services (and persistent objects) to the application.

Following is a very high level view of the Hibernate Application Architecture.



Following is a very detailed level view of the Hibernate Application Architecture.



Configuration Object

The Configuration object is the first Hibernate object you create in any Hibernate application. It is usually created only once during application initialization. It represents a configuration or properties file required by the Hibernate.

The Configuration object provides two key components –

Database Connection – This is handled through one or more configuration files supported by Hibernate. These files are hibernate.properties and hibernate.cfg.xml.

Class Mapping Setup – This component creates the connection between the Java classes and database tables.

SessionFactory Object

Configuration object is used to create a SessionFactory object which in turn configures Hibernate for the application using the supplied configuration file and allows for a Session object to be instantiated. The SessionFactory is a thread safe object and used by all the threads of an application.

The SessionFactory is a heavyweight object; it is usually created during application start up and kept for later use. You would need one SessionFactory object per database using a separate configuration file. So, if you are using multiple databases, then you would have to create multiple SessionFactory objects.

Session Object

A Session is used to get a physical connection with a database. The Session object is lightweight and designed to be instantiated each time an interaction is needed with the database. Persistent objects are saved and retrieved through a Session object.

The session objects should not be kept open for a long time because they are not usually thread safe and they should be created and destroyed them as needed.

Transaction Object

A Transaction represents a unit of work with the database and most of the RDBMS supports transaction functionality. Transactions in Hibernate are handled by an underlying transaction manager and transaction (from JDBC or JTA).

This is an optional object and Hibernate applications may choose not to use this interface, instead managing transactions in their own application code.

Query Object

Query objects use SQL or Hibernate Query Language (HQL) string to retrieve data from the database and create objects. A Query instance is used to bind query parameters, limit the number of results returned by the query, and finally to execute the query.

Criteria Object

Criteria objects are used to create and execute object oriented criteria queries to retrieve objects.

Hibernate Prerequisites

Following is the list of the packages/libraries required by Hibernate and you should install them before starting with Hibernate. To install these packages, you will have to copy library files from /lib into your CLASSPATH, and change your CLASSPATH variable accordingly.

Sr.No.	Packages/Libraries
1	dom4j XML parsing www.dom4j.org/
2	Xalan XSLT Processor https://xml.apache.org/xalan-j/
3	Xerces The Xerces Java Parser https://xml.apache.org/xerces-j/
4	cglib Appropriate changes to Java classes at runtime http://cglib.sourceforge.net/
5	log4j Logging Framework https://logging.apache.org/log4j
6	Commons Logging, Email etc. https://jakarta.apache.org/commons
7	SLF4J Logging Facade for Java https://www.slf4j.org

Hibernate - Configuration

Hibernate also requires a set of configuration settings related to database and other related parameters. All such information is usually supplied as a standard Java properties file called hibernate.properties, or as an XML file named hibernate.cfg.xml.

Hibernate Properties

Following is the list of important properties, you will be required to configure for a databases in a standalone situation –

Sr.No.	Properties & Description
1	hibernate.dialect This property makes Hibernate generate the appropriate SQL for the chosen database.
2	hibernate.connection.driver_class The JDBC driver class.
3	hibernate.connection.url The JDBC URL to the database instance.
4	hibernate.connection.username The database username.
5	hibernate.connection.password The database password.
6	hibernate.connection.pool_size Limits the number of connections waiting in the Hibernate database connection pool.
7	hibernate.connection.autocommit Allows autocommit mode to be used for the JDBC connection.

If you are using a database along with an application server and JNDI, then you would have to configure the following properties –

-Sr.No.	Properties & Description
1	hibernate.connection.datasource The JNDI name defined in the application server context, which you are using for the application.
2	hibernate.jndi.class The InitialContext class for JNDI.
3	hibernate.jndi.<JNDIpropertyname> Passes any JNDI property you like to the JNDI <i>InitialContext</i> .

4	hibernate.jndi.url Provides the URL for JNDI.
5	hibernate.connection.username The database username.
6	hibernate.connection.password The database password.

Hibernate - Sessions

A Session is used to get a physical connection with a database. The Session object is lightweight and designed to be instantiated each time an interaction is needed with the database. Persistent objects are saved and retrieved through a Session object.

The session objects should not be kept open for a long time because they are not usually thread safe and they should be created and destroyed them as needed. The main function of the Session is to offer, create, read, and delete operations for instances of mapped entity classes.

Instances may exist in one of the following three states at a given point in time –

transient – A new instance of a persistent class, which is not associated with a Session and has no representation in the database and no identifier value is considered transient by Hibernate.

persistent – You can make a transient instance persistent by associating it with a Session. A persistent instance has a representation in the database, an identifier value and is associated with a Session.

detached – Once we close the Hibernate Session, the persistent instance will become a detached instance.

Session Interface Methods

There are number of methods provided by the Session interface, but I'm going to list down a few important methods only, which we will use in this tutorial. You can check Hibernate documentation for a complete list of methods associated with Session and SessionFactory.

.Sr.No.	Session Methods & Description
1	Transaction beginTransaction() Begin a unit of work and return the associated Transaction object.
2	void cancelQuery() Cancel the execution of the current query.
3	void clear() Completely clear the session.

