Hibernate ORM 5.2.12.Final User Guide

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[31. References](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#_references)

# Hibernate ORM 5.2.12.Final User Guide

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## Preface

Working with both Object-Oriented software and Relational Databases can be cumbersome and time consuming. Development costs are significantly higher due to a paradigm mismatch between how data is represented in objects versus relational databases. Hibernate is an Object/Relational Mapping solution for Java environments. The term [Object/Relational Mapping](http://en.wikipedia.org/wiki/Object-relational_mapping) refers to the technique of mapping data from an object model representation to a relational data model representation (and visa versa).

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 significantly reduce development time otherwise spent with manual data handling in SQL and JDBC. Hibernate’s design goal is to relieve the developer from 95% of common data persistence-related programming tasks by eliminating the need for manual, hand-crafted data processing using SQL and JDBC. However, unlike many other persistence solutions, Hibernate does not hide the power of SQL from you and guarantees that your investment in relational technology and knowledge is as valid as always.

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.

### Get Involved

* Use Hibernate and report any bugs or issues you find. See [Issue Tracker](http://hibernate.org/issuetracker) for details.
* Try your hand at fixing some bugs or implementing enhancements. Again, see [Issue Tracker](http://hibernate.org/issuetracker).
* Engage with the community using mailing lists, forums, IRC, or other ways listed in the [Community section](http://hibernate.org/community).
* Help improve or translate this documentation. Contact us on the developer mailing list if you have interest.
* Spread the word. Let the rest of your organization know about the benefits of Hibernate.

## System Requirements

Hibernate 5.2 and later versions require at least Java 1.8 and JDBC 4.2.

Hibernate 5.1 and older versions require at least Java 1.6 and JDBC 4.0.

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|  | When building Hibernate 5.1 or older from sources, you need Java 1.7 due to a bug in the JDK 1.6 compiler. |

### Getting Started Guide

New users may want to first look through the [Hibernate Getting Started Guide](https://docs.jboss.org/hibernate/orm/5.2/quickstart/html_single/) for basic information as well as tutorials. There is also a series of [topical guides](http://docs.jboss.org/hibernate/orm/5.2/topical/html_single/) providing deep dives into various topics.

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|  | While having a strong background in SQL is not required to use Hibernate, it certainly helps a lot because it all boils down to SQL statements. Probably even more important is an understanding of data modeling principles. You might want to consider these resources as a good starting point:   * [Data Modeling Wikipedia definition](http://en.wikipedia.org/wiki/Data_modeling) * [Data Modeling 101](http://www.agiledata.org/essays/dataModeling101.html)   Understanding the basics of transactions and design patterns such as Unit of Work [PoEAA](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#PoEAA) or Application Transaction are important as well. These topics will be discussed in the documentation, but a prior understanding will certainly help. |

## 1. Architecture

### 1.1. Overview

Hibernate, as an ORM solution, effectively "sits between" the Java application data access layer and the Relational Database, as can be seen in the diagram above. The Java application makes use of the Hibernate APIs to load, store, query, etc its domain data. Here we will introduce the essential Hibernate APIs. This will be a brief introduction; we will discuss these contracts in detail later.

As a JPA provider, Hibernate implements the Java Persistence API specifications and the association between JPA interfaces and Hibernate specific implementations can be visualized in the following diagram:

SessionFactory (org.hibernate.SessionFactory)

A thread-safe (and immutable) representation of the mapping of the application domain model to a database. Acts as a factory for org.hibernate.Session instances. The EntityManagerFactory is the JPA equivalent of a SessionFactory and basically those two converge into the same SessionFactory implementation.

A SessionFactory is very expensive to create, so, for any given database, the application should have only one associated SessionFactory. The SessionFactory maintains services that Hibernate uses across all Session(s)such as second level caches, connection pools, transaction system integrations, etc.

Session (org.hibernate.Session)

A single-threaded, short-lived object conceptually modeling a "Unit of Work" [PoEAA](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#PoEAA). In JPA nomenclature, the Sessionis represented by an EntityManager.

Behind the scenes, the Hibernate Session wraps a JDBC java.sql.Connection and acts as a factory for org.hibernate.Transaction instances. It maintains a generally "repeatable read" persistence context (first level cache) of the application domain model.

Transaction (org.hibernate.Transaction)

A single-threaded, short-lived object used by the application to demarcate individual physical transaction boundaries.EntityTransaction is the JPA equivalent and both act as an abstraction API to isolate the application from the underlying transaction system in use (JDBC or JTA).

## 2. Domain Model

The term [domain model](https://en.wikipedia.org/wiki/Domain_model) comes from the realm of data modeling. It is the model that ultimately describes the [problem domain](https://en.wikipedia.org/wiki/Problem_domain) you are working in. Sometimes you will also hear the term persistent classes.

Ultimately the application domain model is the central character in an ORM. They make up the classes you wish to map. Hibernate works best if these classes follow the Plain Old Java Object (POJO) / JavaBean programming model. However, none of these rules are hard requirements. Indeed, Hibernate assumes very little about the nature of your persistent objects. You can express a domain model in other ways (using trees of java.util.Map instances, for example).

Historically applications using Hibernate would have used its proprietary XML mapping file format for this purpose. With the coming of JPA, most of this information is now defined in a way that is portable across ORM/JPA providers using annotations (and/or standardized XML format). This chapter will focus on JPA mapping where possible. For Hibernate mapping features not supported by JPA we will prefer Hibernate extension annotations.

### 2.1. Mapping types

Hibernate understands both the Java and JDBC representations of application data. The ability to read/write this data from/to the database is the function of a Hibernate type. A type, in this usage, is an implementation of the org.hibernate.type.Type interface. This Hibernate type also describes various aspects of behavior of the Java type such as how to check for equality, how to clone values, etc.

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|  | *Usage of the word*type  The Hibernate type is neither a Java type nor a SQL data type. It provides information about both of these as well as understanding marshalling between.  When you encounter the term type in discussions of Hibernate, it may refer to the Java type, the JDBC type, or the Hibernate type, depending on context. |

To help understand the type categorizations, let’s look at a simple table and domain model that we wish to map.

*Example 1. Simple table and domain model*

create table Contact (

id integer not null,

first varchar(255),

last varchar(255),

middle varchar(255),

notes varchar(255),

starred boolean not null,

website varchar(255),

primary key (id)

)

@Entity(name = "Contact")

public static class Contact {

@Id

private Integer id;

private Name name;

private String notes;

private URL website;

private boolean starred;

//Getters and setters are omitted for brevity

}

@Embeddable

public class Name {

private String first;

private String middle;

private String last;

// getters and setters omitted

}

In the broadest sense, Hibernate categorizes types into two groups:

* [Value types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#categorization-value)
* [Entity types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#categorization-entity)

#### 2.1.1. Value types

A value type is a piece of data that does not define its own lifecycle. It is, in effect, owned by an entity, which defines its lifecycle.

Looked at another way, all the state of an entity is made up entirely of value types. These state fields or JavaBean properties are termed persistent attributes. The persistent attributes of the Contact class are value types.

Value types are further classified into three sub-categories:

Basic types

in mapping the Contact table, all attributes except for name would be basic types. Basic types are discussed in detail in [Basic Types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic)

Embeddable types

the name attribute is an example of an embeddable type, which is discussed in details in [Embeddable Types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddables)

Collection types

although not featured in the aforementioned example, collection types are also a distinct category among value types. Collection types are further discussed in [Collections](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections)

#### 2.1.2. Entity types

Entities, by nature of their unique identifier, exist independently of other objects whereas values do not. Entities are domain model classes which correlate to rows in a database table, using a unique identifier. Because of the requirement for a unique identifier, entities exist independently and define their own lifecycle. The Contact class itself would be an example of an entity.

Mapping entities is discussed in detail in [Entity](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity).

### 2.2. Naming strategies

Part of the mapping of an object model to the relational database is mapping names from the object model to the corresponding database names. Hibernate looks at this as 2 stage process:

* The first stage is determining a proper logical name from the domain model mapping. A logical name can be either explicitly specified by the user (using @Column or @Table e.g.) or it can be implicitly determined by Hibernate through an [ImplicitNamingStrategy](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#ImplicitNamingStrategy) contract.
* Second is the resolving of this logical name to a physical name which is defined by the [PhysicalNamingStrategy](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#PhysicalNamingStrategy)contract.

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|  | *Historical NamingStrategy contract*  Historically Hibernate defined just a single org.hibernate.cfg.NamingStrategy. That singular NamingStrategy contract actually combined the separate concerns that are now modeled individually as ImplicitNamingStrategy and PhysicalNamingStrategy.  Also, the NamingStrategy contract was often not flexible enough to properly apply a given naming "rule", either because the API lacked the information to decide or because the API was honestly not well defined as it grew.  Due to these limitation, org.hibernate.cfg.NamingStrategy has been deprecated and then removed in favor of ImplicitNamingStrategy and PhysicalNamingStrategy. |

At the core, the idea behind each naming strategy is to minimize the amount of repetitive information a developer must provide for mapping a domain model.

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|  | *JPA Compatibility*  JPA defines inherent rules about implicit logical name determination. If JPA provider portability is a major concern, or if you really just like the JPA-defined implicit naming rules, be sure to stick with ImplicitNamingStrategyJpaCompliantImpl (the default)  Also, JPA defines no separation between logical and physical name. Following the JPA specification, the logical name **is** the physical name. If JPA provider portability is important, applications should prefer not to specify a PhysicalNamingStrategy. |

#### 2.2.1. ImplicitNamingStrategy

When an entity does not explicitly name the database table that it maps to, we need to implicitly determine that table name. Or when a particular attribute does not explicitly name the database column that it maps to, we need to implicitly determine that column name. There are examples of the role of the org.hibernate.boot.model.naming.ImplicitNamingStrategy contract to determine a logical name when the mapping did not provide an explicit name.

Hibernate defines multiple ImplicitNamingStrategy implementations out-of-the-box. Applications are also free to plug-in custom implementations.

There are multiple ways to specify the ImplicitNamingStrategy to use. First, applications can specify the implementation using the hibernate.implicit\_naming\_strategy configuration setting which accepts:

* pre-defined "short names" for the out-of-the-box implementations

default

for org.hibernate.boot.model.naming.ImplicitNamingStrategyJpaCompliantImpl - an alias for jpa

jpa

for org.hibernate.boot.model.naming.ImplicitNamingStrategyJpaCompliantImpl - the JPA 2.0 compliant naming strategy

legacy-hbm

for org.hibernate.boot.model.naming.ImplicitNamingStrategyLegacyHbmImpl - compliant with the original Hibernate NamingStrategy

legacy-jpa

for org.hibernate.boot.model.naming.ImplicitNamingStrategyLegacyJpaImpl - compliant with the legacy NamingStrategy developed for JPA 1.0, which was unfortunately unclear in many respects regarding implicit naming rules

component-path

for org.hibernate.boot.model.naming.ImplicitNamingStrategyComponentPathImpl - mostly follows ImplicitNamingStrategyJpaCompliantImpl rules, except that it uses the full composite paths, as opposed to just the ending property part

* reference to a Class that implements the org.hibernate.boot.model.naming.ImplicitNamingStrategy contract
* FQN of a class that implements the org.hibernate.boot.model.naming.ImplicitNamingStrategy contract

Secondly, applications and integrations can leverage org.hibernate.boot.MetadataBuilder#applyImplicitNamingStrategy to specify the ImplicitNamingStrategy to use. See [Bootstrap](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap) for additional details on bootstrapping.

#### 2.2.2. PhysicalNamingStrategy

Many organizations define rules around the naming of database objects (tables, columns, foreign-keys, etc). The idea of a PhysicalNamingStrategy is to help implement such naming rules without having to hard-code them into the mapping via explicit names.

While the purpose of an ImplicitNamingStrategy is to determine that an attribute named accountNumber maps to a logical column name of accountNumber when not explicitly specified, the purpose of a PhysicalNamingStrategy would be, for example, to say that the physical column name should instead be abbreviated acct\_num.

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|  | It is true that the resolution to acct\_num could have been handled in an ImplicitNamingStrategy in this case. But the point is separation of concerns. The PhysicalNamingStrategy will be applied regardless of whether the attribute explicitly specified the column name or whether we determined that implicitly. The ImplicitNamingStrategy would only be applied if an explicit name was not given. So it depends on needs and intent. |

The default implementation is to simply use the logical name as the physical name. However applications and integrations can define custom implementations of this PhysicalNamingStrategy contract. Here is an example PhysicalNamingStrategy for a fictitious company named Acme Corp whose naming standards are to:

* prefer underscore-delimited words rather than camel-casing
* replace certain words with standard abbreviations

*Example 2. Example PhysicalNamingStrategy implementation*

/\*

\* Hibernate, Relational Persistence for Idiomatic Java

\*

\* License: GNU Lesser General Public License (LGPL), version 2.1 or later.

\* See the lgpl.txt file in the root directory or <http://www.gnu.org/licenses/lgpl-2.1.html>.

\*/

package org.hibernate.userguide.naming;

import java.util.LinkedList;

import java.util.List;

import java.util.Locale;

import java.util.Map;

import java.util.TreeMap;

import org.hibernate.boot.model.naming.Identifier;

import org.hibernate.boot.model.naming.PhysicalNamingStrategy;

import org.hibernate.engine.jdbc.env.spi.JdbcEnvironment;

import org.apache.commons.lang3.StringUtils;

/\*\*

\* An example PhysicalNamingStrategy that implements database object naming standards

\* for our fictitious company Acme Corp.

\* <p/>

\* In general Acme Corp prefers underscore-delimited words rather than camel casing.

\* <p/>

\* Additionally standards call for the replacement of certain words with abbreviations.

\*

\* @author Steve Ebersole

\*/

public class AcmeCorpPhysicalNamingStrategy implements PhysicalNamingStrategy {

private static final Map<String,String> ABBREVIATIONS = buildAbbreviationMap();

@Override

public Identifier toPhysicalCatalogName(Identifier name, JdbcEnvironment jdbcEnvironment) {

// Acme naming standards do not apply to catalog names

return name;

}

@Override

public Identifier toPhysicalSchemaName(Identifier name, JdbcEnvironment jdbcEnvironment) {

// Acme naming standards do not apply to schema names

return name;

}

@Override

public Identifier toPhysicalTableName(Identifier name, JdbcEnvironment jdbcEnvironment) {

final List<String> parts = splitAndReplace( name.getText() );

return jdbcEnvironment.getIdentifierHelper().toIdentifier(

join( parts ),

name.isQuoted()

);

}

@Override

public Identifier toPhysicalSequenceName(Identifier name, JdbcEnvironment jdbcEnvironment) {

final LinkedList<String> parts = splitAndReplace( name.getText() );

// Acme Corp says all sequences should end with \_seq

if ( !"seq".equalsIgnoreCase( parts.getLast() ) ) {

parts.add( "seq" );

}

return jdbcEnvironment.getIdentifierHelper().toIdentifier(

join( parts ),

name.isQuoted()

);

}

@Override

public Identifier toPhysicalColumnName(Identifier name, JdbcEnvironment jdbcEnvironment) {

final List<String> parts = splitAndReplace( name.getText() );

return jdbcEnvironment.getIdentifierHelper().toIdentifier(

join( parts ),

name.isQuoted()

);

}

private static Map<String, String> buildAbbreviationMap() {

TreeMap<String,String> abbreviationMap = new TreeMap<> ( String.CASE\_INSENSITIVE\_ORDER );

abbreviationMap.put( "account", "acct" );

abbreviationMap.put( "number", "num" );

return abbreviationMap;

}

private LinkedList<String> splitAndReplace(String name) {

LinkedList<String> result = new LinkedList<>();

for ( String part : StringUtils.splitByCharacterTypeCamelCase( name ) ) {

if ( part == null || part.trim().isEmpty() ) {

// skip null and space

continue;

}

part = applyAbbreviationReplacement( part );

result.add( part.toLowerCase( Locale.ROOT ) );

}

return result;

}

private String applyAbbreviationReplacement(String word) {

if ( ABBREVIATIONS.containsKey( word ) ) {

return ABBREVIATIONS.get( word );

}

return word;

}

private String join(List<String> parts) {

boolean firstPass = true;

String separator = "";

StringBuilder joined = new StringBuilder();

for ( String part : parts ) {

joined.append( separator ).append( part );

if ( firstPass ) {

firstPass = false;

separator = "\_";

}

}

return joined.toString();

}

}

There are multiple ways to specify the PhysicalNamingStrategy to use. First, applications can specify the implementation using the hibernate.physical\_naming\_strategy configuration setting which accepts:

* reference to a Class that implements the org.hibernate.boot.model.naming.PhysicalNamingStrategy contract
* FQN of a class that implements the org.hibernate.boot.model.naming.PhysicalNamingStrategy contract

Secondly, applications and integrations can leverage org.hibernate.boot.MetadataBuilder#applyPhysicalNamingStrategy. See [Bootstrap](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap) for additional details on bootstrapping.

### 2.3. Basic Types

Basic value types usually map a single database column, to a single, non-aggregated Java type. Hibernate provides a number of built-in basic types, which follow the natural mappings recommended by the JDBC specifications.

Internally Hibernate uses a registry of basic types when it needs to resolve a specific org.hibernate.type.Type.

#### 2.3.1. Hibernate-provided BasicTypes

| *Table 1. Standard BasicTypes* | | | |
| --- | --- | --- | --- |
| **Hibernate type (org.hibernate.type package)** | **JDBC type** | **Java type** | **BasicTypeRegistry key(s)** |
| StringType | VARCHAR | java.lang.String | string, java.lang.String |
| MaterializedClob | CLOB | java.lang.String | materialized\_clob |
| TextType | LONGVARCHAR | java.lang.String | text |
| CharacterType | CHAR | char, java.lang.Character | char, java.lang.Character |
| BooleanType | BIT | boolean, java.lang.Boolean | boolean, java.lang.Boolean |
| NumericBooleanType | INTEGER, 0 is false, 1 is true | boolean, java.lang.Boolean | numeric\_boolean |
| YesNoType | CHAR, 'N'/'n' is false, 'Y'/'y' is true. The uppercase value is written to the database. | boolean, java.lang.Boolean | yes\_no |
| TrueFalseType | CHAR, 'F'/'f' is false, 'T'/'t' is true. The uppercase value is written to the database. | boolean, java.lang.Boolean | true\_false |
| ByteType | TINYINT | byte, java.lang.Byte | byte, java.lang.Byte |
| ShortType | SMALLINT | short, java.lang.Short | short, java.lang.Short |
| IntegerTypes | INTEGER | int, java.lang.Integer | int, java.lang.Integer |
| LongType | BIGINT | long, java.lang.Long | long, java.lang.Long |
| FloatType | FLOAT | float, java.lang.Float | float, java.lang.Float |
| DoubleType | DOUBLE | double, java.lang.Double | double, java.lang.Double |
| BigIntegerType | NUMERIC | java.math.BigInteger | big\_integer, java.math.BigInteger |
| BigDecimalType | NUMERIC | java.math.BigDecimal | big\_decimal, java.math.bigDecimal |
| TimestampType | TIMESTAMP | java.sql.Timestamp | timestamp, java.sql.Timestamp |
| TimeType | TIME | java.sql.Time | time, java.sql.Time |
| DateType | DATE | java.sql.Date | date, java.sql.Date |
| CalendarType | TIMESTAMP | java.util.Calendar | calendar, java.util.Calendar |
| CalendarDateType | DATE | java.util.Calendar | calendar\_date |
| CalendarTimeType | TIME | java.util.Calendar | calendar\_time |
| CurrencyType | java.util.Currency | VARCHAR | currency, java.util.Currency |
| LocaleType | VARCHAR | java.util.Locale | locale, java.utility.locale |
| TimeZoneType | VARCHAR, using the TimeZone ID | java.util.TimeZone | timezone, java.util.TimeZone |
| UrlType | VARCHAR | java.net.URL | url, java.net.URL |
| ClassType | VARCHAR (class FQN) | java.lang.Class | class, java.lang.Class |
| BlobType | BLOB | java.sql.Blob | blob, java.sql.Blob |
| ClobType | CLOB | java.sql.Clob | clob, java.sql.Clob |
| BinaryType | VARBINARY | byte[] | binary, byte[] |
| MaterializedBlobType | BLOB | byte[] | materialized\_blob |
| ImageType | LONGVARBINARY | byte[] | image |
| WrapperBinaryType | VARBINARY | java.lang.Byte[] | wrapper-binary, Byte[], java.lang.Byte[] |
| CharArrayType | VARCHAR | char[] | characters, char[] |
| CharacterArrayType | VARCHAR | java.lang.Character[] | wrapper-characters, Character[], java.lang.Character[] |
| UUIDBinaryType | BINARY | java.util.UUID | uuid-binary, java.util.UUID |
| UUIDCharType | CHAR, can also read VARCHAR | java.util.UUID | uuid-char |
| PostgresUUIDType | PostgreSQL UUID, through Types#OTHER, which complies to the PostgreSQL JDBC driver definition | java.util.UUID | pg-uuid |
| SerializableType | VARBINARY | implementors of java.lang.Serializable | Unlike the other value types, multiple instances of this type are registered. It is registered once under java.io.Serializable, and registered under the specific java.io.Serializable implementation class names. |
| StringNVarcharType | NVARCHAR | java.lang.String | nstring |
| NTextType | LONGNVARCHAR | java.lang.String | ntext |
| NClobType | NCLOB | java.sql.NClob | nclob, java.sql.NClob |
| MaterializedNClobType | NCLOB | java.lang.String | materialized\_nclob |
| PrimitiveCharacterArrayNClobType | NCHAR | char[] | N/A |
| CharacterNCharType | NCHAR | java.lang.Character | ncharacter |
| CharacterArrayNClobType | NCLOB | java.lang.Character[] | N/A |

| *Table 2. Java 8 BasicTypes* | | | |
| --- | --- | --- | --- |
| **Hibernate type (org.hibernate.type package)** | **JDBC type** | **Java type** | **BasicTypeRegistry key(s)** |
| DurationType | BIGINT | java.time.Duration | Duration, java.time.Duration |
| InstantType | TIMESTAMP | java.time.Instant | Instant, java.time.Instant |
| LocalDateTimeType | TIMESTAMP | java.time.LocalDateTime | LocalDateTime, java.time.LocalDateTime |
| LocalDateType | DATE | java.time.LocalDate | LocalDate, java.time.LocalDate |
| LocalTimeType | TIME | java.time.LocalTime | LocalTime, java.time.LocalTime |
| OffsetDateTimeType | TIMESTAMP | java.time.OffsetDateTime | OffsetDateTime, java.time.OffsetDateTime |
| OffsetTimeType | TIME | java.time.OffsetTime | OffsetTime, java.time.OffsetTime |
| ZonedDateTimeType | TIMESTAMP | java.time.ZonedDateTime | ZonedDateTime, java.time.ZonedDateTime |

| *Table 3. Hibernate Spatial BasicTypes* | | | |
| --- | --- | --- | --- |
| **Hibernate type (org.hibernate.spatial package)** | **JDBC type** | **Java type** | **BasicTypeRegistry key(s)** |
| JTSGeometryType | depends on the dialect | com.vividsolutions.jts.geom.Geometry | jts\_geometry, or the classname of Geometry or any of its subclasses |
| GeolatteGeometryType | depends on the dialect | org.geolatte.geom.Geometry | geolatte\_geometry, or the classname of Geometry or any of its subclasses |

|  |  |
| --- | --- |
|  | To use these hibernate-spatial types, you must add the hibernate-spatial dependency to your classpath and use a org.hibernate.spatial.SpatialDialect implementation. See [Spatial](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#spatial) for more details about spatial types. |

These mappings are managed by a service inside Hibernate called the org.hibernate.type.BasicTypeRegistry, which essentially maintains a map of org.hibernate.type.BasicType (a org.hibernate.type.Type specialization) instances keyed by a name. That is the purpose of the "BasicTypeRegistry key(s)" column in the previous tables.

#### 2.3.2. The @Basic annotation

Strictly speaking, a basic type is denoted by the javax.persistence.Basic annotation. Generally speaking, the @Basicannotation can be ignored, as it is assumed by default. Both of the following examples are ultimately the same.

*Example 3. @Basic declared explicitly*

@Entity(name = "Product")

public class Product {

@Id

@Basic

private Integer id;

@Basic

private String sku;

@Basic

private String name;

@Basic

private String description;

}

*Example 4. @Basic being implicitly implied*

@Entity(name = "Product")

public class Product {

@Id

private Integer id;

private String sku;

private String name;

private String description;

}

|  |  |
| --- | --- |
|  | The JPA specification strictly limits the Java types that can be marked as basic to the following listing:   * Java primitive types (boolean, int, etc) * wrappers for the primitive types (java.lang.Boolean, java.lang.Integer, etc) * java.lang.String * java.math.BigInteger * java.math.BigDecimal * java.util.Date * java.util.Calendar * java.sql.Date * java.sql.Time * java.sql.Timestamp * byte[] or Byte[] * char[] or Character[] * enums * any other type that implements Serializable (JPA’s "support" for Serializable types is to directly serialize their state to the database).   If provider portability is a concern, you should stick to just these basic types. Note that JPA 2.1 did add the notion of a javax.persistence.AttributeConverter to help alleviate some of these concerns; see [JPA 2.1 AttributeConverters](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-jpa-convert) for more on this topic. |

The @Basic annotation defines 2 attributes.

optional - boolean (defaults to true)

Defines whether this attribute allows nulls. JPA defines this as "a hint", which essentially means that it effect is specifically required. As long as the type is not primitive, Hibernate takes this to mean that the underlying column should be NULLABLE.

fetch - FetchType (defaults to EAGER)

Defines whether this attribute should be fetched eagerly or lazily. JPA says that EAGER is a requirement to the provider (Hibernate) that the value should be fetched when the owner is fetched, while LAZY is merely a hint that the value be fetched when the attribute is accessed. Hibernate ignores this setting for basic types unless you are using bytecode enhancement. See the [BytecodeEnhancement](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#BytecodeEnhancement) for additional information on fetching and on bytecode enhancement.

#### 2.3.3. The @Column annotation

JPA defines rules for implicitly determining the name of tables and columns. For a detailed discussion of implicit naming see [Naming](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naming).

For basic type attributes, the implicit naming rule is that the column name is the same as the attribute name. If that implicit naming rule does not meet your requirements, you can explicitly tell Hibernate (and other providers) the column name to use.

*Example 5. Explicit column naming*

@Entity(name = "Product")

public class Product {

@Id

private Integer id;

private String sku;

private String name;

@Column( name = "NOTES" )

private String description;

}

Here we use @Column to explicitly map the description attribute to the NOTES column, as opposed to the implicit column name description.

The @Column annotation defines other mapping information as well. See its Javadocs for details.

#### 2.3.4. BasicTypeRegistry

We said before that a Hibernate type is not a Java type, nor a SQL type, but that it understands both and performs the marshalling between them. But looking at the basic type mappings from the previous examples, how did Hibernate know to use its org.hibernate.type.StringType for mapping for java.lang.String attributes, or its org.hibernate.type.IntegerType for mapping java.lang.Integer attributes?

The answer lies in a service inside Hibernate called the org.hibernate.type.BasicTypeRegistry, which essentially maintains a map of org.hibernate.type.BasicType (a org.hibernate.type.Type specialization) instances keyed by a name.

We will see later, in the [Explicit BasicTypes](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-type-annotation) section, that we can explicitly tell Hibernate which BasicType to use for a particular attribute. But first let’s explore how implicit resolution works and how applications can adjust implicit resolution.

|  |  |
| --- | --- |
|  | A thorough discussion of the BasicTypeRegistry and all the different ways to contribute types to it is beyond the scope of this documentation. Please see Integrations Guide for complete details. |

As an example, take a String attribute such as we saw before with Product#sku. Since there was no explicit type mapping, Hibernate looks to the BasicTypeRegistry to find the registered mapping for java.lang.String. This goes back to the "BasicTypeRegistry key(s)" column we saw in the tables at the start of this chapter.

As a baseline within BasicTypeRegistry, Hibernate follows the recommended mappings of JDBC for Java types. JDBC recommends mapping Strings to VARCHAR, which is the exact mapping that StringType handles. So that is the baseline mapping within BasicTypeRegistry for Strings.

Applications can also extend (add new BasicType registrations) or override (replace an existing BasicType registration) using one of the MetadataBuilder#applyBasicType methods or the MetadataBuilder#applyTypes method during bootstrap. For more details, see [Custom BasicTypes](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-custom-type) section.

#### 2.3.5. Explicit BasicTypes

Sometimes you want a particular attribute to be handled differently. Occasionally Hibernate will implicitly pick a BasicType that you do not want (and for some reason you do not want to adjust the BasicTypeRegistry).

In these cases you must explicitly tell Hibernate the BasicType to use, via the org.hibernate.annotations.Typeannotation.

*Example 6. Using @org.hibernate.annotations.Type*

@Entity(name = "Product")

public class Product {

@Id

private Integer id;

private String sku;

@org.hibernate.annotations.Type( type = "nstring" )

private String name;

@org.hibernate.annotations.Type( type = "materialized\_nclob" )

private String description;

}

This tells Hibernate to store the Strings as nationalized data. This is just for illustration purposes; for better ways to indicate nationalized character data see [Mapping Nationalized Character Data](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-nationalized) section.

Additionally, the description is to be handled as a LOB. Again, for better ways to indicate LOBs see [Mapping LOBs](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-lob) section.

The org.hibernate.annotations.Type#type attribute can name any of the following:

* Fully qualified name of any org.hibernate.type.Type implementation
* Any key registered with BasicTypeRegistry
* The name of any known type definitions

#### 2.3.6. Custom BasicTypes

Hibernate makes it relatively easy for developers to create their own basic type mappings type. For example, you might want to persist properties of type java.util.BigInteger to VARCHAR columns, or support completely new types.

There are two approaches to developing a custom type:

* implementing a BasicType and registering it
* implementing a UserType which doesn’t require type registration

As a means of illustrating the different approaches, let’s consider a use case where we need to support a java.util.BitSet mapping that’s stored as a VARCHAR.

##### Implementing a BasicType

The first approach is to directly implement the BasicType interface.

|  |  |
| --- | --- |
|  | Because the BasicType interface has a lot of methods to implement, it’s much more convenient to extend the AbstractStandardBasicType, or the AbstractSingleColumnStandardBasicType if the value is stored in a single database column. |

First, we need to extend the AbstractSingleColumnStandardBasicType like this:

*Example 7. Custom BasicType implementation*

public class BitSetType

extends AbstractSingleColumnStandardBasicType<BitSet>

implements DiscriminatorType<BitSet> {

public static final BitSetType INSTANCE = new BitSetType();

public BitSetType() {

super( VarcharTypeDescriptor.INSTANCE, BitSetTypeDescriptor.INSTANCE );

}

@Override

public BitSet stringToObject(String xml) throws Exception {

return fromString( xml );

}

@Override

public String objectToSQLString(BitSet value, Dialect dialect) throws Exception {

return toString( value );

}

@Override

public String getName() {

return "bitset";

}

}

The AbstractSingleColumnStandardBasicType requires an sqlTypeDescriptor and a javaTypeDescriptor. The sqlTypeDescriptor is VarcharTypeDescriptor.INSTANCE because the database column is a VARCHAR. On the Java side, we need to use a BitSetTypeDescriptor instance which can be implemented like this:

*Example 8. Custom AbstractTypeDescriptor implementation*

public class BitSetTypeDescriptor extends AbstractTypeDescriptor<BitSet> {

private static final String DELIMITER = ",";

public static final BitSetTypeDescriptor INSTANCE = new BitSetTypeDescriptor();

public BitSetTypeDescriptor() {

super( BitSet.class );

}

@Override

public String toString(BitSet value) {

StringBuilder builder = new StringBuilder();

for ( long token : value.toLongArray() ) {

if ( builder.length() > 0 ) {

builder.append( DELIMITER );

}

builder.append( Long.toString( token, 2 ) );

}

return builder.toString();

}

@Override

public BitSet fromString(String string) {

if ( string == null || string.isEmpty() ) {

return null;

}

String[] tokens = string.split( DELIMITER );

long[] values = new long[tokens.length];

for ( int i = 0; i < tokens.length; i++ ) {

values[i] = Long.valueOf( tokens[i], 2 );

}

return BitSet.valueOf( values );

}

@SuppressWarnings({"unchecked"})

public <X> X unwrap(BitSet value, Class<X> type, WrapperOptions options) {

if ( value == null ) {

return null;

}

if ( BitSet.class.isAssignableFrom( type ) ) {

return (X) value;

}

if ( String.class.isAssignableFrom( type ) ) {

return (X) toString( value);

}

throw unknownUnwrap( type );

}

public <X> BitSet wrap(X value, WrapperOptions options) {

if ( value == null ) {

return null;

}

if ( String.class.isInstance( value ) ) {

return fromString( (String) value );

}

if ( BitSet.class.isInstance( value ) ) {

return (BitSet) value;

}

throw unknownWrap( value.getClass() );

}

}

The unwrap method is used when passing a BitSet as a PreparedStatement bind parameter, while the wrap method is used to transform the JDBC column value object (e.g. String in our case) to the actual mapping object type (e.g. BitSet in this example).

The BasicType must be registered, and this can be done at bootstrapping time:

*Example 9. Register a Custom BasicType implementation*

configuration.registerTypeContributor( (typeContributions, serviceRegistry) -> {

typeContributions.contributeType( BitSetType.INSTANCE );

} );

or using the MetadataBuilder

ServiceRegistry standardRegistry =

new StandardServiceRegistryBuilder().build();

MetadataSources sources = new MetadataSources( standardRegistry );

MetadataBuilder metadataBuilder = sources.getMetadataBuilder();

metadataBuilder.applyBasicType( BitSetType.INSTANCE );

With the new BitSetType being registered as bitset, the entity mapping looks like this:

*Example 10. Custom BasicType mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

@Type( type = "bitset" )

private BitSet bitSet;

public Integer getId() {

return id;

}

public void setId(Integer id) {

this.id = id;

}

public BitSet getBitSet() {

return bitSet;

}

public void setBitSet(BitSet bitSet) {

this.bitSet = bitSet;

}

}

Alternatively, use can use a @TypeDef ans skip the registration phase:

*Example 11. Using @TypeDef to register a custom Type*

@Entity(name = "Product")

@TypeDef(

name = "bitset",

defaultForType = BitSet.class,

typeClass = BitSetType.class

)

public static class Product {

@Id

private Integer id;

private BitSet bitSet;

public Integer getId() {

return id;

}

public void setId(Integer id) {

this.id = id;

}

public BitSet getBitSet() {

return bitSet;

}

public void setBitSet(BitSet bitSet) {

this.bitSet = bitSet;

}

}

To validate this new BasicType implementation, we can test it as follows:

*Example 12. Persisting the custom BasicType*

BitSet bitSet = BitSet.valueOf( new long[] {1, 2, 3} );

doInHibernate( this::sessionFactory, session -> {

Product product = new Product( );

product.setId( 1 );

product.setBitSet( bitSet );

session.persist( product );

} );

doInHibernate( this::sessionFactory, session -> {

Product product = session.get( Product.class, 1 );

assertEquals(bitSet, product.getBitSet());

} );

When executing this unit test, Hibernate generates the following SQL statements:

*Example 13. Persisting the custom BasicType*

DEBUG SQL:92 -

insert

into

Product

(bitSet, id)

values

(?, ?)

TRACE BasicBinder:65 - binding parameter [1] as [VARCHAR] - [{0, 65, 128, 129}]

TRACE BasicBinder:65 - binding parameter [2] as [INTEGER] - [1]

DEBUG SQL:92 -

select

bitsettype0\_.id as id1\_0\_0\_,

bitsettype0\_.bitSet as bitSet2\_0\_0\_

from

Product bitsettype0\_

where

bitsettype0\_.id=?

TRACE BasicBinder:65 - binding parameter [1] as [INTEGER] - [1]

TRACE BasicExtractor:61 - extracted value ([bitSet2\_0\_0\_] : [VARCHAR]) - [{0, 65, 128, 129}]

As you can see, the BitSetType takes care of the Java-to-SQL and SQL-to-Java type conversion.

##### Implementing a UserType

The second approach is to implement the UserType interface.

*Example 14. Custom UserType implementation*

public class BitSetUserType implements UserType {

public static final BitSetUserType INSTANCE = new BitSetUserType();

private static final Logger log = Logger.getLogger( BitSetUserType.class );

@Override

public int[] sqlTypes() {

return new int[] {StringType.INSTANCE.sqlType()};

}

@Override

public Class returnedClass() {

return BitSet.class;

}

@Override

public boolean equals(Object x, Object y)

throws HibernateException {

return Objects.equals( x, y );

}

@Override

public int hashCode(Object x)

throws HibernateException {

return Objects.hashCode( x );

}

@Override

public Object nullSafeGet(

ResultSet rs, String[] names, SharedSessionContractImplementor session, Object owner)

throws HibernateException, SQLException {

String columnName = names[0];

String columnValue = (String) rs.getObject( columnName );

log.debugv("Result set column {0} value is {1}", columnName, columnValue);

return columnValue == null ? null :

BitSetTypeDescriptor.INSTANCE.fromString( columnValue );

}

@Override

public void nullSafeSet(

PreparedStatement st, Object value, int index, SharedSessionContractImplementor session)

throws HibernateException, SQLException {

if ( value == null ) {

log.debugv("Binding null to parameter {0} ",index);

st.setNull( index, Types.VARCHAR );

}

else {

String stringValue = BitSetTypeDescriptor.INSTANCE.toString( (BitSet) value );

log.debugv("Binding {0} to parameter {1} ", stringValue, index);

st.setString( index, stringValue );

}

}

@Override

public Object deepCopy(Object value)

throws HibernateException {

return value == null ? null :

BitSet.valueOf( BitSet.class.cast( value ).toLongArray() );

}

@Override

public boolean isMutable() {

return true;

}

@Override

public Serializable disassemble(Object value)

throws HibernateException {

return (BitSet) deepCopy( value );

}

@Override

public Object assemble(Serializable cached, Object owner)

throws HibernateException {

return deepCopy( cached );

}

@Override

public Object replace(Object original, Object target, Object owner)

throws HibernateException {

return deepCopy( original );

}

}

The entity mapping looks as follows:

*Example 15. Custom UserType mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

@Type( type = "bitset" )

private BitSet bitSet;

public Integer getId() {

return id;

}

public void setId(Integer id) {

this.id = id;

}

public BitSet getBitSet() {

return bitSet;

}

public void setBitSet(BitSet bitSet) {

this.bitSet = bitSet;

}

}

In this example, the UserType is registered under the bitset name, and this is done like this:

*Example 16. Register a Custom UserType implementation*

configuration.registerTypeContributor( (typeContributions, serviceRegistry) -> {

typeContributions.contributeType( BitSetUserType.INSTANCE, "bitset");

} );

or using the MetadataBuilder

ServiceRegistry standardRegistry =

new StandardServiceRegistryBuilder().build();

MetadataSources sources = new MetadataSources( standardRegistry );

MetadataBuilder metadataBuilder = sources.getMetadataBuilder();

metadataBuilder.applyBasicType( BitSetUserType.INSTANCE, "bitset" );

|  |  |
| --- | --- |
|  | Like BasicType, you can also register the UserType using a simple name.  Without registration, the UserType mapping requires the fully-classified name:  @Type( type = "org.hibernate.userguide.mapping.basic.BitSetUserType" ) |

When running the previous test case against the BitSetUserType entity mapping, Hibernate executed the following SQL statements:

*Example 17. Persisting the custom BasicType*

DEBUG SQL:92 -

insert

into

Product

(bitSet, id)

values

(?, ?)

DEBUG BitSetUserType:71 - Binding 1,10,11 to parameter 1

TRACE BasicBinder:65 - binding parameter [2] as [INTEGER] - [1]

DEBUG SQL:92 -

select

bitsetuser0\_.id as id1\_0\_0\_,

bitsetuser0\_.bitSet as bitSet2\_0\_0\_

from

Product bitsetuser0\_

where

bitsetuser0\_.id=?

TRACE BasicBinder:65 - binding parameter [1] as [INTEGER] - [1]

DEBUG BitSetUserType:56 - Result set column bitSet2\_0\_0\_ value is 1,10,11

#### 2.3.7. Mapping enums

Hibernate supports the mapping of Java enums as basic value types in a number of different ways.

##### @Enumerated

The original JPA-compliant way to map enums was via the @Enumerated and @MapKeyEnumerated for map keys annotations which works on the principle that the enum values are stored according to one of 2 strategies indicated by javax.persistence.EnumType:

ORDINAL

stored according to the enum value’s ordinal position within the enum class, as indicated by java.lang.Enum#ordinal

STRING

stored according to the enum value’s name, as indicated by java.lang.Enum#name

Assuming the following enumeration:

*Example 18. PhoneType enumeration*

public enum PhoneType {

LAND\_LINE,

MOBILE;

}

In the ORDINAL example, the phone\_type column is defined as an (nullable) INTEGER type and would hold:

NULL

For null values

0

For the LAND\_LINE enum

1

For the MOBILE enum

*Example 19. @Enumerated(ORDINAL) example*

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

@Column(name = "phone\_number")

private String number;

@Enumerated(EnumType.ORDINAL)

@Column(name = "phone\_type")

private PhoneType type;

//Getters and setters are omitted for brevity

}

When persisting this entity, Hibernate generates the following SQL statement:

*Example 20. Persisting an entity with an @Enumerated(ORDINAL) mapping*

Phone phone = new Phone( );

phone.setId( 1L );

phone.setNumber( "123-456-78990" );

phone.setType( PhoneType.MOBILE );

entityManager.persist( phone );

INSERT INTO Phone (phone\_number, phone\_type, id)

VALUES ('123-456-78990', 2, 1)

In the STRING example, the phone\_type column is defined as a (nullable) VARCHAR type and would hold:

NULL

For null values

LAND\_LINE

For the LAND\_LINE enum

MOBILE

For the MOBILE enum

*Example 21. @Enumerated(STRING) example*

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

@Column(name = "phone\_number")

private String number;

@Enumerated(EnumType.STRING)

@Column(name = "phone\_type")

private PhoneType type;

//Getters and setters are omitted for brevity

}

Persisting the same entity like in the @Enumerated(ORDINAL) example, Hibernate generates the following SQL statement:

*Example 22. Persisting an entity with an @Enumerated(STRING) mapping*

INSERT INTO Phone (phone\_number, phone\_type, id)

VALUES ('123-456-78990', 'MOBILE', 1)

##### AttributeConverter

Let’s consider the following Gender enum which stores its values using the 'M' and 'F' codes.

*Example 23. Enum with custom constructor*

public enum Gender {

MALE( 'M' ),

FEMALE( 'F' );

private final char code;

Gender(char code) {

this.code = code;

}

public static Gender fromCode(char code) {

if ( code == 'M' || code == 'm' ) {

return MALE;

}

if ( code == 'F' || code == 'f' ) {

return FEMALE;

}

throw new UnsupportedOperationException(

"The code " + code + " is not supported!"

);

}

public char getCode() {

return code;

}

}

You can map enums in a JPA compliant way using a JPA 2.1 AttributeConverter.

*Example 24. Enum mapping with AttributeConverter example*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

@Convert( converter = GenderConverter.class )

public Gender gender;

//Getters and setters are omitted for brevity

}

@Converter

public static class GenderConverter

implements AttributeConverter<Gender, Character> {

public Character convertToDatabaseColumn( Gender value ) {

if ( value == null ) {

return null;

}

return value.getCode();

}

public Gender convertToEntityAttribute( Character value ) {

if ( value == null ) {

return null;

}

return Gender.fromCode( value );

}

}

Here, the gender column is defined as a CHAR type and would hold:

NULL

For null values

'M'

For the MALE enum

'F'

For the FEMALE enum

For additional details on using AttributeConverters, see [JPA 2.1 AttributeConverters](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-jpa-convert) section.

|  |  |
| --- | --- |
|  | JPA explicitly disallows the use of an AttributeConverter with an attribute marked as @Enumerated. So if using the AttributeConverter approach, be sure not to mark the attribute as @Enumerated. |

##### Custom type

You can also map enums using a Hibernate custom type mapping. Let’s again revisit the Gender enum example, this time using a custom Type to store the more standardized 'M' and 'F' codes.

*Example 25. Enum mapping with custom Type example*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

@Type( type = "org.hibernate.userguide.mapping.basic.GenderType" )

public Gender gender;

//Getters and setters are omitted for brevity

}

public class GenderType extends AbstractSingleColumnStandardBasicType<Gender> {

public static final GenderType INSTANCE = new GenderType();

public GenderType() {

super(

CharTypeDescriptor.INSTANCE,

GenderJavaTypeDescriptor.INSTANCE

);

}

public String getName() {

return "gender";

}

@Override

protected boolean registerUnderJavaType() {

return true;

}

}

public class GenderJavaTypeDescriptor extends AbstractTypeDescriptor<Gender> {

public static final GenderJavaTypeDescriptor INSTANCE =

new GenderJavaTypeDescriptor();

protected GenderJavaTypeDescriptor() {

super( Gender.class );

}

public String toString(Gender value) {

return value == null ? null : value.name();

}

public Gender fromString(String string) {

return string == null ? null : Gender.valueOf( string );

}

public <X> X unwrap(Gender value, Class<X> type, WrapperOptions options) {

return CharacterTypeDescriptor.INSTANCE.unwrap(

value == null ? null : value.getCode(),

type,

options

);

}

public <X> Gender wrap(X value, WrapperOptions options) {

return Gender.fromCode(

CharacterTypeDescriptor.INSTANCE.wrap( value, options )

);

}

}

Again, the gender column is defined as a CHAR type and would hold:

NULL

For null values

'M'

For the MALE enum

'F'

For the FEMALE enum

For additional details on using custom types, see [Custom BasicTypes](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-custom-type) section.

#### 2.3.8. Mapping LOBs

Mapping LOBs (database Large Objects) come in 2 forms, those using the JDBC locator types and those materializing the LOB data.

JDBC LOB locators exist to allow efficient access to the LOB data. They allow the JDBC driver to stream parts of the LOB data as needed, potentially freeing up memory space. However they can be unnatural to deal with and have certain limitations. For example, a LOB locator is only portably valid during the duration of the transaction in which it was obtained.

The idea of materialized LOBs is to trade-off the potential efficiency (not all drivers handle LOB data efficiently) for a more natural programming paradigm using familiar Java types such as String or byte[], etc for these LOBs.

Materialized deals with the entire LOB contents in memory, whereas LOB locators (in theory) allow streaming parts of the LOB contents into memory as needed.

The JDBC LOB locator types include:

* java.sql.Blob
* java.sql.Clob
* java.sql.NClob

Mapping materialized forms of these LOB values would use more familiar Java types such as String, char[], byte[], etc. The trade off for more familiar is usually performance.

For a first look, let’s assume we have a CLOB column that we would like to map (NCLOB character LOB data will be covered in [Mapping Nationalized Character Data](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-nationalized) section).

*Example 26. CLOB - SQL*

CREATE TABLE Product (

id INTEGER NOT NULL

image clob

name VARCHAR(255)

PRIMARY KEY ( id )

)

Let’s first map this using the @Lob JPA annotation and the java.sql.Clob type:

*Example 27. CLOB mapped to java.sql.Clob*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

private Clob warranty;

//Getters and setters are omitted for brevity

}

To persist such an entity, you have to create a Clob using plain JDBC:

*Example 28. Persisting a java.sql.Clob entity*

String warranty = "My product warranty";

final Product product = new Product();

product.setId( 1 );

product.setName( "Mobile phone" );

session.doWork( connection -> {

product.setWarranty( ClobProxy.generateProxy( warranty ) );

} );

entityManager.persist( product );

To retrieve the Clob content, you need to transform the underlying java.io.Reader:

*Example 29. Returning a java.sql.Clob entity*

Product product = entityManager.find( Product.class, productId );

try (Reader reader = product.getWarranty().getCharacterStream()) {

assertEquals( "My product warranty", toString( reader ) );

}

We could also map the CLOB in a materialized form. This way, we can either use a String or a char[].

*Example 30. CLOB mapped to String*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

private String warranty;

//Getters and setters are omitted for brevity

}

|  |  |
| --- | --- |
|  | How JDBC deals with LOB data varies from driver to driver, and Hibernate tries to handle all these variances on your behalf.  However, some drivers are trickier (e.g. PostgreSQL JDBC drivers), and, in such cases, you may have to do some extra to get LOBs working. Such discussions are beyond the scope of this guide. |

We might even want the materialized data as a char array (for some crazy reason).

*Example 31. CLOB - materialized char[] mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

private char[] warranty;

//Getters and setters are omitted for brevity

}

BLOB data is mapped in a similar fashion.

*Example 32. BLOB - SQL*

CREATE TABLE Product (

id INTEGER NOT NULL ,

image blob ,

name VARCHAR(255) ,

PRIMARY KEY ( id )

)

Let’s first map this using the JDBC java.sql.Blob type.

*Example 33. BLOB mapped to java.sql.Blob*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

private Blob image;

//Getters and setters are omitted for brevity

}

To persist such an entity, you have to create a Blob using plain JDBC:

*Example 34. Persisting a java.sql.Blob entity*

byte[] image = new byte[] {1, 2, 3};

final Product product = new Product();

product.setId( 1 );

product.setName( "Mobile phone" );

session.doWork( connection -> {

product.setImage( BlobProxy.generateProxy( image ) );

} );

entityManager.persist( product );

To retrieve the Blob content, you need to transform the underlying java.io.Reader:

*Example 35. Returning a java.sql.Blob entity*

Product product = entityManager.find( Product.class, productId );

try (InputStream inputStream = product.getImage().getBinaryStream()) {

assertArrayEquals(new byte[] {1, 2, 3}, toBytes( inputStream ) );

}

We could also map the BLOB in a materialized form (e.g. byte[]).

*Example 36. BLOB mapped to byte[]*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

private byte[] image;

//Getters and setters are omitted for brevity

}

#### 2.3.9. Mapping Nationalized Character Data

JDBC 4 added the ability to explicitly handle nationalized character data. To this end it added specific nationalized character data types.

* NCHAR
* NVARCHAR
* LONGNVARCHAR
* NCLOB

*Example 37. NVARCHAR - SQL*

CREATE TABLE Product (

id INTEGER NOT NULL ,

name VARCHAR(255) ,

warranty NVARCHAR(255) ,

PRIMARY KEY ( id )

)

To map a specific attribute to a nationalized variant data type, Hibernate defines the @Nationalized annotation.

*Example 38. NVARCHAR mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Nationalized

private String warranty;

//Getters and setters are omitted for brevity

}

Just like with CLOB, Hibernate can also deal with NCLOB SQL data types:

*Example 39. NCLOB - SQL*

CREATE TABLE Product (

id INTEGER NOT NULL ,

name VARCHAR(255) ,

warranty nclob ,

PRIMARY KEY ( id )

)

Hibernate can map the NCLOB to a java.sql.NClob

*Example 40. NCLOB mapped to java.sql.NClob*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

@Nationalized

// Clob also works, because NClob extends Clob.

// The database type is still NCLOB either way and handled as such.

private NClob warranty;

//Getters and setters are omitted for brevity

}

To persist such an entity, you have to create a NClob using plain JDBC:

*Example 41. Persisting a java.sql.NClob entity*

String warranty = "My product warranty";

final Product product = new Product();

product.setId( 1 );

product.setName( "Mobile phone" );

session.doWork( connection -> {

product.setWarranty( connection.createNClob() );

product.getWarranty().setString( 1, warranty );

} );

entityManager.persist( product );

To retrieve the NClob content, you need to transform the underlying java.io.Reader:

*Example 42. Returning a java.sql.NClob entity*

Product product = entityManager.find( Product.class, productId );

try (Reader reader = product.getWarranty().getCharacterStream()) {

assertEquals( "My product warranty", toString( reader ) );

}

We could also map the NCLOB in a materialized form. This way, we can either use a String or a char[].

*Example 43. NCLOB mapped to String*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

@Nationalized

private String warranty;

//Getters and setters are omitted for brevity

}

We might even want the materialized data as a char array.

*Example 44. NCLOB - materialized char[] mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Integer id;

private String name;

@Lob

@Nationalized

private char[] warranty;

//Getters and setters are omitted for brevity

}

|  |  |
| --- | --- |
|  | If you application and database are entirely nationalized you may instead want to enable nationalized character data as the default. You can do this via the hibernate.use\_nationalized\_character\_data setting or by calling MetadataBuilder#enableGlobalNationalizedCharacterDataSupport during bootstrap. |

#### 2.3.10. Mapping UUID Values

Hibernate also allows you to map UUID values, again in a number of ways.

|  |  |
| --- | --- |
|  | The default UUID mapping is as binary because it represents more efficient storage. However many applications prefer the readability of character storage. To switch the default mapping, simply call MetadataBuilder.applyBasicType( UUIDCharType.INSTANCE, UUID.class.getName() ). |

#### 2.3.11. UUID as binary

As mentioned, the default mapping for UUID attributes. Maps the UUID to a byte[] using java.util.UUID#getMostSignificantBits and java.util.UUID#getLeastSignificantBits and stores that as BINARY data.

Chosen as the default simply because it is generally more efficient from storage perspective.

#### 2.3.12. UUID as (var)char

Maps the UUID to a String using java.util.UUID#toString and java.util.UUID#fromString and stores that as CHARor VARCHAR data.

#### 2.3.13. PostgeSQL-specific UUID

|  |  |
| --- | --- |
|  | When using one of the PostgreSQL Dialects, this becomes the default UUID mapping. |

Maps the UUID using PostgreSQL’s specific UUID data type. The PostgreSQL JDBC driver chooses to map its UUID type to the OTHER code. Note that this can cause difficulty as the driver chooses to map many different data types to OTHER.

#### 2.3.14. UUID as identifier

Hibernate supports using UUID values as identifiers, and they can even be generated on user’s behalf. For details, see the discussion of generators in [Identifier generators](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers).

#### 2.3.15. Mapping Date/Time Values

Hibernate allows various Java Date/Time classes to be mapped as persistent domain model entity properties. The SQL standard defines three Date/Time types:

DATE

Represents a calendar date by storing years, months and days. The JDBC equivalent is java.sql.Date

TIME

Represents the time of a day and it stores hours, minutes and seconds. The JDBC equivalent is java.sql.Time

TIMESTAMP

It stores both a DATE and a TIME plus nanoseconds. The JDBC equivalent is java.sql.Timestamp

|  |  |
| --- | --- |
|  | To avoid dependencies on the java.sql package, it’s common to use the java.util or java.timeDate/Time classes instead. |

While the java.sql classes define a direct association to the SQL Date/Time data types, the java.util or java.timeproperties need to explicitly mark the SQL type correlation with the @Temporal annotation. This way, a java.util.Dateor a java.util.Calendar can be mapped to either an SQL DATE, TIME or TIMESTAMP type.

Considering the following entity:

*Example 45. java.util.Date mapped as DATE*

@Entity(name = "DateEvent")

public static class DateEvent {

@Id

@GeneratedValue

private Long id;

@Column(name = "`timestamp`")

@Temporal(TemporalType.DATE)

private Date timestamp;

//Getters and setters are omitted for brevity

}

When persisting such entity:

*Example 46. Persisting a java.util.Date mapping*

DateEvent dateEvent = new DateEvent( new Date() );

entityManager.persist( dateEvent );

Hibernate generates the following INSERT statement:

INSERT INTO DateEvent ( timestamp, id )

VALUES ( '2015-12-29', 1 )

Only the year, month and the day field were saved into the database.

If we change the @Temporal type to TIME:

*Example 47. java.util.Date mapped as TIME*

@Column(name = "`timestamp`")

@Temporal(TemporalType.TIME)

private Date timestamp;

Hibernate will issue an INSERT statement containing the hour, minutes and seconds.

INSERT INTO DateEvent ( timestamp, id )

VALUES ( '16:51:58', 1 )

When the @Temporal type is set to TIMESTAMP:

*Example 48. java.util.Date mapped as TIMESTAMP*

@Column(name = "`timestamp`")

@Temporal(TemporalType.TIMESTAMP)

private Date timestamp;

Hibernate will include both the DATE, the TIME and the nanoseconds in the INSERT statement:

INSERT INTO DateEvent ( timestamp, id )

VALUES ( '2015-12-29 16:54:04.544', 1 )

|  |  |
| --- | --- |
|  | Just like the java.util.Date, the java.util.Calendar requires the @Temporal annotation in order to know what JDBC data type to be chosen: DATE, TIME or TIMESTAMP. If the java.util.Datemarks a point in time, the java.util.Calendar takes into consideration the default Time Zone. |

##### Mapping Java 8 Date/Time Values

Java 8 came with a new Date/Time API, offering support for instant dates, intervals, local and zoned Date/Time immutable instances, bundled in the java.time package.

The mapping between the standard SQL Date/Time types and the supported Java 8 Date/Time class types looks as follows;

DATE

java.time.LocalDate

TIME

java.time.LocalTime, java.time.OffsetTime

TIMESTAMP

java.time.Instant, java.time.LocalDateTime, java.time.OffsetDateTime and java.time.ZonedDateTime

|  |  |
| --- | --- |
|  | Because the mapping between Java 8 Date/Time classes and the SQL types is implicit, there is not need to specify the @Temporal annotation. Setting it on the java.time classes throws the following exception:  org.hibernate.AnnotationException: @Temporal should only be set on a java.util.Date or java.util.Calendar property |

##### Using a specific time zone

By default, Hibernate is going to use the [PreparedStatement.setTimestamp(int parameterIndex, java.sql.Timestamp)](https://docs.oracle.com/javase/8/docs/api/java/sql/PreparedStatement.html#setTimestamp-int-java.sql.Timestamp-) or [PreparedStatement.setTime(int parameterIndex, java.sql.Time x)](https://docs.oracle.com/javase/8/docs/api/java/sql/PreparedStatement.html#setTime-int-java.sql.Time-) when saving a java.sql.Timestamp or a java.sql.Time property.

When the time zone is not specified, the JDBC driver is going to use the underlying JVM default time zone, which might not be suitable if the application is used from all across the globe. For this reason, it is very common to use a single reference time zone (e.g. UTC) whenever saving/loading data from the database.

One alternative would be to configure all JVMs to use the reference time zone:

Declaratively

java -Duser.timezone=UTC ...

Programmatically

TimeZone.setDefault( TimeZone.getTimeZone( "UTC" ) );

However, as explained in [this article](http://in.relation.to/2016/09/12/jdbc-time-zone-configuration-property/), this is not always practical especially for front-end nodes. For this reason, Hibernate offers the hibernate.jdbc.time\_zone configuration property which can be configured:

Declaratively, at the SessionFactory level

settings.put(

AvailableSettings.JDBC\_TIME\_ZONE,

TimeZone.getTimeZone( "UTC" )

);

Programmatically, on a per Session basis

Session session = sessionFactory()

.withOptions()

.jdbcTimeZone( TimeZone.getTimeZone( "UTC" ) )

.openSession();

With this configuration property in place, Hibernate is going to call the [PreparedStatement.setTimestamp(int parameterIndex, java.sql.Timestamp, Calendar cal)](https://docs.oracle.com/javase/8/docs/api/java/sql/PreparedStatement.html#setTimestamp-int-java.sql.Timestamp-java.util.Calendar-) or [PreparedStatement.setTime(int parameterIndex, java.sql.Time x, Calendar cal)](https://docs.oracle.com/javase/8/docs/api/java/sql/PreparedStatement.html#setTime-int-java.sql.Time-java.util.Calendar-), where the java.util.Calendar references the time zone provided via the hibernate.jdbc.time\_zone property.

#### 2.3.16. JPA 2.1 AttributeConverters

Although Hibernate has long been offering [custom types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-custom-type), as a JPA 2.1 provider, it also supports AttributeConverter as well.

With a custom AttributeConverter, the application developer can map a given JDBC type to an entity basic type.

In the following example, the java.util.Period is going to be mapped to a VARCHAR database column.

*Example 49. java.util.Period custom AttributeConverter*

@Converter

public class PeriodStringConverter

implements AttributeConverter<Period, String> {

@Override

public String convertToDatabaseColumn(Period attribute) {

return attribute.toString();

}

@Override

public Period convertToEntityAttribute(String dbData) {

return Period.parse( dbData );

}

}

To make use of this custom converter, the @Convert annotation must decorate the entity attribute.

*Example 50. Entity using the custom java.util.Period AttributeConverter mapping*

@Entity(name = "Event")

public static class Event {

@Id

@GeneratedValue

private Long id;

@Convert(converter = PeriodStringConverter.class)

@Column(columnDefinition = "")

private Period span;

//Getters and setters are omitted for brevity

}

When persisting such entity, Hibernate will do the type conversion based on the AttributeConverter logic:

*Example 51. Persisting entity using the custom AttributeConverter*

INSERT INTO Event ( span, id )

VALUES ( 'P1Y2M3D', 1 )

##### AttributeConverter Java and JDBC types

In cases when the Java type specified for the "database side" of the conversion (the second AttributeConverter bind parameter) is not known, Hibernate will fallback to a java.io.Serializable type.

If the Java type is not know to Hibernate, you will encounter the following message:

*HHH000481: Encountered Java type for which we could not locate a JavaTypeDescriptor and which does not appear to implement equals and/or hashCode. This can lead to significant performance problems when performing equality/dirty checking involving this Java type. Consider registering a custom JavaTypeDescriptor or at least implementing equals/hashCode.*

Whether a Java type is "known" means it has an entry in the JavaTypeDescriptorRegistry. While by default Hibernate loads many JDK types into the JavaTypeDescriptorRegistry, an application can also expand the JavaTypeDescriptorRegistry by adding new JavaTypeDescriptor entries.

This way, Hibernate will also know how to handle a specific Java Object type at the JDBC level.

##### JPA 2.1 AttributeConverter Mutability Plan

A basic type that’s converted by a JPA AttributeConverter is immutable if the underlying Java type is immutable and is mutable if the associated attribute type is mutable as well.

Therefore, mutability is given by the [JavaTypeDescriptor#getMutabilityPlan](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/type/descriptor/java/JavaTypeDescriptor.html#getMutabilityPlan--) of the associated entity attribute type.

###### Immutable types

If the entity attribute is a String, a primitive wrapper (e.g. Integer, Long) an Enum type, or any other immutable Object type, then you can only change the entity attribute value by reassigning it to a new value.

Considering we have the same Period entity attribute as illustrated in the [JPA 2.1 AttributeConverters](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-jpa-convert) section:

@Entity(name = "Event")

public static class Event {

@Id

@GeneratedValue

private Long id;

@Convert(converter = PeriodStringConverter.class)

@Column(columnDefinition = "")

private Period span;

//Getters and setters are omitted for brevity

}

The only way to change the span attribute is to reassign it to a different value:

Event event = entityManager.createQuery( "from Event", Event.class ).getSingleResult();

event.setSpan(Period

.ofYears( 3 )

.plusMonths( 2 )

.plusDays( 1 )

);

###### Mutable types

On the other hand, consider the following example where the Money type is a mutable.

public static class Money {

private long cents;

public Money(long cents) {

this.cents = cents;

}

public long getCents() {

return cents;

}

public void setCents(long cents) {

this.cents = cents;

}

}

public static class MoneyConverter

implements AttributeConverter<Money, Long> {

@Override

public Long convertToDatabaseColumn(Money attribute) {

return attribute == null ? null : attribute.getCents();

}

@Override

public Money convertToEntityAttribute(Long dbData) {

return dbData == null ? null : new Money( dbData );

}

}

@Entity(name = "Account")

public static class Account {

@Id

private Long id;

private String owner;

@Convert(converter = MoneyConverter.class)

private Money balance;

//Getters and setters are omitted for brevity

}

A mutable Object allows you to modify its internal structure, and Hibernate dirty checking mechanism is going to propagate the change to the database:

Account account = entityManager.find( Account.class, 1L );

account.getBalance().setCents( 150 \* 100L );

entityManager.persist( account );

|  |  |
| --- | --- |
|  | Although the AttributeConverter types can be mutable so that dirty checking, deep copying and second-level caching work properly, treating these as immutable (when they really are) is more efficient.  For this reason, prefer immutable types over mutable ones whenever possible. |

#### 2.3.17. 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. While traditionally, Hibernate used backticks for escaping SQL reserved keywords, JPA uses double quotes instead.

Once the reserved keywords are escaped, Hibernate will use the correct quotation style for the SQL Dialect. This is usually double quotes, but SQL Server uses brackets and MySQL uses backticks.

*Example 52. Hibernate legacy quoting*

@Entity(name = "Product")

public static class Product {

@Id

private Long id;

@Column(name = "`name`")

private String name;

@Column(name = "`number`")

private String number;

//Getters and setters are omitted for brevity

}

*Example 53. JPA quoting*

@Entity(name = "Product")

public static class Product {

@Id

private Long id;

@Column(name = "\"name\"")

private String name;

@Column(name = "\"number\"")

private String number;

//Getters and setters are omitted for brevity

}

Because name and number are reserved words, the Product entity mapping uses backtricks to quote these column names.

When saving the following Product entity, Hibernate generates the following SQL insert statement:

*Example 54. Persisting a quoted column name*

Product product = new Product();

product.setId( 1L );

product.setName( "Mobile phone" );

product.setNumber( "123-456-7890" );

entityManager.persist( product );

INSERT INTO Product ("name", "number", id)

VALUES ('Mobile phone', '123-456-7890', 1)

##### Global quoting

Hibernate can also quote all identifiers (e.g. table, columns) using the following configuration property:

<property

name="hibernate.globally\_quoted\_identifiers"

value="true"

/>

This way, we don’t need to manually quote any identifier:

*Example 55. JPA quoting*

@Entity(name = "Product")

public static class Product {

@Id

private Long id;

private String name;

private String number;

//Getters and setters are omitted for brevity

}

When persisting a Product entity, Hibernate is going to quote all identifiers as in the following example:

INSERT INTO "Product" ("name", "number", "id")

VALUES ('Mobile phone', '123-456-7890', 1)

As you can see, both the table name and all the column have been quoted.

For more about quoting-related configuration properties, check out the [Mapping configurations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#configurations-mapping) section as well.

#### 2.3.18. 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 to retrieve the generated values.

Properties marked as generated must additionally be non-insertable and non-updateable. Only @Version and @Basictypes 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 creationTimestamp fall into this category.

ALWAYS

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

To mark a property as generated, use The Hibernate specific @Generated annotation.

##### @Generated annotation

The [@Generated](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Generated.html) annotation is used so that Hibernate can fetch the currently annotated property after the entity has been persisted or updated. For this reason, the @Generated annotation accepts a [GenerationTime](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenerationTime.html) enum value.

Considering the following entity:

*Example 56. @Generated mapping example*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String firstName;

private String lastName;

private String middleName1;

private String middleName2;

private String middleName3;

private String middleName4;

private String middleName5;

@Generated( value = GenerationTime.ALWAYS )

@Column(columnDefinition =

"AS CONCAT(" +

" COALESCE(firstName, ''), " +

" COALESCE(' ' + middleName1, ''), " +

" COALESCE(' ' + middleName2, ''), " +

" COALESCE(' ' + middleName3, ''), " +

" COALESCE(' ' + middleName4, ''), " +

" COALESCE(' ' + middleName5, ''), " +

" COALESCE(' ' + lastName, '') " +

")")

private String fullName;

}

When the Person entity is persisted, Hibernate is going to fetch the calculated fullName column from the database, which concatenates the first, middle, and last name.

*Example 57. @Generated persist example*

Person person = new Person();

person.setId( 1L );

person.setFirstName( "John" );

person.setMiddleName1( "Flávio" );

person.setMiddleName2( "André" );

person.setMiddleName3( "Frederico" );

person.setMiddleName4( "Rúben" );

person.setMiddleName5( "Artur" );

person.setLastName( "Doe" );

entityManager.persist( person );

entityManager.flush();

assertEquals("John Flávio André Frederico Rúben Artur Doe", person.getFullName());

INSERT INTO Person

(

firstName,

lastName,

middleName1,

middleName2,

middleName3,

middleName4,

middleName5,

id

)

values

(?, ?, ?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [John]

-- binding parameter [2] as [VARCHAR] - [Doe]

-- binding parameter [3] as [VARCHAR] - [Flávio]

-- binding parameter [4] as [VARCHAR] - [André]

-- binding parameter [5] as [VARCHAR] - [Frederico]

-- binding parameter [6] as [VARCHAR] - [Rúben]

-- binding parameter [7] as [VARCHAR] - [Artur]

-- binding parameter [8] as [BIGINT] - [1]

SELECT

p.fullName as fullName3\_0\_

FROM

Person p

WHERE

p.id=?

-- binding parameter [1] as [BIGINT] - [1]

-- extracted value ([fullName3\_0\_] : [VARCHAR]) - [John Flávio André Frederico Rúben Artur Doe]

The same goes when the Person entity is updated. Hibernate is going to fetch the calculated fullName column from the database after the entity is modified.

*Example 58. @Generated update example*

Person person = entityManager.find( Person.class, 1L );

person.setLastName( "Doe Jr" );

entityManager.flush();

assertEquals("John Flávio André Frederico Rúben Artur Doe Jr", person.getFullName());

UPDATE

Person

SET

firstName=?,

lastName=?,

middleName1=?,

middleName2=?,

middleName3=?,

middleName4=?,

middleName5=?

WHERE

id=?

-- binding parameter [1] as [VARCHAR] - [John]

-- binding parameter [2] as [VARCHAR] - [Doe Jr]

-- binding parameter [3] as [VARCHAR] - [Flávio]

-- binding parameter [4] as [VARCHAR] - [André]

-- binding parameter [5] as [VARCHAR] - [Frederico]

-- binding parameter [6] as [VARCHAR] - [Rúben]

-- binding parameter [7] as [VARCHAR] - [Artur]

-- binding parameter [8] as [BIGINT] - [1]

SELECT

p.fullName as fullName3\_0\_

FROM

Person p

WHERE

p.id=?

-- binding parameter [1] as [BIGINT] - [1]

-- extracted value ([fullName3\_0\_] : [VARCHAR]) - [John Flávio André Frederico Rúben Artur Doe Jr]

##### @GeneratorType annotation

The [@GeneratorType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GeneratorType.html) annotation is used so that you can provide a custom generator to set the value of the currently annotated property.

For this reason, the @GeneratorType annotation accepts a [GenerationTime](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenerationTime.html) enum value and a custom [ValueGenerator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ValueGenerator.html)class type.

Considering the following entity:

*Example 59. @GeneratorType mapping example*

public static class CurrentUser {

public static final CurrentUser INSTANCE = new CurrentUser();

private static final ThreadLocal<String> storage = new ThreadLocal<>();

public void logIn(String user) {

storage.set( user );

}

public void logOut() {

storage.remove();

}

public String get() {

return storage.get();

}

}

public static class LoggedUserGenerator implements ValueGenerator<String> {

@Override

public String generateValue(

Session session, Object owner) {

return CurrentUser.INSTANCE.get();

}

}

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String firstName;

private String lastName;

@GeneratorType( type = LoggedUserGenerator.class, when = GenerationTime.INSERT)

private String createdBy;

@GeneratorType( type = LoggedUserGenerator.class, when = GenerationTime.ALWAYS)

private String updatedBy;

}

When the Person entity is persisted, Hibernate is going to populate the createdBy column with the currently logged user.

*Example 60. @Generated persist example*

CurrentUser.INSTANCE.logIn( "Alice" );

doInJPA( this::entityManagerFactory, entityManager -> {

Person person = new Person();

person.setId( 1L );

person.setFirstName( "John" );

person.setLastName( "Doe" );

entityManager.persist( person );

} );

CurrentUser.INSTANCE.logOut();

INSERT INTO Person

(

createdBy,

firstName,

lastName,

updatedBy,

id

)

VALUES

(?, ?, ?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Alice]

-- binding parameter [2] as [VARCHAR] - [John]

-- binding parameter [3] as [VARCHAR] - [Doe]

-- binding parameter [4] as [VARCHAR] - [Alice]

-- binding parameter [5] as [BIGINT] - [1]

The same goes when the Person entity is updated. Hibernate is going to populate the updatedBy column with the currently logged user.

*Example 61. @Generated update example*

CurrentUser.INSTANCE.logIn( "Bob" );

doInJPA( this::entityManagerFactory, entityManager -> {

Person person = entityManager.find( Person.class, 1L );

person.setFirstName( "Mr. John" );

} );

CurrentUser.INSTANCE.logOut();

UPDATE Person

SET

createdBy = ?,

firstName = ?,

lastName = ?,

updatedBy = ?

WHERE

id = ?

-- binding parameter [1] as [VARCHAR] - [Alice]

-- binding parameter [2] as [VARCHAR] - [Mr. John]

-- binding parameter [3] as [VARCHAR] - [Doe]

-- binding parameter [4] as [VARCHAR] - [Bob]

-- binding parameter [5] as [BIGINT] - [1]

##### @CreationTimestamp annotation

The @CreationTimestamp annotation instructs Hibernate to set the annotated entity attribute with the current timestamp value of the JVM when the entity is being persisted.

The supported property types are:

* java.util.Date
* java.util.Calendar
* java.sql.Date
* java.sql.Time
* java.sql.Timestamp

*Example 62. @CreationTimestamp mapping example*

@Entity(name = "Event")

public static class Event {

@Id

@GeneratedValue

private Long id;

@Column(name = "`timestamp`")

@CreationTimestamp

private Date timestamp;

public Event() {}

public Long getId() {

return id;

}

public Date getTimestamp() {

return timestamp;

}

}

When the Event entity is persisted, Hibernate is going to populate the underlying timestamp column with the current JVM timestamp value:

*Example 63. @CreationTimestamp persist example*

Event dateEvent = new Event( );

entityManager.persist( dateEvent );

INSERT INTO Event ("timestamp", id)

VALUES (?, ?)

-- binding parameter [1] as [TIMESTAMP] - [Tue Nov 15 16:24:20 EET 2016]

-- binding parameter [2] as [BIGINT] - [1]

##### @UpdateTimestamp annotation

The @UpdateTimestamp annotation instructs Hibernate to set the annotated entity attribute with the current timestamp value of the JVM when the entity is being persisted.

The supported property types are:

* java.util.Date
* java.util.Calendar
* java.sql.Date
* java.sql.Time
* java.sql.Timestamp

*Example 64. @UpdateTimestamp mapping example*

@Entity(name = "Bid")

public static class Bid {

@Id

@GeneratedValue

private Long id;

@Column(name = "updated\_on")

@UpdateTimestamp

private Date updatedOn;

@Column(name = "updated\_by")

private String updatedBy;

private Long cents;

//Getters and setters are omitted for brevity

}

When the Bid entity is persisted, Hibernate is going to populate the underlying updated\_on column with the current JVM timestamp value:

*Example 65. @UpdateTimestamp persist example*

Bid bid = new Bid();

bid.setUpdatedBy( "John Doe" );

bid.setCents( 150 \* 100L );

entityManager.persist( bid );

INSERT INTO Bid (cents, updated\_by, updated\_on, id)

VALUES (?, ?, ?, ?)

-- binding parameter [1] as [BIGINT] - [15000]

-- binding parameter [2] as [VARCHAR] - [John Doe]

-- binding parameter [3] as [TIMESTAMP] - [Tue Apr 18 17:21:46 EEST 2017]

-- binding parameter [4] as [BIGINT] - [1]

When updating the Bid entity, Hibernate is going to modify the updated\_on column with the current JVM timestamp value:

*Example 66. @UpdateTimestamp update example*

Bid bid = entityManager.find( Bid.class, 1L );

bid.setUpdatedBy( "John Doe Jr." );

bid.setCents( 160 \* 100L );

entityManager.persist( bid );

UPDATE Bid SET

cents = ?,

updated\_by = ?,

updated\_on = ?

where

id = ?

-- binding parameter [1] as [BIGINT] - [16000]

-- binding parameter [2] as [VARCHAR] - [John Doe Jr.]

-- binding parameter [3] as [TIMESTAMP] - [Tue Apr 18 17:49:24 EEST 2017]

-- binding parameter [4] as [BIGINT] - [1]

##### @ValueGenerationType meta-annotation

Hibernate 4.3 introduced the @ValueGenerationType meta-annotation, which is a new approach to declaring generated attributes or customizing generators.

@Generated has been retrofitted to use the @ValueGenerationType meta-annotation. But @ValueGenerationTypeexposes more features than what @Generated currently supports, and, to leverage some of those features, you’d simply wire up a new generator annotation.

As you’ll see in the following examples, the @ValueGenerationType meta-annotation is used when declaring the custom annotation used to mark the entity properties that need a specific generation strategy. The actual generation logic must be implemented in class that implements the AnnotationValueGeneration interface.

###### Database-generated values

For example, let’s say we want the timestamps to be generated by calls to the standard ANSI SQL function current\_timestamp (rather than triggers or DEFAULT values):

*Example 67. A ValueGenerationType mapping for database generation*

@Entity(name = "Event")

public static class Event {

@Id

@GeneratedValue

private Long id;

@Column(name = "`timestamp`")

@FunctionCreationTimestamp

private Date timestamp;

public Event() {}

public Long getId() {

return id;

}

public Date getTimestamp() {

return timestamp;

}

}

@ValueGenerationType(generatedBy = FunctionCreationValueGeneration.class)

@Retention(RetentionPolicy.RUNTIME)

public @interface FunctionCreationTimestamp {}

public static class FunctionCreationValueGeneration

implements AnnotationValueGeneration<FunctionCreationTimestamp> {

@Override

public void initialize(FunctionCreationTimestamp annotation, Class<?> propertyType) {

}

/\*\*

\* Generate value on INSERT

\* @return when to generate the value

\*/

public GenerationTiming getGenerationTiming() {

return GenerationTiming.INSERT;

}

/\*\*

\* Returns null because the value is generated by the database.

\* @return null

\*/

public ValueGenerator<?> getValueGenerator() {

return null;

}

/\*\*

\* Returns true because the value is generated by the database.

\* @return true

\*/

public boolean referenceColumnInSql() {

return true;

}

/\*\*

\* Returns the database-generated value

\* @return database-generated value

\*/

public String getDatabaseGeneratedReferencedColumnValue() {

return "current\_timestamp";

}

}

When persisting an Event entity, Hibernate generates the following SQL statement:

INSERT INTO Event ("timestamp", id)

VALUES (current\_timestamp, 1)

As you can see, the current\_timestamp value was used for assigning the timestamp column value.

###### In-memory-generated values

If the timestamp value needs to be generated in-memory, the following mapping must be used instead:

*Example 68. A ValueGenerationType mapping for in-memory value generation*

@Entity(name = "Event")

public static class Event {

@Id

@GeneratedValue

private Long id;

@Column(name = "`timestamp`")

@FunctionCreationTimestamp

private Date timestamp;

public Event() {}

public Long getId() {

return id;

}

public Date getTimestamp() {

return timestamp;

}

}

@ValueGenerationType(generatedBy = FunctionCreationValueGeneration.class)

@Retention(RetentionPolicy.RUNTIME)

public @interface FunctionCreationTimestamp {}

public static class FunctionCreationValueGeneration

implements AnnotationValueGeneration<FunctionCreationTimestamp> {

@Override

public void initialize(FunctionCreationTimestamp annotation, Class<?> propertyType) {

}

/\*\*

\* Generate value on INSERT

\* @return when to generate the value

\*/

public GenerationTiming getGenerationTiming() {

return GenerationTiming.INSERT;

}

/\*\*

\* Returns the in-memory generated value

\* @return {@code true}

\*/

public ValueGenerator<?> getValueGenerator() {

return (session, owner) -> new Date( );

}

/\*\*

\* Returns false because the value is generated by the database.

\* @return false

\*/

public boolean referenceColumnInSql() {

return false;

}

/\*\*

\* Returns null because the value is generated in-memory.

\* @return null

\*/

public String getDatabaseGeneratedReferencedColumnValue() {

return null;

}

}

When persisting an Event entity, Hibernate generates the following SQL statement:

INSERT INTO Event ("timestamp", id)

VALUES ('Tue Mar 01 10:58:18 EET 2016', 1)

As you can see, the new Date() object value was used for assigning the timestamp column value.

#### 2.3.19. Column transformers: read and write expressions

Hibernate allows you to customize the SQL it uses to read and write the values of columns mapped to @Basic types. For example, if your database provides a set of data encryption functions, you can invoke them for individual columns like in the following example.

*Example 69. @ColumnTransformer example*

@Entity(name = "Employee")

public static class Employee {

@Id

private Long id;

@NaturalId

private String username;

@Column(name = "pswd")

@ColumnTransformer(

read = "decrypt( 'AES', '00', pswd )",

write = "encrypt('AES', '00', ?)"

)

private String password;

private int accessLevel;

@ManyToOne(fetch = FetchType.LAZY)

private Department department;

@ManyToMany(mappedBy = "employees")

private List<Project> projects = new ArrayList<>();

//Getters and setters omitted for brevity

}

|  |  |
| --- | --- |
|  | You can use the plural form @ColumnTransformers if more than one columns need to define either of these rules. |

If a property uses more than one column, you must use the forColumn attribute to specify which column, the expressions are targeting.

*Example 70. @ColumnTransformer forColumn attribute usage*

@Entity(name = "Savings")

public static class Savings {

@Id

private Long id;

@Type(type = "org.hibernate.userguide.mapping.basic.MonetaryAmountUserType")

@Columns(columns = {

@Column(name = "money"),

@Column(name = "currency")

})

@ColumnTransformer(

forColumn = "money",

read = "money / 100",

write = "? \* 100"

)

private MonetaryAmount wallet;

//Getters and setters omitted for brevity

}

Hibernate applies the custom expressions automatically whenever the property is referenced in a query. This functionality is similar to a derived-property [@Formula](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-formula) with two differences:

* The property is backed by one or more columns that are exported as part of automatic schema generation.
* The property is read-write, not read-only.

The write expression, if specified, must contain exactly one '?' placeholder for the value.

*Example 71. Persisting an entity with a @ColumnTransformer and a composite type*

doInJPA( this::entityManagerFactory, entityManager -> {

Savings savings = new Savings( );

savings.setId( 1L );

savings.setWallet( new MonetaryAmount( BigDecimal.TEN, Currency.getInstance( Locale.US ) ) );

entityManager.persist( savings );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

Savings savings = entityManager.find( Savings.class, 1L );

assertEquals( 10, savings.getWallet().getAmount().intValue());

} );

INSERT INTO Savings (money, currency, id)

VALUES (10 \* 100, 'USD', 1)

SELECT

s.id as id1\_0\_0\_,

s.money / 100 as money2\_0\_0\_,

s.currency as currency3\_0\_0\_

FROM

Savings s

WHERE

s.id = 1

#### 2.3.20. @Formula

Sometimes, you want the Database to do some computation for you rather than in the JVM, you might also create some kind of virtual column. You can use a SQL fragment (aka formula) instead of mapping a property into a column. This kind of property is read only (its value is calculated by your formula fragment)

|  |  |
| --- | --- |
|  | You should be aware that the @Formula annotation takes a native SQL clause which can affect database portability. |

*Example 72. @Formula mapping usage*

@Entity(name = "Account")

public static class Account {

@Id

private Long id;

private Double credit;

private Double rate;

@Formula(value = "credit \* rate")

private Double interest;

//Getters and setters omitted for brevity

}

When loading the Account entity, Hibernate is going to calculate the interest property using the configured @Formula:

*Example 73. Persisting an entity with a @Formula mapping*

doInJPA( this::entityManagerFactory, entityManager -> {

Account account = new Account( );

account.setId( 1L );

account.setCredit( 5000d );

account.setRate( 1.25 / 100 );

entityManager.persist( account );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

Account account = entityManager.find( Account.class, 1L );

assertEquals( Double.valueOf( 62.5d ), account.getInterest());

} );

INSERT INTO Account (credit, rate, id)

VALUES (5000.0, 0.0125, 1)

SELECT

a.id as id1\_0\_0\_,

a.credit as credit2\_0\_0\_,

a.rate as rate3\_0\_0\_,

a.credit \* a.rate as formula0\_0\_

FROM

Account a

WHERE

a.id = 1

|  |  |
| --- | --- |
|  | The SQL fragment can be as complex as you want and even include subselects. |

#### 2.3.21. @Where

Sometimes, you want to filter out entities or collections using a custom SQL criteria. This can be achieved using the @Where annotation, which can be applied to entities and collections.

*Example 74. @Where mapping usage*

public enum AccountType {

DEBIT,

CREDIT

}

@Entity(name = "Client")

public static class Client {

@Id

private Long id;

private String name;

@Where( clause = "account\_type = 'DEBIT'")

@OneToMany(mappedBy = "client")

private List<Account> debitAccounts = new ArrayList<>( );

@Where( clause = "account\_type = 'CREDIT'")

@OneToMany(mappedBy = "client")

private List<Account> creditAccounts = new ArrayList<>( );

//Getters and setters omitted for brevity

}

@Entity(name = "Account")

@Where( clause = "active = true" )

public static class Account {

@Id

private Long id;

@ManyToOne

private Client client;

@Column(name = "account\_type")

@Enumerated(EnumType.STRING)

private AccountType type;

private Double amount;

private Double rate;

private boolean active;

//Getters and setters omitted for brevity

}

If the database contains the following entities:

*Example 75. Persisting an fetching entities with a @Where mapping*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = new Client();

client.setId( 1L );

client.setName( "John Doe" );

entityManager.persist( client );

Account account1 = new Account( );

account1.setId( 1L );

account1.setType( AccountType.CREDIT );

account1.setAmount( 5000d );

account1.setRate( 1.25 / 100 );

account1.setActive( true );

account1.setClient( client );

client.getCreditAccounts().add( account1 );

entityManager.persist( account1 );

Account account2 = new Account( );

account2.setId( 2L );

account2.setType( AccountType.DEBIT );

account2.setAmount( 0d );

account2.setRate( 1.05 / 100 );

account2.setActive( false );

account2.setClient( client );

client.getDebitAccounts().add( account2 );

entityManager.persist( account2 );

Account account3 = new Account( );

account3.setType( AccountType.DEBIT );

account3.setId( 3L );

account3.setAmount( 250d );

account3.setRate( 1.05 / 100 );

account3.setActive( true );

account3.setClient( client );

client.getDebitAccounts().add( account3 );

entityManager.persist( account3 );

} );

INSERT INTO Client (name, id)

VALUES ('John Doe', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 5000.0, 1, 0.0125, 'CREDIT', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (false, 0.0, 1, 0.0105, 'DEBIT', 2)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 250.0, 1, 0.0105, 'DEBIT', 3)

When executing an Account entity query, Hibernate is going to filter out all records that are not active.

*Example 76. Query entities mapped with @Where*

doInJPA( this::entityManagerFactory, entityManager -> {

List<Account> accounts = entityManager.createQuery(

"select a from Account a", Account.class)

.getResultList();

assertEquals( 2, accounts.size());

} );

SELECT

a.id as id1\_0\_,

a.active as active2\_0\_,

a.amount as amount3\_0\_,

a.client\_id as client\_i6\_0\_,

a.rate as rate4\_0\_,

a.account\_type as account\_5\_0\_

FROM

Account a

WHERE ( a.active = true )

When fetching the debitAccounts or the creditAccounts collections, Hibernate is going to apply the @Where clause filtering criteria to the associated child entities.

*Example 77. Traversing collections mapped with @Where*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = entityManager.find( Client.class, 1L );

assertEquals( 1, client.getCreditAccounts().size() );

assertEquals( 1, client.getDebitAccounts().size() );

} );

SELECT

c.client\_id as client\_i6\_0\_0\_,

c.id as id1\_0\_0\_,

c.id as id1\_0\_1\_,

c.active as active2\_0\_1\_,

c.amount as amount3\_0\_1\_,

c.client\_id as client\_i6\_0\_1\_,

c.rate as rate4\_0\_1\_,

c.account\_type as account\_5\_0\_1\_

FROM

Account c

WHERE ( c.active = true and c.account\_type = 'CREDIT' ) AND c.client\_id = 1

SELECT

d.client\_id as client\_i6\_0\_0\_,

d.id as id1\_0\_0\_,

d.id as id1\_0\_1\_,

d.active as active2\_0\_1\_,

d.amount as amount3\_0\_1\_,

d.client\_id as client\_i6\_0\_1\_,

d.rate as rate4\_0\_1\_,

d.account\_type as account\_5\_0\_1\_

FROM

Account d

WHERE ( d.active = true and d.account\_type = 'DEBIT' ) AND d.client\_id = 1

#### 2.3.22. @WhereJoinTable

Just like @Where annotation, @WhereJoinTable is used to filter out collections using a joined table (e.g. @ManyToMany association).

*Example 78. @WhereJoinTable mapping example*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

@ManyToMany

@JoinTable(

name = "Book\_Reader",

joinColumns = @JoinColumn(name = "book\_id"),

inverseJoinColumns = @JoinColumn(name = "reader\_id")

)

@WhereJoinTable( clause = "created\_on > DATEADD( 'DAY', -7, CURRENT\_TIMESTAMP() )")

private List<Reader> currentWeekReaders = new ArrayList<>( );

//Getters and setters omitted for brevity

}

@Entity(name = "Reader")

public static class Reader {

@Id

private Long id;

private String name;

//Getters and setters omitted for brevity

}

create table Book (

id bigint not null,

author varchar(255),

title varchar(255),

primary key (id)

)

create table Book\_Reader (

book\_id bigint not null,

reader\_id bigint not null

)

create table Reader (

id bigint not null,

name varchar(255),

primary key (id)

)

alter table Book\_Reader

add constraint FKsscixgaa5f8lphs9bjdtpf9g

foreign key (reader\_id)

references Reader

alter table Book\_Reader

add constraint FKoyrwu9tnwlukd1616qhck21ra

foreign key (book\_id)

references Book

alter table Book\_Reader

add created\_on timestamp

default current\_timestamp

In the example above, the current week Reader entities are included in the currentWeekReaders collection which uses the @WhereJoinTable annotation to filter the joined table rows according to the provided SQL clause.

Considering that the following two Book\_Reader entries are added into our system:

*Example 79. @WhereJoinTable test data*

Book book = new Book();

book.setId( 1L );

book.setTitle( "High-Performance Java Persistence" );

book.setAuthor( "Vad Mihalcea" );

entityManager.persist( book );

Reader reader1 = new Reader();

reader1.setId( 1L );

reader1.setName( "John Doe" );

entityManager.persist( reader1 );

Reader reader2 = new Reader();

reader2.setId( 2L );

reader2.setName( "John Doe Jr." );

entityManager.persist( reader2 );

statement.executeUpdate(

"INSERT INTO Book\_Reader " +

" (book\_id, reader\_id) " +

"VALUES " +

" (1, 1) "

);

statement.executeUpdate(

"INSERT INTO Book\_Reader " +

" (book\_id, reader\_id, created\_on) " +

"VALUES " +

" (1, 2, DATEADD( 'DAY', -10, CURRENT\_TIMESTAMP() )) "

);

When fetching the currentWeekReaders collection, Hibernate is going to find one one entry:

*Example 80. @WhereJoinTable fetch example*

Book book = entityManager.find( Book.class, 1L );

assertEquals( 1, book.getCurrentWeekReaders().size() );

#### 2.3.23. @Filter

The @Filter annotation is another way to filter out entities or collections using a custom SQL criteria, for both entities and collections. Unlike the @Where annotation, @Filter allows you to parameterize the filter clause at runtime.

*Example 81. @Filter mapping usage*

public enum AccountType {

DEBIT,

CREDIT

}

@Entity(name = "Client")

public static class Client {

@Id

private Long id;

private String name;

@OneToMany(mappedBy = "client")

@Filter(name="activeAccount", condition="active = :active")

private List<Account> accounts = new ArrayList<>( );

//Getters and setters omitted for brevity

}

@Entity(name = "Account")

@FilterDef(name="activeAccount", parameters=@ParamDef( name="active", type="boolean" ) )

@Filter(name="activeAccount", condition="active = :active")

public static class Account {

@Id

private Long id;

@ManyToOne

private Client client;

@Column(name = "account\_type")

@Enumerated(EnumType.STRING)

private AccountType type;

private Double amount;

private Double rate;

private boolean active;

//Getters and setters omitted for brevity

}

If the database contains the following entities:

*Example 82. Persisting an fetching entities with a @Filter mapping*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = new Client();

client.setId( 1L );

client.setName( "John Doe" );

entityManager.persist( client );

Account account1 = new Account( );

account1.setId( 1L );

account1.setType( AccountType.CREDIT );

account1.setAmount( 5000d );

account1.setRate( 1.25 / 100 );

account1.setActive( true );

account1.setClient( client );

client.getAccounts().add( account1 );

entityManager.persist( account1 );

Account account2 = new Account( );

account2.setId( 2L );

account2.setType( AccountType.DEBIT );

account2.setAmount( 0d );

account2.setRate( 1.05 / 100 );

account2.setActive( false );

account2.setClient( client );

client.getAccounts().add( account2 );

entityManager.persist( account2 );

Account account3 = new Account( );

account3.setType( AccountType.DEBIT );

account3.setId( 3L );

account3.setAmount( 250d );

account3.setRate( 1.05 / 100 );

account3.setActive( true );

account3.setClient( client );

client.getAccounts().add( account3 );

entityManager.persist( account3 );

} );

INSERT INTO Client (name, id)

VALUES ('John Doe', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 5000.0, 1, 0.0125, 'CREDIT', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (false, 0.0, 1, 0.0105, 'DEBIT', 2)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 250.0, 1, 0.0105, 'DEBIT', 3)

By default, without explicitly enabling the filter, Hibernate is going to fetch all Account entities. If the filter is enabled and the filter parameter value is provided, then Hibernate is going to apply the filtering criteria to the associated Account entities.

*Example 83. Query entities mapped with @Filter*

doInJPA( this::entityManagerFactory, entityManager -> {

List<Account> accounts = entityManager.createQuery(

"select a from Account a", Account.class)

.getResultList();

assertEquals( 3, accounts.size());

} );

doInJPA( this::entityManagerFactory, entityManager -> {

log.infof( "Activate filter [%s]", "activeAccount");

entityManager

.unwrap( Session.class )

.enableFilter( "activeAccount" )

.setParameter( "active", true);

List<Account> accounts = entityManager.createQuery(

"select a from Account a", Account.class)

.getResultList();

assertEquals( 2, accounts.size());

} );

SELECT

a.id as id1\_0\_,

a.active as active2\_0\_,

a.amount as amount3\_0\_,

a.client\_id as client\_i6\_0\_,

a.rate as rate4\_0\_,

a.account\_type as account\_5\_0\_

FROM

Account a

-- Activate filter [activeAccount]

SELECT

a.id as id1\_0\_,

a.active as active2\_0\_,

a.amount as amount3\_0\_,

a.client\_id as client\_i6\_0\_,

a.rate as rate4\_0\_,

a.account\_type as account\_5\_0\_

FROM

Account a

WHERE

a.active = true

|  |  |
| --- | --- |
|  | Filters apply to entity queries, but not to direct fetching. Therefore, in the following example, the filter is not taken into consideration when fetching an entity from the Persistence Context.  *Fetching entities mapped with @Filter*  doInJPA( this::entityManagerFactory, entityManager -> {  log.infof( "Activate filter [%s]", "activeAccount");  entityManager  .unwrap( Session.class )  .enableFilter( "activeAccount" )  .setParameter( "active", true);  Account account = entityManager.find( Account.class, 2L );  assertFalse( account.isActive() );  } );  SELECT  a.id as id1\_0\_0\_,  a.active as active2\_0\_0\_,  a.amount as amount3\_0\_0\_,  a.client\_id as client\_i6\_0\_0\_,  a.rate as rate4\_0\_0\_,  a.account\_type as account\_5\_0\_0\_,  c.id as id1\_1\_1\_,  c.name as name2\_1\_1\_  FROM  Account a  LEFT OUTER JOIN  Client c  ON a.client\_id=c.id  WHERE  a.id = 2  As you can see from the example above, contrary to an entity query, the filter does not prevent the entity from being loaded. |

Just like with entity queries, collections can be filtered as well, but only if the filter is explicitly enabled on the currently running Hibernate Session. This way, when fetching the accounts collections, Hibernate is going to apply the @Filterclause filtering criteria to the associated collection entries.