4	Connection close() End the session by releasing the JDBC connection and cleaning up.
5	Criteria createCriteria(Class persistentClass) Create a new Criteria instance, for the given entity class, or a superclass of an entity class.
6	Criteria createCriteria(String entityName) Create a new Criteria instance, for the given entity name.
7	Serializable getIdentifier(Object object) Return the identifier value of the given entity as associated with this session.
8	Query createFilter(Object collection, String queryString) Create a new instance of Query for the given collection and filter string.
9	Query createQuery(String queryString) Create a new instance of Query for the given HQL query string.
10	SQLQuery createSQLQuery(String queryString) Create a new instance of SQLQuery for the given SQL query string.
11	void delete(Object object) Remove a persistent instance from the datastore.
12	void delete(String entityName, Object object) Remove a persistent instance from the datastore.
13	Session get(String entityName, Serializable id) Return the persistent instance of the given named entity with the given identifier, or null if there is no such persistent instance.
14	SessionFactory getSessionFactory() Get the session factory which created this session.
15	void refresh(Object object) Re-read the state of the given instance from the underlying database.
16	Transaction getTransaction() Get the Transaction instance associated with this session.
17	boolean isConnected() Check if the session is currently connected.
18	boolean isDirty() Does this session contain any changes which must be synchronized with the database?
19	boolean isOpen() Check if the session is still open.

20	<code>Serializable save(Object object)</code> Persist the given transient instance, first assigning a generated identifier.
21	<code>void saveOrUpdate(Object object)</code> Either save(Object) or update(Object) the given instance.
22	<code>void update(Object object)</code> Update the persistent instance with the identifier of the given detached instance.
23	<code>void update(String entityName, Object object)</code> Update the persistent instance with the identifier of the given detached instance.

Sr.No.	Session Methods & Description
1	<code>Transaction beginTransaction()</code> Begin a unit of work and return the associated Transaction object.
2	<code>void cancelQuery()</code> Cancel the execution of the current query.
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5	<code>Criteria createCriteria(Class persistentClass)</code> Create a new Criteria instance, for the given entity class, or a superclass of an entity class.
6	<code>Criteria createCriteria(String entityName)</code> Create a new Criteria instance, for the given entity name.
7	<code>Serializable getIdentifier(Object object)</code> Return the identifier value of the given entity as associated with this session.
8	<code>Query createFilter(Object collection, String queryString)</code> Create a new instance of Query for the given collection and filter string.
9	<code>Query createQuery(String queryString)</code> Create a new instance of Query for the given HQL query string.
10	<code>SQLQuery createSQLQuery(String queryString)</code> Create a new instance of SQLQuery for the given SQL query string.
11	<code>void delete(Object object)</code> Remove a persistent instance from the datastore.

12	<code>void delete(String entityName, Object object)</code> Remove a persistent instance from the datastore.
13	<code>Session get(String entityName, Serializable id)</code> Return the persistent instance of the given named entity with the given identifier, or null if there is no such persistent instance.
14	<code>SessionFactory getSessionFactory()</code> Get the session factory which created this session.
15	<code>void refresh(Object object)</code> Re-read the state of the given instance from the underlying database.
16	<code>Transaction getTransaction()</code> Get the Transaction instance associated with this session.
17	<code>boolean isConnected()</code> Check if the session is currently connected.
18	<code>boolean isDirty()</code> Does this session contain any changes which must be synchronized with the database?
19	<code>boolean isOpen()</code> Check if the session is still open.
20	<code>Serializable save(Object object)</code> Persist the given transient instance, first assigning a generated identifier.
21	<code>void saveOrUpdate(Object object)</code> Either save(Object) or update(Object) the given instance.
22	<code>void update(Object object)</code> Update the persistent instance with the identifier of the given detached instance.
23	<code>void update(String entityName, Object object)</code> Update the persistent instance with the identifier of the given detached instance.

Hibernate - Persistent Class

The entire concept of Hibernate is to take the values from Java class attributes and persist them to a database table. A mapping document helps Hibernate in determining how to pull the values from the classes and map them with table and associated fields.

Java classes whose objects or instances will be stored in database tables are called persistent classes in Hibernate. Hibernate works best if these classes follow some simple rules, also known as the Plain Old Java Object (POJO) programming model.

There are following main rules of persistent classes, however, none of these rules are hard requirements –

All Java classes that will be persisted need a default constructor.

All classes should contain an ID in order to allow easy identification of your objects within Hibernate and the database. This property maps to the primary key column of a database table.

All attributes that will be persisted should be declared private and have getXXX and setXXX methods defined in the JavaBean style.

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.

All classes that do not extend or implement some specialized classes and interfaces required by the EJB framework.

Simple POJO Example

```
public class Employee {  
    private int id;  
    private String firstName;  
    private String lastName;  
    private int salary;  
  
    public Employee() {}  
    public Employee(String fname, String lname, int salary) {  
        this.firstName = fname;  
        this.lastName = lname;  
        this.salary = salary;  
    }  
  
    public int getId() {  
        return id;  
    }  
  
    public void setId( int id ) {  
        this.id = id;  
    }  
  
    public String getFirstName() {  
        return firstName;  
    }  
  
    public void setFirstName( String first_name ) {  
        this.firstName = first_name;  
    }  
  
    public String getLastname() {  
        return lastName;  
    }
```

```
}

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

public int getSalary() {
    return salary;
}
public void setSalary( int salary ) {
    this.salary = salary;
}
}
```

Hibernate - Mapping Files

An Object/relational mappings are usually defined in an XML document. This mapping file instructs Hibernate – how to map the defined class or classes to the database tables?

Let us consider our previously defined POJO class

```
public class Employee {
    private int id;
    private String firstName;
    private String lastName;
    private int salary;

    public Employee() {}

    public Employee(String fname, String lname, int salary) {
        this.firstName = fname;
        this.lastName = lname;
        this.salary = salary;
    }
}
```

Consider above objects need to be stored and retrieved into the following RDBMS table –

```
create table EMPLOYEE (
    id INT NOT NULL auto_increment,
    first_name VARCHAR(20) default NULL,
    last_name VARCHAR(20) default NULL,
    salary   INT default NULL,
    PRIMARY KEY (id)
);
```

Based on the two above entities, we can define following mapping file, which instructs Hibernate how to map the defined class or classes to the database tables.

```

<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-mapping PUBLIC
"-//Hibernate/Hibernate Mapping DTD//EN"
"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">

<hibernate-mapping>
    <class name = "Employee" table = "EMPLOYEE">
        <meta attribute = "class-description">
            This class contains the employee detail.
        </meta>

        <id name = "id" type = "int" column = "id">
            <generator class="native"/>
        </id>

        <property name = "firstName" column = "first_name" type = "string"/>
        <property name = "lastName" column = "last_name" type = "string"/>
        <property name = "salary" column = "salary" type = "int"/>

    </class>
</hibernate-mapping>

```

You should save the mapping document in a file with the format <classname>.hbm.xml. We saved our mapping document in the file Employee.hbm.xml.

Primitive Types

Mapping type	Java type	ANSI SQL Type
integer	int or java.lang.Integer	INTEGER
long	long or java.lang.Long	BIGINT
short	short or java.lang.Short	SMALLINT
float	float or java.lang.Float	FLOAT
double	double or java.lang.Double	DOUBLE
big_decimal	java.math.BigDecimal	NUMERIC
character	java.lang.String	CHAR(1)
string	java.lang.String	VARCHAR
byte	byte or java.lang.Byte	TINYINT
boolean	boolean or java.lang.Boolean	BIT

yes/no	boolean or java.lang.Boolean	CHAR(1) ('Y' or 'N')
true/false	boolean or java.lang.Boolean	CHAR(1) ('T' or 'F')

Date and Time Types

Mapping type	Java type	ANSI SQL Type
date	java.util.Date or java.sql.Date	DATE
time	java.util.Date or java.sql.Time	TIME
timestamp	java.util.Date or java.sql.Timestamp	TIMESTAMP
calendar	java.util.Calendar	TIMESTAMP
calendar_date	java.util.Calendar	DATE

Binary and Large Object Types

Mapping type	Java type	ANSI SQL Type
binary	byte[]	VARBINARY (or BLOB)
text	java.lang.String	CLOB
serializable	any Java class that implements java.io.Serializable	VARBINARY (or BLOB)
clob	java.sql.Clob	CLOB
blob	java.sql.Blob	BLOB

JDK-related Types

Mapping type	Java type	ANSI SQL Type
class	java.lang.Class	VARCHAR
locale	java.util.Locale	VARCHAR
timezone	java.util.TimeZone	VARCHAR
currency	java.util.Currency	VARCHAR

Hibernate - O/R Mappings

three most important mapping topics, which we have to learn in detail.

These are –

- Mapping of collections,
- Mapping of associations between entity classes, and
- Component Mappings.

Collections Mappings

If an entity or class has collection of values for a particular variable, then we can map those values using any one of the collection interfaces available in java. Hibernate can persist instances of `java.util.Map`, `java.util.Set`, `java.util.SortedMap`, `java.util.SortedSet`, `java.util.List`, and any array of persistent entities or values.

Sr.No.	Collection type & Mapping Description
1	<u>java.util.Set</u> This is mapped with a <code><set></code> element and initialized with <code>java.util.HashSet</code>
2	<u>java.util.SortedSet</u> This is mapped with a <code><set></code> element and initialized with <code>java.util.TreeSet</code> . The sort attribute can be set to either a comparator or natural ordering.
3	<u>java.util.List</u> This is mapped with a <code><list></code> element and initialized with <code>java.util.ArrayList</code>
4	<u>java.util.Collection</u> This is mapped with a <code><bag></code> or <code><ibag></code> element and initialized with <code>java.util.ArrayList</code>
5	<u>java.util.Map</u> This is mapped with a <code><map></code> element and initialized with <code>java.util.HashMap</code>
6	<u>java.util.SortedMap</u> This is mapped with a <code><map></code> element and initialized with <code>java.util.TreeMap</code> . The sort attribute can be set to either a comparator or natural ordering.

Component Mappings

It is very much possible that an Entity class can have a reference to another class as a member variable. If the referred class does not have its own life cycle and completely depends on the life cycle of the owning entity class, then the referred class hence therefore is called as the Component class.

The mapping of Collection of Components is also possible in a similar way just as the mapping of regular Collections with minor configuration differences. We will see these two mappings in detail with examples.

Component Mappings

Mapping for a class having a reference to another class as a member variable.

Association Mappings

The mapping of associations between entity classes and the relationships between tables is the soul of ORM. Following are the four ways in which the cardinality of the relationship between the objects can be expressed. An association mapping can be unidirectional as well as bidirectional.

Sr.No.	Mapping type & Description
1	Many-to-One Mapping many-to-one relationship using Hibernate
2	One-to-One Mapping one-to-one relationship using Hibernate
3	One-to-Many Mapping one-to-many relationship using Hibernate
4	Many-to-Many Mapping many-to-many relationship using Hibernate

Hibernate - Annotations

Hibernate annotations are the newest way to define mappings without the use of XML file. You can use annotations in addition to or as a replacement of XML mapping metadata.

Hibernate Annotations is the powerful way to provide the metadata for the Object and Relational Table mapping. All the metadata is clubbed into the POJO java file along with the code, this helps the user to understand the table structure and POJO simultaneously during the development.

you will need to install the Hibernate 3.x annotations distribution package, available from the sourceforge: (Download Hibernate Annotation) and copy hibernate-annotations.jar, lib/hibernate-comons-annotations.jar and lib/ejb3-persistence.jar from the Hibernate Annotations distribution to your CLASSPATH.

Following is the mapping of Employee class with annotations to map objects with the defined EMPLOYEE table

```
import javax.persistence.*;
```

```
@Entity
@Table(name = "EMPLOYEE")
public class Employee {
    @Id @GeneratedValue
    @Column(name = "id")
    private int id;

    @Column(name = "first_name")
```

```
private String firstName;

@Column(name = "last_name")
private String lastName;

@Column(name = "salary")
private int salary;

public Employee() {}

public int getId() {
    return id;
}

public void setId( int id ) {
    this.id = id;
}

public String getFirstName() {
    return firstName;
}

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

public String getLastName() {
    return lastName;
}

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

public int getSalary() {
    return salary;
}

public void setSalary( int salary ) {
    this.salary = salary;
}
```

Hibernate - Query Language

Hibernate Query Language (HQL) is an object-oriented query language, similar to SQL, but instead of operating on tables and columns, HQL works with persistent objects and their properties. HQL queries are translated by Hibernate into conventional SQL queries, which in turns perform action on database.