*Example 84. Traversing collections mapped with @Filter*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = entityManager.find( Client.class, 1L );

assertEquals( 3, client.getAccounts().size() );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

log.infof( "Activate filter [%s]", "activeAccount");

entityManager

.unwrap( Session.class )

.enableFilter( "activeAccount" )

.setParameter( "active", true);

Client client = entityManager.find( Client.class, 1L );

assertEquals( 2, client.getAccounts().size() );

} );

SELECT

c.id as id1\_1\_0\_,

c.name as name2\_1\_0\_

FROM

Client c

WHERE

c.id = 1

SELECT

a.id as id1\_0\_,

a.active as active2\_0\_,

a.amount as amount3\_0\_,

a.client\_id as client\_i6\_0\_,

a.rate as rate4\_0\_,

a.account\_type as account\_5\_0\_

FROM

Account a

WHERE

a.client\_id = 1

-- Activate filter [activeAccount]

SELECT

c.id as id1\_1\_0\_,

c.name as name2\_1\_0\_

FROM

Client c

WHERE

c.id = 1

SELECT

a.id as id1\_0\_,

a.active as active2\_0\_,

a.amount as amount3\_0\_,

a.client\_id as client\_i6\_0\_,

a.rate as rate4\_0\_,

a.account\_type as account\_5\_0\_

FROM

Account a

WHERE

accounts0\_.active = true

and a.client\_id = 1

|  |  |
| --- | --- |
|  | The main advantage of @Filter over the @Where clause is that the filtering criteria can be customized at runtime. |
|  | It’s not possible to combine the @Filter and @Cache collection annotations. This limitation is due to ensuring consistency and because the filtering information is not stored in the second-level cache.  If caching was allowed for a currently filtered collection, then the second-level cache would store only a subset of the whole collection. Afterward, every other Session will get the filtered collection from the cache, even if the Session-level filters have not been explicitly activated.  For this reason, the second-level collection cache is limited to storing whole collections, and not subsets. |

#### 2.3.24. @FilterJoinTable

When using the @Filter annotation with collections, the filtering is done against the child entries (entities or embeddables). However, if you have a link table between the parent entity and the child table, then you need to use the @FilterJoinTable to filter child entries according to some column contained in the join table.

The @FilterJoinTable annotation can be, therefore, applied to a unidirectional @OneToMany collection as illustrate din the following mapping:

*Example 85. @FilterJoinTable mapping usage*

public enum AccountType {

DEBIT,

CREDIT

}

@Entity(name = "Client")

@FilterDef(name="firstAccounts", parameters=@ParamDef( name="maxOrderId", type="int" ) )

@Filter(name="firstAccounts", condition="order\_id <= :maxOrderId")

public static class Client {

@Id

private Long id;

private String name;

@OneToMany

@OrderColumn(name = "order\_id")

@FilterJoinTable(name="firstAccounts", condition="order\_id <= :maxOrderId")

private List<Account> accounts = new ArrayList<>( );

//Getters and setters omitted for brevity

}

@Entity(name = "Account")

public static class Account {

@Id

private Long id;

@Column(name = "account\_type")

@Enumerated(EnumType.STRING)

private AccountType type;

private Double amount;

private Double rate;

private boolean active;

//Getters and setters omitted for brevity

}

If the database contains the following entities:

*Example 86. Persisting an fetching entities with a @FilterJoinTable mapping*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = new Client();

client.setId( 1L );

client.setName( "John Doe" );

entityManager.persist( client );

Account account1 = new Account( );

account1.setId( 1L );

account1.setType( AccountType.CREDIT );

account1.setAmount( 5000d );

account1.setRate( 1.25 / 100 );

account1.setActive( true );

client.getAccounts().add( account1 );

entityManager.persist( account1 );

Account account2 = new Account( );

account2.setId( 2L );

account2.setType( AccountType.DEBIT );

account2.setAmount( 0d );

account2.setRate( 1.05 / 100 );

account2.setActive( false );

client.getAccounts().add( account2 );

entityManager.persist( account2 );

Account account3 = new Account( );

account3.setType( AccountType.DEBIT );

account3.setId( 3L );

account3.setAmount( 250d );

account3.setRate( 1.05 / 100 );

account3.setActive( true );

client.getAccounts().add( account3 );

entityManager.persist( account3 );

} );

INSERT INTO Client (name, id)

VALUES ('John Doe', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 5000.0, 1, 0.0125, 'CREDIT', 1)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (false, 0.0, 1, 0.0105, 'DEBIT', 2)

INSERT INTO Account (active, amount, client\_id, rate, account\_type, id)

VALUES (true, 250.0, 1, 0.0105, 'DEBIT', 3)

INSERT INTO Client\_Account (Client\_id, order\_id, accounts\_id)

VALUES (1, 0, 1)

INSERT INTO Client\_Account (Client\_id, order\_id, accounts\_id)

VALUES (1, 0, 1)

INSERT INTO Client\_Account (Client\_id, order\_id, accounts\_id)

VALUES (1, 1, 2)

INSERT INTO Client\_Account (Client\_id, order\_id, accounts\_id)

VALUES (1, 2, 3)

The collections can be filtered if the associated filter is enabled on the currently running Hibernate Session. This way, when fetching the accounts collections, Hibernate is going to apply the @FilterJoinTable clause filtering criteria to the associated collection entries.

*Example 87. Traversing collections mapped with @FilterJoinTable*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = entityManager.find( Client.class, 1L );

assertEquals( 3, client.getAccounts().size());

} );

doInJPA( this::entityManagerFactory, entityManager -> {

log.infof( "Activate filter [%s]", "firstAccounts");

Client client = entityManager.find( Client.class, 1L );

entityManager

.unwrap( Session.class )

.enableFilter( "firstAccounts" )

.setParameter( "maxOrderId", 1);

assertEquals( 2, client.getAccounts().size());

} );

SELECT

ca.Client\_id as Client\_i1\_2\_0\_,

ca.accounts\_id as accounts2\_2\_0\_,

ca.order\_id as order\_id3\_0\_,

a.id as id1\_0\_1\_,

a.active as active2\_0\_1\_,

a.amount as amount3\_0\_1\_,

a.rate as rate4\_0\_1\_,

a.account\_type as account\_5\_0\_1\_

FROM

Client\_Account ca

INNER JOIN

Account a

ON ca.accounts\_id=a.id

WHERE

ca.Client\_id = ?

-- binding parameter [1] as [BIGINT] - [1]

-- Activate filter [firstAccounts]

SELECT

ca.Client\_id as Client\_i1\_2\_0\_,

ca.accounts\_id as accounts2\_2\_0\_,

ca.order\_id as order\_id3\_0\_,

a.id as id1\_0\_1\_,

a.active as active2\_0\_1\_,

a.amount as amount3\_0\_1\_,

a.rate as rate4\_0\_1\_,

a.account\_type as account\_5\_0\_1\_

FROM

Client\_Account ca

INNER JOIN

Account a

ON ca.accounts\_id=a.id

WHERE

ca.order\_id <= ?

AND ca.Client\_id = ?

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [BIGINT] - [1]

#### 2.3.25. @Filter with @SqlFragmentAlias

When using the @Filter annotation and working with entities that are mapped onto multiple database tables, you will need to use the [@SqlFragmentAlias](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SqlFragmentAlias.html) annotation if the @Filter defines a condition that uses predicates across multiple tables.

*Example 88. @SqlFragmentAlias mapping usage*

@Entity(name = "Account")

@Table(name = "account")

@SecondaryTable(

name = "account\_details"

)

@SQLDelete(

sql = "UPDATE account\_details SET deleted = true WHERE id = ? "

)

@FilterDef(

name="activeAccount",

parameters = @ParamDef(

name="active",

type="boolean"

)

)

@Filter(

name="activeAccount",

condition="{a}.active = :active and {ad}.deleted = false",

aliases = {

@SqlFragmentAlias( alias = "a", table= "account"),

@SqlFragmentAlias( alias = "ad", table= "account\_details"),

}

)

public static class Account {

@Id

private Long id;

private Double amount;

private Double rate;

private boolean active;

@Column(table = "account\_details")

private boolean deleted;

//Getters and setters omitted for brevity

}

Now, when fetching the Account entities and activating the filter, Hibernate is going to apply the right table aliases to the filter predicates:

*Example 89. Fetching a collection filtered with @SqlFragmentAlias*

entityManager

.unwrap( Session.class )

.enableFilter( "activeAccount" )

.setParameter( "active", true);

List<Account> accounts = entityManager.createQuery(

"select a from Account a", Account.class)

.getResultList();

select

filtersqlf0\_.id as id1\_0\_,

filtersqlf0\_.active as active2\_0\_,

filtersqlf0\_.amount as amount3\_0\_,

filtersqlf0\_.rate as rate4\_0\_,

filtersqlf0\_1\_.deleted as deleted1\_1\_

from

account filtersqlf0\_

left outer join

account\_details filtersqlf0\_1\_

on filtersqlf0\_.id=filtersqlf0\_1\_.id

where

filtersqlf0\_.active = ?

and filtersqlf0\_1\_.deleted = false

-- binding parameter [1] as [BOOLEAN] - [true]

#### 2.3.26. @Any mapping

There is one more type of property mapping. The @Any mapping 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 (e.g. audit logs, user session data, etc). |

The @Any annotation describes the column holding the metadata information. To link the value of the metadata information and an actual entity type, the @AnyDef and @AnyDefs annotations are used. The metaType 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 idType. You must specify the mapping from values of the metaType to class names.

For the next examples, consider the following Property class hierarchy:

*Example 90. Property class hierarchy*

public interface Property<T> {

String getName();

T getValue();

}

@Entity

@Table(name="integer\_property")

public class IntegerProperty implements Property<Integer> {

@Id

private Long id;

@Column(name = "`name`")

private String name;

@Column(name = "`value`")

private Integer value;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

@Override

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public Integer getValue() {

return value;

}

public void setValue(Integer value) {

this.value = value;

}

}

@Entity

@Table(name="string\_property")

public class StringProperty implements Property<String> {

@Id

private Long id;

@Column(name = "`name`")

private String name;

@Column(name = "`value`")

private String value;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

@Override

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public String getValue() {

return value;

}

public void setValue(String value) {

this.value = value;

}

}

A PropertyHolder can reference any such property, and, because each Property belongs to a separate table, the @Anyannotation is, therefore, required.

*Example 91. @Any mapping usage*

@Entity

@Table( name = "property\_holder" )

public class PropertyHolder {

@Id

private Long id;

@Any(

metaDef = "PropertyMetaDef",

metaColumn = @Column( name = "property\_type" )

)

@JoinColumn( name = "property\_id" )

private Property property;

//Getters and setters are omitted for brevity

}

CREATE TABLE property\_holder (

id BIGINT NOT NULL,

property\_type VARCHAR(255),

property\_id BIGINT,

PRIMARY KEY ( id )

)

As you can see, there are two columns used to reference a Property instance: property\_id and property\_type. The property\_id is used to match the id column of either the string\_property or integer\_property tables, while the property\_type is used to match the string\_property or the integer\_property table.

The table resolving mapping is defined by the metaDef attribute which references an @AnyMetaDef mapping. Although the @AnyMetaDef mapping could be set right next to the @Any annotation, it’s good practice to reuse it, therefore it makes sense to configure it on a class or package-level basis.

The package-info.java contains the @AnyMetaDef mapping:

*Example 92. @Any mapping usage*

@AnyMetaDef( name= "PropertyMetaDef", metaType = "string", idType = "long",

metaValues = {

@MetaValue(value = "S", targetEntity = StringProperty.class),

@MetaValue(value = "I", targetEntity = IntegerProperty.class)

}

)

package org.hibernate.userguide.mapping.basic.any;

import org.hibernate.annotations.AnyMetaDef;

import org.hibernate.annotations.MetaValue;

|  |  |
| --- | --- |
|  | It is recommended to place the @AnyMetaDef mapping as a package metadata. |

To see how the @Any annotation in action, consider the following example:

*Example 93. @Any mapping usage*

doInHibernate( this::sessionFactory, session -> {

IntegerProperty ageProperty = new IntegerProperty();

ageProperty.setId( 1L );

ageProperty.setName( "age" );

ageProperty.setValue( 23 );

StringProperty nameProperty = new StringProperty();

nameProperty.setId( 1L );

nameProperty.setName( "name" );

nameProperty.setValue( "John Doe" );

session.persist( ageProperty );

session.persist( nameProperty );

PropertyHolder namePropertyHolder = new PropertyHolder();

namePropertyHolder.setId( 1L );

namePropertyHolder.setProperty( nameProperty );

session.persist( namePropertyHolder );

} );

doInHibernate( this::sessionFactory, session -> {

PropertyHolder propertyHolder = session.get( PropertyHolder.class, 1L );

assertEquals("name", propertyHolder.getProperty().getName());

assertEquals("John Doe", propertyHolder.getProperty().getValue());

} );

INSERT INTO integer\_property

( "name", "value", id )

VALUES ( 'age', 23, 1 )

INSERT INTO string\_property

( "name", "value", id )

VALUES ( 'name', 'John Doe', 1 )

INSERT INTO property\_holder

( property\_type, property\_id, id )

VALUES ( 'S', 1, 1 )

SELECT ph.id AS id1\_1\_0\_,

ph.property\_type AS property2\_1\_0\_,

ph.property\_id AS property3\_1\_0\_

FROM property\_holder ph

WHERE ph.id = 1

SELECT sp.id AS id1\_2\_0\_,

sp."name" AS name2\_2\_0\_,

sp."value" AS value3\_2\_0\_

FROM string\_property sp

WHERE sp.id = 1

##### @ManyToAny mapping

The @Any mapping is useful to emulate a @ManyToOne association when there can be multiple target entities. To emulate a @OneToMany association, the @ManyToAny annotation must be used.

In the following example, the PropertyRepository entity has a collection of Property entities. The repository\_properties link table holds the associations between PropertyRepository and Property entities.

*Example 94. @ManyToAny mapping usage*

@Entity

@Table( name = "property\_repository" )

public class PropertyRepository {

@Id

private Long id;

@ManyToAny(

metaDef = "PropertyMetaDef",

metaColumn = @Column( name = "property\_type" )

)

@Cascade( { org.hibernate.annotations.CascadeType.ALL })

@JoinTable(name = "repository\_properties",

joinColumns = @JoinColumn(name = "repository\_id"),

inverseJoinColumns = @JoinColumn(name = "property\_id")

)

private List<Property<?>> properties = new ArrayList<>( );

//Getters and setters are omitted for brevity

}

CREATE TABLE property\_repository (

id BIGINT NOT NULL,

PRIMARY KEY ( id )

)

CREATE TABLE repository\_properties (

repository\_id BIGINT NOT NULL,

property\_type VARCHAR(255),

property\_id BIGINT NOT NULL

)

To see how the @ManyToAny annotation works, consider the following example:

*Example 95. @Any mapping usage*

doInHibernate( this::sessionFactory, session -> {

IntegerProperty ageProperty = new IntegerProperty();

ageProperty.setId( 1L );

ageProperty.setName( "age" );

ageProperty.setValue( 23 );

StringProperty nameProperty = new StringProperty();

nameProperty.setId( 1L );

nameProperty.setName( "name" );

nameProperty.setValue( "John Doe" );

session.persist( ageProperty );

session.persist( nameProperty );

PropertyRepository propertyRepository = new PropertyRepository();

propertyRepository.setId( 1L );

propertyRepository.getProperties().add( ageProperty );

propertyRepository.getProperties().add( nameProperty );

session.persist( propertyRepository );

} );

doInHibernate( this::sessionFactory, session -> {

PropertyRepository propertyRepository = session.get( PropertyRepository.class, 1L );

assertEquals(2, propertyRepository.getProperties().size());

for(Property property : propertyRepository.getProperties()) {

assertNotNull( property.getValue() );

}

} );

INSERT INTO integer\_property

( "name", "value", id )

VALUES ( 'age', 23, 1 )

INSERT INTO string\_property

( "name", "value", id )

VALUES ( 'name', 'John Doe', 1 )

INSERT INTO property\_repository ( id )

VALUES ( 1 )

INSERT INTO repository\_properties

( repository\_id , property\_type , property\_id )

VALUES

( 1 , 'I' , 1 )

INSERT INTO repository\_properties

( repository\_id , property\_type , property\_id )

VALUES

( 1 , 'S' , 1 )

SELECT pr.id AS id1\_1\_0\_

FROM property\_repository pr

WHERE pr.id = 1

SELECT ip.id AS id1\_0\_0\_ ,

integerpro0\_."name" AS name2\_0\_0\_ ,

integerpro0\_."value" AS value3\_0\_0\_

FROM integer\_property integerpro0\_

WHERE integerpro0\_.id = 1

SELECT sp.id AS id1\_3\_0\_ ,

sp."name" AS name2\_3\_0\_ ,

sp."value" AS value3\_3\_0\_

FROM string\_property sp

WHERE sp.id = 1

#### 2.3.27. @JoinFormula mapping

The [@JoinFormula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/JoinFormula.html) annotation is used to customize the join between a child Foreign Key and a parent row Primary Key.

*Example 96. @JoinFormula mapping usage*

@Entity(name = "User")

@Table(name = "users")

public static class User {

@Id

private Long id;

private String firstName;

private String lastName;

private String phoneNumber;

@ManyToOne

@JoinFormula( "REGEXP\_REPLACE(phoneNumber, '\\+(\\d+)-.\*', '\\1')::int" )

private Country country;

//Getters and setters omitted for brevity

}

@Entity(name = "Country")

@Table(name = "countries")

public static class Country {

@Id

private Integer id;

private String name;

public int getId() {

return id;

}

public void setId(int id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( !( o instanceof Country ) ) {

return false;

}

Country country = (Country) o;

return Objects.equals( getId(), country.getId() );

}

@Override

public int hashCode() {

return Objects.hash( getId() );

}

}

CREATE TABLE countries (

id int4 NOT NULL,

name VARCHAR(255),

PRIMARY KEY ( id )

)

CREATE TABLE users (

id int8 NOT NULL,

firstName VARCHAR(255),

lastName VARCHAR(255),

phoneNumber VARCHAR(255),

PRIMARY KEY ( id )

)

The country association in the User entity is mapped by the country identifier provided by the phoneNumber property.

Considering we have the following entities:

*Example 97. @JoinFormula mapping usage*

Country US = new Country();

US.setId( 1 );

US.setName( "United States" );

Country Romania = new Country();

Romania.setId( 40 );

Romania.setName( "Romania" );

doInJPA( this::entityManagerFactory, entityManager -> {

entityManager.persist( US );

entityManager.persist( Romania );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

User user1 = new User( );

user1.setId( 1L );

user1.setFirstName( "John" );

user1.setLastName( "Doe" );

user1.setPhoneNumber( "+1-234-5678" );

entityManager.persist( user1 );

User user2 = new User( );

user2.setId( 2L );

user2.setFirstName( "Vlad" );

user2.setLastName( "Mihalcea" );

user2.setPhoneNumber( "+40-123-4567" );

entityManager.persist( user2 );

} );

When fetching the User entities, the country property is mapped by the @JoinFormula expression:

*Example 98. @JoinFormula mapping usage*

doInJPA( this::entityManagerFactory, entityManager -> {

log.info( "Fetch User entities" );

User john = entityManager.find( User.class, 1L );

assertEquals( US, john.getCountry());

User vlad = entityManager.find( User.class, 2L );

assertEquals( Romania, vlad.getCountry());

} );

-- Fetch User entities

SELECT

u.id as id1\_1\_0\_,

u.firstName as firstNam2\_1\_0\_,

u.lastName as lastName3\_1\_0\_,

u.phoneNumber as phoneNum4\_1\_0\_,

REGEXP\_REPLACE(u.phoneNumber, '\+(\d+)-.\*', '\1')::int as formula1\_0\_,

c.id as id1\_0\_1\_,

c.name as name2\_0\_1\_

FROM

users u

LEFT OUTER JOIN

countries c

ON REGEXP\_REPLACE(u.phoneNumber, '\+(\d+)-.\*', '\1')::int = c.id

WHERE

u.id=?

-- binding parameter [1] as [BIGINT] - [1]

SELECT

u.id as id1\_1\_0\_,

u.firstName as firstNam2\_1\_0\_,

u.lastName as lastName3\_1\_0\_,

u.phoneNumber as phoneNum4\_1\_0\_,

REGEXP\_REPLACE(u.phoneNumber, '\+(\d+)-.\*', '\1')::int as formula1\_0\_,

c.id as id1\_0\_1\_,

c.name as name2\_0\_1\_

FROM

users u

LEFT OUTER JOIN

countries c

ON REGEXP\_REPLACE(u.phoneNumber, '\+(\d+)-.\*', '\1')::int = c.id

WHERE

u.id=?

-- binding parameter [1] as [BIGINT] - [2]

Therefore, the @JoinFormula annotation is used to define a custom join association between the parent-child association.

#### 2.3.28. @JoinColumnOrFormula mapping

The [@JoinColumnOrFormula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/JoinColumnOrFormula.html) annotation is used to customize the join between a child Foreign Key and a parent row Primary Key when we need to take into consideration a column value as well as a @JoinFormula.

*Example 99. @JoinColumnOrFormula mapping usage*

@Entity(name = "User")

@Table(name = "users")

public static class User {

@Id

private Long id;

private String firstName;

private String lastName;

private String language;

@ManyToOne

@JoinColumnOrFormula( column =

@JoinColumn(

name = "language",

referencedColumnName = "primaryLanguage",

insertable = false,

updatable = false

)

)

@JoinColumnOrFormula( formula =

@JoinFormula(

value = "true",

referencedColumnName = "is\_default"

)

)

private Country country;

//Getters and setters omitted for brevity

}

@Entity(name = "Country")

@Table(name = "countries")

public static class Country implements Serializable {

@Id

private Integer id;

private String name;

private String primaryLanguage;

@Column(name = "is\_default")

private boolean \_default;

public int getId() {

return id;

}

public void setId(int id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public String getPrimaryLanguage() {

return primaryLanguage;

}

public void setPrimaryLanguage(String primaryLanguage) {

this.primaryLanguage = primaryLanguage;

}

public boolean isDefault() {

return \_default;

}

public void setDefault(boolean \_default) {

this.\_default = \_default;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( !( o instanceof Country ) ) {

return false;

}

Country country = (Country) o;

return Objects.equals( getId(), country.getId() );

}

@Override

public int hashCode() {

return Objects.hash( getId() );

}

}

CREATE TABLE countries (

id INTEGER NOT NULL,

is\_default boolean,

name VARCHAR(255),

primaryLanguage VARCHAR(255),

PRIMARY KEY ( id )

)

CREATE TABLE users (

id BIGINT NOT NULL,

firstName VARCHAR(255),

language VARCHAR(255),

lastName VARCHAR(255),

PRIMARY KEY ( id )

)

The country association in the User entity is mapped by the language property value and the associated Countryis\_default column value.

Considering we have the following entities:

*Example 100. @JoinColumnOrFormula persist example*

Country US = new Country();

US.setId( 1 );

US.setDefault( true );

US.setPrimaryLanguage( "English" );

US.setName( "United States" );

Country Romania = new Country();

Romania.setId( 40 );

Romania.setDefault( true );

Romania.setName( "Romania" );

Romania.setPrimaryLanguage( "Romanian" );

doInJPA( this::entityManagerFactory, entityManager -> {

entityManager.persist( US );

entityManager.persist( Romania );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

User user1 = new User( );

user1.setId( 1L );

user1.setFirstName( "John" );

user1.setLastName( "Doe" );

user1.setLanguage( "English" );

entityManager.persist( user1 );

User user2 = new User( );

user2.setId( 2L );

user2.setFirstName( "Vlad" );

user2.setLastName( "Mihalcea" );

user2.setLanguage( "Romanian" );

entityManager.persist( user2 );

} );

When fetching the User entities, the country property is mapped by the @JoinColumnOrFormula expression:

*Example 101. @JoinColumnOrFormula fetching example*

doInJPA( this::entityManagerFactory, entityManager -> {

log.info( "Fetch User entities" );

User john = entityManager.find( User.class, 1L );

assertEquals( US, john.getCountry());

User vlad = entityManager.find( User.class, 2L );

assertEquals( Romania, vlad.getCountry());

} );

SELECT

u.id as id1\_1\_0\_,

u.language as language3\_1\_0\_,

u.firstName as firstNam2\_1\_0\_,

u.lastName as lastName4\_1\_0\_,

1 as formula1\_0\_,

c.id as id1\_0\_1\_,

c.is\_default as is\_defau2\_0\_1\_,

c.name as name3\_0\_1\_,

c.primaryLanguage as primaryL4\_0\_1\_

FROM

users u

LEFT OUTER JOIN

countries c

ON u.language = c.primaryLanguage

AND 1 = c.is\_default

WHERE

u.id = ?

-- binding parameter [1] as [BIGINT] - [1]

SELECT

u.id as id1\_1\_0\_,

u.language as language3\_1\_0\_,

u.firstName as firstNam2\_1\_0\_,

u.lastName as lastName4\_1\_0\_,

1 as formula1\_0\_,

c.id as id1\_0\_1\_,

c.is\_default as is\_defau2\_0\_1\_,

c.name as name3\_0\_1\_,

c.primaryLanguage as primaryL4\_0\_1\_

FROM

users u

LEFT OUTER JOIN

countries c

ON u.language = c.primaryLanguage

AND 1 = c.is\_default

WHERE

u.id = ?

-- binding parameter [1] as [BIGINT] - [2]

Therefore, the @JoinColumnOrFormula annotation is used to define a custom join association between the parent-child association.

#### 2.3.29. @Target mapping

The [@Target](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Target.html) annotation is used to specify the implementation class of a given association that is mapped via an interface. The [@ManyToOne](http://docs.oracle.com/javaee/7/api/javax/persistence/ManyToOne.html), [@OneToOne](http://docs.oracle.com/javaee/7/api/javax/persistence/OneToOne.html), [@OneToMany](http://docs.oracle.com/javaee/7/api/javax/persistence/OneToMany.html), and [@ManyToMany](http://docs.oracle.com/javaee/7/api/javax/persistence/ManyToMany.html) feature a [targetEntity](http://docs.oracle.com/javaee/7/api/javax/persistence/ManyToOne.html#targetEntity--) attribute to specify the actual class of the entiity association when an interface is used for the mapping.

The [@ElementCollection](http://docs.oracle.com/javaee/7/api/javax/persistence/ElementCollection.html) association has a [targetClass](http://docs.oracle.com/javaee/7/api/javax/persistence/ElementCollection.html#targetClass--) attribute for the same purpose.

However, for simple embeddable types, there is no such construct and so you need to use the Hibernate-specific @Targetannotation instead.

*Example 102. @Target mapping usage*

public interface Coordinates {

double x();

double y();

}

@Embeddable

public static class GPS implements Coordinates {

private double latitude;

private double longitude;

private GPS() {

}

public GPS(double latitude, double longitude) {

this.latitude = latitude;

this.longitude = longitude;

}

@Override

public double x() {

return latitude;

}

@Override

public double y() {

return longitude;

}

}

@Entity(name = "City")

public static class City {

@Id

@GeneratedValue

private Long id;

private String name;

@Embedded

@Target( GPS.class )

private Coordinates coordinates;

//Getters and setters omitted for brevity

}

The coordinates embeddable type is mapped as the Coordinates interface. However, Hibernate needs to know the actual implementation tye, which is GPS in this case, hence the @Target annotation is used to provide this information.

Assuming we have persisted the following City entity:

*Example 103. @Target persist example*

doInJPA( this::entityManagerFactory, entityManager -> {

City cluj = new City();

cluj.setName( "Cluj" );

cluj.setCoordinates( new GPS( 46.77120, 23.62360 ) );

entityManager.persist( cluj );

} );

When fetching the City entity, the coordinates property is mapped by the @Target expression:

*Example 104. @Target fetching example*

doInJPA( this::entityManagerFactory, entityManager -> {

City cluj = entityManager.find( City.class, 1L );

assertEquals( 46.77120, cluj.getCoordinates().x(), 0.00001 );

assertEquals( 23.62360, cluj.getCoordinates().y(), 0.00001 );

} );

SELECT

c.id as id1\_0\_0\_,

c.latitude as latitude2\_0\_0\_,

c.longitude as longitud3\_0\_0\_,

c.name as name4\_0\_0\_

FROM

City c

WHERE

c.id = ?

-- binding parameter [1] as [BIGINT] - [1]

-- extracted value ([latitude2\_0\_0\_] : [DOUBLE]) - [46.7712]

-- extracted value ([longitud3\_0\_0\_] : [DOUBLE]) - [23.6236]

-- extracted value ([name4\_0\_0\_] : [VARCHAR]) - [Cluj]

Therefore, the @Target annotation is used to define a custom join association between the parent-child association.

#### 2.3.30. @Parent mapping

The Hibernate-specific @Parent annotation allows you to reference the owner entity from within an embeddable.

*Example 105. @Parent mapping usage*

@Embeddable

public static class GPS {

private double latitude;

private double longitude;

@Parent

private City city;

private GPS() {

}

public GPS(double latitude, double longitude) {

this.latitude = latitude;

this.longitude = longitude;

}

public double getLatitude() {

return latitude;

}

public double getLongitude() {

return longitude;

}

public City getCity() {

return city;

}

public void setCity(City city) {

this.city = city;

}

}

@Entity(name = "City")

public static class City {

@Id

@GeneratedValue

private Long id;

private String name;

@Embedded

@Target( GPS.class )

private GPS coordinates;

//Getters and setters omitted for brevity

}

Assuming we have persisted the following City entity:

*Example 106. @Parent persist example*

doInJPA( this::entityManagerFactory, entityManager -> {

City cluj = new City();

cluj.setName( "Cluj" );

cluj.setCoordinates( new GPS( 46.77120, 23.62360 ) );

entityManager.persist( cluj );

} );

When fetching the City entity, the city property of the embeddable type acts as a back reference to the owning parent entity:

*Example 107. @Parent fetching example*

doInJPA( this::entityManagerFactory, entityManager -> {

City cluj = entityManager.find( City.class, 1L );

assertSame( cluj, cluj.getCoordinates().getCity() );

} );

Therefore, the @Parent annotation is used to define the association between an embeddable type and the owning entity.

### 2.4. Embeddable types

Historically Hibernate called these components. JPA calls them embeddables. Either way the concept is the same: a composition of values.

For example we might have a Publisher class that is a composition of name and country, or a Location class that is a composition of country and city.

|  |  |
| --- | --- |
|  | *Usage of the word*embeddable  To avoid any confusion with the annotation that marks a given embeddable type, the annotation will be further referred as @Embeddable.  Throughout this chapter and thereafter, for brevity sake, embeddable types may also be referred as embeddable. |

*Example 108. Embeddable type example*

@Embeddable

public static class Publisher {

private String name;

private Location location;

public Publisher(String name, Location location) {

this.name = name;

this.location = location;

}

private Publisher() {}

//Getters and setters are omitted for brevity

}

@Embeddable

public static class Location {

private String country;

private String city;

public Location(String country, String city) {

this.country = country;

this.city = city;

}

private Location() {}

//Getters and setters are omitted for brevity

}

An embeddable type is another form of value type, and its lifecycle is bound to a parent entity type, therefore inheriting the attribute access from its parent (for details on attribute access, see [Access strategies](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#access-embeddable-types)).

Embeddable types can be made up of basic values as well as associations, with the caveat that, when used as collection elements, they cannot define collections themselves.

#### 2.4.1. Component / Embedded

Most often, embeddable types are used to group multiple basic type mappings and reuse them across several entities.

*Example 109. Simple Embeddedable*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

private Publisher publisher;

//Getters and setters are omitted for brevity

}

@Embeddable

public static class Publisher {

@Column(name = "publisher\_name")

private String name;

@Column(name = "publisher\_country")

private String country;

public Publisher(String name, String country) {

this.name = name;

this.country = country;

}

private Publisher() {}

//Getters and setters are omitted for brevity

}

create table Book (

id bigint not null,

author varchar(255),

publisher\_country varchar(255),

publisher\_name varchar(255),

title varchar(255),

primary key (id)

)

|  |  |
| --- | --- |
|  | JPA defines two terms for working with an embeddable type: @Embeddable and @Embedded.  @Embeddable is used to describe the mapping type itself (e.g. Publisher).  @Embedded is for referencing a given embeddable type (e.g. book#publisher). |

So, the embeddable type is represented by the Publisher class and the parent entity makes use of it through the book#publisher object composition.

The composed values are mapped to the same table as the parent table. Composition is part of good Object-oriented data modeling (idiomatic Java). In fact, that table could also be mapped by the following entity type instead.

*Example 110. Alternative to embeddable type composition*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

@Column(name = "publisher\_name")

private String publisherName;

@Column(name = "publisher\_country")

private String publisherCountry;

//Getters and setters are omitted for brevity

}

The composition form is certainly more Object-oriented, and that becomes more evident as we work with multiple embeddable types.

#### 2.4.2. Multiple embeddable types

Although from an object-oriented perspective, it’s much more convenient to work with embeddable types, this example doesn’t work as-is. When the same embeddable type is included multiple times in the same parent entity type, the JPA specification demands setting the associated column names explicitly.

This requirement is due to how object properties are mapped to database columns. By default, JPA expects a database column having the same name with its associated object property. When including multiple embeddables, the implicit name-based mapping rule doesn’t work anymore because multiple object properties could end-up being mapped to the same database column.

We have a few options to handle this issue.

#### 2.4.3. Overriding Embeddable types

JPA defines the @AttributeOverride annotation to handle this scenario. This way, the mapping conflict is resolved by setting up explicit name-based property-column type mappings.

If an Embeddabe type is used multiple times in some entity, you need to use the [@AttributeOverride](http://docs.oracle.com/javaee/7/api/javax/persistence/AttributeOverride.html) and[@AssociationOverride](http://docs.oracle.com/javaee/7/api/javax/persistence/AssociationOverride.html) annotations to override the default column names definied by the Embeddable.

Considering you have the following Publisher embeddable type which defines a @ManyToOne association with the Country entity:

*Example 111. Embeddable type with a @ManyToOne association*

@Embeddable

public static class Publisher {

private String name;

@ManyToOne(fetch = FetchType.LAZY)

private Country country;

public Publisher(String name, Country country) {

this.name = name;

this.country = country;

}

private Publisher() {}

//Getters and setters are omitted for brevity

}

@Entity(name = "Country")

public static class Country {

@Id

@GeneratedValue

private Long id;

@NaturalId

private String name;

//Getters and setters are omitted for brevity

}

create table Country (

id bigint not null,

name varchar(255),

primary key (id)

)

alter table Country

add constraint UK\_p1n05aafu73sbm3ggsxqeditd

unique (name)

Now, if you have a Book entity which declares two Publisher embeddable types for the ebook and paperback version, you cannot use the default Publisher embeddable mapping since there will be a conflict between the two embeddable column mappings.

Therefore, the Book entity needs to override the embeddable type mappings for each Publisher attribute:

*Example 112. Overriding embeddable type attributes*

@Entity(name = "Book")

@AttributeOverrides({

@AttributeOverride(

name = "ebookPublisher.name",

column = @Column(name = "ebook\_publisher\_name")

),

@AttributeOverride(

name = "paperBackPublisher.name",

column = @Column(name = "paper\_back\_publisher\_name")

)

})

@AssociationOverrides({

@AssociationOverride(

name = "ebookPublisher.country",

joinColumns = @JoinColumn(name = "ebook\_publisher\_country\_id")

),

@AssociationOverride(

name = "paperBackPublisher.country",

joinColumns = @JoinColumn(name = "paper\_back\_publisher\_country\_id")

)

})

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

private Publisher ebookPublisher;

private Publisher paperBackPublisher;

//Getters and setters are omitted for brevity

}

create table Book (

id bigint not null,

author varchar(255),

ebook\_publisher\_name varchar(255),

paper\_back\_publisher\_name varchar(255),

title varchar(255),

ebook\_publisher\_country\_id bigint,

paper\_back\_publisher\_country\_id bigint,

primary key (id)

)

alter table Book

add constraint FKm39ibh5jstybnslaoojkbac2g

foreign key (ebook\_publisher\_country\_id)

references Country

alter table Book

add constraint FK7kqy9da323p7jw7wvqgs6aek7

foreign key (paper\_back\_publisher\_country\_id)

references Country

#### 2.4.4. Embeddables and ImplicitNamingStrategy

|  |  |
| --- | --- |
|  | This is a Hibernate specific feature. Users concerned with JPA provider portability should instead prefer explicit column naming with @AttributeOverride. |

Hibernate naming strategies are covered in detail in [Naming](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naming). However, for the purposes of this discussion, Hibernate has the capability to interpret implicit column names in a way that is safe for use with multiple embeddable types.

*Example 113. Implicit multiple embeddable type mapping*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

private Publisher ebookPublisher;

private Publisher paperBackPublisher;

//Getters and setters are omitted for brevity

}

@Embeddable

public static class Publisher {

private String name;

@ManyToOne(fetch = FetchType.LAZY)

private Country country;

public Publisher(String name, Country country) {

this.name = name;

this.country = country;

}

private Publisher() {}

//Getters and setters are omitted for brevity

}

@Entity(name = "Country")

public static class Country {

@Id

@GeneratedValue

private Long id;

@NaturalId

private String name;

//Getters and setters are omitted for brevity

}

To make it work, you need to use the ImplicitNamingStrategyComponentPathImpl naming strategy.

*Example 114. Enabling implicit embeddable type mapping using the component path naming strategy*

metadataBuilder.applyImplicitNamingStrategy(

ImplicitNamingStrategyComponentPathImpl.INSTANCE

);

Now the "path" to attributes are used in the implicit column naming:

create table Book (

id bigint not null,

author varchar(255),

ebookPublisher\_name varchar(255),

paperBackPublisher\_name varchar(255),

title varchar(255),

ebookPublisher\_country\_id bigint,

paperBackPublisher\_country\_id bigint,

primary key (id)

)

You could even develop your own naming strategy to do other types of implicit naming strategies.

#### 2.4.5. Collections of embeddable types

Collections of embeddable types are specifically value collections (as embeddable types are a value type). Value collections are covered in detail in [Collections of value types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-value).

#### 2.4.6. Embeddable types as Map key

Embeddable types can also be used as Map keys. This topic is converted in detail in [Map - key](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map).

#### 2.4.7. Embeddable types as identifiers

Embeddable types can also be used as entity type identifiers. This usage is covered in detail in [Composite identifiers](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite).

|  |  |
| --- | --- |
|  | Embeddable types that are used as collection entries, map keys or entity type identifiers cannot include their own collection mappings. |

### 2.5. Entity types

|  |  |
| --- | --- |
|  | *Usage of the word*entity  The entity type describes the mapping between the actual persistable domain model object and a database table row. To avoid any confusion with the annotation that marks a given entity type, the annotation will be further referred as @Entity.  Throughout this chapter and thereafter, entity types will be simply referred as entity. |

#### 2.5.1. POJO Models

Section 2.1 The Entity Class of the JPA 2.1 specification defines its requirements for an entity class. Applications that wish to remain portable across JPA providers should adhere to these requirements.

* The entity class must be annotated with the javax.persistence.Entity annotation (or be denoted as such in XML mapping)
* The entity class must have a public or protected no-argument constructor. It may define additional constructors as well.
* The entity class must be a top-level class.
* An enum or interface may not be designated as an entity.
* The entity class must not be final. No methods or persistent instance variables of the entity class may be final.
* If an entity instance is to be used remotely as a detached object, the entity class must implement the Serializableinterface.
* Both abstract and concrete classes can be entities. Entities may extend non-entity classes as well as entity classes, and non-entity classes may extend entity classes.
* The persistent state of an entity is represented by instance variables, which may correspond to JavaBean-style properties. An instance variable must be directly accessed only from within the methods of the entity by the entity instance itself. The state of the entity is available to clients only through the entity’s accessor methods (getter/setter methods) or other business methods.

Hibernate, however, is not as strict in its requirements. The differences from the list above include:

* The entity class must have a no-argument constructor, which may be public, protected or package visibility. It may define additional constructors as well.
* The entity class need not be a top-level class.
* Technically Hibernate can persist final classes or classes with final persistent state accessor (getter/setter) methods. However, it is generally not a good idea as doing so will stop Hibernate from being able to generate proxies for lazy-loading the entity.
* Hibernate does not restrict the application developer from exposing instance variables and reference them from outside the entity class itself. The validity of such a paradigm, however, is debatable at best.

Let’s look at each requirement in detail.

#### 2.5.2. Prefer non-final classes

A central feature of Hibernate is the ability to load lazily certain entity instance variables (attributes) via runtime proxies. This feature depends upon the entity class being non-final or else implementing an interface that declares all the attribute getters/setters. You can still persist final classes that do not implement such an interface with Hibernate, but you will not be able to use proxies for fetching lazy associations, therefore limiting your options for performance tuning. For the very same reason, you should also avoid declaring persistent attribute getters and setters as final.

|  |  |
| --- | --- |
|  | Starting in 5.0 Hibernate offers a more robust version of bytecode enhancement as another means for handling lazy loading. Hibernate had some bytecode re-writing capabilities prior to 5.0 but they were very rudimentary. See the [BytecodeEnhancement](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#BytecodeEnhancement) for additional information on fetching and on bytecode enhancement. |

#### 2.5.3. Implement a no-argument constructor

The entity class should have a no-argument constructor. Both Hibernate and JPA require this.

JPA requires that this constructor be defined as public or protected. Hibernate, for the most part, does not care about the constructor visibility, as long as the system SecurityManager allows overriding the visibility setting. That said, the constructor should be defined with at least package visibility if you wish to leverage runtime proxy generation.

#### 2.5.4. Declare getters and setters for persistent attributes

The JPA specification requires this, otherwise the model would prevent accessing the entity persistent state fields directly from outside the entity itself.

Although Hibernate does not require it, it is recommended to follow the JavaBean conventions and define getters and setters for entity persistent attributes. Nevertheless, you can still tell Hibernate to directly access the entity fields.

Attributes (whether fields or getters/setters) need not be declared public. Hibernate can deal with attributes declared with public, protected, package or private visibility. Again, if wanting to use runtime proxy generation for lazy loading, the getter/setter should grant access to at least package visibility.

#### 2.5.5. Provide identifier attribute(s)

|  |  |
| --- | --- |
|  | Historically this was considered optional. However, not defining identifier attribute(s) on the entity should be considered a deprecated feature that will be removed in an upcoming release. |

The identifier attribute does not necessarily need to be mapped to the column(s) that physically define the primary key. However, it should map to column(s) that can uniquely identify each row.

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

The placement of the @Id annotation marks the [persistence state access strategy](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#access).

*Example 115. Identifier mapping*

@Id

private Long id;

Hibernate offers multiple identifier generation strategies, see the [Identifier Generators](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers) chapter for more about this topic.

#### 2.5.6. Mapping the entity

The main piece in mapping the entity is the javax.persistence.Entity annotation. The @Entity annotation defines just one attribute name which is used to give a specific entity name for use in JPQL queries. By default, the entity name represents the unqualified name of the entity class itself.

*Example 116. Simple @Entity mapping*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

An entity models a database table. The identifier uniquely identifies each row in that table. By default, the name of the table is assumed to be the same as the name of the entity. To explicitly give the name of the table or to specify other information about the table, we would use the javax.persistence.Table annotation.

*Example 117. Simple @Entity with @Table*

@Entity(name = "Book")

@Table(

catalog = "public",

schema = "store",

name = "book"

)

public static class Book {

@Id

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

#### 2.5.7. Implementing equals() and hashCode()

|  |  |
| --- | --- |
|  | Much of the discussion in this section deals with the relation of an entity to a Hibernate Session, whether the entity is managed, transient or detached. If you are unfamiliar with these topics, they are explained in the [Persistence Context](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc) chapter. |

Whether to implement equals() and hashCode() methods in your domain model, let alone how to implement them, is a surprisingly tricky discussion when it comes to ORM.

There is really just one absolute case: a class that acts as an identifier must implement equals/hashCode based on the id value(s). Generally, this is pertinent for user-defined classes used as composite identifiers. Beyond this one very specific use case and few others we will discuss below, you may want to consider not implementing equals/hashCode altogether.

So what’s all the fuss? Normally, most Java objects provide a built-in equals() and hashCode() based on the object’s identity, so each new object will be different from all others. This is generally what you want in ordinary Java programming. Conceptually however this starts to break down when you start to think about the possibility of multiple instances of a class representing the same data.

This is, in fact, exactly the case when dealing with data coming from a database. Every time we load a specific Personfrom the database we would naturally get a unique instance. Hibernate, however, works hard to make sure that does not happen within a given Session. In fact, Hibernate guarantees equivalence of persistent identity (database row) and Java identity inside a particular session scope. So if we ask a Hibernate Session to load that specific Person multiple times we will actually get back the same instance:

*Example 118. Scope of identity*

Book book1 = entityManager.find( Book.class, 1L );

Book book2 = entityManager.find( Book.class, 1L );

assertTrue( book1 == book2 );

Consider we have a Library parent entity which contains a java.util.Set of Book entities:

Library entity mapping

@Entity(name = "Library")

public static class Library {

@Id

private Long id;

private String name;

@OneToMany(cascade = CascadeType.ALL)

@JoinColumn(name = "book\_id")

private Set<Book> books = new HashSet<>();

//Getters and setters are omitted for brevity

}

*Example 119. Set usage with Session-scoped identity*

Library library = entityManager.find( Library.class, 1L );

Book book1 = entityManager.find( Book.class, 1L );

Book book2 = entityManager.find( Book.class, 1L );

library.getBooks().add( book1 );

library.getBooks().add( book2 );

assertEquals( 1, library.getBooks().size() );

However, the semantic changes when we mix instances loaded from different Sessions:

*Example 120. Mixed Sessions*

Book book1 = doInJPA( this::entityManagerFactory, entityManager -> {

return entityManager.find( Book.class, 1L );

} );

Book book2 = doInJPA( this::entityManagerFactory, entityManager -> {

return entityManager.find( Book.class, 1L );

} );

assertFalse( book1 == book2 );

doInJPA( this::entityManagerFactory, entityManager -> {

Set<Book> books = new HashSet<>();

books.add( book1 );

books.add( book2 );

assertEquals( 2, books.size() );

} );

Specifically the outcome in this last example will depend on whether the Book class implemented equals/hashCode, and, if so, how.

If the Book class did not override the default equals/hashCode, then the two Book object reference are not going to be equal since their references are different.

Consider yet another case:

*Example 121. Sets with transient entities*

Library library = entityManager.find( Library.class, 1L );

Book book1 = new Book();

book1.setId( 100L );

book1.setTitle( "High-Performance Java Persistence" );

Book book2 = new Book();

book2.setId( 101L );

book2.setTitle( "Java Persistence with Hibernate" );

library.getBooks().add( book1 );

library.getBooks().add( book2 );

assertEquals( 2, library.getBooks().size() );

In cases where you will be dealing with entities outside of a Session (whether they be transient or detached), especially in cases where you will be using them in Java collections, you should consider implementing equals/hashCode.

A common initial approach is to use the entity’s identifier attribute as the basis for equals/hashCode calculations:

*Example 122. Naive equals/hashCode implementation*

@Entity(name = "Library")

public static class Library {

@Id

private Long id;

private String name;

@OneToMany(cascade = CascadeType.ALL)

@JoinColumn(name = "book\_id")

private Set<Book> books = new HashSet<>();

//Getters and setters are omitted for brevity

}

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Book book = (Book) o;

return Objects.equals( id, book.id );

}

@Override

public int hashCode() {

return Objects.hash( id );

}

}

It turns out that this still breaks when adding transient instance of Book to a set as we saw in the last example:

*Example 123. Auto-generated identifiers with Sets and naive equals/hashCode*

Book book1 = new Book();

book1.setTitle( "High-Performance Java Persistence" );

Book book2 = new Book();

book2.setTitle( "Java Persistence with Hibernate" );

Library library = doInJPA( this::entityManagerFactory, entityManager -> {

Library \_library = entityManager.find( Library.class, 1L );

\_library.getBooks().add( book1 );

\_library.getBooks().add( book2 );

return \_library;

} );

assertFalse( library.getBooks().contains( book1 ) );

assertFalse( library.getBooks().contains( book2 ) );

The issue here is a conflict between the use of generated identifier, the contract of Set and the equals/hashCode implementations. Set says that the equals/hashCode value for an object should not change while the object is part of the Set. But that is exactly what happened here because the equals/hasCode are based on the (generated) id, which was not set until the JPA transaction is committed.

Note that this is just a concern when using generated identifiers. If you are using assigned identifiers this will not be a problem, assuming the identifier value is assigned prior to adding to the Set.

Another option is to force the identifier to be generated and set prior to adding to the Set:

*Example 124. Forcing the flush before adding to the Set*

Book book1 = new Book();

book1.setTitle( "High-Performance Java Persistence" );

Book book2 = new Book();

book2.setTitle( "Java Persistence with Hibernate" );

Library library = doInJPA( this::entityManagerFactory, entityManager -> {

Library \_library = entityManager.find( Library.class, 1L );

entityManager.persist( book1 );

entityManager.persist( book2 );

entityManager.flush();

\_library.getBooks().add( book1 );

\_library.getBooks().add( book2 );

return \_library;

} );

assertTrue( library.getBooks().contains( book1 ) );

assertTrue( library.getBooks().contains( book2 ) );

But this is often not feasible.

The final approach is to use a "better" equals/hashCode implementation, making use of a natural-id or business-key.

*Example 125. Natural Id equals/hashCode*

@Entity(name = "Library")

public static class Library {

@Id

private Long id;

private String name;

@OneToMany(cascade = CascadeType.ALL)

@JoinColumn(name = "book\_id")

private Set<Book> books = new HashSet<>();

//Getters and setters are omitted for brevity

}

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

@NaturalId

private String isbn;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Book book = (Book) o;

return Objects.equals( isbn, book.isbn );

}

@Override

public int hashCode() {

return Objects.hash( isbn );

}

}

This time, when adding a Book to the Library Set, you can retrieve the Book even after it’s being persisted:

*Example 126. Natural Id equals/hashCode persist example*

Book book1 = new Book();

book1.setTitle( "High-Performance Java Persistence" );

book1.setIsbn( "978-9730228236" );

Library library = doInJPA( this::entityManagerFactory, entityManager -> {

Library \_library = entityManager.find( Library.class, 1L );

\_library.getBooks().add( book1 );

return \_library;

} );

assertTrue( library.getBooks().contains( book1 ) );

As you can see the question of equals/hashCode is not trivial, nor is there a one-size-fits-all solution.

|  |  |
| --- | --- |
|  | Although using a natural-id is best for equals and hashCode, sometimes you only have the entity identifier that provides a unique constraint.  It’s possible to use the entity identifier for equality check, but it needs a workaround:   * you need to provide a constant value for hashCode so that the hash code value does not change before and after the entity is flushed. * you need to compare the entity identifier equality only for non-transient entities. |

For details on mapping the identifier, see the [Identifiers](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers) chapter.

#### 2.5.8. Mapping the entity to a SQL query

You can map an entity to a SQL query using the [@Subselect](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Subselect.html) annotation.

*Example 127. @Subselect entity mapping*

@Entity(name = "Client")

@Table(name = "client")

public static class Client {

@Id

private Long id;

@Column(name = "first\_name")

private String firstName;

@Column(name = "last\_name")

private String lastName;

//Getters and setters omitted for brevity

}

@Entity(name = "Account")

@Table(name = "account")

public static class Account {

@Id

private Long id;

@ManyToOne

private Client client;

private String description;

//Getters and setters omitted for brevity

}

@Entity(name = "AccountTransaction")

@Table(name = "account\_transaction")

public static class AccountTransaction {

@Id

@GeneratedValue

private Long id;

@ManyToOne

private Account account;

private Integer cents;

private String description;

//Getters and setters omitted for brevity

}

@Entity(name = "AccountSummary")

@Subselect(

"select " +

" a.id as id, " +

" concat(concat(c.first\_name, ' '), c.last\_name) as clientName, " +

" sum(at.cents) as balance " +

"from account a " +

"join client c on c.id = a.client\_id " +

"join account\_transaction at on a.id = at.account\_id " +

"group by a.id, concat(concat(c.first\_name, ' '), c.last\_name)"

)

@Synchronize( {"client", "account", "account\_transaction"} )

public static class AccountSummary {

@Id

private Long id;

private String clientName;

private int balance;

//Getters and setters omitted for brevity

}

In the example above, the Account entity does not retain any balance since every account operation is registered as an AccountTransaction. To find the Account balance, we need to query the AccountSummary which shares the same identifier with the Account entity.

However, the AccountSummary is not mapped to a physical table, but to an SQL query.

So, if we have the following AccountTransaction record, the AccountSummary balance will mach the proper amount of money in this Account.

*Example 128. Finding a @Subselect entity*

doInJPA( this::entityManagerFactory, entityManager -> {

Client client = new Client();

client.setId( 1L );

client.setFirstName( "John" );

client.setLastName( "Doe" );

entityManager.persist( client );

Account account = new Account();

account.setId( 1L );

account.setClient( client );

account.setDescription( "Checking account" );

entityManager.persist( account );

AccountTransaction transaction = new AccountTransaction();

transaction.setAccount( account );

transaction.setDescription( "Salary" );

transaction.setCents( 100 \* 7000 );

entityManager.persist( transaction );

AccountSummary summary = entityManager.createQuery(

"select s " +

"from AccountSummary s " +

"where s.id = :id", AccountSummary.class)

.setParameter( "id", account.getId() )

.getSingleResult();

assertEquals( "John Doe", summary.getClientName() );

assertEquals( 100 \* 7000, summary.getBalance() );

} );

If we add a new AccountTransaction entity and refresh the AccountSummary entity, the balance is updated accordingly:

*Example 129. Refreshing a @Subselect entity*

doInJPA( this::entityManagerFactory, entityManager -> {

AccountSummary summary = entityManager.find( AccountSummary.class, 1L );

assertEquals( "John Doe", summary.getClientName() );

assertEquals( 100 \* 7000, summary.getBalance() );

AccountTransaction transaction = new AccountTransaction();

transaction.setAccount( entityManager.getReference( Account.class, 1L ) );

transaction.setDescription( "Shopping" );

transaction.setCents( -100 \* 2200 );

entityManager.persist( transaction );

entityManager.flush();

entityManager.refresh( summary );

assertEquals( 100 \* 4800, summary.getBalance() );

} );

The goal of the @Synchronize annotation in the AccountSummary entity mapping is to instruct Hibernate which database tables are needed by the underlying @Subselect SQL query. This way, when executing a HQL or JPQL which selects from the AccountSummary entity, Hibernate will trigger a Persistence Context flush if there are pending Account, Client or AccountTransaction entity state transitions.

#### 2.5.9. Define a custom entity proxy

By default, when it needs to use a proxy instead of the actual Pojo, Hibernate is going to use a Bytecode manipulation library like [Javassist](http://jboss-javassist.github.io/javassist/) or [Byte Buddy](http://bytebuddy.net/).

However, if the entity class is final, Javassist will not create a Proxy and you will get a Pojo even when you only need a Proxy reference. In this case, you could proxy an interface that this particular entity implements, as illustrated by the following example.

*Example 130. Final entity class implementing the Identifiable interface*

public interface Identifiable {

Long getId();

void setId(Long id);

}

@Entity( name = "Book" )

@Proxy(proxyClass = Identifiable.class)

public static final class Book implements Identifiable {

@Id

private Long id;

private String title;

private String author;

@Override

public Long getId() {

return id;

}

@Override

public void setId(Long id) {

this.id = id;

}

//Other getters and setters omitted for brevity

}

The [@Proxy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Proxy.html) annotation is used to specify a custom Proxy implementation for the current annotated entity.

When loading the Book entity proxy, Hibernate is going to proxy the Identifiable interface instead as illustarted by the following example:

*Example 131. Proxying the final entity class implementing the Identifiable interface*

doInHibernate( this::sessionFactory, session -> {

Book book = new Book();

book.setId( 1L );

book.setTitle( "High-Performance Java Persistence" );

book.setAuthor( "Vlad Mihalcea" );

session.persist( book );

} );

doInHibernate( this::sessionFactory, session -> {

Identifiable book = session.getReference( Book.class, 1L );

assertTrue(

"Loaded entity is not an instance of the proxy interface",

Identifiable.class.isInstance( book )

);

assertFalse(

"Proxy class was not created",

Book.class.isInstance( book )

);

} );

into

Book

(author, title, id)

values

(?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Vlad Mihalcea]

-- binding parameter [2] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [3] as [BIGINT] - [1]

As you can see in the associated SQL snippet, Hibernate issues no SQL SELECT query since the Proxy can be constructed without needing to fetch the actual entity Pojo.

#### 2.5.10. Dynamic entity proxies using the @Tuplizer annotation

It is possible to map your entities as dynamic proxies using the [@Tuplizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Tuplizer.html) annotation.

In the following entity mapping, both the embeddable and the entity are mapped as interfaces, not Pojos.

*Example 132. Dynamic entity proxy mapping*

@Entity

@Tuplizer(impl = DynamicEntityTuplizer.class)

public interface Cuisine {

@Id

@GeneratedValue

Long getId();

void setId(Long id);

String getName();

void setName(String name);

@Tuplizer(impl = DynamicEmbeddableTuplizer.class)

Country getCountry();

void setCountry(Country country);

}

@Embeddable

public interface Country {

@Column(name = "CountryName")

String getName();

void setName(String name);

}

The @Tuplizer instructs Hibernate to use the DynamicEntityTuplizer and DynamicEmbeddableTuplizer to handle the associated entity and embeddable object types.

Both the Cuising entity and the Country embeddable types are going to be instantiated as Java dynamic proxies, as you can see in the following DynamicInstantiator example:

*Example 133. Instantiating entities and embeddables as dynamic proxies*

public class DynamicEntityTuplizer extends PojoEntityTuplizer {

public DynamicEntityTuplizer(

EntityMetamodel entityMetamodel,

PersistentClass mappedEntity) {

super( entityMetamodel, mappedEntity );

}

@Override

protected Instantiator buildInstantiator(

EntityMetamodel entityMetamodel,

PersistentClass persistentClass) {

return new DynamicInstantiator(

persistentClass.getClassName()

);

}

@Override

protected ProxyFactory buildProxyFactory(

PersistentClass persistentClass,

Getter idGetter,

Setter idSetter) {

return super.buildProxyFactory(

persistentClass, idGetter,

idSetter

);

}

}

public class DynamicEmbeddableTuplizer

extends PojoComponentTuplizer {

public DynamicEmbeddableTuplizer(Component embeddable) {

super( embeddable );

}

protected Instantiator buildInstantiator(Component embeddable) {

return new DynamicInstantiator(

embeddable.getComponentClassName()

);

}

}

public class DynamicInstantiator

implements Instantiator {

private final Class targetClass;

public DynamicInstantiator(String targetClassName) {

try {

this.targetClass = Class.forName( targetClassName );

}

catch (ClassNotFoundException e) {

throw new HibernateException( e );

}

}

public Object instantiate(Serializable id) {

return ProxyHelper.newProxy( targetClass, id );

}

public Object instantiate() {

return instantiate( null );

}

public boolean isInstance(Object object) {

try {

return targetClass.isInstance( object );

}

catch( Throwable t ) {

throw new HibernateException(

"could not get handle to entity as interface : " + t

);

}

}

}

public class ProxyHelper {

public static <T> T newProxy(Class<T> targetClass, Serializable id) {

return ( T ) Proxy.newProxyInstance(

targetClass.getClassLoader(),

new Class[] {

targetClass

},

new DataProxyHandler(

targetClass.getName(),

id

)

);

}

public static String extractEntityName(Object object) {

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;

}

}

public final class DataProxyHandler implements InvocationHandler {

private String entityName;

private Map<String, Object> 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 this.hashCode();

}

return null;

}

public String getEntityName() {

return entityName;

}

}

With the DynamicInstantiator in place, we can work with the dynamic proxy entities just like with Pojo entities.

*Example 134. Persisting entities and embeddables as dynamic proxies*

Cuisine \_cuisine = doInHibernateSessionBuilder(

() -> sessionFactory()

.withOptions()

.interceptor( new EntityNameInterceptor() ),

session -> {

Cuisine cuisine = ProxyHelper.newProxy( Cuisine.class, null );

cuisine.setName( "Française" );

Country country = ProxyHelper.newProxy( Country.class, null );

country.setName( "France" );

cuisine.setCountry( country );

session.persist( cuisine );

return cuisine;

} );

doInHibernateSessionBuilder(

() -> sessionFactory()

.withOptions()

.interceptor( new EntityNameInterceptor() ),

session -> {

Cuisine cuisine = session.get( Cuisine.class, \_cuisine.getId() );

assertEquals( "Française", cuisine.getName() );

assertEquals( "France", cuisine.getCountry().getName() );

} );

#### 2.5.11. Define a custom entity persister

The [@Persister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Persister.html) annotation is used to specify a custom entity or collection persister.

For entities, the custom persister must implement the [EntityPersister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/entity/EntityPersister.html) interface.

For collections, the custom persister must implement the [CollectionPersister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/collection/CollectionPersister.html) interface.

*Example 135. Entity persister mapping*

@Entity

@Persister( impl = EntityPersister.class )

public class Author {

@Id

public Integer id;

@OneToMany( mappedBy = "author" )

@Persister( impl = CollectionPersister.class )

public Set<Book> books = new HashSet<>();

//Getters and setters omitted for brevity

public void addBook(Book book) {

this.books.add( book );

book.setAuthor( this );

}

}

@Entity

@Persister( impl = EntityPersister.class )

public class Book {

@Id

public Integer id;

private String title;

@ManyToOne(fetch = FetchType.LAZY)

public Author author;

//Getters and setters omitted for brevity

}

By providing you own EntityPersister and CollectionPersister implementations, you can control how entities and collections are persisted in to the database.

#### 2.5.12. Access strategies

As a JPA provider, Hibernate can introspect both the entity attributes (instance fields) or the accessors (instance properties). By default, the placement of the @Id annotation gives the default access strategy. When placed on a field, Hibernate will assume field-based access. Place on the identifier getter, Hibernate will use property-based access.

|  |  |
| --- | --- |
|  | You should pay attention to [Java Beans specification](https://docs.oracle.com/javase/7/docs/api/java/beans/Introspector.html#decapitalize(java.lang.String)) in regard to naming properties to avoid issues such as [Property name beginning with at least two uppercase characters has odd functionality in HQL](https://hibernate.atlassian.net/browse/HCANN-63)! |

Embeddable types inherit the access strategy from their parent entities.

##### Field-based access

*Example 136. Field-based access*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

When using field-based access, adding other entity-level methods is much more flexible because Hibernate won’t consider those part of the persistence state. To exclude a field from being part of the entity persistent state, the field must be marked with the @Transient annotation.

|  |  |
| --- | --- |
|  | Another advantage of using field-based access is that some entity attributes can be hidden from outside the entity. An example of such attribute is the entity @Version field, which, usually, does not need to be manipulated by the data access layer. With field-based access, we can simply omit the getter and the setter for this version field, and Hibernate can still leverage the optimistic concurrency control mechanism. |

##### Property-based access

*Example 137. Property-based access*

@Entity(name = "Book")

public static class Book {

private Long id;

private String title;

private String author;

@Id

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

public String getAuthor() {

return author;

}

public void setAuthor(String author) {

this.author = author;

}

}

When using property-based access, Hibernate uses the accessors for both reading and writing the entity state. Every other method that will be added to the entity (e.g. helper methods for synchronizing both ends of a bidirectional one-to-many association) will have to be marked with the @Transient annotation.

##### Overriding the default access strategy

The default access strategy mechanism can be overridden with the JPA @Access annotation. In the following example, the @Version attribute is accessed by its field and not by its getter, like the rest of entity attributes.

*Example 138. Overriding access strategy*

@Entity(name = "Book")

public static class Book {

private Long id;

private String title;

private String author;

@Access( AccessType.FIELD )

@Version

private int version;

@Id

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

public String getAuthor() {

return author;

}

public void setAuthor(String author) {

this.author = author;

}

}

##### Embeddable types and access strategy

Because embeddables are managed by their owning entities, the access strategy is therefore inherited from the entity too. This applies to both simple embeddable types as well as for collection of embeddables.

The embeddable types can overrule the default implicit access strategy (inherited from the owning entity). In the following example, the embeddable uses property-based access, no matter what access strategy the owning entity is choosing:

*Example 139. Embeddable with exclusive access strategy*

@Embeddable

@Access( AccessType.PROPERTY )

public static class Author {

private String firstName;

private String lastName;

public Author() {

}

public Author(String firstName, String lastName) {

this.firstName = firstName;

this.lastName = lastName;

}

public String getFirstName() {

return firstName;

}

public void setFirstName(String firstName) {

this.firstName = firstName;

}

public String getLastName() {

return lastName;

}

public void setLastName(String lastName) {

this.lastName = lastName;

}

}

The owning entity can use field-based access while the embeddable uses property-based access as it has chosen explicitly:

*Example 140. Entity including a single embeddable type*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

@Embedded

private Author author;

//Getters and setters are omitted for brevity

}

This works also for collection of embeddable types:

*Example 141. Entity including a collection of embeddable types*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

@ElementCollection

@CollectionTable(

name = "book\_author",

joinColumns = @JoinColumn(name = "book\_id")

)

private List<Author> authors = new ArrayList<>();

//Getters and setters are omitted for brevity

}

### 2.6. Identifiers

Identifiers model the primary key of an entity. They are used to uniquely identify each specific entity.

Hibernate and JPA both make the following assumptions about the corresponding database column(s):

UNIQUE

The values must uniquely identify each row.

NOT NULL

The values cannot be null. For composite ids, no part can be null.

IMMUTABLE

The values, once inserted, can never be changed. This is more a general guide, than a hard-fast rule as opinions vary. JPA defines the behavior of changing the value of the identifier attribute to be undefined; Hibernate simply does not support that. In cases where the values for the PK you have chosen will be updated, Hibernate recommends mapping the mutable value as a natural id, and use a surrogate id for the PK. See [Natural Ids](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid).

|  |  |
| --- | --- |
|  | Technically the identifier does not have to map to the column(s) physically defined as the table primary key. They just need to map to column(s) that uniquely identify each row. However this documentation will continue to use the terms identifier and primary key interchangeably. |

Every entity must define an identifier. For entity inheritance hierarchies, the identifier must be defined just on the entity that is the root of the hierarchy.

An identifier might be simple (single value) or composite (multiple values).

#### 2.6.1. Simple identifiers

Simple identifiers map to a single basic attribute, and are denoted using the javax.persistence.Id annotation.

According to JPA only the following types should be used as identifier attribute types:

* any Java primitive type
* any primitive wrapper type
* java.lang.String
* java.util.Date (TemporalType#DATE)
* java.sql.Date
* java.math.BigDecimal
* java.math.BigInteger

Any types used for identifier attributes beyond this list will not be portable.

##### Assigned identifiers

Values for simple identifiers can be assigned, as we have seen in the examples above. The expectation for assigned identifier values is that the application assigns (sets them on the entity attribute) prior to calling save/persist.

*Example 142. Simple assigned entity identifier*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

##### Generated identifiers

Values for simple identifiers can be generated. To denote that an identifier attribute is generated, it is annotated with javax.persistence.GeneratedValue

*Example 143. Simple generated identifier*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

Additionally, to the type restriction list above, JPA says that if using generated identifier values (see below) only integer types (short, int, long) will be portably supported.

The expectation for generated identifier values is that Hibernate will generate the value when the save/persist occurs.

Identifier value generations strategies are discussed in detail in the [Generated identifier values](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators) section.

#### 2.6.2. Composite identifiers

Composite identifiers correspond to one or more persistent attributes. Here are the rules governing composite identifiers, as defined by the JPA specification.

* The composite identifier must be represented by a "primary key class". The primary key class may be defined using the javax.persistence.EmbeddedId annotation (see [Composite identifiers with @EmbeddedId](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite-aggregated)), or defined using the javax.persistence.IdClass annotation (see [Composite identifiers with @IdClass](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite-nonaggregated)).
* The primary key class must be public and must have a public no-arg constructor.
* The primary key class must be serializable.
* The primary key class must define equals and hashCode methods, consistent with equality for the underlying database types to which the primary key is mapped.

|  |  |
| --- | --- |
|  | The restriction that a composite identifier has to be represented by a "primary key class" is only JPA specific. Hibernate does allow composite identifiers to be defined without a "primary key class", although that modeling technique is deprecated and therefore omitted from this discussion. |

The attributes making up the composition can be either basic, composite, ManyToOne. Note especially that collections and one-to-ones are never appropriate.

#### 2.6.3. Composite identifiers with @EmbeddedId

Modeling a composite identifier using an EmbeddedId simply means defining an embeddable to be a composition for the one or more attributes making up the identifier, and then exposing an attribute of that embeddable type on the entity.

*Example 144. Basic @EmbeddedId*

@Entity(name = "SystemUser")

public static class SystemUser {

@EmbeddedId

private PK pk;

private String name;

//Getters and setters are omitted for brevity

}

@Embeddable

public static class PK implements Serializable {

private String subsystem;

private String username;

public PK(String subsystem, String username) {

this.subsystem = subsystem;

this.username = username;

}

private PK() {

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

PK pk = (PK) o;

return Objects.equals( subsystem, pk.subsystem ) &&

Objects.equals( username, pk.username );

}

@Override

public int hashCode() {

return Objects.hash( subsystem, username );

}

}

As mentioned before, EmbeddedIds can even contain @ManyToOne attributes.

*Example 145. @EmbeddedId with @ManyToOne*

@Entity(name = "SystemUser")

public static class SystemUser {

@EmbeddedId

private PK pk;

private String name;

//Getters and setters are omitted for brevity

}

@Entity(name = "Subsystem")

public static class Subsystem {

@Id

private String id;

private String description;

//Getters and setters are omitted for brevity

}

@Embeddable

public static class PK implements Serializable {

@ManyToOne(fetch = FetchType.LAZY)

private Subsystem subsystem;

private String username;

public PK(Subsystem subsystem, String username) {

this.subsystem = subsystem;

this.username = username;

}

private PK() {

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

PK pk = (PK) o;

return Objects.equals( subsystem, pk.subsystem ) &&

Objects.equals( username, pk.username );

}

@Override

public int hashCode() {

return Objects.hash( subsystem, username );

}

}

|  |  |
| --- | --- |
|  | Hibernate supports directly modeling the ManyToOne in the PK class, whether @EmbeddedId or @IdClass.  However, that is not portably supported by the JPA specification. In JPA terms one would use "derived identifiers"; for details, see [Derived Identifiers](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-derived). |

#### 2.6.4. Composite identifiers with @IdClass

Modeling a composite identifier using an IdClass differs from using an EmbeddedId in that the entity defines each individual attribute making up the composition. The IdClass simply acts as a "shadow".

*Example 146. Basic @IdClass*

@Entity(name = "SystemUser")

@IdClass( PK.class )

public static class SystemUser {

@Id

private String subsystem;

@Id

private String username;

private String name;

public PK getId() {

return new PK(

subsystem,

username

);

}

public void setId(PK id) {

this.subsystem = id.getSubsystem();

this.username = id.getUsername();

}

//Getters and setters are omitted for brevity

}

public static class PK implements Serializable {

private String subsystem;

private String username;

public PK(String subsystem, String username) {

this.subsystem = subsystem;

this.username = username;

}

private PK() {

}

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

PK pk = (PK) o;

return Objects.equals( subsystem, pk.subsystem ) &&

Objects.equals( username, pk.username );

}

@Override

public int hashCode() {

return Objects.hash( subsystem, username );

}

}

Non-aggregated composite identifiers can also contain ManyToOne attributes as we saw with aggregated ones (still non-portably).

*Example 147. IdClass with @ManyToOne*

@Entity(name = "SystemUser")

@IdClass( PK.class )

public static class SystemUser {

@Id

@ManyToOne(fetch = FetchType.LAZY)

private Subsystem subsystem;

@Id

private String username;

private String name;

//Getters and setters are omitted for brevity

}

@Entity(name = "Subsystem")

public static class Subsystem {

@Id

private String id;

private String description;

//Getters and setters are omitted for brevity

}

public static class PK implements Serializable {

private Subsystem subsystem;

private String username;

public PK(Subsystem subsystem, String username) {

this.subsystem = subsystem;

this.username = username;

}

private PK() {

}

//Getters and setters are omitted for brevity

}

With non-aggregated composite identifiers, Hibernate also supports "partial" generation of the composite values.

*Example 148. @IdClass with partial identifier generation using @GeneratedValue*

@Entity(name = "SystemUser")

@IdClass( PK.class )

public static class SystemUser {

@Id

private String subsystem;

@Id

private String username;

@Id

@GeneratedValue

private Integer registrationId;

private String name;

public PK getId() {

return new PK(

subsystem,

username,

registrationId

);

}

public void setId(PK id) {

this.subsystem = id.getSubsystem();

this.username = id.getUsername();

this.registrationId = id.getRegistrationId();

}

//Getters and setters are omitted for brevity

}

public static class PK implements Serializable {

private String subsystem;

private String username;

private Integer registrationId;

public PK(String subsystem, String username) {

this.subsystem = subsystem;

this.username = username;

}

public PK(String subsystem, String username, Integer registrationId) {

this.subsystem = subsystem;

this.username = username;

this.registrationId = registrationId;

}

private PK() {

}

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

PK pk = (PK) o;

return Objects.equals( subsystem, pk.subsystem ) &&

Objects.equals( username, pk.username ) &&

Objects.equals( registrationId, pk.registrationId );

}

@Override

public int hashCode() {

return Objects.hash( subsystem, username, registrationId );

}

}

|  |  |
| --- | --- |
|  | This feature exists because of a highly questionable interpretation of the JPA specification made by the SpecJ committee.  Hibernate does not feel that JPA defines support for this, but added the feature simply to be usable in SpecJ benchmarks. Use of this feature may or may not be portable from a JPA perspective. |

#### 2.6.5. Composite identifiers with associations

Hibernate allows defining a composite identifier out of entity associations. In the following example, the PersonAddressentity identifier is formed of two @ManyToOne associations.

*Example 149. Composite identifiers with associations*

@Entity(name = "Book")

public static class Book implements Serializable {

@Id

@ManyToOne(fetch = FetchType.LAZY)

private Author author;

@Id

@ManyToOne(fetch = FetchType.LAZY)

private Publisher publisher;

@Id

private String title;

public Book(Author author, Publisher publisher, String title) {

this.author = author;

this.publisher = publisher;

this.title = title;

}

private Book() {

}

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Book book = (Book) o;

return Objects.equals( author, book.author ) &&

Objects.equals( publisher, book.publisher ) &&

Objects.equals( title, book.title );

}

@Override

public int hashCode() {

return Objects.hash( author, publisher, title );

}

}

@Entity(name = "Author")

public static class Author implements Serializable {

@Id

private String name;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Author author = (Author) o;

return Objects.equals( name, author.name );

}

@Override

public int hashCode() {

return Objects.hash( name );

}

}

@Entity(name = "Publisher")

public static class Publisher implements Serializable {

@Id

private String name;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Publisher publisher = (Publisher) o;

return Objects.equals( name, publisher.name );

}

@Override

public int hashCode() {

return Objects.hash( name );

}

}

Although the mapping is much simpler than using an @EmbeddedId or an @IdClass, there’s no separation between the entity instance and the actual identifier. To query this entity, an instance of the entity itself must be supplied to the persistence context.

*Example 150. Fetchcing with composite identifiers*

Book book = entityManager.find( Book.class, new Book(

author,

publisher,

"High-Performance Java Persistence"

) );

assertEquals( "Vlad Mihalcea", book.getAuthor().getName() );

#### 2.6.6. Generated identifier values

|  |  |
| --- | --- |
|  | For discussion of generated values for non-identifier attributes, see [Generated properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated). |

Hibernate supports identifier value generation across a number of different types. Remember that JPA portably defines identifier value generation just for integer types.

Identifier value generation is indicates using the javax.persistence.GeneratedValue annotation. The most important piece of information here is the specified javax.persistence.GenerationType which indicates how values will be generated.

|  |  |
| --- | --- |
|  | The discussions below assume that the application is using Hibernate’s "new generator mappings" as indicated by the hibernate.id.new\_generator\_mappings setting orMetadataBuilder.enableNewIdentifierGeneratorSupport method during bootstrap. Starting with Hibernate 5, this is set to true by default. If applications set this to false the resolutions discussed here will be very different. The rest of the discussion here assumes this setting is enabled (true). |

AUTO (the default)

Indicates that the persistence provider (Hibernate) should choose an appropriate generation strategy. See [Interpreting AUTO](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-auto).

IDENTITY

Indicates that database IDENTITY columns will be used for primary key value generation. See [Using IDENTITY columns](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-identity).

SEQUENCE

Indicates that database sequence should be used for obtaining primary key values. See [Using sequences](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-sequence).

TABLE

Indicates that a database table should be used for obtaining primary key values. See [Using table identifier generator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-table).

#### 2.6.7. Interpreting AUTO

How a persistence provider interprets the AUTO generation type is left up to the provider.

The default behavior is to look at the java type of the identifier attribute.

If the identifier type is UUID, Hibernate is going to use an [UUID identifier](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-uuid).

If the identifier type is numerical (e.g. Long, Integer), then Hibernate is going to use the IdGeneratorStrategyInterpreter to resolve the identifier generator strategy. The IdGeneratorStrategyInterpreter has two implementations:

FallbackInterpreter

This is the default strategy since Hibernate 5.0. For older versions, this strategy is enabled through the [hibernate.id.new\_generator\_mappings](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#configurations-mapping) configuration property . When using this strategy, AUTO always resolves to SequenceStyleGenerator. If the underlying database supports sequences, then a SEQUENCE generator is used. Otherwise, a TABLE generator is going to be used instead.

LegacyFallbackInterpreter

This is a legacy mechanism that was used by Hibernate prior to version 5.0 or when the [hibernate.id.new\_generator\_mappings](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#configurations-mapping) configuration property is false. The legacy strategy maps AUTO to the native generator strategy which uses the [Dialect#getNativeIdentifierGeneratorStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/dialect/Dialect.html#getNativeIdentifierGeneratorStrategy--) to resolve the actual identifier generator (e.g. identity or sequence).

#### 2.6.8. Using sequences

For implementing database sequence-based identifier value generation Hibernate makes use of its org.hibernate.id.enhanced.SequenceStyleGenerator id generator. It is important to note that SequenceStyleGenerator is capable of working against databases that do not support sequences by switching to a table as the underlying backing. This gives Hibernate a huge degree of portability across databases while still maintaining consistent id generation behavior (versus say choosing between SEQUENCE and IDENTITY). This backing storage is completely transparent to the user.

The preferred (and portable) way to configure this generator is using the JPA-defined javax.persistence.SequenceGenerator annotation.

The simplest form is to simply request sequence generation; Hibernate will use a single, implicitly-named sequence (hibernate\_sequence) for all such unnamed definitions.

*Example 151. Unnamed sequence*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.SEQUENCE

)

private Long id;

@Column(name = "product\_name")

private String name;

//Getters and setters are omitted for brevity

}

Using javax.persistence.SequenceGenerator, you can specify a specific database sequence name.

*Example 152. Named sequence*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.SEQUENCE,

generator = "sequence-generator"

)

@SequenceGenerator(

name = "sequence-generator",

sequenceName = "product\_sequence"

)

private Long id;

@Column(name = "product\_name")

private String name;

//Getters and setters are omitted for brevity

}

The javax.persistence.SequenceGenerator annotataion allows you to specify additional configurations as well.

*Example 153. Configured sequence*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.SEQUENCE,

generator = "sequence-generator"

)

@SequenceGenerator(

name = "sequence-generator",

sequenceName = "product\_sequence",

allocationSize = 5

)

private Long id;

@Column(name = "product\_name")

private String name;

//Getters and setters are omitted for brevity

}

#### 2.6.9. Using IDENTITY columns

For implementing identifier value generation based on IDENTITY columns, Hibernate makes use of its org.hibernate.id.IdentityGenerator id generator which expects the identifier to generated by INSERT into the table. IdentityGenerator understands 3 different ways that the INSERT-generated value might be retrieved:

* If Hibernate believes the JDBC environment supports java.sql.Statement#getGeneratedKeys, then that approach will be used for extracting the IDENTITY generated keys.
* Otherwise, if Dialect#supportsInsertSelectIdentity reports true, Hibernate will use the Dialect specific INSERT+SELECT statement syntax.
* Otherwise, Hibernate will expect that the database supports some form of asking for the most recently inserted IDENTITY value via a separate SQL command as indicated by Dialect#getIdentitySelectString.

|  |  |
| --- | --- |
|  | It is important to realize that this imposes a runtime behavior where the entity row **must** be physically inserted prior to the identifier value being known. This can mess up extended persistence contexts (conversations). Because of the runtime imposition/inconsistency Hibernate suggest other forms of identifier value generation be used. |
|  | There is yet another important runtime impact of choosing IDENTITY generation: Hibernate will not be able to JDBC batching for inserts of the entities that use IDENTITY generation. The importance of this depends on the application specific use cases. If the application is not usually creating many new instances of a given type of entity that uses IDENTITY generation, then this is not an important impact since batching would not have been helpful anyway. |

#### 2.6.10. Using table identifier generator

Hibernate achieves table-based identifier generation based on its org.hibernate.id.enhanced.TableGenerator which defines a table capable of holding multiple named value segments for any number of entities.

The basic idea is that a given table-generator table (hibernate\_sequences for example) can hold multiple segments of identifier generation values.

*Example 154. Unnamed table generator*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.TABLE

)

private Long id;

@Column(name = "product\_name")

private String name;

//Getters and setters are omitted for brevity

}

create table hibernate\_sequences (

sequence\_name varchar2(255 char) not null,

next\_val number(19,0),

primary key (sequence\_name)

)

If no table name is given Hibernate assumes an implicit name of hibernate\_sequences.

Additionally, because no javax.persistence.TableGenerator#pkColumnValue is specified, Hibernate will use the default segment (sequence\_name='default') from the hibernate\_sequences table.

However, you can configure the table identifier generator using the [@TableGenerator](http://docs.oracle.com/javaee/7/api/javax/persistence/TableGenerator.html) annotation.

*Example 155. Configured table generator*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.TABLE,

generator = "table-generator"

)

@TableGenerator(

name = "table-generator",

table = "table\_identifier",

pkColumnName = "table\_name",

valueColumnName = "product\_id",

allocationSize = 5

)

private Long id;

@Column(name = "product\_name")

private String name;

//Getters and setters are omitted for brevity

}

create table table\_identifier (

table\_name varchar2(255 char) not null,

product\_id number(19,0),

primary key (table\_name)

)

Now, when inserting 3 Product entities, Hibernate generates the following statements:

] .Configured table generator persist example

for ( long i = 1; i <= 3; i++ ) {

Product product = new Product();

product.setName( String.format( "Product %d", i ) );

entityManager.persist( product );

}

select

tbl.product\_id

from

table\_identifier tbl

where

tbl.table\_name = ?

for update

-- binding parameter [1] - [Product]

insert

into

table\_identifier

(table\_name, product\_id)

values

(?, ?)

-- binding parameter [1] - [Product]

-- binding parameter [2] - [1]

update

table\_identifier

set

product\_id= ?

where

product\_id= ?

and table\_name= ?

-- binding parameter [1] - [6]

-- binding parameter [2] - [1]

select

tbl.product\_id

from

table\_identifier tbl

where

tbl.table\_name= ? for update

update

table\_identifier

set

product\_id= ?

where

product\_id= ?

and table\_name= ?

-- binding parameter [1] - [11]

-- binding parameter [2] - [6]

insert

into

Product

(product\_name, id)

values

(?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 1]

-- binding parameter [2] as [BIGINT] - [1]

insert

into

Product

(product\_name, id)

values

(?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 2]

-- binding parameter [2] as [BIGINT] - [2]

insert

into

Product

(product\_name, id)

values

(?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 3]

-- binding parameter [2] as [BIGINT] - [3]

#### 2.6.11. Using UUID generation

As mentioned above, Hibernate supports UUID identifier value generation. This is supported through its org.hibernate.id.UUIDGenerator id generator.

UUIDGenerator supports pluggable strategies for exactly how the UUID is generated. These strategies are defined by the org.hibernate.id.UUIDGenerationStrategy contract. The default strategy is a version 4 (random) strategy according to IETF RFC 4122. Hibernate does ship with an alternative strategy which is a RFC 4122 version 1 (time-based) strategy (using ip address rather than mac address).

*Example 156. Implicitly using the random UUID strategy*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue

private UUID id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

To specify an alternative generation strategy, we’d have to define some configuration via @GenericGenerator. Here we choose the RFC 4122 version 1 compliant strategy named org.hibernate.id.uuid.CustomVersionOneStrategy.

*Example 157. Implicitly using the random UUID strategy*

@Entity(name = "Book")

public static class Book {

@Id

@GeneratedValue( generator = "custom-uuid" )

@GenericGenerator(

name = "custom-uuid",

strategy = "org.hibernate.id.UUIDGenerator",

parameters = {

@Parameter(

name = "uuid\_gen\_strategy\_class",

value = "org.hibernate.id.uuid.CustomVersionOneStrategy"

)

}

)

private UUID id;

private String title;

private String author;

//Getters and setters are omitted for brevity

}

#### 2.6.12. Optimizers

Most of the Hibernate generators that separately obtain identifier values from database structures support the use of pluggable optimizers. Optimizers help manage the number of times Hibernate has to talk to the database in order to generate identifier values. For example, with no optimizer applied to a sequence-generator, every time the application asked Hibernate to generate an identifier it would need to grab the next sequence value from the database. But if we can minimize the number of times we need to communicate with the database here, the application will be able to perform better. Which is, in fact, the role of these optimizers.

none

No optimization is performed. We communicate with the database each and every time an identifier value is needed from the generator.

pooled-lo

The pooled-lo optimizer works on the principle that the increment-value is encoded into the database table/sequence structure. In sequence-terms this means that the sequence is defined with a greater-that-1 increment size.

For example, consider a brand new sequence defined as create sequence m\_sequence start with 1 increment by 20. This sequence essentially defines a "pool" of 20 usable id values each and every time we ask it for its next-value. The pooled-lo optimizer interprets the next-value as the low end of that pool.

So when we first ask it for next-value, we’d get 1. We then assume that the valid pool would be the values from 1-20 inclusive.

The next call to the sequence would result in 21, which would define 21-40 as the valid range. And so on. The "lo" part of the name indicates that the value from the database table/sequence is interpreted as the pool lo(w) end.

pooled

Just like pooled-lo, except that here the value from the table/sequence is interpreted as the high end of the value pool.

hilo; legacy-hilo

Define a custom algorithm for generating pools of values based on a single value from a table or sequence.

These optimizers are not recommended for use. They are maintained (and mentioned) here simply for use by legacy applications that used these strategies previously.

|  |  |
| --- | --- |
|  | Applications can also implement and use their own optimizer strategies, as defined by the org.hibernate.id.enhanced.Optimizer contract. |

#### 2.6.13. Using @GenericGenerator

@GenericGenerator allows integration of any Hibernate org.hibernate.id.IdentifierGenerator implementation, including any of the specific ones discussed here and any custom ones.

To make use of the pooled or pooled-lo optimizers, the entity mapping must use the [@GenericGenerator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenericGenerator.html) annotation:

*Example 158. Pooled-lo optimizer mapping using @GenericGenerator mapping*

@Entity(name = "Product")

public static class Product {

@Id

@GeneratedValue(

strategy = GenerationType.SEQUENCE,

generator = "product\_generator"

)

@GenericGenerator(

name = "product\_generator",

strategy = "org.hibernate.id.enhanced.SequenceStyleGenerator",

parameters = {

@Parameter(name = "sequence\_name", value = "product\_sequence"),

@Parameter(name = "initial\_value", value = "1"),

@Parameter(name = "increment\_size", value = "3"),

@Parameter(name = "optimizer", value = "pooled-lo")

}

)

private Long id;

@Column(name = "p\_name")

private String name;

@Column(name = "p\_number")

private String number;

//Getters and setters are omitted for brevity

}

Now, when saving 5 Person entities and flushing the Persistence Context after every 3 entities:

*Example 159. Pooled-lo optimizer mapping using @GenericGenerator mapping*

for ( long i = 1; i <= 5; i++ ) {

if(i % 3 == 0) {

entityManager.flush();

}

Product product = new Product();

product.setName( String.format( "Product %d", i ) );

product.setNumber( String.format( "P\_100\_%d", i ) );

entityManager.persist( product );

}

CALL NEXT VALUE FOR product\_sequence

INSERT INTO Product (p\_name, p\_number, id)

VALUES (?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 1]

-- binding parameter [2] as [VARCHAR] - [P\_100\_1]

-- binding parameter [3] as [BIGINT] - [1]

INSERT INTO Product (p\_name, p\_number, id)

VALUES (?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 2]

-- binding parameter [2] as [VARCHAR] - [P\_100\_2]

-- binding parameter [3] as [BIGINT] - [2]

CALL NEXT VALUE FOR product\_sequence

INSERT INTO Product (p\_name, p\_number, id)

VALUES (?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 3]

-- binding parameter [2] as [VARCHAR] - [P\_100\_3]

-- binding parameter [3] as [BIGINT] - [3]

INSERT INTO Product (p\_name, p\_number, id)

VALUES (?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 4]

-- binding parameter [2] as [VARCHAR] - [P\_100\_4]

-- binding parameter [3] as [BIGINT] - [4]

INSERT INTO Product (p\_name, p\_number, id)

VALUES (?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Product 5]

-- binding parameter [2] as [VARCHAR] - [P\_100\_5]

-- binding parameter [3] as [BIGINT] - [5]

As you can see from the list of generated SQL statements, you can insert 3 entities for one database sequence call. This way, the pooled and the pooled-lo optimizers allow you to reduce the number of database roundtrips, therefore reducing the overall transaction response time.

#### 2.6.14. Derived Identifiers

JPA 2.0 added support for derived identifiers which allow an entity to borrow the identifier from a many-to-one or one-to-one association.

*Example 160. Derived identifier with @MapsId*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@NaturalId

private String registrationNumber;

public Person() {}

public Person(String registrationNumber) {

this.registrationNumber = registrationNumber;

}

//Getters and setters are omitted for brevity

}

@Entity(name = "PersonDetails")

public static class PersonDetails {

@Id

private Long id;

private String nickName;

@OneToOne

@MapsId

private Person person;

//Getters and setters are omitted for brevity

}

In the example above, the PersonDetails entity uses the id column for both the entity identifier and for the one-to-one association to the Person entity. The value of the PersonDetails entity identifier is "derived" from the identifier of its parent Person entity.

*Example 161. Derived identifier with @MapsId persist example*

doInJPA( this::entityManagerFactory, entityManager -> {

Person person = new Person( "ABC-123" );

person.setId( 1L );

entityManager.persist( person );

PersonDetails personDetails = new PersonDetails();

personDetails.setNickName( "John Doe" );

personDetails.setPerson( person );

entityManager.persist( personDetails );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

PersonDetails personDetails = entityManager.find( PersonDetails.class, 1L );

assertEquals("John Doe", personDetails.getNickName());

} );

The @MapsId annotation can also reference columns from an @EmbeddedId identifier as well.

The previous example can also be mapped using @PrimaryKeyJoinColumn.

*Example 162. Derived identifier @PrimaryKeyJoinColumn*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@NaturalId

private String registrationNumber;

public Person() {}

public Person(String registrationNumber) {

this.registrationNumber = registrationNumber;

}

//Getters and setters are omitted for brevity

}

@Entity(name = "PersonDetails")

public static class PersonDetails {

@Id

private Long id;

private String nickName;

@OneToOne

@PrimaryKeyJoinColumn

private Person person;

public void setPerson(Person person) {

this.person = person;

this.id = person.getId();

}

//Other getters and setters are omitted for brevity

}

|  |  |
| --- | --- |
|  | Unlike @MapsId, the application developer is responsible for ensuring that the identifier and the many-to-one (or one-to-one) association are in sync as you can see in the PersonDetails#setPerson method. |

#### 2.6.15. @RowId

If you annotate a given entity with the @RowId annotation and the underlying database supports fetching a record by ROWID (e.g. Oracle), then Hibernate can use the ROWID pseudo-column for CRUD operations.

*Example 163. @RowId entity maapping*

@Entity(name = "Product")

@RowId("ROWID")

public static class Product {

@Id

private Long id;

@Column(name = "`name`")

private String name;

@Column(name = "`number`")

private String number;

//Getters and setters are omitted for brevity

}

Now, when fetching an entity and modifying it, Hibernate uses the ROWID pseudo-column for the UPDATE SQL statement.

*Example 164. @RowId example*

Product product = entityManager.find( Product.class, 1L );

product.setName( "Smart phone" );

SELECT

p.id as id1\_0\_0\_,

p."name" as name2\_0\_0\_,

p."number" as number3\_0\_0\_,

p.ROWID as rowid\_0\_

FROM

Product p

WHERE

p.id = ?

-- binding parameter [1] as [BIGINT] - [1]

-- extracted value ([name2\_0\_0\_] : [VARCHAR]) - [Mobile phone]

-- extracted value ([number3\_0\_0\_] : [VARCHAR]) - [123-456-7890]

-- extracted ROWID value: AAAwkBAAEAAACP3AAA

UPDATE

Product

SET

"name" = ?,

"number" = ?

WHERE

ROWID = ?

-- binding parameter [1] as [VARCHAR] - [Smart phone]

-- binding parameter [2] as [VARCHAR] - [123-456-7890]

-- binding parameter [3] as ROWID - [AAAwkBAAEAAACP3AAA]

### 2.7. Associations

Associations describe how two or more entities form a relationship based on a database joining semantics.

#### 2.7.1. @ManyToOne

@ManyToOne is the most common association, having a direct equivalent in the relational database as well (e.g. foreign key), and so it establishes a relationship between a child entity and a parent.