Although you can use SQL statements directly with Hibernate using Native SQL, but I would recommend to use HQL whenever possible to avoid database portability hassles, and to take advantage of Hibernate's SQL generation and caching strategies.

Keywords like SELECT, FROM, and WHERE, etc., are not case sensitive, but properties like table and column names are case sensitive in HQL.

FROM Clause

You will use FROM clause if you want to load a complete persistent objects into memory. Following is the simple syntax of using FROM clause –

```
String hql = "FROM Employee";
Query query = session.createQuery(hql);
List results = query.list();
```

If you need to fully qualify a class name in HQL, just specify the package and class name as follows –

```
String hql = "FROM com.hibernatebook.criteria.Employee";
Query query = session.createQuery(hql);
List results = query.list();
```

AS Clause

The AS clause can be used to assign aliases to the classes in your HQL queries, especially when you have the long queries. For instance, our previous simple example would be the following –

```
String hql = "FROM Employee AS E";
Query query = session.createQuery(hql);
List results = query.list();
```

The AS keyword is optional and you can also specify the alias directly after the class name, as follows –

```
String hql = "FROM Employee E";
Query query = session.createQuery(hql);
List results = query.list();
```

SELECT Clause

The SELECT clause provides more control over the result set then the from clause. If you want to obtain few properties of objects instead of the complete object, use the SELECT clause. Following is the simple syntax of using SELECT clause to get just first_name field of the Employee object –

```
String hql = "SELECT E.firstName FROM Employee E";
Query query = session.createQuery(hql);
List results = query.list();
```

It is notable here that Employee.firstName is a property of Employee object rather than a field of the EMPLOYEE table.

WHERE Clause

If you want to narrow the specific objects that are returned from storage, you use the WHERE clause. Following is the simple syntax of using WHERE clause –

```
String hql = "FROM Employee E WHERE E.id = 10";
Query query = session.createQuery(hql);
List results = query.list();
```

ORDER BY Clause

To sort your HQL query's results, you will need to use the ORDER BY clause. You can order the results by any property on the objects in the result set either ascending (ASC) or descending (DESC). Following is the simple syntax of using ORDER BY clause –

```
String hql = "FROM Employee E WHERE E.id > 10 ORDER BY E.salary DESC";
Query query = session.createQuery(hql);
List results = query.list();
```

If you wanted to sort by more than one property, you would just add the additional properties to the end of the order by clause, separated by commas as follows –

```
String hql = "FROM Employee E WHERE E.id > 10 " +
    "ORDER BY E.firstName DESC, E.salary DESC ";
Query query = session.createQuery(hql);
List results = query.list();
```

GROUP BY Clause

This clause lets Hibernate pull information from the database and group it based on a value of an attribute and, typically, use the result to include an aggregate value. Following is the simple syntax of using GROUP BY clause –

```
String hql = "SELECT SUM(E.salary), E.firstName FROM Employee E " +
    "GROUP BY E.firstName";
Query query = session.createQuery(hql);
List results = query.list();
```

Using Named Parameters

Hibernate supports named parameters in its HQL queries. This makes writing HQL queries that accept input from the user easy and you do not have to defend against SQL injection attacks. Following is the simple syntax of using named parameters –

```
String hql = "FROM Employee E WHERE E.id = :employee_id";
Query query = session.createQuery(hql);
query.setParameter("employee_id", 10);
```

```
List results = query.list();
```

UPDATE Clause

Bulk updates are new to HQL with Hibernate 3, and delete work differently in Hibernate 3 than they did in Hibernate 2. The Query interface now contains a method called executeUpdate() for executing HQL UPDATE or DELETE statements.

The UPDATE clause can be used to update one or more properties of an one or more objects. Following is the simple syntax of using UPDATE clause –

```
String hql = "UPDATE Employee set salary = :salary" +  
    "WHERE id = :employee_id";  
Query query = session.createQuery(hql);  
query.setParameter("salary", 1000);  
query.setParameter("employee_id", 10);  
int result = query.executeUpdate();  
System.out.println("Rows affected: " + result);
```

DELETE Clause

The DELETE clause can be used to delete one or more objects. Following is the simple syntax of using DELETE clause –

```
String hql = "DELETE FROM Employee" +  
    "WHERE id = :employee_id";  
Query query = session.createQuery(hql);  
  
query.setParameter("employee_id", 10);  
int result = query.executeUpdate();  
System.out.println("Rows affected: " + result);
```

INSERT Clause

HQL supports INSERT INTO clause only where records can be inserted from one object to another object. Following is the simple syntax of using INSERT INTO clause –

```
String hql = "INSERT INTO Employee(firstName, lastName, salary)" +  
    "SELECT firstName, lastName, salary FROM old_employee";  
Query query = session.createQuery(hql);  
int result = query.executeUpdate();  
System.out.println("Rows affected: " + result);
```

Aggregate Methods

HQL supports a range of aggregate methods, similar to SQL. They work the same way in HQL as in SQL and following is the list of the available functions –

Sr.No.	Functions & Description
1	avg(property name) The average of a property's value
2	count(property name or *) The number of times a property occurs in the results
3	max(property name) The maximum value of the property values
4	min(property name) The minimum value of the property values
5	sum(property name) The sum total of the property values

The distinct keyword only counts the unique values in the row set.

```
String hql = "SELECT count(distinct E.firstName) FROM Employee E";
Query query = session.createQuery(hql);
List results = query.list();
```

Pagination using Query

There are two methods of the Query interface for pagination.