*Example 165. @ManyToOne association*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

public Person() {

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@Column(name = "`number`")

private String number;

@ManyToOne

@JoinColumn(name = "person\_id",

foreignKey = @ForeignKey(name = "PERSON\_ID\_FK")

)

private Person person;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

public Long getId() {

return id;

}

public String getNumber() {

return number;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

person\_id BIGINT ,

PRIMARY KEY ( id )

)

ALTER TABLE Phone

ADD CONSTRAINT PERSON\_ID\_FK

FOREIGN KEY (person\_id) REFERENCES Person

Each entity has a lifecycle of its own. Once the @ManyToOne association is set, Hibernate will set the associated database foreign key column.

*Example 166. @ManyToOne association lifecycle*

Person person = new Person();

entityManager.persist( person );

Phone phone = new Phone( "123-456-7890" );

phone.setPerson( person );

entityManager.persist( phone );

entityManager.flush();

phone.setPerson( null );

INSERT INTO Person ( id )

VALUES ( 1 )

INSERT INTO Phone ( number, person\_id, id )

VALUES ( '123-456-7890', 1, 2 )

UPDATE Phone

SET number = '123-456-7890',

person\_id = NULL

WHERE id = 2

#### 2.7.2. @OneToMany

The @OneToMany association links a parent entity with one or more child entities. If the @OneToMany doesn’t have a mirroring @ManyToOne association on the child side, the @OneToMany association is unidirectional. If there is a @ManyToOne association on the child side, the @OneToMany association is bidirectional and the application developer can navigate this relationship from both ends.

##### Unidirectional @OneToMany

When using a unidirectional @OneToMany association, Hibernate resorts to using a link table between the two joining entities.

*Example 167. Unidirectional @OneToMany association*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@OneToMany(cascade = CascadeType.ALL, orphanRemoval = true)

private List<Phone> phones = new ArrayList<>();

public Person() {

}

public List<Phone> getPhones() {

return phones;

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

public Long getId() {

return id;

}

public String getNumber() {

return number;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Person\_Phone (

Person\_id BIGINT NOT NULL ,

phones\_id BIGINT NOT NULL

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

PRIMARY KEY ( id )

)

ALTER TABLE Person\_Phone

ADD CONSTRAINT UK\_9uhc5itwc9h5gcng944pcaslf

UNIQUE (phones\_id)

ALTER TABLE Person\_Phone

ADD CONSTRAINT FKr38us2n8g5p9rj0b494sd3391

FOREIGN KEY (phones\_id) REFERENCES Phone

ALTER TABLE Person\_Phone

ADD CONSTRAINT FK2ex4e4p7w1cj310kg2woisjl2

FOREIGN KEY (Person\_id) REFERENCES Person

|  |  |
| --- | --- |
|  | The @OneToMany association is by definition a parent association, even if it’s a unidirectional or a bidirectional one. Only the parent side of an association makes sense to cascade its entity state transitions to children. |

*Example 168. Cascading @OneToMany association*

Person person = new Person();

Phone phone1 = new Phone( "123-456-7890" );

Phone phone2 = new Phone( "321-654-0987" );

person.getPhones().add( phone1 );

person.getPhones().add( phone2 );

entityManager.persist( person );

entityManager.flush();

person.getPhones().remove( phone1 );

INSERT INTO Person

( id )

VALUES ( 1 )

INSERT INTO Phone

( number, id )

VALUES ( '123 - 456 - 7890', 2 )

INSERT INTO Phone

( number, id )

VALUES ( '321 - 654 - 0987', 3 )

INSERT INTO Person\_Phone

( Person\_id, phones\_id )

VALUES ( 1, 2 )

INSERT INTO Person\_Phone

( Person\_id, phones\_id )

VALUES ( 1, 3 )

DELETE FROM Person\_Phone

WHERE Person\_id = 1

INSERT INTO Person\_Phone

( Person\_id, phones\_id )

VALUES ( 1, 3 )

DELETE FROM Phone

WHERE id = 2

When persisting the Person entity, the cascade will propagate the persist operation to the underlying Phone children as well. Upon removing a Phone from the phones collection, the association row is deleted from the link table, and the orphanRemoval attribute will trigger a Phone removal as well.

|  |  |
| --- | --- |
|  | The unidirectional associations are not very efficient when it comes to removing child entities. In this particular example, upon flushing the persistence context, Hibernate deletes all database child entries and reinserts the ones that are still found in the in-memory persistence context.  On the other hand, a bidirectional @OneToMany association is much more efficient because the child entity controls the association. |

##### Bidirectional @OneToMany

The bidirectional @OneToMany association also requires a @ManyToOne association on the child side. Although the Domain Model exposes two sides to navigate this association, behind the scenes, the relational database has only one foreign key for this relationship.

Every bidirectional association must have one owning side only (the child side), the other one being referred to as the inverse (or the mappedBy) side.

*Example 169. @OneToMany association mappedBy the @ManyToOne side*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL, orphanRemoval = true)

private List<Phone> phones = new ArrayList<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public List<Phone> getPhones() {

return phones;

}

public void addPhone(Phone phone) {

phones.add( phone );

phone.setPerson( this );

}

public void removePhone(Phone phone) {

phones.remove( phone );

phone.setPerson( null );

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@NaturalId

@Column(name = "`number`", unique = true)

private String number;

@ManyToOne

private Person person;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

public Long getId() {

return id;

}

public String getNumber() {

return number;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

person\_id BIGINT ,

PRIMARY KEY ( id )

)

ALTER TABLE Phone

ADD CONSTRAINT UK\_l329ab0g4c1t78onljnxmbnp6

UNIQUE (number)

ALTER TABLE Phone

ADD CONSTRAINT FKmw13yfsjypiiq0i1osdkaeqpg

FOREIGN KEY (person\_id) REFERENCES Person

|  |  |
| --- | --- |
|  | Whenever a bidirectional association is formed, the application developer must make sure both sides are in-sync at all times. The addPhone() and removePhone() are utilities methods that synchronize both ends whenever a child element is added or removed. |

Because the Phone class has a @NaturalId column (the phone number being unique), the equals() and the hashCode() can make use of this property, and so the removePhone() logic is reduced to the remove() Java Collection method.

*Example 170. Bidirectional @OneToMany with an owner @ManyToOne side lifecycle*

Person person = new Person();

Phone phone1 = new Phone( "123-456-7890" );

Phone phone2 = new Phone( "321-654-0987" );

person.addPhone( phone1 );

person.addPhone( phone2 );

entityManager.persist( person );

entityManager.flush();

person.removePhone( phone1 );

INSERT INTO Phone

( number, person\_id, id )

VALUES ( '123-456-7890', NULL, 2 )

INSERT INTO Phone

( number, person\_id, id )

VALUES ( '321-654-0987', NULL, 3 )

DELETE FROM Phone

WHERE id = 2

Unlike the unidirectional @OneToMany, the bidirectional association is much more efficient when managing the collection persistence state. Every element removal only requires a single update (in which the foreign key column is set to NULL), and, if the child entity lifecycle is bound to its owning parent so that the child cannot exist without its parent, then we can annotate the association with the orphan-removal attribute and disassociating the child will trigger a delete statement on the actual child table row as well.

#### 2.7.3. @OneToOne

The @OneToOne association can either be unidirectional or bidirectional. A unidirectional association follows the relational database foreign key semantics, the client-side owning the relationship. A bidirectional association features a mappedBy @OneToOne parent side too.

##### Unidirectional @OneToOne

*Example 171. Unidirectional @OneToOne*

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@Column(name = "`number`")

private String number;

@OneToOne

@JoinColumn(name = "details\_id")

private PhoneDetails details;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

public Long getId() {

return id;

}

public String getNumber() {

return number;

}

public PhoneDetails getDetails() {

return details;

}

public void setDetails(PhoneDetails details) {

this.details = details;

}

}

@Entity(name = "PhoneDetails")

public static class PhoneDetails {

@Id

@GeneratedValue

private Long id;

private String provider;

private String technology;

public PhoneDetails() {

}

public PhoneDetails(String provider, String technology) {

this.provider = provider;

this.technology = technology;

}

public String getProvider() {

return provider;

}

public String getTechnology() {

return technology;

}

public void setTechnology(String technology) {

this.technology = technology;

}

}

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

details\_id BIGINT ,

PRIMARY KEY ( id )

)

CREATE TABLE PhoneDetails (

id BIGINT NOT NULL ,

provider VARCHAR(255) ,

technology VARCHAR(255) ,

PRIMARY KEY ( id )

)

ALTER TABLE Phone

ADD CONSTRAINT FKnoj7cj83ppfqbnvqqa5kolub7

FOREIGN KEY (details\_id) REFERENCES PhoneDetails

From a relational database point of view, the underlying schema is identical to the unidirectional @ManyToOneassociation, as the client-side controls the relationship based on the foreign key column.

But then, it’s unusual to consider the Phone as a client-side and the PhoneDetails as the parent-side because the details cannot exist without an actual phone. A much more natural mapping would be if the Phone were the parent-side, therefore pushing the foreign key into the PhoneDetails table. This mapping requires a bidirectional @OneToOneassociation as you can see in the following example:

##### Bidirectional @OneToOne

*Example 172. Bidirectional @OneToOne*

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@Column(name = "`number`")

private String number;

@OneToOne(mappedBy = "phone", cascade = CascadeType.ALL, orphanRemoval = true, fetch = FetchType.LAZY)

private PhoneDetails details;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

public Long getId() {

return id;

}

public String getNumber() {

return number;

}

public PhoneDetails getDetails() {

return details;

}

public void addDetails(PhoneDetails details) {

details.setPhone( this );

this.details = details;

}

public void removeDetails() {

if ( details != null ) {

details.setPhone( null );

this.details = null;

}

}

}

@Entity(name = "PhoneDetails")

public static class PhoneDetails {

@Id

@GeneratedValue

private Long id;

private String provider;

private String technology;

@OneToOne(fetch = FetchType.LAZY)

@JoinColumn(name = "phone\_id")

private Phone phone;

public PhoneDetails() {

}

public PhoneDetails(String provider, String technology) {

this.provider = provider;

this.technology = technology;

}

public String getProvider() {

return provider;

}

public String getTechnology() {

return technology;

}

public void setTechnology(String technology) {

this.technology = technology;

}

public Phone getPhone() {

return phone;

}

public void setPhone(Phone phone) {

this.phone = phone;

}

}

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE PhoneDetails (

id BIGINT NOT NULL ,

provider VARCHAR(255) ,

technology VARCHAR(255) ,

phone\_id BIGINT ,

PRIMARY KEY ( id )

)

ALTER TABLE PhoneDetails

ADD CONSTRAINT FKeotuev8ja8v0sdh29dynqj05p

FOREIGN KEY (phone\_id) REFERENCES Phone

This time, the PhoneDetails owns the association, and, like any bidirectional association, the parent-side can propagate its lifecycle to the child-side through cascading.

*Example 173. Bidirectional @OneToOne lifecycle*

Phone phone = new Phone( "123-456-7890" );

PhoneDetails details = new PhoneDetails( "T-Mobile", "GSM" );

phone.addDetails( details );

entityManager.persist( phone );

INSERT INTO Phone ( number, id )

VALUES ( '123 - 456 - 7890', 1 )

INSERT INTO PhoneDetails ( phone\_id, provider, technology, id )

VALUES ( 1, 'T - Mobile, GSM', 2 )

When using a bidirectional @OneToOne association, Hibernate enforces the unique constraint upon fetching the child-side. If there are more than one children associated with the same parent, Hibernate will throw a org.hibernate.exception.ConstraintViolationException. Continuing the previous example, when adding another PhoneDetails, Hibernate validates the uniqueness constraint when reloading the Phone object.

*Example 174. Bidirectional @OneToOne unique constraint*

PhoneDetails otherDetails = new PhoneDetails( "T-Mobile", "CDMA" );

otherDetails.setPhone( phone );

entityManager.persist( otherDetails );

entityManager.flush();

entityManager.clear();

//throws javax.persistence.PersistenceException: org.hibernate.HibernateException: More than one row with the given identifier was found: 1

phone = entityManager.find( Phone.class, phone.getId() );

###### Bidirectional @OneToOne lazy association

Although you might annotate the parent-side association to be fetched lazily, Hibernate cannot honor this request since it cannot know whether the association is null or not.

The only way to figure out whether there is an associated record on the child side is to fetch the child association using a secondary query. Because this can lead to N+1 query issues, it’s much more efficient to use unidirectional @OneToOneassociations with the @MapsId annotation in place.

However, if you really need to use a bidirectional association and want to make sure that this is always going to be fetched lazily, then you need to enable lazy state initialization bytecode enhancement and use the [@LazyToOne](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyToOne.html) annotation as well.

*Example 175. Bidirectional @OneToOne lazy parent-side association*

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

@Column(name = "`number`")

private String number;

@OneToOne(

mappedBy = "phone",

cascade = CascadeType.ALL,

orphanRemoval = true,

fetch = FetchType.LAZY

)

@LazyToOne( LazyToOneOption.NO\_PROXY )

private PhoneDetails details;

public Phone() {

}

public Phone(String number) {

this.number = number;

}

//Getters and setters are omitted for brevity

}

@Entity(name = "PhoneDetails")

public static class PhoneDetails {

@Id

@GeneratedValue

private Long id;

private String provider;

private String technology;

@OneToOne(fetch = FetchType.LAZY)

@JoinColumn(name = "phone\_id")

private Phone phone;

public PhoneDetails() {

}

public PhoneDetails(String provider, String technology) {

this.provider = provider;

this.technology = technology;

}

//Getters and setters are omitted for brevity

}

For more about how to enable Bytecode enhancement, see the [BytecodeEnhancement chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#BytecodeEnhancement).

#### 2.7.4. @ManyToMany

The @ManyToMany association requires a link table that joins two entities. Like the @OneToMany association, @ManyToMany can be a either unidirectional or bidirectional.

##### Unidirectional @ManyToMany

*Example 176. Unidirectional @ManyToMany*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@ManyToMany(cascade = {CascadeType.PERSIST, CascadeType.MERGE})

private List<Address> addresses = new ArrayList<>();

public Person() {

}

public List<Address> getAddresses() {

return addresses;

}

}

@Entity(name = "Address")

public static class Address {

@Id

@GeneratedValue

private Long id;

private String street;

@Column(name = "`number`")

private String number;

public Address() {

}

public Address(String street, String number) {

this.street = street;

this.number = number;

}

public Long getId() {

return id;

}

public String getStreet() {

return street;

}

public String getNumber() {

return number;

}

}

CREATE TABLE Address (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

street VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Person\_Address (

Person\_id BIGINT NOT NULL ,

addresses\_id BIGINT NOT NULL

)

ALTER TABLE Person\_Address

ADD CONSTRAINT FKm7j0bnabh2yr0pe99il1d066u

FOREIGN KEY (addresses\_id) REFERENCES Address

ALTER TABLE Person\_Address

ADD CONSTRAINT FKba7rc9qe2vh44u93u0p2auwti

FOREIGN KEY (Person\_id) REFERENCES Person

Just like with unidirectional @OneToMany associations, the link table is controlled by the owning side.

When an entity is removed from the @ManyToMany collection, Hibernate simply deletes the joining record in the link table. Unfortunately, this operation requires removing all entries associated with a given parent and recreating the ones that are listed in the current running persistent context.

*Example 177. Unidirectional @ManyToMany lifecycle*

Person person1 = new Person();

Person person2 = new Person();

Address address1 = new Address( "12th Avenue", "12A" );

Address address2 = new Address( "18th Avenue", "18B" );

person1.getAddresses().add( address1 );

person1.getAddresses().add( address2 );

person2.getAddresses().add( address1 );

entityManager.persist( person1 );

entityManager.persist( person2 );

entityManager.flush();

person1.getAddresses().remove( address1 );

INSERT INTO Person ( id )

VALUES ( 1 )

INSERT INTO Address ( number, street, id )

VALUES ( '12A', '12th Avenue', 2 )

INSERT INTO Address ( number, street, id )

VALUES ( '18B', '18th Avenue', 3 )

INSERT INTO Person ( id )

VALUES ( 4 )

INSERT INTO Person\_Address ( Person\_id, addresses\_id )

VALUES ( 1, 2 )

INSERT INTO Person\_Address ( Person\_id, addresses\_id )

VALUES ( 1, 3 )

INSERT INTO Person\_Address ( Person\_id, addresses\_id )

VALUES ( 4, 2 )

DELETE FROM Person\_Address

WHERE Person\_id = 1

INSERT INTO Person\_Address ( Person\_id, addresses\_id )

VALUES ( 1, 3 )

|  |  |
| --- | --- |
|  | For @ManyToMany associations, the REMOVE entity state transition doesn’t make sense to be cascaded because it will propagate beyond the link table. Since the other side might be referenced by other entities on the parent-side, the automatic removal might end up in a ConstraintViolationException.  For example, if @ManyToMany(cascade = CascadeType.ALL) was defined and the first person would be deleted, Hibernate would throw an exception because another person is still associated with the address that’s being deleted.  Person person1 = entityManager.find(Person.class, personId);  entityManager.remove(person1);  Caused by: javax.persistence.PersistenceException: org.hibernate.exception.ConstraintViolationException: could not execute statement  Caused by: org.hibernate.exception.ConstraintViolationException: could not execute statement  Caused by: java.sql.SQLIntegrityConstraintViolationException: integrity constraint violation: foreign key no action; FKM7J0BNABH2YR0PE99IL1D066U table: PERSON\_ADDRESS |

By simply removing the parent-side, Hibernate can safely remove the associated link records as you can see in the following example:

*Example 178. Unidirectional @ManyToMany entity removal*

Person person1 = entityManager.find( Person.class, personId );

entityManager.remove( person1 );

DELETE FROM Person\_Address

WHERE Person\_id = 1

DELETE FROM Person

WHERE id = 1

##### Bidirectional @ManyToMany

A bidirectional @ManyToMany association has an owning and a mappedBy side. To preserve synchronicity between both sides, it’s good practice to provide helper methods for adding or removing child entities.

*Example 179. Bidirectional @ManyToMany*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@NaturalId

private String registrationNumber;

@ManyToMany(cascade = {CascadeType.PERSIST, CascadeType.MERGE})

private List<Address> addresses = new ArrayList<>();

public Person() {

}

public Person(String registrationNumber) {

this.registrationNumber = registrationNumber;

}

public List<Address> getAddresses() {

return addresses;

}

public void addAddress(Address address) {

addresses.add( address );

address.getOwners().add( this );

}

public void removeAddress(Address address) {

addresses.remove( address );

address.getOwners().remove( this );

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Person person = (Person) o;

return Objects.equals( registrationNumber, person.registrationNumber );

}

@Override

public int hashCode() {

return Objects.hash( registrationNumber );

}

}

@Entity(name = "Address")

public static class Address {

@Id

@GeneratedValue

private Long id;

private String street;

@Column(name = "`number`")

private String number;

private String postalCode;

@ManyToMany(mappedBy = "addresses")

private List<Person> owners = new ArrayList<>();

public Address() {

}

public Address(String street, String number, String postalCode) {

this.street = street;

this.number = number;

this.postalCode = postalCode;

}

public Long getId() {

return id;

}

public String getStreet() {

return street;

}

public String getNumber() {

return number;

}

public String getPostalCode() {

return postalCode;

}

public List<Person> getOwners() {

return owners;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Address address = (Address) o;

return Objects.equals( street, address.street ) &&

Objects.equals( number, address.number ) &&

Objects.equals( postalCode, address.postalCode );

}

@Override

public int hashCode() {

return Objects.hash( street, number, postalCode );

}

}

CREATE TABLE Address (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

postalCode VARCHAR(255) ,

street VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE Person (

id BIGINT NOT NULL ,

registrationNumber VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE Person\_Address (

owners\_id BIGINT NOT NULL ,

addresses\_id BIGINT NOT NULL

)

ALTER TABLE Person

ADD CONSTRAINT UK\_23enodonj49jm8uwec4i7y37f

UNIQUE (registrationNumber)

ALTER TABLE Person\_Address

ADD CONSTRAINT FKm7j0bnabh2yr0pe99il1d066u

FOREIGN KEY (addresses\_id) REFERENCES Address

ALTER TABLE Person\_Address

ADD CONSTRAINT FKbn86l24gmxdv2vmekayqcsgup

FOREIGN KEY (owners\_id) REFERENCES Person

With the helper methods in place, the synchronicity management can be simplified, as you can see in the following example:

*Example 180. Bidirectional @ManyToMany lifecycle*

Person person1 = new Person( "ABC-123" );

Person person2 = new Person( "DEF-456" );

Address address1 = new Address( "12th Avenue", "12A", "4005A" );

Address address2 = new Address( "18th Avenue", "18B", "4007B" );

person1.addAddress( address1 );

person1.addAddress( address2 );

person2.addAddress( address1 );

entityManager.persist( person1 );

entityManager.persist( person2 );

entityManager.flush();

person1.removeAddress( address1 );

INSERT INTO Person ( registrationNumber, id )

VALUES ( 'ABC-123', 1 )

INSERT INTO Address ( number, postalCode, street, id )

VALUES ( '12A', '4005A', '12th Avenue', 2 )

INSERT INTO Address ( number, postalCode, street, id )

VALUES ( '18B', '4007B', '18th Avenue', 3 )

INSERT INTO Person ( registrationNumber, id )

VALUES ( 'DEF-456', 4 )

INSERT INTO Person\_Address ( owners\_id, addresses\_id )

VALUES ( 1, 2 )

INSERT INTO Person\_Address ( owners\_id, addresses\_id )

VALUES ( 1, 3 )

INSERT INTO Person\_Address ( owners\_id, addresses\_id )

VALUES ( 4, 2 )

DELETE FROM Person\_Address

WHERE owners\_id = 1

INSERT INTO Person\_Address ( owners\_id, addresses\_id )

VALUES ( 1, 3 )

If a bidirectional @OneToMany association performs better when removing or changing the order of child elements, the @ManyToMany relationship cannot benefit from such an optimization because the foreign key side is not in control. To overcome this limitation, the link table must be directly exposed and the @ManyToMany association split into two bidirectional @OneToMany relationships.

##### Bidirectional many-to-many with a link entity

To most natural @ManyToMany association follows the same logic employed by the database schema, and the link table has an associated entity which controls the relationship for both sides that need to be joined.

*Example 181. Bidirectional many-to-many with link entity*

@Entity(name = "Person")

public static class Person implements Serializable {

@Id

@GeneratedValue

private Long id;

@NaturalId

private String registrationNumber;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL, orphanRemoval = true)

private List<PersonAddress> addresses = new ArrayList<>();

public Person() {

}

public Person(String registrationNumber) {

this.registrationNumber = registrationNumber;

}

public Long getId() {

return id;

}

public List<PersonAddress> getAddresses() {

return addresses;

}

public void addAddress(Address address) {

PersonAddress personAddress = new PersonAddress( this, address );

addresses.add( personAddress );

address.getOwners().add( personAddress );

}

public void removeAddress(Address address) {

PersonAddress personAddress = new PersonAddress( this, address );

address.getOwners().remove( personAddress );

addresses.remove( personAddress );

personAddress.setPerson( null );

personAddress.setAddress( null );

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Person person = (Person) o;

return Objects.equals( registrationNumber, person.registrationNumber );

}

@Override

public int hashCode() {

return Objects.hash( registrationNumber );

}

}

@Entity(name = "PersonAddress")

public static class PersonAddress implements Serializable {

@Id

@ManyToOne

private Person person;

@Id

@ManyToOne

private Address address;

public PersonAddress() {

}

public PersonAddress(Person person, Address address) {

this.person = person;

this.address = address;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

public Address getAddress() {

return address;

}

public void setAddress(Address address) {

this.address = address;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

PersonAddress that = (PersonAddress) o;

return Objects.equals( person, that.person ) &&

Objects.equals( address, that.address );

}

@Override

public int hashCode() {

return Objects.hash( person, address );

}

}

@Entity(name = "Address")

public static class Address implements Serializable {

@Id

@GeneratedValue

private Long id;

private String street;

@Column(name = "`number`")

private String number;

private String postalCode;

@OneToMany(mappedBy = "address", cascade = CascadeType.ALL, orphanRemoval = true)

private List<PersonAddress> owners = new ArrayList<>();

public Address() {

}

public Address(String street, String number, String postalCode) {

this.street = street;

this.number = number;

this.postalCode = postalCode;

}

public Long getId() {

return id;

}

public String getStreet() {

return street;

}

public String getNumber() {

return number;

}

public String getPostalCode() {

return postalCode;

}

public List<PersonAddress> getOwners() {

return owners;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Address address = (Address) o;

return Objects.equals( street, address.street ) &&

Objects.equals( number, address.number ) &&

Objects.equals( postalCode, address.postalCode );

}

@Override

public int hashCode() {

return Objects.hash( street, number, postalCode );

}

}

CREATE TABLE Address (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

postalCode VARCHAR(255) ,

street VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE Person (

id BIGINT NOT NULL ,

registrationNumber VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE PersonAddress (

person\_id BIGINT NOT NULL ,

address\_id BIGINT NOT NULL ,

PRIMARY KEY ( person\_id, address\_id )

)

ALTER TABLE Person

ADD CONSTRAINT UK\_23enodonj49jm8uwec4i7y37f

UNIQUE (registrationNumber)

ALTER TABLE PersonAddress

ADD CONSTRAINT FK8b3lru5fyej1aarjflamwghqq

FOREIGN KEY (person\_id) REFERENCES Person

ALTER TABLE PersonAddress

ADD CONSTRAINT FK7p69mgialumhegyl4byrh65jk

FOREIGN KEY (address\_id) REFERENCES Address

Both the Person and the Address have a mappedBy @OneToMany side, while the PersonAddress owns the personand the address @ManyToOne associations. Because this mapping is formed out of two bidirectional associations, the helper methods are even more relevant.

|  |  |
| --- | --- |
|  | The aforementioned example uses a Hibernate specific mapping for the link entity since JPA doesn’t allow building a composite identifier out of multiple @ManyToOne associations. For more details, see the [Composite identifiers - associations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite-associations) section. |

The entity state transitions are better managed than in the previous bidirectional @ManyToMany case.

*Example 182. Bidirectional many-to-many with link entity lifecycle*

Person person1 = new Person( "ABC-123" );

Person person2 = new Person( "DEF-456" );

Address address1 = new Address( "12th Avenue", "12A", "4005A" );

Address address2 = new Address( "18th Avenue", "18B", "4007B" );

entityManager.persist( person1 );

entityManager.persist( person2 );

entityManager.persist( address1 );

entityManager.persist( address2 );

person1.addAddress( address1 );

person1.addAddress( address2 );

person2.addAddress( address1 );

entityManager.flush();

log.info( "Removing address" );

person1.removeAddress( address1 );

INSERT INTO Person ( registrationNumber, id )

VALUES ( 'ABC-123', 1 )

INSERT INTO Person ( registrationNumber, id )

VALUES ( 'DEF-456', 2 )

INSERT INTO Address ( number, postalCode, street, id )

VALUES ( '12A', '4005A', '12th Avenue', 3 )

INSERT INTO Address ( number, postalCode, street, id )

VALUES ( '18B', '4007B', '18th Avenue', 4 )

INSERT INTO PersonAddress ( person\_id, address\_id )

VALUES ( 1, 3 )

INSERT INTO PersonAddress ( person\_id, address\_id )

VALUES ( 1, 4 )

INSERT INTO PersonAddress ( person\_id, address\_id )

VALUES ( 2, 3 )

DELETE FROM PersonAddress

WHERE person\_id = 1 AND address\_id = 3

There is only one delete statement executed because, this time, the association is controlled by the @ManyToOne side which only has to monitor the state of the underlying foreign key relationship to trigger the right DML statement.

#### 2.7.5. @NotFound association mapping

When dealing with associations which are not enforced by a Foreign Key, it’s possible to bump into inconsistencies if the child record cannot reference a parent entity.

By default, Hibernate will complain whenever a child association references a non-existing parent record. However, you can configure this behavior so that Hibernate can ignore such an Exception and simply assign null as a parent object referenced.

To ignore non-existing parent entity references, even though not really recommended, it’s possible to use the annotation org.hibernate.annotation.NotFound annotation with a value of org.hibernate.annotations.NotFoundAction.IGNORE.

Considering the following City and Person entity mappings:

*Example 183. @NotFound mapping example*

@Entity

@Table( name = "Person" )

public static class Person {

@Id

private Long id;

private String name;

private String cityName;

@ManyToOne( fetch = FetchType.LAZY )

@NotFound ( action = NotFoundAction.IGNORE )

@JoinColumn(

name = "cityName",

referencedColumnName = "name",

insertable = false,

updatable = false

)

private City city;

//Getters and setters are omitted for brevity

}

@Entity

@Table( name = "City" )

public static class City implements Serializable {

@Id

@GeneratedValue

private Long id;

private String name;

//Getters and setters are omitted for brevity

}

If we have the following entities in our database:

*Example 184. @NotFound mapping example*

City \_NewYork = new City();

\_NewYork.setName( "New York" );

entityManager.persist( \_NewYork );

Person person = new Person();

person.setId( 1L );

person.setName( "John Doe" );

person.setCityName( "New York" );

entityManager.persist( person );

When loading the Person entity, Hibernate is able to locate the associated City parent entity:

*Example 185. @NotFound find existing entity example*

Person person = entityManager.find( Person.class, 1L );

assertEquals( "New York", person.getCity().getName() );

However, if we change the cityName attribute to a non-existing city:

*Example 186. @NotFound change to non-existing City example*

person.setCityName( "Atlantis" );

Hibernate is not going to throw any exception, and it will assign a value of null for the non-existing City entity reference:

*Example 187. @NotFound find non-existing City example*

Person person = entityManager.find( Person.class, 1L );

assertEquals( "Atlantis", person.getCityName() );

assertNull( null, person.getCity() );

### 2.8. Collections

Naturally Hibernate also allows to persist collections. These persistent collections can contain almost any other Hibernate type, including: basic types, custom types, components and references to other entities. In this context, the distinction between value and reference semantics is very important. An object in a collection might be handled with value semantics (its life cycle being 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 owner of the collection is always an entity, even if the collection is defined by an embeddable type. Collections form one/many-to-many associations between types so there can be:

* value type collections
* embeddable type collections
* entity collections

Hibernate uses its own collection implementations which are enriched with lazy-loading, caching or state change detection semantics. For this reason, persistent collections must be declared as an interface type. The actual interface might be java.util.Collection, java.util.List, java.util.Set, java.util.Map, java.util.SortedSet, java.util.SortedMap or even other object types (meaning you will have to write an implementation of org.hibernate.usertype.UserCollectionType).

As the following example demonstrates, it’s important to use the interface type and not the collection implementation, as declared in the entity mapping.

*Example 188. Hibernate uses its own collection implementations*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@ElementCollection

private List<String> phones = new ArrayList<>();

public List<String> getPhones() {

return phones;

}

}

Person person = entityManager.find( Person.class, 1L );

//Throws java.lang.ClassCastException: org.hibernate.collection.internal.PersistentBag cannot be cast to java.util.ArrayList

ArrayList<String> phones = (ArrayList<String>) person.getPhones();

|  |  |
| --- | --- |
|  | It is important that collections be defined using the appropriate Java Collections Framework interface rather than a specific implementation. From a theoretical perspective, this just follows good design principles. From a practical perspective, Hibernate (like other persistence providers) will use their own collection implementations which conform to the Java Collections Framework interfaces. |

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

#### 2.8.1. Collections as a value type

Value and embeddable type collections have a similar behavior as simple value types because they are automatically persisted when referenced by a persistent object and 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. Collection-valued properties do not support null value semantics because Hibernate does not distinguish between a null collection reference and an empty collection. |

#### 2.8.2. Collections of value types

Collections of value type include basic and embeddable types. Collections cannot be nested, and, when used in collections, embeddable types are not allowed to define other collections.

For collections of value types, JPA 2.0 defines the @ElementCollection annotation. The lifecycle of the value-type collection is entirely controlled by its owning entity.

Considering the previous example mapping, when clearing the phone collection, Hibernate deletes all the associated phones. When adding a new element to the value type collection, Hibernate issues a new insert statement.

*Example 189. Value type collection lifecycle*

person.getPhones().clear();

person.getPhones().add( "123-456-7890" );

person.getPhones().add( "456-000-1234" );

DELETE FROM Person\_phones WHERE Person\_id = 1

INSERT INTO Person\_phones ( Person\_id, phones )

VALUES ( 1, '123-456-7890' )

INSERT INTO Person\_phones (Person\_id, phones)

VALUES ( 1, '456-000-1234' )

If removing all elements or adding new ones is rather straightforward, removing a certain entry actually requires reconstructing the whole collection from scratch.

*Example 190. Removing collection elements*

person.getPhones().remove( 0 );

DELETE FROM Person\_phones WHERE Person\_id = 1

INSERT INTO Person\_phones ( Person\_id, phones )

VALUES ( 1, '456-000-1234' )

Depending on the number of elements, this behavior might not be efficient, if many elements need to be deleted and reinserted back into the database table. A workaround is to use an @OrderColumn, which, although not as efficient as when using the actual link table primary key, might improve the efficiency of the remove operations.

*Example 191. Removing collection elements using the order column*

@ElementCollection

@OrderColumn(name = "order\_id")

private List<String> phones = new ArrayList<>();

person.getPhones().remove( 0 );

DELETE FROM Person\_phones

WHERE Person\_id = 1

AND order\_id = 1

UPDATE Person\_phones

SET phones = '456-000-1234'

WHERE Person\_id = 1

AND order\_id = 0

|  |  |
| --- | --- |
|  | The @OrderColumn column works best when removing from the tail of the collection, as it only requires a single delete statement. Removing from the head or the middle of the collection requires deleting the extra elements and updating the remaining ones to preserve element order. |

Embeddable type collections behave the same way as value type collections. Adding embeddables to the collection triggers the associated insert statements and removing elements from the collection will generate delete statements.

*Example 192. Embeddable type collections*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@ElementCollection

private List<Phone> phones = new ArrayList<>();

public List<Phone> getPhones() {

return phones;

}

}

@Embeddable

public static class Phone {

private String type;

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(String type, String number) {

this.type = type;

this.number = number;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

}

person.getPhones().add( new Phone( "landline", "028-234-9876" ) );

person.getPhones().add( new Phone( "mobile", "072-122-9876" ) );

INSERT INTO Person\_phones ( Person\_id, number, type )

VALUES ( 1, '028-234-9876', 'landline' )

INSERT INTO Person\_phones ( Person\_id, number, type )

VALUES ( 1, '072-122-9876', 'mobile' )

#### 2.8.3. Collections of entities

If value type collections can only form a one-to-many association between an owner entity and multiple basic or embeddable types, entity collections can represent both [@OneToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-one-to-many) and [@ManyToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-many) associations.

From a relational database perspective, associations are defined by the foreign key side (the child-side). With value type collections, only the entity can control the association (the parent-side), but for a collection of entities, both sides of the association are managed by the persistence context.

For this reason, entity collections can be devised into two main categories: unidirectional and bidirectional associations. Unidirectional associations are very similar to value type collections since only the parent side controls this relationship. Bidirectional associations are more tricky since, even if sides need to be in-sync at all times, only one side is responsible for managing the association. A bidirectional association has an owning side and an inverse (mappedBy) side.

Another way of categorizing entity collections is by the underlying collection type, and so we can have:

* bags
* indexed lists
* sets
* sorted sets
* maps
* sorted maps
* arrays

In the following sections, we will go through all these collection types and discuss both unidirectional and bidirectional associations.

#### 2.8.4. Bags

Bags are unordered lists and we can have unidirectional bags or bidirectional ones.

##### Unidirectional bags

The unidirectional bag is mapped using a single @OneToMany annotation on the parent side of the association. Behind the scenes, Hibernate requires an association table to manage the parent-child relationship, as we can see in the following example:

*Example 193. Unidirectional bag*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

private List<Phone> phones = new ArrayList<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public List<Phone> getPhones() {

return phones;

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

private String type;

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Person\_Phone (

Person\_id BIGINT NOT NULL ,

phones\_id BIGINT NOT NULL

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

type VARCHAR(255) ,

PRIMARY KEY ( id )

)

ALTER TABLE Person\_Phone

ADD CONSTRAINT UK\_9uhc5itwc9h5gcng944pcaslf

UNIQUE (phones\_id)

ALTER TABLE Person\_Phone

ADD CONSTRAINT FKr38us2n8g5p9rj0b494sd3391

FOREIGN KEY (phones\_id) REFERENCES Phone

ALTER TABLE Person\_Phone

ADD CONSTRAINT FK2ex4e4p7w1cj310kg2woisjl2

FOREIGN KEY (Person\_id) REFERENCES Person

|  |  |
| --- | --- |
|  | Because both the parent and the child sides are entities, the persistence context manages each entity separately. Cascades can propagate an entity state transition from a parent entity to its children. |

By marking the parent side with the CascadeType.ALL attribute, the unidirectional association lifecycle becomes very similar to that of a value type collection.

*Example 194. Unidirectional bag lifecycle*

Person person = new Person( 1L );

person.getPhones().add( new Phone( 1L, "landline", "028-234-9876" ) );

person.getPhones().add( new Phone( 2L, "mobile", "072-122-9876" ) );

entityManager.persist( person );

INSERT INTO Person ( id )

VALUES ( 1 )

INSERT INTO Phone ( number, type, id )

VALUES ( '028-234-9876', 'landline', 1 )

INSERT INTO Phone ( number, type, id )

VALUES ( '072-122-9876', 'mobile', 2 )

INSERT INTO Person\_Phone ( Person\_id, phones\_id )

VALUES ( 1, 1 )

INSERT INTO Person\_Phone ( Person\_id, phones\_id )

VALUES ( 1, 2 )

In the example above, once the parent entity is persisted, the child entities are going to be persisted as well.

|  |  |
| --- | --- |
|  | Just like value type collections, unidirectional bags are not as efficient when it comes to modifying the collection structure (removing or reshuffling elements). Because the parent-side cannot uniquely identify each individual child, Hibernate might delete all child table rows associated with the parent entity and re-add them according to the current collection state. |

##### Bidirectional bags

The bidirectional bag is the most common type of entity collection. The @ManyToOne side is the owning side of the bidirectional bag association, while the @OneToMany is the inverse side, being marked with the mappedBy attribute.

*Example 195. Bidirectional bag*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

private List<Phone> phones = new ArrayList<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public List<Phone> getPhones() {

return phones;

}

public void addPhone(Phone phone) {

phones.add( phone );

phone.setPerson( this );

}

public void removePhone(Phone phone) {

phones.remove( phone );

phone.setPerson( null );

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

private String type;

@Column(name = "`number`", unique = true)

@NaturalId

private String number;

@ManyToOne

private Person person;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

CREATE TABLE Person (

id BIGINT NOT NULL, PRIMARY KEY (id)

)

CREATE TABLE Phone (

id BIGINT NOT NULL,

number VARCHAR(255),

type VARCHAR(255),

person\_id BIGINT,

PRIMARY KEY (id)

)

ALTER TABLE Phone

ADD CONSTRAINT UK\_l329ab0g4c1t78onljnxmbnp6

UNIQUE (number)

ALTER TABLE Phone

ADD CONSTRAINT FKmw13yfsjypiiq0i1osdkaeqpg

FOREIGN KEy (person\_id) REFERENCES Person

*Example 196. Bidirectional bag lifecycle*

person.addPhone( new Phone( 1L, "landline", "028-234-9876" ) );

person.addPhone( new Phone( 2L, "mobile", "072-122-9876" ) );

entityManager.flush();

person.removePhone( person.getPhones().get( 0 ) );

INSERT INTO Phone (number, person\_id, type, id)

VALUES ( '028-234-9876', 1, 'landline', 1 )

INSERT INTO Phone (number, person\_id, type, id)

VALUES ( '072-122-9876', 1, 'mobile', 2 )

UPDATE Phone

SET person\_id = NULL, type = 'landline' where id = 1

*Example 197. Bidirectional bag with orphan removal*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL, orphanRemoval = true)

private List<Phone> phones = new ArrayList<>();

DELETE FROM Phone WHERE id = 1

When rerunning the previous example, the child will get removed because the parent-side propagates the removal upon disassociating the child entity reference.

#### 2.8.5. Ordered Lists

Although they use the List interface on the Java side, bags don’t retain element order. To preserve the collection element order, there are two possibilities:

@OrderBy

the collection is ordered upon retrieval using a child entity property

@OrderColumn

the collection uses a dedicated order column in the collection link table

##### Unidirectional ordered lists

When using the @OrderBy annotation, the mapping looks as follows:

*Example 198. Unidirectional @OrderBy list*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

@OrderBy("number")

private List<Phone> phones = new ArrayList<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public List<Phone> getPhones() {

return phones;

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

private String type;

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

}

The database mapping is the same as with the [Unidirectional bags](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-bag) example, so it won’t be repeated. Upon fetching the collection, Hibernate generates the following select statement:

*Example 199. Unidirectional @OrderBy list select statement*

SELECT

phones0\_.Person\_id AS Person\_i1\_1\_0\_,

phones0\_.phones\_id AS phones\_i2\_1\_0\_,

unidirecti1\_.id AS id1\_2\_1\_,

unidirecti1\_."number" AS number2\_2\_1\_,

unidirecti1\_.type AS type3\_2\_1\_

FROM

Person\_Phone phones0\_

INNER JOIN

Phone unidirecti1\_ ON phones0\_.phones\_id=unidirecti1\_.id

WHERE

phones0\_.Person\_id = 1

ORDER BY

unidirecti1\_."number"

The child table column is used to order the list elements.

|  |  |
| --- | --- |
|  | The @OrderBy annotation can take multiple entity properties, and each property can take an ordering direction too (e.g. @OrderBy("name ASC, type DESC")).  If no property is specified (e.g. @OrderBy), the primary key of the child entity table is used for ordering. |

Another ordering option is to use the @OrderColumn annotation:

*Example 200. Unidirectional @OrderColumn list*

@OneToMany(cascade = CascadeType.ALL)

@OrderColumn(name = "order\_id")

private List<Phone> phones = new ArrayList<>();

CREATE TABLE Person\_Phone (

Person\_id BIGINT NOT NULL ,

phones\_id BIGINT NOT NULL ,

order\_id INTEGER NOT NULL ,

PRIMARY KEY ( Person\_id, order\_id )

)

This time, the link table takes the order\_id column and uses it to materialize the collection element order. When fetching the list, the following select query is executed:

*Example 201. Unidirectional @OrderColumn list select statement*

select

phones0\_.Person\_id as Person\_i1\_1\_0\_,

phones0\_.phones\_id as phones\_i2\_1\_0\_,

phones0\_.order\_id as order\_id3\_0\_,

unidirecti1\_.id as id1\_2\_1\_,

unidirecti1\_.number as number2\_2\_1\_,

unidirecti1\_.type as type3\_2\_1\_

from

Person\_Phone phones0\_

inner join

Phone unidirecti1\_

on phones0\_.phones\_id=unidirecti1\_.id

where

phones0\_.Person\_id = 1

With the order\_id column in place, Hibernate can order the list in-memory after it’s being fetched from the database.

##### Bidirectional ordered lists

The mapping is similar with the [Bidirectional bags](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-bidirectional-bag) example, just that the parent side is going to be annotated with either @OrderBy or @OrderColumn.

*Example 202. Bidirectional @OrderBy list*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@OrderBy("number")

private List<Phone> phones = new ArrayList<>();

Just like with the unidirectional @OrderBy list, the number column is used to order the statement on the SQL level.

When using the @OrderColumn annotation, the order\_id column is going to be embedded in the child table:

*Example 203. Bidirectional @OrderColumn list*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@OrderColumn(name = "order\_id")

private List<Phone> phones = new ArrayList<>();

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

type VARCHAR(255) ,

person\_id BIGINT ,

order\_id INTEGER ,

PRIMARY KEY ( id )

)

When fetching the collection, Hibernate will use the fetched ordered columns to sort the elements according to the @OrderColumn mapping.

##### Customizing ordered list ordinal

You can customize the ordinal of the underlying ordered list by using the [@ListIndexBase](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ListIndexBase.html) annotation.

*Example 204. @ListIndexBase mapping example*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@OrderColumn(name = "order\_id")

@ListIndexBase(100)

private List<Phone> phones = new ArrayList<>();

When inserting two Phone records, Hibernate is going to start the List index from 100 this time.

*Example 205. @ListIndexBase persist example*

Person person = new Person( 1L );

entityManager.persist( person );

person.addPhone( new Phone( 1L, "landline", "028-234-9876" ) );

person.addPhone( new Phone( 2L, "mobile", "072-122-9876" ) );

INSERT INTO Phone("number", person\_id, type, id)

VALUES ('028-234-9876', 1, 'landline', 1)

INSERT INTO Phone("number", person\_id, type, id)

VALUES ('072-122-9876', 1, 'mobile', 2)

UPDATE Phone

SET order\_id = 100

WHERE id = 1

UPDATE Phone

SET order\_id = 101

WHERE id = 2

##### Customizing ORDER BY SQL clause

While the JPA [@OrderBy](http://docs.oracle.com/javaee/7/api/javax/persistence/OrderBy.html) annotation allows you to specify the entity attributes used for sorting when fetching the current annotated collection, the Hibernate specific [@OrderBy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OrderBy.html) annotation is used to specify a **SQL** clause instead.

In the following example, the @OrderBy annotations uses the CHAR\_LENGTH SQL function to order the Article entities by the size of their contents.

*Example 206. @OrderBy mapping example*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@org.hibernate.annotations.OrderBy(clause = "CHAR\_LENGTH(name) DESC")

private List<Article> articles = new ArrayList<>();

//Getters and setters are omitted for brevity

}

@Entity(name = "Article")

public static class Article {

@Id

@GeneratedValue

private Long id;

private String name;

private String content;

@ManyToOne(fetch = FetchType.LAZY)

private Person person;

private Article() {

}

public Article(String name, String content) {

this.name = name;

this.content = content;

}

//Getters and setters are omitted for brevity

}

When fetching the articles collection, Hibernate uses the ORDER BY SQL clause provided by the mapping:

*Example 207. @OrderBy fetching example*

Person person = entityManager.find( Person.class, 1L );

assertEquals(

"High-Performance Hibernate",

person.getArticles().get( 0 ).getName()

);

select

a.person\_id as person\_i4\_0\_0\_,

a.id as id1\_0\_0\_,

a.content as content2\_0\_1\_,

a.name as name3\_0\_1\_,

a.person\_id as person\_i4\_0\_1\_

from

Article a

where

a.person\_id = ?

order by

CHAR\_LENGTH(a.name) desc

#### 2.8.6. Sets

Sets are collections that don’t allow duplicate entries and Hibernate supports both the unordered Set and the natural-ordering SortedSet.

##### Unidirectional sets

The unidirectional set uses a link table to hold the parent-child associations and the entity mapping looks as follows:

*Example 208. Unidirectional set*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

private Set<Phone> phones = new HashSet<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Set<Phone> getPhones() {

return phones;

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

private String type;

@NaturalId

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

The unidirectional set lifecycle is similar to that of the [Unidirectional bags](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-bag), so it can be omitted. The only difference is that Set doesn’t allow duplicates, but this constraint is enforced by the Java object contract rather then the database mapping.

|  |  |
| --- | --- |
|  | When using sets, it’s very important to supply proper equals/hashCode implementations for child entities. In the absence of a custom equals/hashCode implementation logic, Hibernate will use the default Java reference-based object equality which might render unexpected results when mixing detached and managed object instances. |

##### Bidirectional sets

Just like bidirectional bags, the bidirectional set doesn’t use a link table, and the child table has a foreign key referencing the parent table primary key. The lifecycle is just like with bidirectional bags except for the duplicates which are filtered out.

*Example 209. Bidirectional set*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

private Set<Phone> phones = new HashSet<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Set<Phone> getPhones() {

return phones;

}

public void addPhone(Phone phone) {

phones.add( phone );

phone.setPerson( this );

}

public void removePhone(Phone phone) {

phones.remove( phone );

phone.setPerson( null );

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

private String type;

@Column(name = "`number`", unique = true)

@NaturalId

private String number;

@ManyToOne

private Person person;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

#### 2.8.7. Sorted sets

For sorted sets, the entity mapping must use the SortedSet interface instead. According to the SortedSet contract, all elements must implement the Comparable interface and therefore provide the sorting logic.

##### Unidirectional sorted sets

A SortedSet that relies on the natural sorting order given by the child element Comparable implementation logic must be annotated with the @SortNatural Hibernate annotation.

*Example 210. Unidirectional natural sorted set*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

@SortNatural

private SortedSet<Phone> phones = new TreeSet<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Set<Phone> getPhones() {

return phones;

}

}

@Entity(name = "Phone")

public static class Phone implements Comparable<Phone> {

@Id

private Long id;

private String type;

@NaturalId

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

@Override

public int compareTo(Phone o) {

return number.compareTo( o.getNumber() );

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

The lifecycle and the database mapping are identical to the [Unidirectional bags](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-bag), so they are intentionally omitted.

To provide a custom sorting logic, Hibernate also provides a @SortComparator annotation:

*Example 211. Unidirectional custom comparator sorted set*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

@SortComparator(ReverseComparator.class)

private SortedSet<Phone> phones = new TreeSet<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Set<Phone> getPhones() {

return phones;

}

}

public static class ReverseComparator implements Comparator<Phone> {

@Override

public int compare(Phone o1, Phone o2) {

return o2.compareTo( o1 );

}

}

@Entity(name = "Phone")

public static class Phone implements Comparable<Phone> {

@Id

private Long id;

private String type;

@NaturalId

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(Long id, String type, String number) {

this.id = id;

this.type = type;

this.number = number;

}

public Long getId() {

return id;

}

public String getType() {

return type;

}

public String getNumber() {

return number;

}

@Override

public int compareTo(Phone o) {

return number.compareTo( o.getNumber() );

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

##### Bidirectional sorted sets

The @SortNatural and @SortComparator work the same for bidirectional sorted sets too:

*Example 212. Bidirectional natural sorted set*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@SortNatural

private SortedSet<Phone> phones = new TreeSet<>();

@OneToMany(cascade = CascadeType.ALL)

@SortComparator(ReverseComparator.class)

#### 2.8.8. Maps

A java.util.Map is ternary association because it required a parent entity a map key and a value. An entity can either be a map key or a map value, depending on the mapping. Hibernate allows using the following map keys:

MapKeyColumn

for value type maps, the map key is a column in the link table that defines the grouping logic

MapKey

the map key is either the primary key or another property of the entity stored as a map entry value

MapKeyEnumerated

the map key is an Enum of the target child entity

MapKeyTemporal

the map key is a Date or a Calendar of the target child entity

MapKeyJoinColumn

the map key is an entity mapped as an association in the child entity that’s stored as a map entry key

##### Value type maps

A map of value type must use the @ElementCollection annotation, just like value type lists, bags or sets.

*Example 213. Value type map with an entity as a map key*

public enum PhoneType {

LAND\_LINE,

MOBILE

}

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@Temporal(TemporalType.TIMESTAMP)

@ElementCollection

@CollectionTable(name = "phone\_register")

@Column(name = "since")

@MapKeyJoinColumn(name = "phone\_id", referencedColumnName = "id")

private Map<Phone, Date> phoneRegister = new HashMap<>();

public Person() {}

public Person(Long id) {

this.id = id;

}

public Map<Phone, Date> getPhoneRegister() {

return phoneRegister;

}

}

@Embeddable

public static class Phone {

private PhoneType type;

@Column(name = "`number`")

private String number;

public Phone() {

}

public Phone(PhoneType type, String number) {

this.type = type;

this.number = number;

}

public PhoneType getType() {

return type;

}

public String getNumber() {

return number;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE phone\_register (

Person\_id BIGINT NOT NULL ,

since TIMESTAMP ,

number VARCHAR(255) NOT NULL ,

type INTEGER NOT NULL ,

PRIMARY KEY ( Person\_id, number, type )

)

ALTER TABLE phone\_register

ADD CONSTRAINT FKrmcsa34hr68of2rq8qf526mlk

FOREIGN KEY (Person\_id) REFERENCES Person

Adding entries to the map generates the following SQL statements:

*Example 214. Adding value type map entries*

person.getPhoneRegister().put(

new Phone( PhoneType.LAND\_LINE, "028-234-9876" ), new Date()

);

person.getPhoneRegister().put(

new Phone( PhoneType.MOBILE, "072-122-9876" ), new Date()

);

INSERT INTO phone\_register (Person\_id, number, type, since)

VALUES (1, '072-122-9876', 1, '2015-12-15 17:16:45.311')

INSERT INTO phone\_register (Person\_id, number, type, since)

VALUES (1, '028-234-9876', 0, '2015-12-15 17:16:45.311')

##### Maps with a custom key type

Hibernate defines the [@MapKeyType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/MapKeyType.html) annotation which you can use to customize the Map key type.

Considering you have the following tables in your database:

create table person (

id int8 not null,

primary key (id)

)

create table call\_register (

person\_id int8 not null,

phone\_number int4,

call\_timestamp\_epoch int8 not null,

primary key (person\_id, call\_key)

)

alter table if exists call\_register

add constraint FKsn58spsregnjyn8xt61qkxsub

foreign key (person\_id)

references person

The call\_register records the call history for every person. The call\_timestamp\_epoch column stores the phone call timestamp as a Unix timestamp since epoch.

|  |  |
| --- | --- |
|  | The @MapKeyColumn annotation is used to define the table column holding the key while the @Column mapping gives the value of the java.util.Map in question. |

Since we want to map all the calls by their associated java.util.Date, not by their timestamp since epoch which is a number, the entity mapping looks as follows:

*Example 215. @MapKeyType mapping example*

@Entity

@Table(name = "person")

public static class Person {

@Id

private Long id;

@ElementCollection

@CollectionTable(

name = "call\_register",

joinColumns = @JoinColumn(name = "person\_id")

)

@MapKeyType(

@Type(

type = "org.hibernate.userguide.collections.type.TimestampEpochType"

)

)

@MapKeyColumn( name = "call\_timestamp\_epoch" )

@Column(name = "phone\_number")

private Map<Date, Integer> callRegister = new HashMap<>();

public void setId(Long id) {

this.id = id;

}

public Map<Date, Integer> getCallRegister() {

return callRegister;

}

}

The associated TimestampEpochType looks as follows:

public class TimestampEpochType

extends AbstractSingleColumnStandardBasicType<Date>

implements VersionType<Date>, LiteralType<Date> {

public static final TimestampEpochType INSTANCE = new TimestampEpochType();

public TimestampEpochType() {

super(

BigIntTypeDescriptor.INSTANCE,

JdbcTimestampTypeDescriptor.INSTANCE

);

}

@Override

public String getName() {

return "epoch";

}

@Override

public Date next(

Date current,

SharedSessionContractImplementor session) {

return seed( session );

}

@Override

public Date seed(

SharedSessionContractImplementor session) {

return new Timestamp( System.currentTimeMillis() );

}

@Override

public Comparator<Date> getComparator() {

return getJavaTypeDescriptor().getComparator();

}

@Override

public String objectToSQLString(

Date value,

Dialect dialect) throws Exception {

final Timestamp ts = Timestamp.class.isInstance( value )

? ( Timestamp ) value

: new Timestamp( value.getTime() );

return StringType.INSTANCE.objectToSQLString(

ts.toString(), dialect

);

}

@Override

public Date fromStringValue(

String xml) throws HibernateException {

return fromString( xml );

}

}

The TimestampEpochType allows us to map a Unix timestamp since epoch to a java.util.Date. But, without the @MapKeyType Hibernate annotation, it would nt be possible to customize the Map key type.

##### Maps having an interface type as the key

Considering you have the following PhoneNumber interface with an implementation given by the MobilePhone class type:

*Example 216. PhoneNumber interface and the MobilePhone class type*

public interface PhoneNumber {

String get();

}

@Embeddable

public static class MobilePhone

implements PhoneNumber {

static PhoneNumber fromString(String phoneNumber) {

String[] tokens = phoneNumber.split( "-" );

if ( tokens.length != 3 ) {

throw new IllegalArgumentException( "invalid phone number: " + phoneNumber );

}

int i = 0;

return new MobilePhone(

tokens[i++],

tokens[i++],

tokens[i]

);

}

private MobilePhone() {

}

public MobilePhone(

String countryCode,

String operatorCode,

String subscriberCode) {

this.countryCode = countryCode;

this.operatorCode = operatorCode;

this.subscriberCode = subscriberCode;

}

@Column(name = "country\_code")

private String countryCode;

@Column(name = "operator\_code")

private String operatorCode;

@Column(name = "subscriber\_code")

private String subscriberCode;

@Override

public String get() {

return String.format(

"%s-%s-%s",

countryCode,

operatorCode,

subscriberCode

);

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

MobilePhone that = (MobilePhone) o;

return Objects.equals( countryCode, that.countryCode ) &&

Objects.equals( operatorCode, that.operatorCode ) &&

Objects.equals( subscriberCode, that.subscriberCode );

}

@Override

public int hashCode() {

return Objects.hash( countryCode, operatorCode, subscriberCode );

}

}

If you want to use the PhoneNumber interface as a java.util.Map key, then you need to supply the [@MapKeyClass](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyClass.html)annotation as well.

*Example 217. @MapKeyClass mapping example*

@Entity

@Table(name = "person")

public static class Person {

@Id

private Long id;

@ElementCollection

@CollectionTable(

name = "call\_register",

joinColumns = @JoinColumn(name = "person\_id")

)

@MapKeyColumn( name = "call\_timestamp\_epoch" )

@MapKeyClass( MobilePhone.class )

@Column(name = "call\_register")

private Map<PhoneNumber, Integer> callRegister = new HashMap<>();

//Getters and setters are omitted for brevity

}

create table person (

id bigint not null,

primary key (id)

)

create table call\_register (

person\_id bigint not null,

call\_register integer,

country\_code varchar(255) not null,

operator\_code varchar(255) not null,

subscriber\_code varchar(255) not null,

primary key (person\_id, country\_code, operator\_code, subscriber\_code)

)

alter table call\_register

add constraint FKqyj2at6ik010jqckeaw23jtv2

foreign key (person\_id)

references person

When inserting a Person with a callRegister containing 2 MobilePhone references, Hibernate generates the following SQL statements:

*Example 218. @MapKeyClass persist example*

Person person = new Person();

person.setId( 1L );

person.getCallRegister().put( new MobilePhone( "01", "234", "567" ), 101 );

person.getCallRegister().put( new MobilePhone( "01", "234", "789" ), 102 );

entityManager.persist( person );

insert into person (id) values (?)

-- binding parameter [1] as [BIGINT] - [1]

insert into call\_register(

person\_id,

country\_code,

operator\_code,

subscriber\_code,

call\_register

)

values

(?, ?, ?, ?, ?)

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [VARCHAR] - [01]

-- binding parameter [3] as [VARCHAR] - [234]

-- binding parameter [4] as [VARCHAR] - [789]

-- binding parameter [5] as [INTEGER] - [102]

insert into call\_register(

person\_id,

country\_code,

operator\_code,

subscriber\_code,

call\_register

)

values

(?, ?, ?, ?, ?)

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [VARCHAR] - [01]

-- binding parameter [3] as [VARCHAR] - [234]

-- binding parameter [4] as [VARCHAR] - [567]

-- binding parameter [5] as [INTEGER] - [101]

When fetching a Person and accessing the callRegister Map, Hibernate generates the following SQL statements:

*Example 219. @MapKeyClass fetch example*

Person person = entityManager.find( Person.class, 1L );

assertEquals( 2, person.getCallRegister().size() );

assertEquals(

Integer.valueOf( 101 ),

person.getCallRegister().get( MobilePhone.fromString( "01-234-567" ) )

);

assertEquals(

Integer.valueOf( 102 ),

person.getCallRegister().get( MobilePhone.fromString( "01-234-789" ) )

);

select

cr.person\_id as person\_i1\_0\_0\_,

cr.call\_register as call\_reg2\_0\_0\_,

cr.country\_code as country\_3\_0\_,

cr.operator\_code as operator4\_0\_,

cr.subscriber\_code as subscrib5\_0\_

from

call\_register cr

where

cr.person\_id = ?

-- binding parameter [1] as [BIGINT] - [1]

-- extracted value ([person\_i1\_0\_0\_] : [BIGINT]) - [1]

-- extracted value ([call\_reg2\_0\_0\_] : [INTEGER]) - [101]

-- extracted value ([country\_3\_0\_] : [VARCHAR]) - [01]

-- extracted value ([operator4\_0\_] : [VARCHAR]) - [234]

-- extracted value ([subscrib5\_0\_] : [VARCHAR]) - [567]

-- extracted value ([person\_i1\_0\_0\_] : [BIGINT]) - [1]

-- extracted value ([call\_reg2\_0\_0\_] : [INTEGER]) - [102]

-- extracted value ([country\_3\_0\_] : [VARCHAR]) - [01]

-- extracted value ([operator4\_0\_] : [VARCHAR]) - [234]

-- extracted value ([subscrib5\_0\_] : [VARCHAR]) - [789]

##### Unidirectional maps

A unidirectional map exposes a parent-child association from the parent-side only.

The following example shows a unidirectional map which also uses a @MapKeyTemporal annotation. The map key is a timestamp and it’s taken from the child entity table.

|  |  |
| --- | --- |
|  | The @MapKey annotation is used to define the entity attribute used as a key of the java.util.Mapin question. |

*Example 220. Unidirectional Map*

public enum PhoneType {

LAND\_LINE,

MOBILE

}

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL, orphanRemoval = true)

@JoinTable(

name = "phone\_register",

joinColumns = @JoinColumn(name = "phone\_id"),

inverseJoinColumns = @JoinColumn(name = "person\_id"))

@MapKey(name = "since")

@MapKeyTemporal(TemporalType.TIMESTAMP)

private Map<Date, Phone> phoneRegister = new HashMap<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Map<Date, Phone> getPhoneRegister() {

return phoneRegister;

}

public void addPhone(Phone phone) {

phoneRegister.put( phone.getSince(), phone );

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

private PhoneType type;

@Column(name = "`number`")

private String number;

private Date since;

public Phone() {

}

public Phone(PhoneType type, String number, Date since) {

this.type = type;

this.number = number;

this.since = since;

}

public PhoneType getType() {

return type;

}

public String getNumber() {

return number;

}

public Date getSince() {

return since;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

since TIMESTAMP ,

type INTEGER ,

PRIMARY KEY ( id )

)

CREATE TABLE phone\_register (

phone\_id BIGINT NOT NULL ,

person\_id BIGINT NOT NULL ,

PRIMARY KEY ( phone\_id, person\_id )

)

ALTER TABLE phone\_register

ADD CONSTRAINT FKc3jajlx41lw6clbygbw8wm65w

FOREIGN KEY (person\_id) REFERENCES Phone

ALTER TABLE phone\_register

ADD CONSTRAINT FK6npoomh1rp660o1b55py9ndw4

FOREIGN KEY (phone\_id) REFERENCES Person

##### Bidirectional maps

Like most bidirectional associations, this relationship is owned by the child-side while the parent is the inverse side and can propagate its own state transitions to the child entities.

In the following example, you can see that @MapKeyEnumerated was used so that the Phone enumeration becomes the map key.

*Example 221. Bidirectional Map*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL, orphanRemoval = true)

@MapKey(name = "type")

@MapKeyEnumerated

private Map<PhoneType, Phone> phoneRegister = new HashMap<>();

public Person() {

}

public Person(Long id) {

this.id = id;

}

public Map<PhoneType, Phone> getPhoneRegister() {

return phoneRegister;

}

public void addPhone(Phone phone) {

phone.setPerson( this );

phoneRegister.put( phone.getType(), phone );

}

}

@Entity(name = "Phone")

public static class Phone {

@Id

@GeneratedValue

private Long id;

private PhoneType type;

@Column(name = "`number`")

private String number;

private Date since;

@ManyToOne

private Person person;

public Phone() {

}

public Phone(PhoneType type, String number, Date since) {

this.type = type;

this.number = number;

this.since = since;

}

public PhoneType getType() {

return type;

}

public String getNumber() {

return number;

}

public Date getSince() {

return since;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE Phone (

id BIGINT NOT NULL ,

number VARCHAR(255) ,

since TIMESTAMP ,

type INTEGER ,

person\_id BIGINT ,

PRIMARY KEY ( id )

)

ALTER TABLE Phone

ADD CONSTRAINT FKmw13yfsjypiiq0i1osdkaeqpg

FOREIGN KEY (person\_id) REFERENCES Person

#### 2.8.9. Arrays

When discussing arrays, it is important to understand the distinction between SQL array types and Java arrays that are mapped as part of the application’s domain model.

Not all databases implement the SQL-99 ARRAY type and, for this reason, Hibernate doesn’t support native database array types.

Hibernate does support the mapping of arrays in the Java domain model - conceptually the same as mapping a List. However, it is important to realize that it is impossible for Hibernate to offer lazy-loading for arrays of entities and, for this reason, it is strongly recommended to map a "collection" of entities using a List rather than an array.

#### 2.8.10. Arrays as binary

By default, Hibernate will choose a BINARY type, as supported by the current Dialect.

*Example 222. Arrays stored as binary*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String[] phones;

public Person() {

}

public Person(Long id) {

this.id = id;

}

public String[] getPhones() {

return phones;

}

public void setPhones(String[] phones) {

this.phones = phones;

}

}

CREATE TABLE Person (

id BIGINT NOT NULL ,

phones VARBINARY(255) ,

PRIMARY KEY ( id )

)

|  |  |
| --- | --- |
|  | If you want to map arrays such as String[] or int[] to database-specific array types like PostgreSQL integer[] or text[], you need to write a custom Hibernate Type.  Check out [this article](https://vladmihalcea.com/2017/06/21/how-to-map-java-and-sql-arrays-with-jpa-and-hibernate/) for an example of how to write such a custom Hibernate Type. |

#### 2.8.11. Collections as basic value type

Notice how all the previous examples explicitly mark the collection attribute as either ElementCollection, OneToManyor ManyToMany. Collections not marked as such require a custom Hibernate Type and the collection elements must be stored in a single database column.

This is sometimes beneficial. Consider a use-case such as a VARCHAR column that represents a delimited list/set of Strings.

*Example 223. Comma delimited collection*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@Type(type = "comma\_delimited\_strings")

private List<String> phones = new ArrayList<>();

public List<String> getPhones() {

return phones;

}

}

public class CommaDelimitedStringsJavaTypeDescriptor extends AbstractTypeDescriptor<List> {

public static final String DELIMITER = ",";

public CommaDelimitedStringsJavaTypeDescriptor() {

super(

List.class,

new MutableMutabilityPlan<List>() {

@Override

protected List deepCopyNotNull(List value) {

return new ArrayList( value );

}

}

);

}

@Override

public String toString(List value) {

return ( (List<String>) value ).stream().collect( Collectors.joining( DELIMITER ) );

}

@Override

public List fromString(String string) {

List<String> values = new ArrayList<>();

Collections.addAll( values, string.split( DELIMITER ) );

return values;

}

@Override

public <X> X unwrap(List value, Class<X> type, WrapperOptions options) {

return (X) toString( value );

}

@Override

public <X> List wrap(X value, WrapperOptions options) {

return fromString( (String) value );

}

}

public class CommaDelimitedStringsType extends AbstractSingleColumnStandardBasicType<List> {

public CommaDelimitedStringsType() {

super(

VarcharTypeDescriptor.INSTANCE,

new CommaDelimitedStringsJavaTypeDescriptor()

);

}

@Override

public String getName() {

return "comma\_delimited\_strings";

}

}

The developer can use the comma-delimited collection like any other collection we’ve discussed so far and Hibernate will take care of the type transformation part. The collection itself behaves like any other basic value type, as its lifecycle is bound to its owner entity.

*Example 224. Comma delimited collection lifecycle*

person.phones.add( "027-123-4567" );

person.phones.add( "028-234-9876" );

session.flush();

person.getPhones().remove( 0 );

INSERT INTO Person ( phones, id )

VALUES ( '027-123-4567,028-234-9876', 1 )

UPDATE Person

SET phones = '028-234-9876'

WHERE id = 1

See the Hibernate Integrations Guide for more details on developing custom value type mappings.

#### 2.8.12. Custom collection types

If you wish to use other collection types than List, Set or Map, like Queue for instance, you have to use a custom collection type, as illustrated by the following example:

*Example 225. Custom collection mapping example*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

@OneToMany(cascade = CascadeType.ALL)

@CollectionType( type = "org.hibernate.userguide.collections.type.QueueType")

private Collection<Phone> phones = new LinkedList<>();

//Constructors are omitted for brevity

public Queue<Phone> getPhones() {

return (Queue<Phone>) phones;

}

}

@Entity(name = "Phone")

public static class Phone implements Comparable<Phone> {

@Id

private Long id;

private String type;

@NaturalId

@Column(name = "`number`")

private String number;

//Getters and setters are omitted for brevity

@Override

public int compareTo(Phone o) {

return number.compareTo( o.getNumber() );

}

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Phone phone = (Phone) o;

return Objects.equals( number, phone.number );

}

@Override

public int hashCode() {

return Objects.hash( number );

}

}

public class QueueType implements UserCollectionType {

@Override

public PersistentCollection instantiate(

SharedSessionContractImplementor session,

CollectionPersister persister) throws HibernateException {

return new PersistentQueue( session );

}

@Override

public PersistentCollection wrap(

SharedSessionContractImplementor session,

Object collection) {

return new PersistentQueue( session, (List) collection );

}

@Override

public Iterator getElementsIterator(Object collection) {

return ( (Queue) collection ).iterator();

}

@Override

public boolean contains(Object collection, Object entity) {

return ( (Queue) collection ).contains( entity );

}

@Override

public Object indexOf(Object collection, Object entity) {

int i = ( (List) collection ).indexOf( entity );

return ( i < 0 ) ? null : i;

}

@Override

public Object replaceElements(

Object original,

Object target,

CollectionPersister persister,

Object owner,

Map copyCache,

SharedSessionContractImplementor session)

throws HibernateException {

Queue result = (Queue) target;

result.clear();

result.addAll( (Queue) original );

return result;

}

@Override

public Object instantiate(int anticipatedSize) {

return new LinkedList<>();

}

}

public class PersistentQueue extends PersistentBag implements Queue {

public PersistentQueue(SharedSessionContractImplementor session) {

super( session );

}

public PersistentQueue(SharedSessionContractImplementor session, List list) {

super( session, list );

}

@Override

public boolean offer(Object o) {

return add(o);

}

@Override

public Object remove() {

return poll();

}

@Override

public Object poll() {

int size = size();

if(size > 0) {

Object first = get(0);

remove( 0 );

return first;

}

throw new NoSuchElementException();

}

@Override

public Object element() {

return peek();

}

@Override

public Object peek() {

return size() > 0 ? get( 0 ) : null;

}

}

|  |  |
| --- | --- |
|  | The reason why the Queue interface is not used for the entity attribute is because Hibernate only allows the following types:   * java.util.List * java.util.Set * java.util.Map * java.util.SortedSet * java.util.SortedMap   However, the custom collection type can still be customized as long as the base type is one of the aformentioned persistent types. |

This way, the Phone collection can be used as a java.util.Queue:

*Example 226. Custom collection example*

Person person = entityManager.find( Person.class, 1L );

Queue<Phone> phones = person.getPhones();

Phone head = phones.peek();

assertSame(head, phones.poll());

assertEquals( 1, phones.size() );

### 2.9. Natural Ids

Natural ids represent domain model unique identifiers that have a meaning in the real world too. Even if a natural id does not make a good primary key (surrogate keys being usually preferred), it’s still useful to tell Hibernate about it. As we will see later, Hibernate provides a dedicated, efficient API for loading an entity by its natural id much like it offers for loading by its identifier (PK).

#### 2.9.1. Natural Id Mapping

Natural ids are defined in terms of on e or more persistent attributes.

*Example 227. Natural id using single basic attribute*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

@NaturalId

private String isbn;

//Getters and setters are omitted for brevity

}

*Example 228. Natural id using single embedded attribute*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

@NaturalId

@Embedded

private Isbn isbn;

//Getters and setters are omitted for brevity

}

@Embeddable

public static class Isbn implements Serializable {

private String isbn10;

private String isbn13;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Isbn isbn = (Isbn) o;

return Objects.equals( isbn10, isbn.isbn10 ) &&

Objects.equals( isbn13, isbn.isbn13 );

}

@Override

public int hashCode() {

return Objects.hash( isbn10, isbn13 );

}

}

*Example 229. Natural id using multiple persistent attributes*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

private String author;

@NaturalId

private String productNumber;

@NaturalId

@ManyToOne(fetch = FetchType.LAZY)

private Publisher publisher;

//Getters and setters are omitted for brevity

}

@Entity(name = "Publisher")

public static class Publisher implements Serializable {

@Id

private Long id;

private String name;

//Getters and setters are omitted for brevity

@Override

public boolean equals(Object o) {

if ( this == o ) {

return true;

}

if ( o == null || getClass() != o.getClass() ) {

return false;

}

Publisher publisher = (Publisher) o;

return Objects.equals( id, publisher.id ) &&

Objects.equals( name, publisher.name );

}

@Override

public int hashCode() {

return Objects.hash( id, name );

}

}

#### 2.9.2. Natural Id API

As stated before, Hibernate provides an API for loading entities by their associate natural id. This is represented by the org.hibernate.NaturalIdLoadAccess contract obtained via Session#byNaturalId.

|  |  |
| --- | --- |
|  | If the entity does not define a natural id, trying to load an entity by its natural id will throw an exception. |

*Example 230. Using NaturalIdLoadAccess*

Book book = entityManager

.unwrap(Session.class)

.byNaturalId( Book.class )

.using( "isbn", "978-9730228236" )

.load();

Book book = entityManager

.unwrap(Session.class)

.byNaturalId( Book.class )

.using(

"isbn",

new Isbn(

"973022823X",

"978-9730228236"

) )

.load();

Book book = entityManager

.unwrap(Session.class)

.byNaturalId( Book.class )

.using("productNumber", "973022823X")

.using("publisher", publisher)

.load();

NaturalIdLoadAccess offers 2 distinct methods for obtaining the entity:

load()

obtains a reference to the entity, making sure that the entity state is initialized

getReference()

obtains a reference to the entity. The state may or may not be initialized. If the entity is already associated with the current running Session, that reference (loaded or not) is returned. If the entity is not loaded in the current Session and the entity supports proxy generation, an uninitialized proxy is generated and returned, otherwise the entity is loaded from the database and returned.

NaturalIdLoadAccess allows loading an entity by natural id and at the same time apply a pessimistic lock. For additional details on locking, see the [Locking](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking) chapter.

We will discuss the last method available on NaturalIdLoadAccess ( setSynchronizationEnabled() ) in [Natural Id - Mutability and Caching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid-mutability-caching).

Because the Company and PostalCarrier entities define "simple" natural ids, we can load them as follows:

*Example 231. Loading by simple natural id*

Book book = entityManager

.unwrap(Session.class)

.bySimpleNaturalId( Book.class )

.load( "978-9730228236" );

Book book = entityManager

.unwrap(Session.class)

.bySimpleNaturalId( Book.class )

.load(

new Isbn(

"973022823X",

"978-9730228236"

)

);

Here we see the use of the org.hibernate.SimpleNaturalIdLoadAccess contract, obtained via `Session#bySimpleNaturalId().

SimpleNaturalIdLoadAccess is similar to NaturalIdLoadAccess except that it does not define the using method. Instead, because these simple natural ids are defined based on just one attribute we can directly pass the corresponding natural id attribute value directly to the load() and getReference() methods.

|  |  |
| --- | --- |
|  | If the entity does not define a natural id, or if the natural id is not of a "simple" type, an exception will be thrown there. |

#### 2.9.3. Natural Id - Mutability and Caching

A natural id may be mutable or immutable. By default the @NaturalId annotation marks an immutable natural id attribute. An immutable natural id is expected to never change its value.

If the value(s) of the natural id attribute(s) change, @NaturalId(mutable=true) should be used instead.

*Example 232. Mutable natural id mapping*

@Entity(name = "Author")

public static class Author {

@Id

private Long id;

private String name;

@NaturalId(mutable = true)

private String email;

//Getters and setters are omitted for brevity

}

Within the Session, Hibernate maintains a mapping from natural id values to entity identifiers (PK) values. If natural ids values changed, it is possible for this mapping to become out of date until a flush occurs.

To work around this condition, Hibernate will attempt to discover any such pending changes and adjust them when the load() or getReference() methods are executed. To be clear: this is only pertinent for mutable natural ids.

|  |  |
| --- | --- |
|  | This discovery and adjustment have a performance impact. If an application is certain that none of its mutable natural ids already associated with the Session have changed, it can disable that checking by calling setSynchronizationEnabled(false) (the default is true). This will force Hibernate to circumvent the checking of mutable natural ids. |

*Example 233. Mutable natural id synchronization use-case*

Author author = entityManager

.unwrap(Session.class)

.bySimpleNaturalId( Author.class )

.load( "john@acme.com" );

author.setEmail( "john.doe@acme.com" );

assertNull(

entityManager

.unwrap(Session.class)

.bySimpleNaturalId( Author.class )

.setSynchronizationEnabled( false )

.load( "john.doe@acme.com" )

);

assertSame( author,

entityManager

.unwrap(Session.class)

.bySimpleNaturalId( Author.class )

.setSynchronizationEnabled( true )

.load( "john.doe@acme.com" )

);

Not only can this NaturalId-to-PK resolution be cached in the Session, but we can also have it cached in the second-level cache if second level caching is enabled.

*Example 234. Natural id caching*

@Entity(name = "Book")

@NaturalIdCache

public static class Book {

@Id

private Long id;

private String title;

private String author;

@NaturalId

private String isbn;

//Getters and setters are omitted for brevity

}

### 2.10. Dynamic Model

|  |  |
| --- | --- |
|  | JPA only acknowledges the entity model mapping so, if you are concerned about JPA provider portability, it’s best to stick to the strict POJO model. On the other hand, Hibernate can work with both POJO entities as well as with dynamic entity models. |

#### 2.10.1. Dynamic mapping models

Persistent entities do not necessarily have to be represented as POJO/JavaBean classes. Hibernate also supports dynamic models (using Map of Maps at runtime). With this approach, you do not write persistent classes, only mapping files.

A given entity has just one entity mode within a given SessionFactory. This is a change from previous versions which allowed to define multiple entity modes for an entity and to select which to load. Entity modes can now be mixed within a domain model; a dynamic entity might reference a POJO entity, and vice versa.

*Example 235. Dynamic domain model Hibernate mapping*

<!DOCTYPE hibernate-mapping PUBLIC

"-//Hibernate/Hibernate Mapping DTD 3.0//EN"

"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd">

<hibernate-mapping>

<class entity-name="Book">

<id name="isbn" column="isbn" length="32" type="string"/>

<property name="title" not-null="true" length="50" type="string"/>

<property name="author" not-null="true" length="50" type="string"/>

</class>

</hibernate-mapping>

After you defined your entity mapping, you need to instruct Hibernate to use the dynamic mapping mode:

*Example 236. Dynamic domain model Hibernate mapping*

settings.put( "hibernate.default\_entity\_mode", "dynamic-map" );

When you are going to save the following Book dynamic entity, Hibernate is going to generate the following SQL statement:

*Example 237. Persist dynamic entity*

Map<String, String> book = new HashMap<>();

book.put( "isbn", "978-9730228236" );

book.put( "title", "High-Performance Java Persistence" );

book.put( "author", "Vlad Mihalcea" );

entityManager

.unwrap(Session.class)

.save( "Book", book );

insert

into

Book

(title, author, isbn)

values

(?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [2] as [VARCHAR] - [Vlad Mihalcea]

-- binding parameter [3] as [VARCHAR] - [978-9730228236]

|  |  |
| --- | --- |
|  | The main advantage of dynamic models is quick turnaround time for prototyping without the need for entity class implementation. The main down-fall is that you lose compile-time type checking and will likely deal with many exceptions at runtime. However, 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.  It is also interesting to note that dynamic models are great for certain integration use cases as well. Envers, for example, makes extensive use of dynamic models to represent the historical data. |

### 2.11. Inheritance

Although relational database systems don’t provide support for inheritance, Hibernate provides several strategies to leverage this object-oriented trait onto domain model entities:

MappedSuperclass

Inheritance is implemented in domain model only without reflecting it in the database schema. See [MappedSuperclass](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-mapped-superclass).

Single table

The domain model class hierarchy is materialized into a single table which contains entities belonging to different class types. See [Single table](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-single-table).

Joined table

The base class and all the subclasses have their own database tables and fetching a subclass entity requires a join with the parent table as well. See [Joined table](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-joined-table).

Table per class

Each subclass has its own table containing both the subclass and the base class properties. See [Table per class](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-table-per-class).

#### 2.11.1. MappedSuperclass

In the following domain model class hierarchy, a 'DebitAccount' and a 'CreditAccount' share the same 'Account' base class.

When using MappedSuperclass, the inheritance is visible in the domain model only and each database table contains both the base class and the subclass properties.

*Example 238. @MappedSuperclass inheritance*

@MappedSuperclass

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE DebitAccount (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

overdraftFee NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

CREATE TABLE CreditAccount (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

creditLimit NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

|  |  |
| --- | --- |
|  | Because the @MappedSuperclass inheritance model is not mirrored at database level, it’s not possible to use polymorphic queries (fetching subclasses by their base class). |

#### 2.11.2. Single table

The single table inheritance strategy maps all subclasses to only one database table. Each subclass declares its own persistent properties. Version and id properties are assumed to be inherited from the root class.

|  |  |
| --- | --- |
|  | When omitting an explicit inheritance strategy (e.g. @Inheritance), JPA will choose the SINGLE\_TABLE strategy by default. |

*Example 239. Single Table inheritance*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.SINGLE\_TABLE)

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE Account (

DTYPE VARCHAR(31) NOT NULL ,

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

overdraftFee NUMERIC(19, 2) ,

creditLimit NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

Each subclass in a hierarchy must define a unique discriminator value, which is used to differentiate between rows belonging to separate subclass types. If this is not specified, the DTYPE column is used as a discriminator, storing the associated subclass name.

*Example 240. Single Table inheritance discriminator column*

DebitAccount debitAccount = new DebitAccount();

debitAccount.setId( 1L );

debitAccount.setOwner( "John Doe" );

debitAccount.setBalance( BigDecimal.valueOf( 100 ) );

debitAccount.setInterestRate( BigDecimal.valueOf( 1.5d ) );

debitAccount.setOverdraftFee( BigDecimal.valueOf( 25 ) );

CreditAccount creditAccount = new CreditAccount();

creditAccount.setId( 2L );

creditAccount.setOwner( "John Doe" );

creditAccount.setBalance( BigDecimal.valueOf( 1000 ) );

creditAccount.setInterestRate( BigDecimal.valueOf( 1.9d ) );

creditAccount.setCreditLimit( BigDecimal.valueOf( 5000 ) );

entityManager.persist( debitAccount );

entityManager.persist( creditAccount );

INSERT INTO Account (balance, interestRate, owner, overdraftFee, DTYPE, id)

VALUES (100, 1.5, 'John Doe', 25, 'DebitAccount', 1)

INSERT INTO Account (balance, interestRate, owner, creditLimit, DTYPE, id)

VALUES (1000, 1.9, 'John Doe', 5000, 'CreditAccount', 2)

When using polymorphic queries, only a single table is required to be scanned to fetch all associated subclass instances.

*Example 241. Single Table polymorphic query*

List<Account> accounts = entityManager

.createQuery( "select a from Account a" )

.getResultList();

SELECT singletabl0\_.id AS id2\_0\_ ,

singletabl0\_.balance AS balance3\_0\_ ,

singletabl0\_.interestRate AS interest4\_0\_ ,

singletabl0\_.owner AS owner5\_0\_ ,

singletabl0\_.overdraftFee AS overdraf6\_0\_ ,

singletabl0\_.creditLimit AS creditLi7\_0\_ ,

singletabl0\_.DTYPE AS DTYPE1\_0\_

FROM Account singletabl0\_

|  |  |
| --- | --- |
|  | Among all other inheritance alternatives, the single table strategy performs the best since it requires access to one table only. Because all subclass columns are stored in a single table, it’s not possible to use NOT NULL constraints anymore, so integrity checks must be moved either into the data access layer or enforced through CHECK or TRIGGER constraints. |

##### Discriminator

The discriminator column contains marker values that tell the persistence layer what subclass to instantiate for a particular row. Hibernate Core supports the following restricted set of types as discriminator column: String, char, int, byte, short, boolean(including yes\_no, true\_false).

Use the @DiscriminatorColumn to define the discriminator column as well as the discriminator type.

|  |  |
| --- | --- |
|  | The enum DiscriminatorType used in javax.persistence.DiscriminatorColumn only contains the values STRING, CHAR and INTEGER which means that not all Hibernate supported types are available via the @DiscriminatorColumn annotation. You can also use @DiscriminatorFormula to express in SQL a virtual discriminator column. This is particularly useful when the discriminator value can be extracted from one or more columns of the table. Both @DiscriminatorColumn and @DiscriminatorFormulaare to be set on the root entity (once per persisted hierarchy).  @org.hibernate.annotations.DiscriminatorOptions allows to optionally specify Hibernate specific discriminator options which are not standardized in JPA. The available options are force and insert.  The force attribute is useful if the table contains rows with extra discriminator values that are not mapped to a persistent class. This could for example occur when working with a legacy database. If force is set to true Hibernate will specify the allowed discriminator values in the SELECT query, even when retrieving all instances of the root class.  The second option, insert, tells Hibernate whether or not to include the discriminator column in SQL INSERTs. Usually, the column should be part of the INSERT statement, but if your discriminator column is also part of a mapped composite identifier you have to set this option to false. |
|  | There used to be @org.hibernate.annotations.ForceDiscriminator annotation which was deprecated in version 3.6 and later removed. Use @DiscriminatorOptions instead. |

###### Discriminator formula

Assuming a legacy database schema where the discriminator is based on inspecting a certain column, we can take advantage of the Hibernate specific @DiscriminatorFormula annotation and map the inheritance model as follows:

*Example 242. Single Table discriminator formula*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.SINGLE\_TABLE)

@DiscriminatorFormula(

"case when debitKey is not null " +

"then 'Debit' " +

"else ( " +

" case when creditKey is not null " +

" then 'Credit' " +

" else 'Unknown' " +

" end ) " +

"end "

)

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

@DiscriminatorValue(value = "Debit")

public static class DebitAccount extends Account {

private String debitKey;

private BigDecimal overdraftFee;

private DebitAccount() {

}

public DebitAccount(String debitKey) {

this.debitKey = debitKey;

}

public String getDebitKey() {

return debitKey;

}

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

@DiscriminatorValue(value = "Credit")

public static class CreditAccount extends Account {

private String creditKey;

private BigDecimal creditLimit;

private CreditAccount() {

}

public CreditAccount(String creditKey) {

this.creditKey = creditKey;

}

public String getCreditKey() {

return creditKey;

}

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE Account (

id int8 NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

debitKey VARCHAR(255) ,

overdraftFee NUMERIC(19, 2) ,

creditKey VARCHAR(255) ,

creditLimit NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

The @DiscriminatorFormula defines a custom SQL clause that can be used to identify a certain subclass type. The @DiscriminatorValue defines the mapping between the result of the @DiscriminatorFormula and the inheritance subclass type.

###### Implicit discriminator values

Aside from the usual discriminator values assigned to each individual subclass type, the @DiscriminatorValue can take two additional values:

null

If the underlying discriminator column is null, the null discriminator mapping is going to be used.

not null

If the underlying discriminator column has a not-null value that is not explicitly mapped to any entity, the not-nulldiscriminator mapping used.

To understand how these two values work, consider the following entity mapping:

*Example 243. @DiscriminatorValue null and not-null entity mapping*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.SINGLE\_TABLE)

@DiscriminatorValue( "null" )

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

@DiscriminatorValue( "Debit" )

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

@DiscriminatorValue( "Credit" )

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

@Entity(name = "OtherAccount")

@DiscriminatorValue( "not null" )

public static class OtherAccount extends Account {

private boolean active;

public boolean isActive() {

return active;

}

public void setActive(boolean active) {

this.active = active;

}

}

The Account class has a @DiscriminatorValue( "null" ) mapping, meaning that any account row which does not contain any discriminator value will be mapped to an Account base class entity. The DebitAccount and CreditAccount entities use explicit discriminator values. The OtherAccount entity is used as a generic account type because it maps any database row whose discriminator column is not explicitly assigned to any other entity in the current inheritance tree.

To visualize how it works, consider the following example:

*Example 244. @DiscriminatorValue null and not-null entity persistence*

DebitAccount debitAccount = new DebitAccount();

debitAccount.setId( 1L );

debitAccount.setOwner( "John Doe" );

debitAccount.setBalance( BigDecimal.valueOf( 100 ) );

debitAccount.setInterestRate( BigDecimal.valueOf( 1.5d ) );

debitAccount.setOverdraftFee( BigDecimal.valueOf( 25 ) );

CreditAccount creditAccount = new CreditAccount();

creditAccount.setId( 2L );

creditAccount.setOwner( "John Doe" );

creditAccount.setBalance( BigDecimal.valueOf( 1000 ) );

creditAccount.setInterestRate( BigDecimal.valueOf( 1.9d ) );

creditAccount.setCreditLimit( BigDecimal.valueOf( 5000 ) );

Account account = new Account();

account.setId( 3L );

account.setOwner( "John Doe" );

account.setBalance( BigDecimal.valueOf( 1000 ) );

account.setInterestRate( BigDecimal.valueOf( 1.9d ) );

entityManager.persist( debitAccount );

entityManager.persist( creditAccount );

entityManager.persist( account );

entityManager.unwrap( Session.class ).doWork( connection -> {

try(Statement statement = connection.createStatement()) {

statement.executeUpdate(

"insert into Account (DTYPE, active, balance, interestRate, owner, id) " +

"values ('Other', true, 25, 0.5, 'Vlad', 4)"

);

}

} );

Map<Long, Account> accounts = entityManager.createQuery(

"select a from Account a", Account.class )

.getResultList()

.stream()

.collect( Collectors.toMap( Account::getId, Function.identity()));

assertEquals(4, accounts.size());

assertEquals( DebitAccount.class, accounts.get( 1L ).getClass() );

assertEquals( CreditAccount.class, accounts.get( 2L ).getClass() );

assertEquals( Account.class, accounts.get( 3L ).getClass() );

assertEquals( OtherAccount.class, accounts.get( 4L ).getClass() );

INSERT INTO Account (balance, interestRate, owner, overdraftFee, DTYPE, id)

VALUES (100, 1.5, 'John Doe', 25, 'Debit', 1)

INSERT INTO Account (balance, interestRate, owner, overdraftFee, DTYPE, id)

VALUES (1000, 1.9, 'John Doe', 5000, 'Credit', 2)

INSERT INTO Account (balance, interestRate, owner, id)

VALUES (1000, 1.9, 'John Doe', 3)

INSERT INTO Account (DTYPE, active, balance, interestRate, owner, id)

VALUES ('Other', true, 25, 0.5, 'Vlad', 4)

SELECT a.id as id2\_0\_,

a.balance as balance3\_0\_,

a.interestRate as interest4\_0\_,

a.owner as owner5\_0\_,

a.overdraftFee as overdraf6\_0\_,

a.creditLimit as creditLi7\_0\_,

a.active as active8\_0\_,

a.DTYPE as DTYPE1\_0\_

FROM Account a

As you can see, the Account entity row has a value of NULL in the DTYPE discriminator column, while the OtherAccount entity was saved with a DTYPE column value of other which has not explicit mapping.

#### 2.11.3. Joined table

Each subclass can also be mapped to its own table. This is also called table-per-subclass mapping strategy. An inherited state is retrieved by joining with the table of the superclass.

A discriminator column is not required for this mapping strategy. Each subclass must, however, declare a table column holding the object identifier.

*Example 245. Join Table*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.JOINED)

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE Account (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE CreditAccount (

creditLimit NUMERIC(19, 2) ,

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

CREATE TABLE DebitAccount (

overdraftFee NUMERIC(19, 2) ,

id BIGINT NOT NULL ,

PRIMARY KEY ( id )

)

ALTER TABLE CreditAccount

ADD CONSTRAINT FKihw8h3j1k0w31cnyu7jcl7n7n

FOREIGN KEY (id) REFERENCES Account

ALTER TABLE DebitAccount

ADD CONSTRAINT FKia914478noepymc468kiaivqm

FOREIGN KEY (id) REFERENCES Account

|  |  |
| --- | --- |
|  | The primary key of this table is also a foreign key to the superclass table and described by the @PrimaryKeyJoinColumns.  The table name still defaults to the non-qualified class name. Also, if @PrimaryKeyJoinColumn is not set, the primary key / foreign key columns are assumed to have the same names as the primary key columns of the primary table of the superclass. |

*Example 246. Join Table with @PrimaryKeyJoinColumn*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.JOINED)

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

@PrimaryKeyJoinColumn(name = "account\_id")

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

@PrimaryKeyJoinColumn(name = "account\_id")

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE CreditAccount (

creditLimit NUMERIC(19, 2) ,

account\_id BIGINT NOT NULL ,

PRIMARY KEY ( account\_id )

)

CREATE TABLE DebitAccount (

overdraftFee NUMERIC(19, 2) ,

account\_id BIGINT NOT NULL ,

PRIMARY KEY ( account\_id )

)

ALTER TABLE CreditAccount

ADD CONSTRAINT FK8ulmk1wgs5x7igo370jt0q005

FOREIGN KEY (account\_id) REFERENCES Account

ALTER TABLE DebitAccount

ADD CONSTRAINT FK7wjufa570onoidv4omkkru06j

FOREIGN KEY (account\_id) REFERENCES Account

When using polymorphic queries, the base class table must be joined with all subclass tables to fetch every associated subclass instance.

*Example 247. Join Table polymorphic query*

List<Account> accounts = entityManager

.createQuery( "select a from Account a" )

.getResultList();

SELECT jointablet0\_.id AS id1\_0\_ ,

jointablet0\_.balance AS balance2\_0\_ ,

jointablet0\_.interestRate AS interest3\_0\_ ,

jointablet0\_.owner AS owner4\_0\_ ,

jointablet0\_1\_.overdraftFee AS overdraf1\_2\_ ,

jointablet0\_2\_.creditLimit AS creditLi1\_1\_ ,

CASE WHEN jointablet0\_1\_.id IS NOT NULL THEN 1

WHEN jointablet0\_2\_.id IS NOT NULL THEN 2

WHEN jointablet0\_.id IS NOT NULL THEN 0

END AS clazz\_

FROM Account jointablet0\_

LEFT OUTER JOIN DebitAccount jointablet0\_1\_ ON jointablet0\_.id = jointablet0\_1\_.id

LEFT OUTER JOIN CreditAccount jointablet0\_2\_ ON jointablet0\_.id = jointablet0\_2\_.id

|  |  |
| --- | --- |
|  | The joined table inheritance polymorphic queries can use several JOINS which might affect performance when fetching a large number of entities. |

#### 2.11.4. Table per class

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 as a separate entity root. 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.