Sr.No.	Method & Description
1	Query setFirstResult(int startPosition) This method takes an integer that represents the first row in your result set, starting with row 0.
2	Query setMaxResults(int maxResult) This method tells Hibernate to retrieve a fixed number maxResults of objects.

Using above two methods together, we can construct a paging component in our web or Swing application.

```
String hql = "FROM Employee";
Query query = session.createQuery(hql);
query.setFirstResult(1);
query.setMaxResults(10);
List results = query.list();
```

Hibernate - Criteria Queries

Hibernate provides alternate ways of manipulating objects and in turn data available in RDBMS tables. One of the methods is Criteria API, which allows you to build up a criteria query object programmatically where you can apply filtration rules and logical conditions.

The Hibernate Session interface **provides createCriteria()** method, which can be used to create a Criteria object that returns instances of the persistence object's class when your application executes a criteria query.

Following is the simplest example of a criteria query is one, which will simply return every object that corresponds to the Employee class.

```
Criteria cr = session.createCriteria(Employee.class);
List results = cr.list();
```

Restrictions with Criteria

You can use **add()** method available for **Criteria** object to add restriction for a criteria query. Following is the example to add a restriction to return the records with salary is equal to 2000 –

```
Criteria cr = session.createCriteria(Employee.class);
cr.add(Restrictions.eq("salary", 2000));
List results = cr.list();
```

Following are the few more examples covering different scenarios and can be used as per the requirement –

```
Criteria cr = session.createCriteria(Employee.class);

// To get records having salary more than 2000
cr.add(Restrictions.gt("salary", 2000));

// To get records having salary less than 2000
cr.add(Restrictions.lt("salary", 2000));

// To get records having fistName starting with zara
cr.add(Restrictions.like("firstName", "zara%"));

// Case sensitive form of the above restriction.
cr.add(Restrictions.ilike("firstName", "zara%"));

// To get records having salary in between 1000 and 2000
cr.add(Restrictions.between("salary", 1000, 2000));
```

```
// To check if the given property is null  
cr.add(Restrictions.isNull("salary"));  
  
// To check if the given property is not null  
cr.add(Restrictions.isNotNull("salary"));  
  
// To check if the given property is empty  
cr.add(Restrictions.isEmpty("salary"));  
  
// To check if the given property is not empty  
cr.add(Restrictions.isNotEmpty("salary"));
```

You can create AND or OR conditions using LogicalExpression restrictions as follows –

```
Criteria cr = session.createCriteria(Employee.class);  
  
Criterion salary = Restrictions.gt("salary", 2000);  
Criterion name = Restrictions.ilike("firstNname", "zara%");  
  
// To get records matching with OR conditions  
LogicalExpression orExp = Restrictions.or(salary, name);  
cr.add( orExp );  
  
// To get records matching with AND conditions  
LogicalExpression andExp = Restrictions.and(salary, name);  
cr.add( andExp );
```

List results = cr.list();

Though all the above conditions can be used directly with HQL as explained in previous tutorial.

Pagination Using Criteria

There are two methods of the Criteria interface for pagination.

Sr.No.	Method & Description
1	public Criteria setFirstResult(int firstResult) This method takes an integer that represents the first row in your result set, starting with row 0.
2	public Criteria setMaxResults(int maxResults) This method tells Hibernate to retrieve a fixed number maxResults of objects.

Using above two methods together, we can construct a paging component in our web or Swing application. Following is the example, which you can extend to fetch 10 rows at a time –

```
Criteria cr = session.createCriteria(Employee.class);
cr.setFirstResult(1);
cr.setMaxResults(10);
List results = cr.list();
```

Sorting the Results

The Criteria API provides the org.hibernate.criterion.Order class to sort your result set in either ascending or descending order, according to one of your object's properties. This example demonstrates how you would use the Order class to sort the result set –

```
Criteria cr = session.createCriteria(Employee.class);

// To get records having salary more than 2000
cr.add(Restrictions.gt("salary", 2000));

// To sort records in descening order
cr.addOrder(Order.desc("salary"));

// To sort records in ascending order
cr.addOrder(Order.asc("salary"));

List results = cr.list();
```

Projections & Aggregations

The Criteria API provides the org.hibernate.criterion.Projections class, which can be used to get average, maximum, or minimum of the property values. The Projections class is similar to the Restrictions class, in that it provides several static factory methods for obtaining Projection instances.

Following are the few examples covering different scenarios and can be used as per requirement –

```
Criteria cr = session.createCriteria(Employee.class);

// To get total row count.
cr.setProjection(Projections.rowCount());

// To get average of a property.
cr.setProjection(Projections.avg("salary"));

// To get distinct count of a property.
cr.setProjection(Projections.countDistinct("firstName"));

// To get maximum of a property.
cr.setProjection(Projections.max("salary"));

// To get minimum of a property.
cr.setProjection(Projections.min("salary"));
```

```
// To get sum of a property.  
cr.setProjection(Projections.sum("salary"));
```

Hibernate - Native SQL

You can use native SQL to express database queries if you want to utilize database-specific features such as query hints or the CONNECT keyword in Oracle. Hibernate 3.x allows you to specify handwritten SQL, including stored procedures, for all create, update, delete, and load operations.

Your application will create a native SQL query from the session with the `createSQLQuery()` method on the Session interface –

```
public SQLQuery createSQLQuery(String sqlString) throws HibernateException
```

After you pass a string containing the SQL query to the `createSQLQuery()` method, you can associate the SQL result with either an existing Hibernate entity, a join, or a scalar result using `addEntity()`, `addJoin()`, and `addScalar()` methods respectively.