*Example 248. Table per class*

@Entity(name = "Account")

@Inheritance(strategy = InheritanceType.TABLE\_PER\_CLASS)

public static class Account {

@Id

private Long id;

private String owner;

private BigDecimal balance;

private BigDecimal interestRate;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getOwner() {

return owner;

}

public void setOwner(String owner) {

this.owner = owner;

}

public BigDecimal getBalance() {

return balance;

}

public void setBalance(BigDecimal balance) {

this.balance = balance;

}

public BigDecimal getInterestRate() {

return interestRate;

}

public void setInterestRate(BigDecimal interestRate) {

this.interestRate = interestRate;

}

}

@Entity(name = "DebitAccount")

public static class DebitAccount extends Account {

private BigDecimal overdraftFee;

public BigDecimal getOverdraftFee() {

return overdraftFee;

}

public void setOverdraftFee(BigDecimal overdraftFee) {

this.overdraftFee = overdraftFee;

}

}

@Entity(name = "CreditAccount")

public static class CreditAccount extends Account {

private BigDecimal creditLimit;

public BigDecimal getCreditLimit() {

return creditLimit;

}

public void setCreditLimit(BigDecimal creditLimit) {

this.creditLimit = creditLimit;

}

}

CREATE TABLE Account (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

PRIMARY KEY ( id )

)

CREATE TABLE CreditAccount (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

creditLimit NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

CREATE TABLE DebitAccount (

id BIGINT NOT NULL ,

balance NUMERIC(19, 2) ,

interestRate NUMERIC(19, 2) ,

owner VARCHAR(255) ,

overdraftFee NUMERIC(19, 2) ,

PRIMARY KEY ( id )

)

When using polymorphic queries, a UNION is required to fetch the base class table along with all subclass tables as well.

*Example 249. Table per class polymorphic query*

List<Account> accounts = entityManager

.createQuery( "select a from Account a" )

.getResultList();

SELECT tablepercl0\_.id AS id1\_0\_ ,

tablepercl0\_.balance AS balance2\_0\_ ,

tablepercl0\_.interestRate AS interest3\_0\_ ,

tablepercl0\_.owner AS owner4\_0\_ ,

tablepercl0\_.overdraftFee AS overdraf1\_2\_ ,

tablepercl0\_.creditLimit AS creditLi1\_1\_ ,

tablepercl0\_.clazz\_ AS clazz\_

FROM (

SELECT id ,

balance ,

interestRate ,

owner ,

CAST(NULL AS INT) AS overdraftFee ,

CAST(NULL AS INT) AS creditLimit ,

0 AS clazz\_

FROM Account

UNION ALL

SELECT id ,

balance ,

interestRate ,

owner ,

overdraftFee ,

CAST(NULL AS INT) AS creditLimit ,

1 AS clazz\_

FROM DebitAccount

UNION ALL

SELECT id ,

balance ,

interestRate ,

owner ,

CAST(NULL AS INT) AS overdraftFee ,

creditLimit ,

2 AS clazz\_

FROM CreditAccount

) tablepercl0\_

|  |  |
| --- | --- |
|  | Polymorphic queries require multiple UNION queries, so be aware of the performance implications of a large class hierarchy. |

#### 2.11.5. Implicit and explicit polymorphism

By default, when you query a base class entity, the polymorphic query will fetch all subclasses belonging to the base type.

However, you can even query **interfaces or base classes that don’t belong to the JPA entity inheritance model**.

For instance, considering the following DomainModelEntity interface:

*Example 250. Domain Model Entity interface*

public interface DomainModelEntity<ID> {

ID getId();

Integer getVersion();

}

If we have two entity mappings, a Book and a Blog, and the Book entity is mapped with the [@Polymorphism](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Polymorphism.html)annotation and taking the PolymorphismType.EXPLICIT setting:

*Example 251. @Polymorphism entity mapping*

@Entity(name = "Event")

public static class Book implements DomainModelEntity<Long> {

@Id

private Long id;

@Version

private Integer version;

private String title;

private String author;

//Getter and setters omitted for brevity

}

@Entity(name = "Blog")

@Polymorphism(type = PolymorphismType.EXPLICIT)

public static class Blog implements DomainModelEntity<Long> {

@Id

private Long id;

@Version

private Integer version;

private String site;

//Getter and setters omitted for brevity

}

If we have the following entity objects in our system:

*Example 252. Domain Model entity objects*

Book book = new Book();

book.setId( 1L );

book.setAuthor( "Vlad Mihalcea" );

book.setTitle( "High-Performance Java Persistence" );

entityManager.persist( book );

Blog blog = new Blog();

blog.setId( 1L );

blog.setSite( "vladmihalcea.com" );

entityManager.persist( blog );

We can now query against the DomainModelEntity interface, and Hibernate is going to fetch only the entities that are either mapped with @Polymorphism(type = PolymorphismType.IMPLICIT) or they are not annotated at all with the @Polymorphism annotation (implying the IMPLICIT behavior):

*Example 253. Fetching Domain Model entities using non-mapped base class polymorphism*

List<DomainModelEntity> accounts = entityManager

.createQuery(

"select e " +

"from org.hibernate.userguide.inheritance.polymorphism.DomainModelEntity e" )

.getResultList();

assertEquals(1, accounts.size());

assertTrue( accounts.get( 0 ) instanceof Book );

Therefore, only the Book was fetched since the Blog entity was marked with the @Polymorphism(type = PolymorphismType.EXPLICIT) annotation, which instructs Hibernate to skip it when executing a polymorphic query against a non-mapped base class.

### 2.12. Immutability

Immutability can be specified for both entities and collections.

#### 2.12.1. Entity immutability

If a specific entity is immutable, it is good practice to mark it with the @Immutable annotation.

*Example 254. Immutable entity*

@Entity(name = "Event")

@Immutable

public static class Event {

@Id

private Long id;

private Date createdOn;

private String message;

//Getters and setters are omitted for brevity

}

Internally, Hibernate is going to perform several optimizations, such as:

* reducing memory footprint since there is no need to retain the dehydrated state for the dirty checking mechanism
* speeding-up the Persistence Context flushing phase since immutable entities can skip the dirty checking process

Considering the following entity is persisted in the database:

*Example 255. Persisting an immutable entity*

doInJPA( this::entityManagerFactory, entityManager -> {

Event event = new Event();

event.setId( 1L );

event.setCreatedOn( new Date( ) );

event.setMessage( "Hibernate User Guide rocks!" );

entityManager.persist( event );

} );

When loading the entity and trying to change its state, Hibernate will skip any modification, therefore no SQL UPDATEstatement is executed.

*Example 256. The immutable entity ignores any update*

doInJPA( this::entityManagerFactory, entityManager -> {

Event event = entityManager.find( Event.class, 1L );

log.info( "Change event message" );

event.setMessage( "Hibernate User Guide" );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

Event event = entityManager.find( Event.class, 1L );

assertEquals("Hibernate User Guide rocks!", event.getMessage());

} );

SELECT e.id AS id1\_0\_0\_,

e.createdOn AS createdO2\_0\_0\_,

e.message AS message3\_0\_0\_

FROM event e

WHERE e.id = 1

-- Change event message

SELECT e.id AS id1\_0\_0\_,

e.createdOn AS createdO2\_0\_0\_,

e.message AS message3\_0\_0\_

FROM event e

WHERE e.id = 1

#### 2.12.2. Collection immutability

Just like entities, collections can also be marked with the @Immutable annotation.

Considering the following entity mappings:

*Example 257. Immutable collection*

@Entity(name = "Batch")

public static class Batch {

@Id

private Long id;

private String name;

@OneToMany(cascade = CascadeType.ALL)

@Immutable

private List<Event> events = new ArrayList<>( );

//Getters and setters are omitted for brevity

}

@Entity(name = "Event")

@Immutable

public static class Event {

@Id

private Long id;

private Date createdOn;

private String message;

//Getters and setters are omitted for brevity

}

This time, not only the Event entity is immutable, but the Event collection stored by the Batch parent entity. Once the immutable collection is created, it can never be modified.

*Example 258. Persisting an immutable collection*

doInJPA( this::entityManagerFactory, entityManager -> {

Batch batch = new Batch();

batch.setId( 1L );

batch.setName( "Change request" );

Event event1 = new Event();

event1.setId( 1L );

event1.setCreatedOn( new Date( ) );

event1.setMessage( "Update Hibernate User Guide" );

Event event2 = new Event();

event2.setId( 2L );

event2.setCreatedOn( new Date( ) );

event2.setMessage( "Update Hibernate Getting Started Guide" );

batch.getEvents().add( event1 );

batch.getEvents().add( event2 );

entityManager.persist( batch );

} );

The Batch entity is mutable. Only the events collection is immutable.

For instance, we can still modify the entity name:

*Example 259. Changing the mutable entity*

doInJPA( this::entityManagerFactory, entityManager -> {

Batch batch = entityManager.find( Batch.class, 1L );

log.info( "Change batch name" );

batch.setName( "Proposed change request" );

} );

SELECT b.id AS id1\_0\_0\_,

b.name AS name2\_0\_0\_

FROM Batch b

WHERE b.id = 1

-- Change batch name

UPDATE batch

SET name = 'Proposed change request'

WHERE id = 1

However, when trying to modify the events collection:

*Example 260. Immutable collections cannot be modified*

try {

doInJPA( this::entityManagerFactory, entityManager -> {

Batch batch = entityManager.find( Batch.class, 1L );

batch.getEvents().clear();

} );

}

catch ( Exception e ) {

log.error( "Immutable collections cannot be modified" );

}

Unresolved directive in chapters/domain/immutability.adoc - include::extras/immutability/collection-immutability-update-example.log[]

|  |  |
| --- | --- |
|  | While immutable entity changes are simply discarded, modifying an immutable collection end up in a HibernateException being thrown. |

## 3. Bootstrap

The term bootstrapping refers to initializing and starting a software component. In Hibernate, we are specifically talking about the process of building a fully functional SessionFactory instance or EntityManagerFactory instance, for JPA. The process is very different for each.

|  |  |
| --- | --- |
|  | This chapter will not focus on all the possibilities of bootstrapping. Those will be covered in each specific more-relevant chapters later on. Instead, we focus here on the API calls needed to perform the bootstrapping. |
|  | During the bootstrap process, you might want to customize Hibernate behavior so make sure you check the [Configurations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#configurations) section as well. |

### 3.1. JPA Bootstrapping

Bootstrapping Hibernate as a JPA provider can be done in a JPA-spec compliant manner or using a proprietary bootstrapping approach. The standardized approach has some limitations in certain environments, but aside from those, it is **highly** recommended that you use JPA-standardized bootstrapping.

#### 3.1.1. JPA-compliant bootstrapping

In JPA, we are ultimately interested in bootstrapping a javax.persistence.EntityManagerFactory instance. The JPA specification defines two primary standardized bootstrap approaches depending on how the application intends to access the javax.persistence.EntityManager instances from an EntityManagerFactory.

It uses the terms EE and SE for these two approaches, but those terms are very misleading in this context. What the JPA spec calls EE bootstrapping implies the existence of a container (EE, OSGi, etc), who’ll manage and inject the persistence context on behalf of the application. What it calls SE bootstrapping is everything else. We will use the terms container-bootstrapping and application-bootstrapping in this guide.

For compliant container-bootstrapping, the container will build an EntityManagerFactory for each persistent-unit defined in the META-INF/persistence.xml configuration file and make that available to the application for injection via the javax.persistence.PersistenceUnit annotation or via JNDI lookup.

*Example 261. Injecting the default EntityManagerFactory*

@PersistenceUnit

private EntityManagerFactory emf;

Or, in case you have multiple Persistence Units (e.g. multiple persistence.xml configuration files), you can inject a specific EntityManagerFactory by Unit name:

*Example 262. Injecting a specific EntityManagerFactory*

@PersistenceUnit(

unitName = "CRM"

)

private EntityManagerFactory entityManagerFactory;

The META-INF/persistence.xml file looks as follows:

*Example 263. META-INF/persistence.xml configuration file*

<persistence xmlns="http://xmlns.jcp.org/xml/ns/persistence"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/persistence

http://xmlns.jcp.org/xml/ns/persistence/persistence\_2\_1.xsd"

version="2.1">

<persistence-unit name="CRM">

<description>

Persistence unit for Hibernate User Guide

</description>

<provider>org.hibernate.jpa.HibernatePersistenceProvider</provider>

<class>org.hibernate.documentation.userguide.Document</class>

<properties>

<property name="javax.persistence.jdbc.driver"

value="org.h2.Driver" />

<property name="javax.persistence.jdbc.url"

value="jdbc:h2:mem:db1;DB\_CLOSE\_DELAY=-1;MVCC=TRUE" />

<property name="javax.persistence.jdbc.user"

value="sa" />

<property name="javax.persistence.jdbc.password"

value="" />

<property name="hibernate.show\_sql"

value="true" />

<property name="hibernate.hbm2ddl.auto"

value="update" />

</properties>

</persistence-unit>

</persistence>

For compliant application-bootstrapping, rather than the container building the EntityManagerFactory for the application, the application builds the EntityManagerFactory itself using the javax.persistence.Persistencebootstrap class. The application creates an EntityManagerFactory by calling the createEntityManagerFactorymethod:

*Example 264. Application bootstrapped EntityManagerFactory*

// Create an EMF for our CRM persistence-unit.

EntityManagerFactory emf = Persistence.createEntityManagerFactory( "CRM" );

|  |  |
| --- | --- |
|  | If you don’t want to provide a persistence.xml configuration file, JPA allows you to provide all the configuration options in a [PersistenceUnitInfo](http://docs.oracle.com/javaee/7/api/javax/persistence/spi/PersistenceUnitInfo.html) implementation and call[HibernatePersistenceProvider.html#createContainerEntityManagerFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/jpa/HibernatePersistenceProvider.html#createContainerEntityManagerFactory-javax.persistence.spi.PersistenceUnitInfo-java.util.Map-). |

To inject the default Persistence Context, you can use the [@PersistenceContext](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceContext.html) annotation.

*Example 265. Inject the default EntityManager*

@PersistenceContext

private EntityManager em;

To inject a specific Persistence Context, you can use the [@PersistenceContext](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceContext.html) annotation, and you can even pass EntityManager-specific properties using the [@PersistenceProperty](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceProperty.html) annotation.

*Example 266. Inject a configurable EntityManager*

@PersistenceContext(

unitName = "CRM",

properties = {

@PersistenceProperty(

name="org.hibernate.flushMode",

value= "MANUAL"

)

}

)

private EntityManager entityManager;

|  |  |
| --- | --- |
|  | If you would like additional details on accessing and using EntityManager instances, sections 7.6 and 7.7 of the JPA 2.1 specification cover container-managed and application-managed EntityManagers, respectively. |

#### 3.1.2. Externalizing XML mapping files

JPA offers two mapping options:

* annotations
* XML mappings

Although annotations are much more common, there are projects were XML mappings are preferred. You can even mix annotations and XML mappings so that you can override annotation mappings with XML configurations that can be easily changed without recompiling the project source code. This is possible because if there are two conflicting mappings, the XML mappings takes precedence over its annotation counterpart.

The JPA specifications requires the XML mappings to be located on the class path:

*An object/relational mapping XML file named orm.xml may be specified in the META-INF directory in the root of the persistence unit or in the META-INF directory of any jar file referenced by the persistence.xml.*

*Alternatively, or in addition, one or more mapping files may be referenced by the mapping-file elements of the persistence-unit element. These mapping files may be present anywhere on the class path.*

*— Section 8.2.1.6.2 of the JPA 2.1 Specification*

Therefore, the mapping files can reside in the application jar artifacts, or they can be stored in an external folder location with the cogitation that that location be included in the class path.

Hibernate is more lenient in this regard so you can use any external location even outside of the application configured class path.

*Example 267. META-INF/persistence.xml configuration file for external XML mappings*

<persistence xmlns="http://xmlns.jcp.org/xml/ns/persistence"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/persistence

http://xmlns.jcp.org/xml/ns/persistence/persistence\_2\_1.xsd"

version="2.1">

<persistence-unit name="CRM">

<description>

Persistence unit for Hibernate User Guide

</description>

<provider>org.hibernate.jpa.HibernatePersistenceProvider</provider>

<mapping-file>file:///etc/opt/app/mappings/orm.xml</mapping-file>

<properties>

<property name="javax.persistence.jdbc.driver"

value="org.h2.Driver" />

<property name="javax.persistence.jdbc.url"

value="jdbc:h2:mem:db1;DB\_CLOSE\_DELAY=-1;MVCC=TRUE" />

<property name="javax.persistence.jdbc.user"

value="sa" />

<property name="javax.persistence.jdbc.password"

value="" />

<property name="hibernate.show\_sql"

value="true" />

<property name="hibernate.hbm2ddl.auto"

value="update" />

</properties>

</persistence-unit>

</persistence>

In the persistence.xml configuration file above, the orm.xml XML file containing all JPA entity mappings is located in the /etc/opt/app/mappings/ folder.

### 3.2. Native Bootstrapping

This section discusses the process of bootstrapping a Hibernate SessionFactory. Specifically it discusses the bootstrapping APIs as redesigned in 5.0. For a discussion of the legacy bootstrapping API, see [Legacy Bootstrapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#appendix-legacy-bootstrap)

#### 3.2.1. Building the ServiceRegistry

The first step in native bootstrapping is the building of a ServiceRegistry holding the services Hibernate will need during bootstrapping and at run time.

Actually, we are concerned with building 2 different ServiceRegistries. First is the org.hibernate.boot.registry.BootstrapServiceRegistry. The BootstrapServiceRegistry is intended to hold services that Hibernate needs at both bootstrap and run time. This boils down to 3 services:

org.hibernate.boot.registry.classloading.spi.ClassLoaderService

which controls how Hibernate interacts with `ClassLoader`s

org.hibernate.integrator.spi.IntegratorService

which controls the management and discovery of org.hibernate.integrator.spi.Integrator instances.

org.hibernate.boot.registry.selector.spi.StrategySelector

which control how Hibernate resolves implementations of various strategy contracts. This is a very powerful service, but a full discussion of it is beyond the scope of this guide.

|  |  |
| --- | --- |
|  | If you are ok with the default behavior of Hibernate in regards to these BootstrapServiceRegistryservices (which is quite often the case, especially in stand-alone environments), then building the BootstrapServiceRegistry can be skipped. |

If you wish to alter how the BootstrapServiceRegistry is built, that is controlled through the org.hibernate.boot.registry.BootstrapServiceRegistryBuilder:

*Example 268. Controlling BootstrapServiceRegistry building*

BootstrapServiceRegistryBuilder bootstrapRegistryBuilder =

new BootstrapServiceRegistryBuilder();

// add a custom ClassLoader

bootstrapRegistryBuilder.applyClassLoader( customClassLoader );

// manually add an Integrator

bootstrapRegistryBuilder.applyIntegrator( customIntegrator );

BootstrapServiceRegistry bootstrapRegistry = bootstrapRegistryBuilder.build();

|  |  |
| --- | --- |
|  | The services of the BootstrapServiceRegistry cannot be extended (added to) nor overridden (replaced). |

The second ServiceRegistry is the org.hibernate.boot.registry.StandardServiceRegistry. You will almost always need to configure the StandardServiceRegistry, which is done through org.hibernate.boot.registry.StandardServiceRegistryBuilder:

*Example 269. Building a BootstrapServiceRegistryBuilder*

// An example using an implicitly built BootstrapServiceRegistry

StandardServiceRegistryBuilder standardRegistryBuilder =

new StandardServiceRegistryBuilder();

// An example using an explicitly built BootstrapServiceRegistry

BootstrapServiceRegistry bootstrapRegistry =

new BootstrapServiceRegistryBuilder().build();

StandardServiceRegistryBuilder standardRegistryBuilder =

new StandardServiceRegistryBuilder( bootstrapRegistry );

A StandardServiceRegistry is also highly configurable via the StandardServiceRegistryBuilder API. See the StandardServiceRegistryBuilder [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/registry/StandardServiceRegistryBuilder.html) for more details.

Some specific methods of interest:

*Example 270. Configuring a MetadataSources*

ServiceRegistry standardRegistry =

new StandardServiceRegistryBuilder().build();

MetadataSources sources = new MetadataSources( standardRegistry );

// alternatively, we can build the MetadataSources without passing

// a service registry, in which case it will build a default

// BootstrapServiceRegistry to use. But the approach shown

// above is preferred

// MetadataSources sources = new MetadataSources();

// add a class using JPA/Hibernate annotations for mapping

sources.addAnnotatedClass( MyEntity.class );

// add the name of a class using JPA/Hibernate annotations for mapping.

// differs from above in that accessing the Class is deferred which is

// important if using runtime bytecode-enhancement

sources.addAnnotatedClassName( "org.hibernate.example.Customer" );

// Read package-level metadata.

sources.addPackage( "hibernate.example" );

// Read package-level metadata.

sources.addPackage( MyEntity.class.getPackage() );

// Adds the named hbm.xml resource as a source: which performs the

// classpath lookup and parses the XML

sources.addResource( "org/hibernate/example/Order.hbm.xml" );

// Adds the named JPA orm.xml resource as a source: which performs the

// classpath lookup and parses the XML

sources.addResource( "org/hibernate/example/Product.orm.xml" );

// Read all mapping documents from a directory tree.

// Assumes that any file named \*.hbm.xml is a mapping document.

sources.addDirectory( new File( ".") );

// Read mappings from a particular XML file

sources.addFile( new File( "./mapping.xml") );

// Read all mappings from a jar file.

// Assumes that any file named \*.hbm.xml is a mapping document.

sources.addJar( new File( "./entities.jar") );

// Read a mapping as an application resource using the convention that a class named foo.bar.MyEntity is

// mapped by a file named foo/bar/MyEntity.hbm.xml which can be resolved as a classpath resource.

sources.addClass( MyEntity.class );

#### 3.2.2. Event Listener registration

The main use cases for an org.hibernate.integrator.spi.Integrator right now are registering event listeners and providing services (see org.hibernate.integrator.spi.ServiceContributingIntegrator). With 5.0 we plan on expanding that to allow altering the metamodel describing the mapping between object and relational models.

*Example 271. Configuring an event listener*

public class MyIntegrator implements org.hibernate.integrator.spi.Integrator {

@Override

public void integrate(

Metadata metadata,

SessionFactoryImplementor sessionFactory,

SessionFactoryServiceRegistry serviceRegistry) {

// As you might expect, an EventListenerRegistry is the thing with which event

// listeners are registered

// It is a service so we look it up using the service registry

final EventListenerRegistry eventListenerRegistry =

serviceRegistry.getService( EventListenerRegistry.class );

// If you wish to have custom determination and handling of "duplicate" listeners,

// you would have to add an implementation of the

// org.hibernate.event.service.spi.DuplicationStrategy contract like this

eventListenerRegistry.addDuplicationStrategy( new CustomDuplicationStrategy() );

// EventListenerRegistry defines 3 ways to register listeners:

// 1) This form overrides any existing registrations with

eventListenerRegistry.setListeners( EventType.AUTO\_FLUSH,

DefaultAutoFlushEventListener.class );

// 2) This form adds the specified listener(s) to the beginning of the listener chain

eventListenerRegistry.prependListeners( EventType.PERSIST,

DefaultPersistEventListener.class );

// 3) This form adds the specified listener(s) to the end of the listener chain

eventListenerRegistry.appendListeners( EventType.MERGE,

DefaultMergeEventListener.class );

}

@Override

public void disintegrate(

SessionFactoryImplementor sessionFactory,

SessionFactoryServiceRegistry serviceRegistry) {

}

}

#### 3.2.3. Building the Metadata

The second step in native bootstrapping is the building of a org.hibernate.boot.Metadata object containing the parsed representations of an application domain model and its mapping to a database. The first thing we obviously need to build a parsed representation is the source information to be parsed (annotated classes, hbm.xml files, orm.xml files). This is the purpose of org.hibernate.boot.MetadataSources:

MetadataSources has many other methods as well, explore its API and [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/MetadataSources.html) for more information. Also, all methods on MetadataSources offer fluent-style call chaining::

*Example 272. Configuring a MetadataSources with method chaining*

ServiceRegistry standardRegistry =

new StandardServiceRegistryBuilder().build();

MetadataSources sources = new MetadataSources( standardRegistry )

.addAnnotatedClass( MyEntity.class )

.addAnnotatedClassName( "org.hibernate.example.Customer" )

.addResource( "org/hibernate/example/Order.hbm.xml" )

.addResource( "org/hibernate/example/Product.orm.xml" );

Once we have the sources of mapping information defined, we need to build the Metadata object. If you are ok with the default behavior in building the Metadata then you can simply call the [buildMetadata](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/MetadataSources.html#buildMetadata--) method of the MetadataSources.

|  |  |
| --- | --- |
|  | Notice that a ServiceRegistry can be passed at a number of points in this bootstrapping process. The suggested approach is to build a StandardServiceRegistry yourself and pass that along to the MetadataSources constructor. From there, MetadataBuilder, Metadata, SessionFactoryBuilderand SessionFactory will all pick up that same StandardServiceRegistry. |

However, if you wish to adjust the process of building Metadata from MetadataSources, you will need to use the MetadataBuilder as obtained via MetadataSources#getMetadataBuilder. MetadataBuilder allows a lot of control over the Metadata building process. See its [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/MetadataBuilder.html) for full details.

*Example 273. Building Metadata via MetadataBuilder*

ServiceRegistry standardRegistry =

new StandardServiceRegistryBuilder().build();

MetadataSources sources = new MetadataSources( standardRegistry );

MetadataBuilder metadataBuilder = sources.getMetadataBuilder();

// Use the JPA-compliant implicit naming strategy

metadataBuilder.applyImplicitNamingStrategy(

ImplicitNamingStrategyJpaCompliantImpl.INSTANCE );

// specify the schema name to use for tables, etc when none is explicitly specified

metadataBuilder.applyImplicitSchemaName( "my\_default\_schema" );

// specify a custom Attribute Converter

metadataBuilder.applyAttributeConverter( myAttributeConverter );

Metadata metadata = metadataBuilder.build();

#### 3.2.4. Building the SessionFactory

The final step in native bootstrapping is to build the SessionFactory itself. Much like discussed above, if you are ok with the default behavior of building a SessionFactory from a Metadata reference, you can simply call the [buildSessionFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/Metadata.html#buildSessionFactory--) method on the Metadata object.

However, if you would like to adjust that building process you will need to use SessionFactoryBuilder as obtained via [Metadata#getSessionFactoryBuilder. Again, see its [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/Metadata.html#getSessionFactoryBuilder--) for more details.

*Example 274. Native Bootstrapping - Putting it all together*

StandardServiceRegistry standardRegistry = new StandardServiceRegistryBuilder()

.configure( "org/hibernate/example/hibernate.cfg.xml" )

.build();

Metadata metadata = new MetadataSources( standardRegistry )

.addAnnotatedClass( MyEntity.class )

.addAnnotatedClassName( "org.hibernate.example.Customer" )

.addResource( "org/hibernate/example/Order.hbm.xml" )

.addResource( "org/hibernate/example/Product.orm.xml" )

.getMetadataBuilder()

.applyImplicitNamingStrategy( ImplicitNamingStrategyJpaCompliantImpl.INSTANCE )

.build();

SessionFactory sessionFactory = metadata.getSessionFactoryBuilder()

.applyBeanManager( getBeanManager() )

.build();

The bootstrapping API is quite flexible, but in most cases it makes the most sense to think of it as a 3 step process:

1. Build the StandardServiceRegistry
2. Build the Metadata
3. Use those 2 to build the SessionFactory

*Example 275. Building SessionFactory via SessionFactoryBuilder*

StandardServiceRegistry standardRegistry = new StandardServiceRegistryBuilder()

.configure( "org/hibernate/example/hibernate.cfg.xml" )

.build();

Metadata metadata = new MetadataSources( standardRegistry )

.addAnnotatedClass( MyEntity.class )

.addAnnotatedClassName( "org.hibernate.example.Customer" )

.addResource( "org/hibernate/example/Order.hbm.xml" )

.addResource( "org/hibernate/example/Product.orm.xml" )

.getMetadataBuilder()

.applyImplicitNamingStrategy( ImplicitNamingStrategyJpaCompliantImpl.INSTANCE )

.build();

SessionFactoryBuilder sessionFactoryBuilder = metadata.getSessionFactoryBuilder();

// Supply an SessionFactory-level Interceptor

sessionFactoryBuilder.applyInterceptor( new CustomSessionFactoryInterceptor() );

// Add a custom observer

sessionFactoryBuilder.addSessionFactoryObservers( new CustomSessionFactoryObserver() );

// Apply a CDI BeanManager ( for JPA event listeners )

sessionFactoryBuilder.applyBeanManager( getBeanManager() );

SessionFactory sessionFactory = sessionFactoryBuilder.build();

## 4. Schema generation

Hibernate allows you to generate the database from the entity mappings.

|  |  |
| --- | --- |
|  | Although the automatic schema generation is very useful for testing and prototyping purposes, in a production environment, it’s much more flexible to manage the schema using incremental migration scripts. |

Traditionally, the process of generating schema from entity mapping has been called HBM2DDL. To get a list of Hibernate-native and JPA-specific configuration properties consider reading the [Configurations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#configurations-hbmddl) section.

Considering the following Domain Model:

*Example 276. Schema generation Domain Model*

@Entity(name = "Customer")

public class Customer {

@Id

private Integer id;

private String name;

@Basic( fetch = FetchType.LAZY )

private UUID accountsPayableXrefId;

@Lob

@Basic( fetch = FetchType.LAZY )

@LazyGroup( "lobs" )

private Blob image;

public Integer getId() {

return id;

}

public void setId(Integer id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public UUID getAccountsPayableXrefId() {

return accountsPayableXrefId;

}

public void setAccountsPayableXrefId(UUID accountsPayableXrefId) {

this.accountsPayableXrefId = accountsPayableXrefId;

}

public Blob getImage() {

return image;

}

public void setImage(Blob image) {

this.image = image;

}

}

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

@OneToMany(mappedBy = "author")

private List<Book> books = new ArrayList<>( );

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public List<Book> getBooks() {

return books;

}

}

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

@NaturalId

private String isbn;

@ManyToOne

private Person author;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

public Person getAuthor() {

return author;

}

public void setAuthor(Person author) {

this.author = author;

}

public String getIsbn() {

return isbn;

}

public void setIsbn(String isbn) {

this.isbn = isbn;

}

}

If the hibernate.hbm2ddl.auto configuration is set to create, Hibernate is going to generate the following database schema:

*Example 277. Auto-generated database schema*

create table Customer (

id integer not null,

accountsPayableXrefId binary,

image blob,

name varchar(255),

primary key (id)

)

create table Book (

id bigint not null,

isbn varchar(255),

title varchar(255),

author\_id bigint,

primary key (id)

)

create table Person (

id bigint not null,

name varchar(255),

primary key (id)

)

alter table Book

add constraint UK\_u31e1frmjp9mxf8k8tmp990i unique (isbn)

alter table Book

add constraint FKrxrgiajod1le3gii8whx2doie

foreign key (author\_id)

references Person

### 4.1. Importing script files

To customize the schema generation process, the hibernate.hbm2ddl.import\_files configuration property must be used to provide other scripts files that Hibernate can use when the SessionFactory is started.

For instance, considering the following schema-generation.sql import file:

*Example 278. Schema generation import file*

create sequence book\_sequence start with 1 increment by 1

If we configure Hibernate to import the script above:

*Example 279. Enabling query cache*

<property

name="hibernate.hbm2ddl.import\_files"

value="schema-generation.sql" />

Hibernate is going to execute the script file after the schema is automatically generated.

### 4.2. Database objects

Hibernate allows you to customize the schema generation process via the HBM database-object element.

Considering the following HBM mapping:

*Example 280. Schema generation HBM database-object*

<?xml version="1.0"?>

<!DOCTYPE hibernate-mapping PUBLIC

"-//Hibernate/Hibernate Mapping DTD 3.0//EN"

"http://www.hibernate.org/dtd/hibernate-mapping-3.0.dtd" >

<hibernate-mapping>

<database-object>

<create>

CREATE OR REPLACE FUNCTION sp\_count\_books(

IN authorId bigint,

OUT bookCount bigint)

RETURNS bigint AS

$BODY$

BEGIN

SELECT COUNT(\*) INTO bookCount

FROM book

WHERE author\_id = authorId;

END;

$BODY$

LANGUAGE plpgsql;

</create>

<drop></drop>

<dialect-scope name="org.hibernate.dialect.PostgreSQL95Dialect" />

</database-object>

</hibernate-mapping>

When the SessionFactory is bootstrapped, Hibernate is going to execute the database-object, therefore creating the sp\_count\_books function.

### 4.3. Database-level checks

Hibernate offers the @Check annotation so that you can specify an arbitrary SQL CHECK constraint which can be defined as follows:

*Example 281. Database check entity mapping example*

@Entity(name = "Book")

@Check( constraints = "CASE WHEN isbn IS NOT NULL THEN LENGTH(isbn) = 13 ELSE true END")

public static class Book {

@Id

private Long id;

private String title;

@NaturalId

private String isbn;

private Double price;

//Getters and setters omitted for brevity

}

Now, if you try to add a Book entity with an isbn attribute whose length is not 13 characters, a ConstraintViolationException is going to be thrown.

*Example 282. Database check failure example*

Book book = new Book();

book.setId( 1L );

book.setPrice( 49.99d );

book.setTitle( "High-Performance Java Persistence" );

book.setIsbn( "11-11-2016" );

entityManager.persist( book );

INSERT INTO Book (isbn, price, title, id)

VALUES ('11-11-2016', 49.99, 'High-Performance Java Persistence', 1)

-- WARN SqlExceptionHelper:129 - SQL Error: 0, SQLState: 23514

-- ERROR SqlExceptionHelper:131 - ERROR: new row for relation "book" violates check constraint "book\_isbn\_check"

### 4.4. Default value for database column

With Hibernate, you can specify a default value for a given database column using the [@ColumnDefault](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ColumnDefault.html) annotation.

*Example 283. @ColumnDefault mapping example*

@Entity(name = "Person")

@DynamicInsert

public static class Person {

@Id

private Long id;

@ColumnDefault("'N/A'")

private String name;

@ColumnDefault("-1")

private Long clientId;

//Getter and setters omitted for brevity

}

CREATE TABLE Person (

id BIGINT NOT NULL,

clientId BIGINT DEFAULT -1,

name VARCHAR(255) DEFAULT 'N/A',

PRIMARY KEY (id)

)

In the mapping above, both the name and clientId table columns are going to use a DEFAULT value.

|  |  |
| --- | --- |
|  | The entity is annotated with the @DynamicInsert annotation so that the INSERT statement does not include the entity attribute that have not been set. |

This way, when omitting the name and the clientId attribute, the database is going to set them according to their default values.

*Example 284. @ColumnDefault mapping example*

doInJPA( this::entityManagerFactory, entityManager -> {

Person person = new Person();

person.setId( 1L );

entityManager.persist( person );

} );

doInJPA( this::entityManagerFactory, entityManager -> {

Person person = entityManager.find( Person.class, 1L );

assertEquals( "N/A", person.getName() );

assertEquals( Long.valueOf( -1L ), person.getClientId() );

} );

INSERT INTO Person (id) VALUES (?)

### 4.5. Columns unique constraint

The [@UniqueConstraint](http://docs.oracle.com/javaee/7/api/javax/persistence/UniqueConstraint.html) annotation is used to specify a unique constraint to be included by the automated schema generator for the primary or secondary table associated with the current annotated entity.

Considering the following entity mapping, Hibernate generates the unique constraint DDL when creating the database schema:

*Example 285. @UniqueConstraint mapping example*

@Entity

@Table(

name = "book",

uniqueConstraints = @UniqueConstraint(

name = "uk\_book\_title\_author",

columnNames = {

"title",

"author\_id"

}

)

)

public static class Book {

@Id

@GeneratedValue

private Long id;

private String title;

@ManyToOne(fetch = FetchType.LAZY)

@JoinColumn(

name = "author\_id",

foreignKey = @ForeignKey(name = "fk\_book\_author\_id")

)

private Author author;

//Getter and setters omitted for brevity

}

@Entity

@Table(name = "author")

public static class Author {

@Id

@GeneratedValue

private Long id;

@Column(name = "first\_name")

private String firstName;

@Column(name = "last\_name")

private String lastName;

//Getter and setters omitted for brevity

}

create table author (

id bigint not null,

first\_name varchar(255),

last\_name varchar(255),

primary key (id)

)

create table book (

id bigint not null,

title varchar(255),

author\_id bigint,

primary key (id)

)

alter table book

add constraint uk\_book\_title\_author

unique (title, author\_id)

alter table book

add constraint fk\_book\_author\_id

foreign key (author\_id)

references author

With the uk\_book\_title\_author unique constraint in place, it’s no longer possible to add two books with the same title and for the same author.

*Example 286. @UniqueConstraintTest persist example*

Author \_author = doInJPA( this::entityManagerFactory, entityManager -> {

Author author = new Author();

author.setFirstName( "Vlad" );

author.setLastName( "Mihalcea" );

entityManager.persist( author );

Book book = new Book();

book.setTitle( "High-Performance Java Persistence" );

book.setAuthor( author );

entityManager.persist( book );

return author;

} );

try {

doInJPA( this::entityManagerFactory, entityManager -> {

Book book = new Book();

book.setTitle( "High-Performance Java Persistence" );

book.setAuthor( \_author );

entityManager.persist( book );

} );

}

catch (Exception expected) {

assertNotNull( ExceptionUtil.findCause( expected, ConstraintViolationException.class ) );

}

insert

into

author

(first\_name, last\_name, id)

values

(?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [Vlad]

-- binding parameter [2] as [VARCHAR] - [Mihalcea]

-- binding parameter [3] as [BIGINT] - [1]

insert

into

book

(author\_id, title, id)

values

(?, ?, ?)

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [3] as [BIGINT] - [2]

insert

into

book

(author\_id, title, id)

values

(?, ?, ?)

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [3] as [BIGINT] - [3]

-- SQL Error: 23505, SQLState: 23505

-- Unique index or primary key violation: "UK\_BOOK\_TITLE\_AUTHOR\_INDEX\_1 ON PUBLIC.BOOK(TITLE, AUTHOR\_ID) VALUES ( /\* key:1 \*/ 3, 'High-Performance Java Persistence', 1)";

The second INSERT statement fails because of the unique constraint violation.

### 4.6. Columns index

The [@Index](http://docs.oracle.com/javaee/7/api/javax/persistence/Index.html) annotation is used by the automated schema generation tool to create a database index.

Considering the following entity mapping, Hibernate generates the index when creating the database schema:

*Example 287. @Index mapping example*

@Entity

@Table(

name = "author",

indexes = @Index(

name = "idx\_author\_first\_last\_name",

columnList = "first\_name, last\_name",

unique = false

)

)

public static class Author {

@Id

@GeneratedValue

private Long id;

@Column(name = "first\_name")

private String firstName;

@Column(name = "last\_name")

private String lastName;

//Getter and setters omitted for brevity

}

create table author (

id bigint not null,

first\_name varchar(255),

last\_name varchar(255),

primary key (id)

)

create index idx\_author\_first\_last\_name

on author (first\_name, last\_name)

## 5. Persistence Contexts

Both the org.hibernate.Session API and javax.persistence.EntityManager API represent a context for dealing with persistent data. This concept is called a persistence context. Persistent data has a state in relation to both a persistence context and the underlying database.

transient

the entity has just been instantiated and is not associated with a persistence context. It has no persistent representation in the database and typically no identifier value has been assigned (unless the assigned generator was used).

managed, or persistent

the entity has an associated identifier and is associated with a persistence context. It may or may not physically exist in the database yet.

detached

the entity has an associated identifier, but is no longer associated with a persistence context (usually because the persistence context was closed or the instance was evicted from the context)

removed

the entity has an associated identifier and is associated with a persistence context, however it is scheduled for removal from the database.

Much of the org.hibernate.Session and javax.persistence.EntityManager methods deal with moving entities between these states.

### 5.1. Accessing Hibernate APIs from JPA

JPA defines an incredibly useful method to allow applications access to the APIs of the underlying provider.

*Example 288. Accessing Hibernate APIs from JPA*

Session session = entityManager.unwrap( Session.class );

SessionImplementor sessionImplementor = entityManager.unwrap( SessionImplementor.class );

SessionFactory sessionFactory = entityManager.getEntityManagerFactory().unwrap( SessionFactory.class );

### 5.2. Bytecode Enhancement

Hibernate "grew up" not supporting bytecode enhancement at all. At that time, Hibernate only supported proxy-based for lazy loading and always used diff-based dirty calculation. Hibernate 3.x saw the first attempts at bytecode enhancement support in Hibernate. We consider those initial attempts (up until 5.0) completely as an incubation. The support for bytecode enhancement in 5.0 onward is what we are discussing here.

#### 5.2.1. Capabilities

Hibernate supports the enhancement of an application Java domain model for the purpose of adding various persistence-related capabilities directly into the class.

##### Lazy attribute loading

Think of this as partial loading support. Essentially you can tell Hibernate that only part(s) of an entity should be loaded upon fetching from the database and when the other part(s) should be loaded as well. Note that this is very much different from proxy-based idea of lazy loading which is entity-centric where the entity’s state is loaded at once as needed. With bytecode enhancement, individual attributes or groups of attributes are loaded as needed.

Lazy attributes can be designated to be loaded together and this is called a "lazy group". By default, all singular attributes are part of a single group, meaning that when one lazy singular attribute is accessed all lazy singular attributes are loaded. Lazy plural attributes, by default, are each a lazy group by themselves. This behavior is explicitly controllable through the @org.hibernate.annotations.LazyGroup annotation.

*Example 289. @LazyGroup example*

@Entity

public class Customer {

@Id

private Integer id;

private String name;

@Basic( fetch = FetchType.LAZY )

private UUID accountsPayableXrefId;

@Lob

@Basic( fetch = FetchType.LAZY )

@LazyGroup( "lobs" )

private Blob image;

public Integer getId() {

return id;

}

public void setId(Integer id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public UUID getAccountsPayableXrefId() {

return accountsPayableXrefId;

}

public void setAccountsPayableXrefId(UUID accountsPayableXrefId) {

this.accountsPayableXrefId = accountsPayableXrefId;

}

public Blob getImage() {

return image;

}

public void setImage(Blob image) {

this.image = image;

}

}

In the above example we have 2 lazy attributes: accountsPayableXrefId and image. Each is part of a different fetch group (accountsPayableXrefId is part of the default fetch group), which means that accessing accountsPayableXrefIdwill not force the loading of image, and vice-versa.

|  |  |
| --- | --- |
|  | As a hopefully temporary legacy hold-over, it is currently required that all lazy singular associations (many-to-one and one-to-one) also include @LazyToOne(LazyToOneOption.NO\_PROXY). The plan is to relax that requirement later. |

##### In-line dirty tracking

Historically Hibernate only supported diff-based dirty calculation for determining which entities in a persistence context have changed. This essentially means that Hibernate would keep track of the last known state of an entity in regards to the database (typically the last read or write). Then, as part of flushing the persistence context, Hibernate would walk every entity associated with the persistence context and check its current state against that "last known database state". This is by far the most thorough approach to dirty checking because it accounts for data-types that can change their internal state (java.util.Date is the prime example of this). However, in a persistence context with a large number of associated entities it can also be a performance-inhibiting approach.

If your application does not need to care about "internal state changing data-type" use cases, bytecode-enhanced dirty tracking might be a worthwhile alternative to consider, especially in terms of performance. In this approach Hibernate will manipulate the bytecode of your classes to add "dirty tracking" directly to the entity, allowing the entity itself to keep track of which of its attributes have changed. During flush time, Hibernate simply asks your entity what has changed rather that having to perform the state-diff calculations.

##### Bidirectional association management

Hibernate strives to keep your application as close to "normal Java usage" (idiomatic Java) as possible. Consider a domain model with a normal Person/Book bidirectional association:

*Example 290. Bidirectional association*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

@OneToMany(mappedBy = "author")

private List<Book> books = new ArrayList<>( );

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public List<Book> getBooks() {

return books;

}

}

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

@NaturalId

private String isbn;

@ManyToOne

private Person author;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

public Person getAuthor() {

return author;

}

public void setAuthor(Person author) {

this.author = author;

}

public String getIsbn() {

return isbn;

}

public void setIsbn(String isbn) {

this.isbn = isbn;

}

}

*Example 291. Incorrect normal Java usage*

Person person = new Person();

person.setName( "John Doe" );

Book book = new Book();

person.getBooks().add( book );

try {

book.getAuthor().getName();

}

catch (NullPointerException expected) {

// This blows up ( NPE ) in normal Java usage

}

This blows up in normal Java usage. The correct normal Java usage is:

*Example 292. Correct normal Java usage*

Person person = new Person();

person.setName( "John Doe" );

Book book = new Book();

person.getBooks().add( book );

book.setAuthor( person );

book.getAuthor().getName();

Bytecode-enhanced bi-directional association management makes that first example work by managing the "other side" of a bi-directional association whenever one side is manipulated.

##### Internal performance optimizations

Additionally, we use the enhancement process to add some additional code that allows us to optimized certain performance characteristics of the persistence context. These are hard to discuss without diving into a discussion of Hibernate internals.

#### 5.2.2. Performing enhancement

##### Run-time enhancement

Currently, run-time enhancement of the domain model is only supported in managed JPA environments following the JPA-defined SPI for performing class transformations. Even then, this support is disabled by default. To enable run-time enhancement, specify hibernate.ejb.use\_class\_enhancer=true as a persistent unit property.

|  |  |
| --- | --- |
|  | Also, at the moment, only annotated classes are supported for run-time enhancement. |

##### Gradle plugin

Hibernate provides a Gradle plugin that is capable of providing build-time enhancement of the domain model as they are compiled as part of a Gradle build. To use the plugin a project would first need to apply it:

*Example 293. Apply the Gradle plugin*

ext {

hibernateVersion = 'hibernate-version-you-want'

}

buildscript {

dependencies {

classpath "org.hibernate:hibernate-gradle-plugin:$hibernateVersion"

}

}

hibernate {

enhance {

// any configuration goes here

}

}

The configuration that is available is exposed through a registered Gradle DSL extension:

enableLazyInitialization

Whether enhancement for lazy attribute loading should be done.

enableDirtyTracking

Whether enhancement for self-dirty tracking should be done.

enableAssociationManagement

Whether enhancement for bi-directional association management should be done.

The default value for all 3 configuration settings is false

The enhance { } block is required in order for enhancement to occur. Enhancement is disabled by default in preparation for additions capabilities (hbm2ddl, etc) in the plugin.

##### Maven plugin

Hibernate provides a Maven plugin capable of providing build-time enhancement of the domain model as they are compiled as part of a Maven build. See the section on the [Gradle plugin](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#BytecodeEnhancement-enhancement-gradle) for details on the configuration settings. Again, the default for those 3 is false.

The Maven plugin supports one additional configuration settings: failOnError, which controls what happens in case of error. Default behavior is to fail the build, but it can be set so that only a warning is issued.

*Example 294. Apply the Maven plugin*

<build>

<plugins>

[...]

<plugin>

<groupId>org.hibernate.orm.tooling</groupId>

<artifactId>hibernate-enhance-maven-plugin</artifactId>

<version>$currentHibernateVersion</version>

<executions>

<execution>

<configuration>

<failOnError>true</failOnError>

<enableLazyInitialization>true</enableLazyInitialization>

<enableDirtyTracking>true</enableDirtyTracking>

<enableAssociationManagement>true</enableAssociationManagement>

</configuration>

<goals>

<goal>enhance</goal>

</goals>

</execution>

</executions>

</plugin>

[...]

</plugins>

</build>

### 5.3. Making entities persistent

Once you’ve created a new entity instance (using the standard new operator) it is in new state. You can make it persistent by associating it to either a org.hibernate.Session or javax.persistence.EntityManager.