Scalar Queries

The most basic SQL query is to get a list of scalars (values) from one or more tables. Following is the syntax for using native SQL for scalar values –

```
String sql = "SELECT first_name, salary FROM EMPLOYEE";  
SQLQuery query = session.createSQLQuery(sql);  
query.setResultTransformer(Criteria.ALIAS_TO_ENTITY_MAP);  
List results = query.list();
```

Entity Queries

The above queries were all about returning scalar values, basically returning the "raw" values from the result set. Following is the syntax to get entity objects as a whole from a native sql query via `addEntity()`.

```
String sql = "SELECT * FROM EMPLOYEE";  
SQLQuery query = session.createSQLQuery(sql);  
query.addEntity(Employee.class);  
List results = query.list();
```

Named SQL Queries

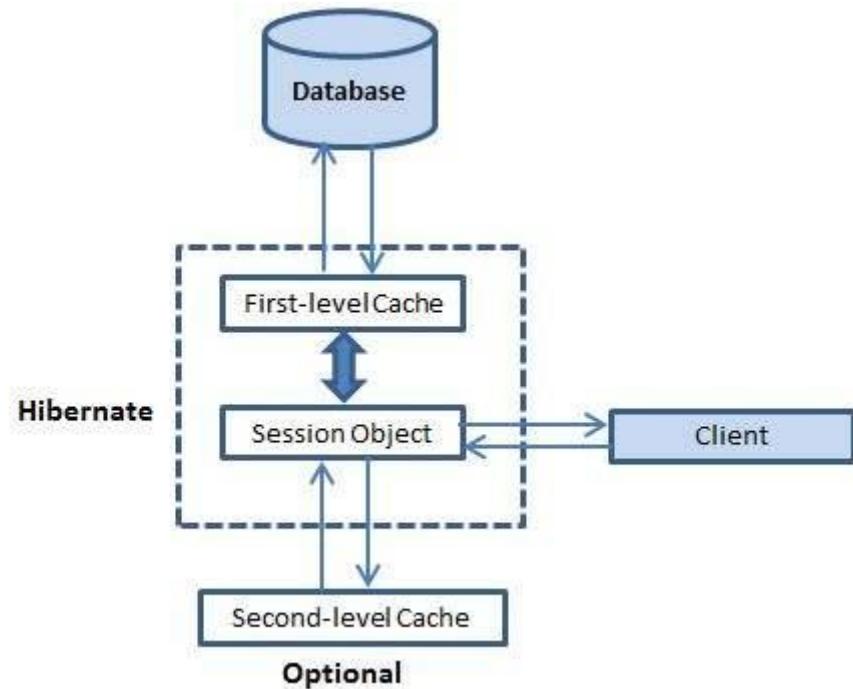
Following is the syntax to get entity objects from a native sql query via `addEntity()` and using named SQL query.

```
String sql = "SELECT * FROM EMPLOYEE WHERE id = :employee_id";  
SQLQuery query = session.createSQLQuery(sql);  
query.addEntity(Employee.class);  
query.setParameter("employee_id", 10);  
List results = query.list();
```

Hibernate - Caching

Caching is a mechanism to enhance the performance of a system. It is a buffer memory that lies between the application and the database. Cache memory stores recently used data items in order to reduce the number of database hits as much as possible.

Caching is important to Hibernate as well. It utilizes a multilevel caching scheme



First-level Cache

The first-level cache is the Session cache and is a mandatory cache through which all requests must pass. The Session object keeps an object under its own power before committing it to the database.

If you issue multiple updates to an object, Hibernate tries to delay doing the update as long as possible to reduce the number of update SQL statements issued. If you close the session, all the objects being cached are lost and either persisted or updated in the database.

Second-level Cache

Second level cache is an optional cache and first-level cache will always be consulted before any attempt is made to locate an object in the second-level cache. The second level cache can be configured on a per-class and per-collection basis and mainly responsible for caching objects across sessions.

Any third-party cache can be used with Hibernate. An `org.hibernate.cache.CacheProvider` interface is provided, which must be implemented to provide Hibernate with a handle to the cache implementation.

Query-level Cache

Hibernate also implements a cache for query resultsets that integrates closely with the second-level cache.

This is an optional feature and requires two additional physical cache regions that hold the cached query results and the timestamps when a table was last updated. This is only useful for queries that are run frequently with the same parameters.

The Second Level Cache

Hibernate uses first-level cache by default and you have nothing to do to use first-level cache. Let's go straight to the optional second-level cache. Not all classes benefit from caching, so it's important to be able to disable the second-level cache.

The Hibernate second-level cache is set up in two steps. First, you have to decide which concurrency strategy to use. After that, you configure cache expiration and physical cache attributes using the cache provider.

Concurrency Strategies

A concurrency strategy is a mediator, which is responsible for storing items of data in the cache and retrieving them from the cache. If you are going to enable a second-level cache, you will have to decide, for each persistent class and collection, which cache concurrency strategy to use.

Transactional – Use this strategy for read-mostly data where it is critical to prevent stale data in concurrent transactions, in the rare case of an update.

Read-write – Again use this strategy for read-mostly data where it is critical to prevent stale data in concurrent transactions, in the rare case of an update.

Nonstrict-read-write – This strategy makes no guarantee of consistency between the cache and the database. Use this strategy if data hardly ever changes and a small likelihood of stale data is not of critical concern.

Read-only – A concurrency strategy suitable for data, which never changes. Use it for reference data only.

If we are going to use second-level caching for our **Employee** class, let us add the mapping element required to tell Hibernate to cache Employee instances using read-write strategy.

```
<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-mapping PUBLIC
"-//Hibernate/Hibernate Mapping DTD//EN"
"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">
<hibernate-mapping>
  <class name = "Employee" table = "EMPLOYEE">

    <meta attribute = "class-description">
      This class contains the employee detail.
    </meta>
```

```
<cache usage = "read-write"/>
  <id name = "id" type = "int" column = "id">
    <generator class="native"/>
  </id>

  <property name = "firstName" column = "first_name" type = "string"/>
  <property name = "lastName" column = "last_name" type = "string"/>
  <property name = "salary" column = "salary" type = "int"/>

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

The usage="read-write" attribute tells Hibernate to use a read-write concurrency strategy for the defined cache.

Cache Provider

Your next step after considering the concurrency strategies, you will use your cache candidate classes to pick a cache provider. Hibernate forces you to choose a single cache provider for the whole application.

Sr.No.	Cache Name & Description
1	EHCache It can cache in memory or on disk and clustered caching and it supports the optional Hibernate query result cache.
2	OSCache Supports caching to memory and disk in a single JVM with a rich set of expiration policies and query cache support.
3	warmCache A cluster cache based on JGroups. It uses clustered invalidation, but doesn't support the Hibernate query cache.
4	JBoss Cache A fully transactional replicated clustered cache also based on the JGroups multicast library. It supports replication or invalidation, synchronous or asynchronous communication, and optimistic and pessimistic locking. The Hibernate query cache is supported.

Every cache provider is not compatible with every concurrency strategy. The following compatibility matrix will help you choose an appropriate combination.

Strategy/Provider	Read-only	Nonstrictread-write	Read-write	Transactional
EHCache	X	X	X	
OSCache	X	X	X	
SwarmCache	X	X		
JBoss Cache	X			X

You will specify a cache provider in hibernate.cfg.xml configuration file. We choose EHCache as our second-level cache provider –

```

<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-configuration SYSTEM
"http://www.hibernate.org/dtd/hibernate-configuration-3.0.dtd">
<hibernate-configuration>
    <session-factory>

        <property name = "hibernate.dialect">
            org.hibernate.dialect.MySQLDialect
        </property>

        <property name = "hibernate.connection.driver_class">
            com.mysql.jdbc.Driver
        </property>

        <!-- Assume students is the database name -->

        <property name = "hibernate.connection.url">
            jdbc:mysql://localhost/test
        </property>

        <property name = "hibernate.connection.username">
            root
        </property>

        <property name = "hibernate.connection.password">
            root123
        </property>
    </session-factory>
</hibernate-configuration>

```

```
<property name = "hibernate.cache.provider_class">
  org.hibernate.cache.EhCacheProvider
</property>

<!-- List of XML mapping files -->
<mapping resource = "Employee.hbm.xml"/>

</session-factory>
</hibernate-configuration>
```

Now, you need to specify the properties of the cache regions. EHCache has its own configuration file, **ehcache.xml**, which should be in the CLASSPATH of the application. A cache configuration in ehcache.xml for the Employee class may look like this –

```
<diskStore path="java.io.tmpdir"/>
```

```
<defaultCache
maxElementsInMemory = "1000"
eternal = "false"
timeToIdleSeconds = "120"
timeToLiveSeconds = "120"
overflowToDisk = "true"
/>
```

```
<cache name = "Employee"
maxElementsInMemory = "500"
eternal = "true"
timeToIdleSeconds = "0"
timeToLiveSeconds = "0"
overflowToDisk = "false"
/>
```

That's it, now we have second-level caching enabled for the Employee class and Hibernate, now hits the second-level cache whenever you navigate to an Employee or when you load an Employee by identifier.

You should analyze your all the classes and choose appropriate caching strategy for each of the classes. Sometime, second-level caching may downgrade the performance of the application. So, it is recommended to benchmark your application first, without enabling caching and later on enable your well suited caching and check the performance. If caching is not improving system performance, then there is no point in enabling any type of caching.

The Query-level Cache

To use the query cache, you must first activate it using the **hibernate.cache.use_query_cache="true"** property in the configuration file. By setting this property to true, you make Hibernate create the necessary caches in memory to hold the query and identifier sets.

Next, to use the query cache, you use the `setCacheable(Boolean)` method of the Query class. For example –

```
Session session = SessionFactory.openSession();
```

```
Query query = session.createQuery("FROM EMPLOYEE");
query.setCacheable(true);
List users = query.list();
SessionFactory.closeSession();
```

Hibernate also supports very fine-grained cache support through the concept of a cache region. A cache region is part of the cache that's given a name.

```
Session session = SessionFactory.openSession();
Query query = session.createQuery("FROM EMPLOYEE");
query.setCacheable(true);
query.setCacheRegion("employee");
List users = query.list();
SessionFactory.closeSession();
```

Hibernate - Batch Processing

Consider a situation when you need to upload a large number of records into your database using Hibernate. Following is the code snippet to achieve this using Hibernate –

```
Session session = SessionFactory.openSession();
Transaction tx = session.beginTransaction();
for ( int i=0; i<100000; i++ ) {
    Employee employee = new Employee(.....);
    session.save(employee);
}
tx.commit();
session.close();
```

By default, Hibernate will cache all the persisted objects in the session-level cache and ultimately your application would fall over with an OutOfMemoryException somewhere around the 50,000th row. You can resolve this problem, if you are using batch processing with Hibernate.

To use the batch processing feature, first set hibernate.jdbc.batch_size as batch size to a number either at 20 or 50 depending on object size. This will tell the hibernate container that every X rows to be inserted as batch. To implement this in your code, we would need to do little modification as follows –

```
Session session = SessionFactory.openSession();
Transaction tx = session.beginTransaction();
for ( int i=0; i<100000; i++ ) {
    Employee employee = new Employee(.....);
    session.save(employee);
    if( i % 50 == 0 ) { // Same as the JDBC batch size
        //flush a batch of inserts and release memory:
        session.flush();
        session.clear();
    }
}
```

```
}
```

```
tx.commit();
```

```
session.close();
```

Above code will work fine for the INSERT operation, but if you are willing to make UPDATE operation, then you can achieve using the following code –

```
Session session = sessionFactory.openSession();
Transaction tx = session.beginTransaction();

ScrollableResults employeeCursor = session.createQuery("FROM EMPLOYEE").scroll();
int count = 0;

while ( employeeCursor.next() ) {
    Employee employee = (Employee) employeeCursor.get(0);
    employee.updateEmployee();
    session.update(employee);
    if ( ++count % 50 == 0 ) {
        session.flush();
        session.clear();
    }
}
tx.commit();
session.close();
```

Batch Processing Example

Let us modify the configuration file to add hibernate.jdbc.batch_size property –

```
<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-configuration SYSTEM
"http://www.hibernate.org/dtd/hibernate-configuration-3.0.dtd">

<hibernate-configuration>
    <session-factory>

        <property name = "hibernate.dialect">
            org.hibernate.dialect.MySQLDialect
        </property>

        <property name = "hibernate.connection.driver_class">
            com.mysql.jdbc.Driver
        </property>

        <!-- Assume students is the database name -->

        <property name = "hibernate.connection.url">
            jdbc:mysql://localhost/test
        </property>
```

```
<property name = "hibernate.connection.username">
    root
</property>

<property name = "hibernate.connection.password">
    root123
</property>

<property name = "hibernate.jdbc.batch_size">
    50
</property>

<!-- List of XML mapping files -->
<mapping resource = "Employee.hbm.xml"/>
```

```
</session-factory>
</hibernate-configuration>
Consider the following POJO Employee class –
```

```
public class Employee {
    private int id;
    private String firstName;
    private String lastName;
    private int salary;

    public Employee() {}

    public Employee(String fname, String lname, int salary) {
        this.firstName = fname;
        this.lastName = lname;
        this.salary = salary;
    }

    public int getId() {
        return id;
    }

    public void setId( int id ) {
        this.id = id;
    }

    public String getFirstName() {
        return firstName;
    }

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

    public String getLastname() {
```

```
    return lastName;
}

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

public int getSalary() {
    return salary;
}

public void setSalary( int salary ) {
    this.salary = salary;
}
```

Let us create the following EMPLOYEE table to store the Employee objects –

```
create table EMPLOYEE (
    id INT NOT NULL auto_increment,
    first_name VARCHAR(20) default NULL,
    last_name VARCHAR(20) default NULL,
    salary    INT default NULL,
    PRIMARY KEY (id)
);
```

Following will be the mapping file to map the Employee objects with EMPLOYEE table –

```
<?xml version = "1.0" encoding = "utf-8"?>
<!DOCTYPE hibernate-mapping PUBLIC
"-//Hibernate/Hibernate Mapping DTD//EN"
"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">

<hibernate-mapping>
    <class name = "Employee" table = "EMPLOYEE">

        <meta attribute = "class-description">
            This class contains the employee detail.
        </meta>

        <id name = "id" type = "int" column = "id">
            <generator class="native"/>
        </id>

        <property name = "firstName" column = "first_name" type = "string"/>
        <property name = "lastName" column = "last_name" type = "string"/>
        <property name = "salary" column = "salary" type = "int"/>
```

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

Finally, we will create our application class with the main() method to run the application where we will use flush() and clear() methods available with Session object so that Hibernate keeps writing these records into the database instead of caching them in the memory.

```
import java.util.*;

import org.hibernate.HibernateException;
import org.hibernate.Session;
import org.hibernate.Transaction;
import org.hibernate.SessionFactory;
import org.hibernate.cfg.Configuration;

public class ManageEmployee {
    private static SessionFactory factory;
    public static void main(String[] args) {

        try {
            factory = new Configuration().configure().buildSessionFactory();
        } catch (Throwable ex) {
            System.err.println("Failed to create sessionFactory object." + ex);
            throw new ExceptionInInitializerError(ex);
        }
        ManageEmployee ME = new ManageEmployee();

        /* Add employee records in batches */
        ME.addEmployees( );
    }

    /* Method to create employee records in batches */
    public void addEmployees( ){
        Session session = factory.openSession();
        Transaction tx = null;
        Integer employeeID = null;

        try {
            tx = session.beginTransaction();
            for ( int i=0; i<100000; i++ ) {
                String fname = "First Name " + i;
                String lname = "Last Name " + i;
                Integer salary = i;
                Employee employee = new Employee(fname, lname, salary);
                session.save(employee);
                if( i % 50 == 0 ) {
                    session.flush();
                    session.clear();
                }
            }
            tx.commit();
        } catch (Exception e) {
            tx.rollback();
            e.printStackTrace();
        }
    }
}
```

```

        }
    }
    tx.commit();
} catch (HibernateException e) {
    if (tx!=null) tx.rollback();
    e.printStackTrace();
} finally {
    session.close();
}
return ;
}
}

```

Hibernate - Interceptors

As you have learnt that in Hibernate, an object will be created and persisted. Once the object has been changed, it must be saved back to the database. This process continues until the next time the object is needed, and it will be loaded from the persistent store.

Thus an object passes through different stages in its life cycle and Interceptor Interface provides methods, which can be called at different stages to perform some required tasks. These methods are 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. Following is the list of all the methods available within the Interceptor interface –

Sr.No.	Method & Description
1	findDirty() This method is be called when the flush() method is called on a Session object.
2	instantiate() This method is called when a persisted class is instantiated.
3	isUnsaved() This method is called when an object is passed to the saveOrUpdate() method/
4	onDelete() This method is called before an object is deleted.
5	onFlushDirty() This method is called when Hibernate detects that an object is dirty (i.e. have been changed) during a flush i.e. update operation.
6	onLoad() This method is called before an object is initialized.

7	onSave() This method is called before an object is saved.
8	postFlush() This method is called after a flush has occurred and an object has been updated in memory.
9	preFlush() This method is called before a flush.

How to Use Interceptors?

To build an interceptor, you can either implement Interceptor class directly or extend Empty Interceptor class. Following will be the simple steps to use Hibernate Interceptor functionality.