*Example 295. Making an entity persistent with JPA*

Person person = new Person();

person.setId( 1L );

person.setName("John Doe");

entityManager.persist( person );

*Example 296. Making an entity persistent with Hibernate API*

Person person = new Person();

person.setId( 1L );

person.setName("John Doe");

session.save( person );

org.hibernate.Session also has a method named persist which follows the exact semantic defined in the JPA specification for the persist method. It is this org.hibernate.Session method to which the Hibernate javax.persistence.EntityManager implementation delegates.

If the DomesticCat entity type has a generated identifier, the value is associated with the instance when the save or persist is called. If the identifier is not automatically generated, the manually assigned (usually natural) key value has to be set on the instance before the save or persist methods are called.

### 5.4. Deleting (removing) entities

Entities can also be deleted.

*Example 297. Deleting an entity with JPA*

entityManager.remove( person );

*Example 298. Deleting an entity with Hibernate API*

session.delete( person );

|  |  |
| --- | --- |
|  | Hibernate itself can handle deleting detached state. JPA, however, disallows it. The implication here is that the entity instance passed to the org.hibernate.Session delete method can be either in managed or detached state, while the entity instance passed to remove on javax.persistence.EntityManager must be in managed state. |

### 5.5. Obtain an entity reference without initializing its data

Sometimes referred to as lazy loading, the ability to obtain a reference to an entity without having to load its data is hugely important. The most common case being the need to create an association between an entity and another existing entity.

*Example 299. Obtaining an entity reference without initializing its data with JPA*

Book book = new Book();

book.setAuthor( entityManager.getReference( Person.class, personId ) );

*Example 300. Obtaining an entity reference without initializing its data with Hibernate API*

Book book = new Book();

book.setId( 1L );

book.setIsbn( "123-456-7890" );

entityManager.persist( book );

book.setAuthor( session.load( Person.class, personId ) );

The above works on the assumption that the entity is defined to allow lazy loading, generally through use of runtime proxies. In both cases an exception will be thrown later if the given entity does not refer to actual database state when the application attempts to use the returned proxy in any way that requires access to its data.

### 5.6. Obtain an entity with its data initialized

It is also quite common to want to obtain an entity along with its data (e.g. like when we need to display it in the UI).

*Example 301. Obtaining an entity reference with its data initialized with JPA*

Person person = entityManager.find( Person.class, personId );

*Example 302. Obtaining an entity reference with its data initialized with Hibernate API*

Person person = session.get( Person.class, personId );

*Example 303. Obtaining an entity reference with its data initialized using the byId() Hibernate API*

Person person = session.byId( Person.class ).load( personId );

In both cases null is returned if no matching database row was found.

It’s possible to return a Java 8 Optional as well:

*Example 304. Obtaining an Optional entity reference with its data initialized using the byId()Hibernate API*

Optional<Person> optionalPerson = session.byId( Person.class ).loadOptional( personId );

### 5.7. Obtain an entity by natural-id

In addition to allowing to load by identifier, Hibernate allows applications to load by declared natural identifier.

*Example 305. Natural-id mapping*

@Entity(name = "Book")

public static class Book {

@Id

private Long id;

private String title;

@NaturalId

private String isbn;

@ManyToOne

private Person author;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

public Person getAuthor() {

return author;

}

public void setAuthor(Person author) {

this.author = author;

}

public String getIsbn() {

return isbn;

}

public void setIsbn(String isbn) {

this.isbn = isbn;

}

}

We can also opt to fetch the entity or just retrieve a reference to it when using the natural identifier loading methods.

*Example 306. Get entity reference by simple natural-id*

Book book = session.bySimpleNaturalId( Book.class ).getReference( isbn );

*Example 307. Load entity by natural-id*

Book book = session

.byNaturalId( Book.class )

.using( "isbn", isbn )

.load( );

We can also use a Java 8 Optional to load an entity by its natural id:

*Example 308. Load an Optional entity by natural-id*

Optional<Book> optionalBook = session

.byNaturalId( Book.class )

.using( "isbn", isbn )

.loadOptional( );

Hibernate offer a consistent API for accessing persistent data by identifier or by the natural-id. Each of these defines the same two data access methods:

getReference

Should be used in cases where the identifier is assumed to exist, where non-existence would be an actual error. Should never be used to test existence. That is because this method will prefer to create and return a proxy if the data is not already associated with the Session rather than hit the database. The quintessential use-case for using this method is to create foreign-key based associations.

load

Will return the persistent data associated with the given identifier value or null if that identifier does not exist.

Each of these two methods define an overloading variant accepting a org.hibernate.LockOptions argument. Locking is discussed in a separate [chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking).

### 5.8. Modifying managed/persistent state

Entities in managed/persistent state may be manipulated by the application and any changes will be automatically detected and persisted when the persistence context is flushed. There is no need to call a particular method to make your modifications persistent.

*Example 309. Modifying managed state with JPA*

Person person = entityManager.find( Person.class, personId );

person.setName("John Doe");

entityManager.flush();

*Example 310. Modifying managed state with Hibernate API*

Person person = session.byId( Person.class ).load( personId );

person.setName("John Doe");

entityManager.flush();

By default, when you modify an entity, all columns but the identifier are being set during update.

Therefore, considering you have the following Product entity mapping:

*Example 311. Product entity mapping*

@Entity(name = "Product")

public static class Product {

@Id

private Long id;

@Column

private String name;

@Column

private String description;

@Column(name = "price\_cents")

private Integer priceCents;

@Column

private Integer quantity;

//Getters and setters are omitted for brevity

}

If you persist the following Product entity:

*Example 312. Persisting a Product entity*

Product book = new Product();

book.setId( 1L );

book.setName( "High-Performance Java Persistence" );

book.setDescription( "Get the most out of your persistence layer" );

book.setPriceCents( 29\_99 );

book.setQuantity( 10\_000 );

entityManager.persist( book );

When you modify the Product entity, Hibernate generates the following SQL UPDATE statement:

*Example 313. Modifying the Product entity*

doInJPA( this::entityManagerFactory, entityManager -> {

Product book = entityManager.find( Product.class, 1L );

book.setPriceCents( 24\_99 );

} );

UPDATE

Product

SET

description = ?,

name = ?,

price\_cents = ?,

quantity = ?

WHERE

id = ?

-- binding parameter [1] as [VARCHAR] - [Get the most out of your persistence layer]

-- binding parameter [2] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [3] as [INTEGER] - [2499]

-- binding parameter [4] as [INTEGER] - [10000]

-- binding parameter [5] as [BIGINT] - [1]

The default UPDATE statement containing all columns has two advantages:

* it allows you to better benefit from JDBC Statement caching.
* it allows you to enable batch updates even if multiple entities modify different properties.

However, there is also one downside to including all columns in the SQL UPDATE statement. If you have multiple indexes, the database might update those redundantly even if you don’t actually modify all column values.

To fix this issue, you can use dynamic updates.

#### 5.8.1. Dynamic updates

To enable dynamic updates, you need to annotate the entity with the @DynamicUpdate annotation:

*Example 314. Product entity mapping*

@Entity(name = "Product")

@DynamicUpdate

public static class Product {

@Id

private Long id;

@Column

private String name;

@Column

private String description;

@Column(name = "price\_cents")

private Integer priceCents;

@Column

private Integer quantity;

//Getters and setters are omitted for brevity

}

This time, when reruning the previous test case, Hibernate generates the following SQL UPDATE statement:

*Example 315. Modifying the Product entity with a dynamic update*

UPDATE

Product

SET

price\_cents = ?

WHERE

id = ?

-- binding parameter [1] as [INTEGER] - [2499]

-- binding parameter [2] as [BIGINT] - [1]

The dynamic update allows you to set just the columns sthat were modified in the associated entity.

### 5.9. Refresh entity state

You can reload an entity instance and its collections at any time.

*Example 316. Refreshing entity state with JPA*

Person person = entityManager.find( Person.class, personId );

entityManager.createQuery( "update Person set name = UPPER(name)" ).executeUpdate();

entityManager.refresh( person );

assertEquals("JOHN DOE", person.getName() );

*Example 317. Refreshing entity state with Hibernate API*

Person person = session.byId( Person.class ).load( personId );

session.doWork( connection -> {

try(Statement statement = connection.createStatement()) {

statement.executeUpdate( "UPDATE Person SET name = UPPER(name)" );

}

} );

session.refresh( person );

assertEquals("JOHN DOE", person.getName() );

One case where this is useful is when it is known that the database state has changed since the data was read. Refreshing allows the current database state to be pulled into the entity instance and the persistence context.

Another case where this might be useful is when database triggers are used to initialize some of the properties of the entity.

|  |  |
| --- | --- |
|  | Only the entity instance and its value type collections are refreshed unless you specify REFRESH as a cascade style of any associations. However, please note that Hibernate has the capability to handle this automatically through its notion of generated properties. See the discussion of non-identifier [generated attributes](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated). |
|  | Traditionally, Hibernate has been allowing detached entities to be refreshed. Unfortunately, JPA prohibits this practice and specifies that an IllegalArgumentException should be thrown instead.  For this reason, when bootstrapping the Hibernate SessionFactory using the native API, the legacy detached entity refresh behavior is going to be preserved. On the other hand, when bootstrapping Hibernate through JPA EntityManagerFactory building process, detached entities are not allowed to be refreshed by default.  However, this default behavior can be overwritten through the hibernate.allow\_refresh\_detached\_entityconfiguration property. If this property is explicitly set to true, then you can refresh detached entities even when using the JPA bootstraps mechanism, therefore bypassing the JPA specification restriction.  For more about the hibernate.allow\_refresh\_detached\_entity configuration property, check out the [Configurations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#misc) section as well. |

#### 5.9.1. Refresh gotchas

The refresh entity state transition is meant to overwrite the entity attributes according to the info currently contained in the associated database record.

However, you have to be very careful when cascading the refresh action to any transient entity.

For instance, consider the following example:

*Example 318. Refreshing entity state gotcha*

try {

Person person = entityManager.find( Person.class, personId );

Book book = new Book();

book.setId( 100L );

book.setTitle( "Hibernate User Guide" );

book.setAuthor( person );

person.getBooks().add( book );

entityManager.refresh( person );

}

catch ( EntityNotFoundException expected ) {

log.info( "Beware when cascading the refresh associations to transient entities!" );

}

In the aforementioned example, an EntityNotFoundException is thrown because the Book entity is still in a transient state. When the refresh action is cascaded from the Person entity, Hibernate will not be able to locate the Book entity in the database.

For this reason, you should be very careful when mixing the refresh action with transient child entity objects.

### 5.10. Working with detached data

Detachment is the process of working with data outside the scope of any persistence context. Data becomes detached in a number of ways. Once the persistence context is closed, all data that was associated with it becomes detached. Clearing the persistence context has the same effect. Evicting a particular entity from the persistence context makes it detached. And finally, serialization will make the deserialized form be detached (the original instance is still managed).

Detached data can still be manipulated, however the persistence context will no longer automatically know about these modification and the application will need to intervene to make the changes persistent again.

#### 5.10.1. Reattaching detached data

Reattachment is the process of taking an incoming entity instance that is in detached state and re-associating it with the current persistence context.

|  |  |
| --- | --- |
|  | JPA does not provide for this model. This is only available through Hibernate org.hibernate.Session. |

*Example 319. Reattaching a detached entity using lock*

Person person = session.byId( Person.class ).load( personId );

//Clear the Session so the person entity becomes detached

session.clear();

person.setName( "Mr. John Doe" );

session.lock( person, LockMode.NONE );

*Example 320. Reattaching a detached entity using saveOrUpdate*

Person person = session.byId( Person.class ).load( personId );

//Clear the Session so the person entity becomes detached

session.clear();

person.setName( "Mr. John Doe" );

session.saveOrUpdate( person );

|  |  |
| --- | --- |
|  | The method name update is a bit misleading here. It does not mean that an SQL UPDATE is immediately performed. It does, however, mean that an SQL UPDATE will be performed when the persistence context is flushed since Hibernate does not know its previous state against which to compare for changes. If the entity is mapped with select-before-update, Hibernate will pull the current state from the database and see if an update is needed. |

Provided the entity is detached, update and saveOrUpdate operate exactly the same.

#### 5.10.2. Merging detached data

Merging is the process of taking an incoming entity instance that is in detached state and copying its data over onto a new managed instance.

Although not exactly per se, the following example is a good visualization of the merge operation internals.

*Example 321. Visualizing merge*

public Person merge(Person detached) {

Person newReference = session.byId( Person.class ).load( detached.getId() );

newReference.setName( detached.getName() );

return newReference;

}

*Example 322. Merging a detached entity with JPA*

Person person = entityManager.find( Person.class, personId );

//Clear the EntityManager so the person entity becomes detached

entityManager.clear();

person.setName( "Mr. John Doe" );

person = entityManager.merge( person );

*Example 323. Merging a detached entity with Hibernate API*

Person person = session.byId( Person.class ).load( personId );

//Clear the Session so the person entity becomes detached

session.clear();

person.setName( "Mr. John Doe" );

person = (Person) session.merge( person );

##### Merging gotchas

For example, Hibernate throws IllegalStateException when merging a parent entity which has references to 2 detached child entities child1 and child2 (obtained from different sessions), and child1 and child2 represent the same persistent entity, Child.

A new configuration property, hibernate.event.merge.entity\_copy\_observer, controls how Hibernate will respond when multiple representations of the same persistent entity ("entity copy") is detected while merging.

The possible values are:

disallow (the default)

throws IllegalStateException if an entity copy is detected

allow

performs the merge operation on each entity copy that is detected

log

(provided for testing only) performs the merge operation on each entity copy that is detected and logs information about the entity copies. This setting requires DEBUG logging be enabled for org.hibernate.event.internal.EntityCopyAllowedLoggedObserver.

In addition, the application may customize the behavior by providing an implementation of org.hibernate.event.spi.EntityCopyObserver and setting hibernate.event.merge.entity\_copy\_observer to the class name. When this property is set to allow or log, Hibernate will merge each entity copy detected while cascading the merge operation. In the process of merging each entity copy, Hibernate will cascade the merge operation from each entity copy to its associations with cascade=CascadeType.MERGE or CascadeType.ALL. The entity state resulting from merging an entity copy will be overwritten when another entity copy is merged.

|  |  |
| --- | --- |
|  | Because cascade order is undefined, the order in which the entity copies are merged is undefined. As a result, if property values in the entity copies are not consistent, the resulting entity state will be indeterminate, and data will be lost from all entity copies except for the last one merged. Therefore, the **last writer wins**.  If an entity copy cascades the merge operation to an association that is (or contains) a new entity, that new entity will be merged (i.e., persisted and the merge operation will be cascaded to its associations according to its mapping), even if that same association is ultimately overwritten when Hibernate merges a different representation having a different value for its association.  If the association is mapped with orphanRemoval = true, the new entity will not be deleted because the semantics of orphanRemoval do not apply if the entity being orphaned is a new entity.  There are known issues when representations of the same persistent entity have different values for a collection. See [HHH-9239](https://hibernate.atlassian.net/browse/HHH-9239) and [HHH-9240](https://hibernate.atlassian.net/browse/HHH-9240) for more details. These issues can cause data loss or corruption.  By setting hibernate.event.merge.entity\_copy\_observer configuration property to allow or log, Hibernate will allow entity copies of any type of entity to be merged.  The only way to exclude particular entity classes or associations that contain critical data is to provide a custom implementation of org.hibernate.event.spi.EntityCopyObserver with the desired behavior, and setting hibernate.event.merge.entity\_copy\_observer to the class name. |
|  | Hibernate provides limited DEBUG logging capabilities that can help determine the entity classes for which entity copies were found. By setting hibernate.event.merge.entity\_copy\_observer to logand enabling DEBUG logging for org.hibernate.event.internal.EntityCopyAllowedLoggedObserver, the following will be logged each time an application calls EntityManager.merge( entity ) or Session.merge( entity ):   * number of times multiple representations of the same persistent entity was detected summarized by entity name; * details by entity name and ID, including output from calling toString() on each representation being merged as well as the merge result.   The log should be reviewed to determine if multiple representations of entities containing critical data are detected. If so, the application should be modified so there is only one representation, and a custom implementation of org.hibernate.event.spi.EntityCopyObserver should be provided to disallow entity copies for entities with critical data.  Using optimistic locking is recommended to detect if different representations are from different versions of the same persistent entity. If they are not from the same version, Hibernate will throw either the JPA OptimisticLockException or the native StaleObjectStateException depending on your bootstrapping strategy. |

### 5.11. Checking persistent state

An application can verify the state of entities and collections in relation to the persistence context.

*Example 324. Verifying managed state with JPA*

boolean contained = entityManager.contains( person );

*Example 325. Verifying managed state with Hibernate API*

boolean contained = session.contains( person );

*Example 326. Verifying laziness with JPA*

PersistenceUnitUtil persistenceUnitUtil = entityManager.getEntityManagerFactory().getPersistenceUnitUtil();

boolean personInitialized = persistenceUnitUtil.isLoaded( person );

boolean personBooksInitialized = persistenceUnitUtil.isLoaded( person.getBooks() );

boolean personNameInitialized = persistenceUnitUtil.isLoaded( person, "name" );

*Example 327. Verifying laziness with Hibernate API*

boolean personInitialized = Hibernate.isInitialized( person );

boolean personBooksInitialized = Hibernate.isInitialized( person.getBooks() );

boolean personNameInitialized = Hibernate.isPropertyInitialized( person, "name" );

In JPA there is an alternative means to check laziness using the following javax.persistence.PersistenceUtil pattern (which is recommended wherever possible).

*Example 328. Alternative JPA means to verify laziness*

PersistenceUtil persistenceUnitUtil = Persistence.getPersistenceUtil();

boolean personInitialized = persistenceUnitUtil.isLoaded( person );

boolean personBooksInitialized = persistenceUnitUtil.isLoaded( person.getBooks() );

boolean personNameInitialized = persistenceUnitUtil.isLoaded( person, "name" );

### 5.12. Evicting entities

When the flush() method is called, the state of the entity is 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.

*Example 329. Detaching an entity from the EntityManager*

for(Person person : entityManager.createQuery("select p from Person p", Person.class)

.getResultList()) {

dtos.add(toDTO(person));

entityManager.detach( person );

}

*Example 330. Evicting an entity from the Hibernate Session*

Session session = entityManager.unwrap( Session.class );

for(Person person : (List<Person>) session.createQuery("select p from Person p").list()) {

dtos.add(toDTO(person));

session.evict( person );

}

To detach all entities from the current persistence context, both the EntityManager and the Hibernate Session define a clear() method.

*Example 331. Clearing the persistence context*

entityManager.clear();

session.clear();

To verify if an entity instance is currently attached to the running persistence context, both the EntityManager and the Hibernate Session define a contains(Object entity) method.

*Example 332. Verify if an entity is contained in a persistence context*

entityManager.contains( person );

session.contains( person );

### 5.13. Cascading entity state transitions

JPA allows you to propagate the state transition from a parent entity to a child. For this purpose, the JPA javax.persistence.CascadeType defines various cascade types:

ALL

cascades all entity state transitions

PERSIST

cascades the entity persist operation.

MERGE

cascades the entity merge operation.

REMOVE

cascades the entity remove operation.

REFRESH

cascades the entity refresh operation.

DETACH

cascades the entity detach operation.

Additionally, the CascadeType.ALL will propagate any Hibernate-specific operation, which is defined by the org.hibernate.annotations.CascadeType enum:

SAVE\_UPDATE

cascades the entity saveOrUpdate operation.

REPLICATE

cascades the entity replicate operation.

LOCK

cascades the entity lock operation.

The following examples will explain some of the aforementioned cascade operations using the following entities:

@Entity

public class Person {

@Id

private Long id;

private String name;

@OneToMany(mappedBy = "owner", cascade = CascadeType.ALL)

private List<Phone> phones = new ArrayList<>();

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public List<Phone> getPhones() {

return phones;

}

public void addPhone(Phone phone) {

this.phones.add( phone );

phone.setOwner( this );

}

}

@Entity

public class Phone {

@Id

private Long id;

@Column(name = "`number`")

private String number;

@ManyToOne(fetch = FetchType.LAZY)

private Person owner;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getNumber() {

return number;

}

public void setNumber(String number) {

this.number = number;

}

public Person getOwner() {

return owner;

}

public void setOwner(Person owner) {

this.owner = owner;

}

}

#### 5.13.1. CascadeType.PERSIST

The CascadeType.PERSIST allows us to persist a child entity along with the parent one.

*Example 333. CascadeType.PERSIST example*

Person person = new Person();

person.setId( 1L );

person.setName( "John Doe" );

Phone phone = new Phone();

phone.setId( 1L );

phone.setNumber( "123-456-7890" );

person.addPhone( phone );

entityManager.persist( person );

INSERT INTO Person ( name, id )

VALUES ( 'John Doe', 1 )

INSERT INTO Phone ( `number`, person\_id, id )

VALUE ( '123-456-7890', 1, 1 )

Even if just the Person parent entity was persisted, Hibernate has managed to cascade the persist operation to the associated Phone child entity as well.

#### 5.13.2. CascadeType.MERGE

The CascadeType.MERGE allows us to merge a child entity along with the parent one.

*Example 334. CascadeType.MERGE example*

Phone phone = entityManager.find( Phone.class, 1L );

Person person = phone.getOwner();

person.setName( "John Doe Jr." );

phone.setNumber( "987-654-3210" );

entityManager.clear();

entityManager.merge( person );

SELECT

p.id as id1\_0\_1\_,

p.name as name2\_0\_1\_,

ph.owner\_id as owner\_id3\_1\_3\_,

ph.id as id1\_1\_3\_,

ph.id as id1\_1\_0\_,

ph."number" as number2\_1\_0\_,

ph.owner\_id as owner\_id3\_1\_0\_

FROM

Person p

LEFT OUTER JOIN

Phone ph

on p.id=ph.owner\_id

WHERE

p.id = 1

During merge, the current state of the entity is copied onto the entity version that was just fetched from the database. That’s the reason why Hibernate executed the SELECT statement which fetched both the Person entity along with its children.

#### 5.13.3. CascadeType.REMOVE

The CascadeType.REMOVE allows us to remove a child entity along with the parent one. Traditionally, Hibernate called this operation delete, that’s why the org.hibernate.annotations.CascadeType provides a DELETE cascade option. However, CascadeType.REMOVE and org.hibernate.annotations.CascadeType.DELETE are identical.

*Example 335. CascadeType.REMOVE example*

Person person = entityManager.find( Person.class, 1L );

entityManager.remove( person );

DELETE FROM Phone WHERE id = 1

DELETE FROM Person WHERE id = 1

#### 5.13.4. CascadeType.DETACH

CascadeType.DETACH is used to propagate the detach operation from a parent entity to a child.

*Example 336. CascadeType.DETACH example*

Person person = entityManager.find( Person.class, 1L );

assertEquals( 1, person.getPhones().size() );

Phone phone = person.getPhones().get( 0 );

assertTrue( entityManager.contains( person ));

assertTrue( entityManager.contains( phone ));

entityManager.detach( person );

assertFalse( entityManager.contains( person ));

assertFalse( entityManager.contains( phone ));

#### 5.13.5. CascadeType.LOCK

Although unintuitively, CascadeType.LOCK does not propagate a lock request from a parent entity to its children. Such a use case requires the use of the PessimisticLockScope.EXTENDED value of the javax.persistence.lock.scopeproperty.

However, CascadeType.LOCK allows us to reattach a parent entity along with its children to the currently running Persistence Context.

*Example 337. CascadeType.LOCK example*

Person person = entityManager.find( Person.class, 1L );

assertEquals( 1, person.getPhones().size() );

Phone phone = person.getPhones().get( 0 );

assertTrue( entityManager.contains( person ) );

assertTrue( entityManager.contains( phone ) );

entityManager.detach( person );

assertFalse( entityManager.contains( person ) );

assertFalse( entityManager.contains( phone ) );

entityManager.unwrap( Session.class )

.buildLockRequest( new LockOptions( LockMode.NONE ) )

.lock( person );

assertTrue( entityManager.contains( person ) );

assertTrue( entityManager.contains( phone ) );

#### 5.13.6. CascadeType.REFRESH

The CascadeType.REFRESH is used to propagate the refresh operation from a parent entity to a child. The refresh operation will discard the current entity state, and it will override it using the one loaded from the database.

*Example 338. CascadeType.REFRESH example*

Person person = entityManager.find( Person.class, 1L );

Phone phone = person.getPhones().get( 0 );

person.setName( "John Doe Jr." );

phone.setNumber( "987-654-3210" );

entityManager.refresh( person );

assertEquals( "John Doe", person.getName() );

assertEquals( "123-456-7890", phone.getNumber() );

SELECT

p.id as id1\_0\_1\_,

p.name as name2\_0\_1\_,

ph.owner\_id as owner\_id3\_1\_3\_,

ph.id as id1\_1\_3\_,

ph.id as id1\_1\_0\_,

ph."number" as number2\_1\_0\_,

ph.owner\_id as owner\_id3\_1\_0\_

FROM

Person p

LEFT OUTER JOIN

Phone ph

ON p.id=ph.owner\_id

WHERE

p.id = 1

In the aforementioned example, you can see that both the Person and Phone entities are refreshed even if we only called this operation on the parent entity only.

#### 5.13.7. CascadeType.REPLICATE

The CascadeType.REPLICATE is to replicate both the parent and the child entities. The replicate operation allows you to synchronize entities coming from different sources of data.

*Example 339. CascadeType.REPLICATE example*

Person person = new Person();

person.setId( 1L );

person.setName( "John Doe Sr." );

Phone phone = new Phone();

phone.setId( 1L );

phone.setNumber( "(01) 123-456-7890" );

person.addPhone( phone );

entityManager.unwrap( Session.class ).replicate( person, ReplicationMode.OVERWRITE );

SELECT

id

FROM

Person

WHERE

id = 1

SELECT

id

FROM

Phone

WHERE

id = 1

UPDATE

Person

SET

name = 'John Doe Sr.'

WHERE

id = 1

UPDATE

Phone

SET

"number" = '(01) 123-456-7890',

owner\_id = 1

WHERE

id = 1

As illustrated by the SQL statements being generated, both the Person and Phone entities are replicated to the underlying database rows.

#### 5.13.8. @OnDelete cascade

While the previous cascade types propagate entity state transitions, the @OnDelete cascade is a DDL-level FK feature which allows you to remove a child record whenever the parent row is deleted.

So, when annotating the @ManyToOne association with @OnDelete( action = OnDeleteAction.CASCADE ), the automatic schema generator will apply the ON DELETE CASCADE SQL directive to the Foreign Key declaration, as illustrated by the following example.

*Example 340. @OnDelete mapping*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String name;

//Getters and setters are omitted for brevity

}

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

@Column(name = "`number`")

private String number;

@ManyToOne(fetch = FetchType.LAZY)

@OnDelete( action = OnDeleteAction.CASCADE )

private Person owner;

//Getters and setters are omitted for brevity

}

create table Person (

id bigint not null,

name varchar(255),

primary key (id)

)

create table Phone (

id bigint not null,

"number" varchar(255),

owner\_id bigint,

primary key (id)

)

alter table Phone

add constraint FK82m836qc1ss2niru7eogfndhl

foreign key (owner\_id)

references Person

on delete cascade

Now, you can just remove the Person entity, and the associated Phone is going to be removed automatically.

*Example 341. @OnDelete example*

Person person = entityManager.find( Person.class, 1L );

entityManager.remove( person );

delete from Person where id = ?

-- binding parameter [1] as [BIGINT] - [1]

## 6. Flushing

Flushing is the process of synchronizing the state of the persistence context with the underlying database. The EntityManager and the Hibernate Session expose a set of methods, through which the application developer can change the persistent state of an entity.

The persistence context acts as a transactional write-behind cache, queuing any entity state change. Like any write-behind cache, changes are first applied in-memory and synchronized with the database during flush time. The flush operation takes every entity state change and translates it to an INSERT, UPDATE or DELETE statement.

|  |  |
| --- | --- |
|  | Because DML statements are grouped together, Hibernate can apply batching transparently. See the [Batching chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#batch) for more information. |

The flushing strategy is given by the [flushMode](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Session.html#getFlushMode--) of the current running Hibernate Session. Although JPA defines only two flushing strategies ([AUTO](https://docs.oracle.com/javaee/7/api/javax/persistence/FlushModeType.html#AUTO) and [COMMIT](https://docs.oracle.com/javaee/7/api/javax/persistence/FlushModeType.html#COMMIT)), Hibernate has a much broader spectrum of flush types:

ALWAYS

Flushes the Session before every query.

AUTO

This is the default mode and it flushes the Session only if necessary.

COMMIT

The Session tries to delay the flush until the current Transaction is committed, although it might flush prematurely too.

MANUAL

The Session flushing is delegated to the application, which must call Session.flush() explicitly in order to apply the persistence context changes.

### 6.1. AUTO flush

By default, Hibernate uses the AUTO flush mode which triggers a flush in the following circumstances:

* prior to committing a Transaction
* prior to executing a JPQL/HQL query that overlaps with the queued entity actions
* before executing any native SQL query that has no registered synchronization

#### 6.1.1. AUTO flush on commit

In the following example, an entity is persisted and then the transaction is committed.

*Example 342. Automatic flushing on commit*

entityManager = entityManagerFactory().createEntityManager();

txn = entityManager.getTransaction();

txn.begin();

Person person = new Person( "John Doe" );

entityManager.persist( person );

log.info( "Entity is in persisted state" );

txn.commit();

--INFO: Entity is in persisted state

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

Hibernate logs the message prior to inserting the entity because the flush only occurred during transaction commit.

|  |  |
| --- | --- |
|  | This is valid for the SEQUENCE and TABLE identifier generators. The IDENTITY generator must execute the insert right after calling persist(). For details, see the discussion of generators in [Identifier generators](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers). |

#### 6.1.2. AUTO flush on JPQL/HQL query

A flush may also be triggered when executing an entity query.

*Example 343. Automatic flushing on JPQL/HQL*

Person person = new Person( "John Doe" );

entityManager.persist( person );

entityManager.createQuery( "select p from Advertisement p" ).getResultList();

entityManager.createQuery( "select p from Person p" ).getResultList();

SELECT a.id AS id1\_0\_ ,

a.title AS title2\_0\_

FROM Advertisement a

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

SELECT p.id AS id1\_1\_ ,

p.name AS name2\_1\_

FROM Person p

The reason why the Advertisement entity query didn’t trigger a flush is because there’s no overlapping between the Advertisement and the Person tables:

*Example 344. Automatic flushing on JPQL/HQL entities*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

private String name;

public Person() {}

public Person(String name) {

this.name = name;

}

public Long getId() {

return id;

}

public String getName() {

return name;

}

}

@Entity(name = "Advertisement")

public static class Advertisement {

@Id

@GeneratedValue

private Long id;

private String title;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

}

When querying for a Person entity, the flush is triggered prior to executing the entity query.

*Example 345. Automatic flushing on JPQL/HQL*

Person person = new Person( "John Doe" );

entityManager.persist( person );

entityManager.createQuery( "select p from Person p" ).getResultList();

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

SELECT p.id AS id1\_1\_ ,

p.name AS name2\_1\_

FROM Person p

This time, the flush was triggered by a JPQL query because the pending entity persist action overlaps with the query being executed.

#### 6.1.3. AUTO flush on native SQL query

When executing a native SQL query, a flush is always triggered when using the EntityManager API.

*Example 346. Automatic flushing on native SQL using EntityManager*

assertTrue(((Number) entityManager

.createNativeQuery( "select count(\*) from Person")

.getSingleResult()).intValue() == 0 );

Person person = new Person( "John Doe" );

entityManager.persist( person );

assertTrue(((Number) entityManager

.createNativeQuery( "select count(\*) from Person")

.getSingleResult()).intValue() == 1 );

The Session API doesn’t trigger an AUTO flush when executing a native query

*Example 347. Automatic flushing on native SQL using Session*

assertTrue(((Number) entityManager

.createNativeQuery( "select count(\*) from Person")

.getSingleResult()).intValue() == 0 );

Person person = new Person( "John Doe" );

entityManager.persist( person );

Session session = entityManager.unwrap(Session.class);

// for this to work, the Session/EntityManager must be put into COMMIT FlushMode

// - this is a change since 5.2 to account for merging EntityManager functionality

// directly into Session. Flushing would be the JPA-spec compliant behavior,

// so we know do that by default.

session.setFlushMode( FlushModeType.COMMIT );

// or using Hibernate's FlushMode enum

//session.setHibernateFlushMode( FlushMode.COMMIT );

assertTrue(((Number) session

.createNativeQuery( "select count(\*) from Person")

.uniqueResult()).intValue() == 0 );

//end::flushing-auto-flush-sql-native-example[\]

} );

}

@Test

public void testFlushAutoSQLSynchronization() {

doInJPA( this::entityManagerFactory, entityManager -> {

entityManager.createNativeQuery( "delete from Person" ).executeUpdate();;

} );

doInJPA( this::entityManagerFactory, entityManager -> {

log.info( "testFlushAutoSQLSynchronization" );

assertTrue(((Number) entityManager

.createNativeQuery( "select count(\*) from Person")

.getSingleResult()).intValue() == 0 );

Person person = new Person( "John Doe" );

entityManager.persist( person );

Session session = entityManager.unwrap( Session.class );

assertTrue(((Number) session

.createNativeQuery( "select count(\*) from Person")

.addSynchronizedEntityClass( Person.class )

.uniqueResult()).intValue() == 1 );

} );

}

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

private String name;

public Person() {}

public Person(String name) {

this.name = name;

}

public Long getId() {

return id;

}

public String getName() {

return name;

}

}

@Entity(name = "Advertisement")

public static class Advertisement {

@Id

@GeneratedValue

private Long id;

private String title;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getTitle() {

return title;

}

public void setTitle(String title) {

this.title = title;

}

}

}

To flush the Session, the query must use a synchronization:

*Example 348. Automatic flushing on native SQL with Session synchronization*

assertTrue(((Number) entityManager

.createNativeQuery( "select count(\*) from Person")

.getSingleResult()).intValue() == 0 );

Person person = new Person( "John Doe" );

entityManager.persist( person );

Session session = entityManager.unwrap( Session.class );

assertTrue(((Number) session

.createNativeQuery( "select count(\*) from Person")

.addSynchronizedEntityClass( Person.class )

.uniqueResult()).intValue() == 1 );

### 6.2. COMMIT flush

JPA also defines a COMMIT flush mode, which is described as follows:

*If FlushModeType.COMMIT is set, the effect of updates made to entities in the persistence context upon queries is unspecified.*

*— Section 3.10.8 of the JPA 2.1 Specification*

When executing a JPQL query, the persistence context is only flushed when the current running transaction is committed.

*Example 349. COMMIT flushing on JPQL*

Person person = new Person("John Doe");

entityManager.persist(person);

entityManager.createQuery("select p from Advertisement p")

.setFlushMode( FlushModeType.COMMIT)

.getResultList();

entityManager.createQuery("select p from Person p")

.setFlushMode( FlushModeType.COMMIT)

.getResultList();

SELECT a.id AS id1\_0\_ ,

a.title AS title2\_0\_

FROM Advertisement a

SELECT p.id AS id1\_1\_ ,

p.name AS name2\_1\_

FROM Person p

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

Because the JPA doesn’t impose a strict rule on delaying flushing, when executing a native SQL query, the persistence context is going to be flushed.

*Example 350. COMMIT flushing on SQL*

Person person = new Person("John Doe");

entityManager.persist(person);

assertTrue(((Number) entityManager

.createNativeQuery("select count(\*) from Person")

.getSingleResult()).intValue() == 1);

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

SELECT COUNT(\*) FROM Person

### 6.3. ALWAYS flush

|  |  |
| --- | --- |
|  | The ALWAYS is only available with the native Session API. |

The ALWAYS flush mode triggers a persistence context flush even when executing a native SQL query against the Session API.

*Example 351. COMMIT flushing on SQL*

Person person = new Person("John Doe");

entityManager.persist(person);

Session session = entityManager.unwrap( Session.class);

assertTrue(((Number) session

.createNativeQuery("select count(\*) from Person")

.setFlushMode( FlushMode.ALWAYS)

.uniqueResult()).intValue() == 1);

INSERT INTO Person (name, id) VALUES ('John Doe', 1)

SELECT COUNT(\*) FROM Person

### 6.4. MANUAL flush

Both the EntityManager and the Hibernate Session define a flush() method that, when called, triggers a manual flush. Hibernate also defines a MANUAL flush mode so the persistence context can only be flushed manually.

*Example 352. MANUAL flushing*

Person person = new Person("John Doe");

entityManager.persist(person);

Session session = entityManager.unwrap( Session.class);

session.setHibernateFlushMode( FlushMode.MANUAL );

assertTrue(((Number) entityManager

.createQuery("select count(id) from Person")

.getSingleResult()).intValue() == 0);

assertTrue(((Number) session

.createNativeQuery("select count(\*) from Person")

.uniqueResult()).intValue() == 0);

SELECT COUNT(p.id) AS col\_0\_0\_

FROM Person p

SELECT COUNT(\*)

FROM Person

The INSERT statement was not executed because the persistence context because there was no manual flush() call.

|  |  |
| --- | --- |
|  | This mode is useful when using multi-request logical transactions and only the last request should flush the persistence context. |

### 6.5. Flush operation order

From a database perspective, a row state can be altered using either an INSERT, an UPDATE or a DELETE statement. Because entity state changes are automatically converted to SQL statements, it’s important to know which entity actions are associated to a given SQL statement.

INSERT

The INSERT statement is generated either by the EntityInsertAction or EntityIdentityInsertAction. These actions are scheduled by the persist operation, either explicitly or through cascading the PersistEvent from a parent to a child entity.

DELETE

The DELETE statement is generated by the EntityDeleteAction or OrphanRemovalAction.

UPDATE

The UPDATE statement is generated by EntityUpdateAction during flushing if the managed entity has been marked modified. The dirty checking mechanism is responsible for determining if a managed entity has been modified since it was first loaded.

Hibernate does not execute the SQL statements in the order of their associated entity state operations.

To visualize how this works, consider the following example:

*Example 353. Flush operation order*

Person person = entityManager.find( Person.class, 1L);

entityManager.remove(person);

Person newPerson = new Person( );

newPerson.setId( 2L );

newPerson.setName( "John Doe" );

entityManager.persist( newPerson );

INSERT INTO Person (name, id)

VALUES ('John Doe', 2L)

DELETE FROM Person WHERE id = 1

Even if we removed the first entity and then persist a new one, Hibernate is going to execute the DELETE statement after the INSERT.

|  |  |
| --- | --- |
|  | The order in which SQL statements are executed is given by the ActionQueue and not by the order in which entity state operations have been previously defined. |

The ActionQueue executes all operations in the following order:

1. OrphanRemovalAction
2. EntityInsertAction or EntityIdentityInsertAction
3. EntityUpdateAction
4. CollectionRemoveAction
5. CollectionUpdateAction
6. CollectionRecreateAction
7. EntityDeleteAction

## 7. Database access

### 7.1. ConnectionProvider

As an ORM tool, probably the single most important thing you need to tell Hibernate is how to connect to your database so that it may connect on behalf of your application. This is ultimately the function of the org.hibernate.engine.jdbc.connections.spi.ConnectionProvider interface. Hibernate provides some out of the box implementations of this interface. ConnectionProvider is also an extension point so you can also use custom implementations from third parties or written yourself. The ConnectionProvider to use is defined by the hibernate.connection.provider\_class setting. See the [org.hibernate.cfg.AvailableSettings#CONNECTION\_PROVIDER](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/cfg/AvailableSettings.html#CONNECTION_PROVIDER)

Generally speaking, applications should not have to configure a ConnectionProvider explicitly if using one of the Hibernate-provided implementations. Hibernate will internally determine which ConnectionProvider to use based on the following algorithm:

1. If hibernate.connection.provider\_class is set, it takes precedence
2. else if hibernate.connection.datasource is set → [Using DataSources](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-datasource)
3. else if any setting prefixed by hibernate.c3p0. is set → [Using c3p0](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-c3p0)
4. else if any setting prefixed by hibernate.proxool. is set → [Using Proxool](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-proxool)
5. else if any setting prefixed by hibernate.hikari. is set → [Using Hikari](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-hikari)
6. else if hibernate.connection.url is set → [Using Hibernate’s built-in (and unsupported) pooling](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-drivermanager)
7. else → [User-provided Connections](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-provided)

### 7.2. Using DataSources

Hibernate can integrate with a javax.sql.DataSource for obtaining JDBC Connections. Applications would tell Hibernate about the DataSource via the (required) hibernate.connection.datasource setting which can either specify a JNDI name or would reference the actual DataSource instance. For cases where a JNDI name is given, be sure to read [JNDI](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#jndi)

|  |  |
| --- | --- |
|  | For JPA applications, note that hibernate.connection.datasource corresponds to either javax.persistence.jtaDataSource or javax.persistence.nonJtaDataSource. |

The DataSource ConnectionProvider also (optionally) accepts the hibernate.connection.username and hibernate.connection.password. If specified, the [DataSource#getConnection(String username, String password)](https://docs.oracle.com/javase/8/docs/api/javax/sql/DataSource.html#getConnection-java.lang.String-java.lang.String-) will be used. Otherwise, the no-arg form is used.

### 7.3. Using c3p0

|  |  |
| --- | --- |
|  | To use this integration, the application must include the hibernate-c3p0 module jar (as well as its dependencies) on the classpath. |

Hibernate also provides support for applications to use [c3p0](http://www.mchange.com/projects/c3p0/) connection pooling. When using this c3p0 support, a number of additional configuration settings are recognized.

Transaction isolation of the Connections is managed by the ConnectionProvider itself. See [ConnectionProvider support for transaction isolation setting](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-isolation).

hibernate.connection.driver\_class

The name of the JDBC Driver class to use

hibernate.connection.url

The JDBC connection url.

Any settings prefixed with hibernate.connection. (other than the "special ones")

These all have the hibernate.connection. prefix stripped and the rest will be passed as JDBC connection properties

hibernate.c3p0.min\_size or c3p0.minPoolSize

The minimum size of the c3p0 pool. See [c3p0 minPoolSize](http://www.mchange.com/projects/c3p0/#minPoolSize)

hibernate.c3p0.max\_size or c3p0.maxPoolSize

The maximum size of the c3p0 pool. See [c3p0 maxPoolSize](http://www.mchange.com/projects/c3p0/#maxPoolSize)

hibernate.c3p0.timeout or c3p0.maxIdleTime

The Connection idle time. See [c3p0 maxIdleTime](http://www.mchange.com/projects/c3p0/#maxIdleTime)

hibernate.c3p0.max\_statements or c3p0.maxStatements

Controls the c3p0 PreparedStatement cache size (if using). See [c3p0 maxStatements](http://www.mchange.com/projects/c3p0/#maxStatements)

hibernate.c3p0.acquire\_increment or c3p0.acquireIncrement

Number of connections c3p0 should acquire at a time when pool is exhausted. See [c3p0 acquireIncrement](http://www.mchange.com/projects/c3p0/#acquireIncrement)

hibernate.c3p0.idle\_test\_period or c3p0.idleConnectionTestPeriod

Idle time before a c3p0 pooled connection is validated. See [c3p0 idleConnectionTestPeriod](http://www.mchange.com/projects/c3p0/#idleConnectionTestPeriod)

hibernate.c3p0.initialPoolSize

The initial c3p0 pool size. If not specified, default is to use the min pool size. See [c3p0 initialPoolSize](http://www.mchange.com/projects/c3p0/#initialPoolSize)

Any other settings prefixed with hibernate.c3p0.

Will have the hibernate. portion stripped and be passed to c3p0.

Any other settings prefixed with c3p0.

Get passed to c3p0 as is. See [c3p0 configuration](http://www.mchange.com/projects/c3p0/#configuration)

### 7.4. Using Proxool

|  |  |
| --- | --- |
|  | To use this integration, the application must include the hibernate-proxool module jar (as well as its dependencies) on the classpath. |

Hibernate also provides support for applications to use [Proxool](http://proxool.sourceforge.net/) connection pooling.

Transaction isolation of the Connections is managed by the ConnectionProvider itself. See [ConnectionProvider support for transaction isolation setting](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-isolation).

### 7.5. Using existing Proxool pools

Controlled by the hibernate.proxool.existing\_pool setting. If set to true, this ConnectionProvider will use an already existing Proxool pool by alias as indicated by the hibernate.proxool.pool\_alias setting.

### 7.6. Configuring Proxool via XML

The hibernate.proxool.xml setting names a Proxool configuration XML file to be loaded as a classpath resource and loaded by Proxool’s JAXPConfigurator. See [proxool configuration](http://proxool.sourceforge.net/configure.html). hibernate.proxool.pool\_alias must be set to indicate which pool to use.

### 7.7. Configuring Proxool via Properties

The hibernate.proxool.properties setting names a Proxool configuration properties file to be loaded as a classpath resource and loaded by Proxool’s PropertyConfigurator. See [proxool configuration](http://proxool.sourceforge.net/configure.html). hibernate.proxool.pool\_aliasmust be set to indicate which pool to use.

### 7.8. Using Hikari

|  |  |
| --- | --- |
|  | To use this integration, the application must include the hibernate-hikari module jar (as well as its dependencies) on the classpath. |

Hibernate also provides support for applications to use [Hikari](http://brettwooldridge.github.io/HikariCP/) connection pool.

Set all of your Hikari settings in Hibernate prefixed by hibernate.hikari. and this ConnectionProvider will pick them up and pass them along to Hikari. Additionally, this ConnectionProvider will pick up the following Hibernate-specific properties and map them to the corresponding Hikari ones (any hibernate.hikari. prefixed ones have precedence):

hibernate.connection.driver\_class

Mapped to Hikari’s driverClassName setting

hibernate.connection.url

Mapped to Hikari’s jdbcUrl setting

hibernate.connection.username

Mapped to Hikari’s username setting

hibernate.connection.password

Mapped to Hikari’s password setting

hibernate.connection.isolation

Mapped to Hikari’s transactionIsolation setting. See [ConnectionProvider support for transaction isolation setting](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#database-connectionprovider-isolation). Note that Hikari only supports JDBC standard isolation levels (apparently).

hibernate.connection.autocommit

Mapped to Hikari’s autoCommit setting

### 7.9. Using Hibernate’s built-in (and unsupported) pooling

|  |  |
| --- | --- |
|  | The built-in connection pool is not supported supported for use. |

This section is here just for completeness.

### 7.10. User-provided Connections

It is possible to use Hibernate by simply passing a Connection to use to the Session when the Session is opened. This usage is discouraged and not discussed here.

### 7.11. ConnectionProvider support for transaction isolation setting

All of the provided ConnectionProvider implementations, other than DataSourceConnectionProvider, support consistent setting of transaction isolation for all Connections obtained from the underlying pool. The value for hibernate.connection.isolation can be specified in one of 3 formats:

* the integer value accepted at the JDBC level
* the name of the java.sql.Connection constant field representing the isolation you would like to use. For example, TRANSACTION\_REPEATABLE\_READ for [java.sql.Connection#TRANSACTION\_REPEATABLE\_READ](https://docs.oracle.com/javase/8/docs/api/java/sql/Connection.html#TRANSACTION_REPEATABLE_READ). Not that this is only supported for JDBC standard isolation levels, not for isolation levels specific to a particular JDBC driver.
* a short-name version of the java.sql.Connection constant field without the TRANSACTION\_ prefix. For example, REPEATABLE\_READ for [java.sql.Connection#TRANSACTION\_REPEATABLE\_READ](https://docs.oracle.com/javase/8/docs/api/java/sql/Connection.html#TRANSACTION_REPEATABLE_READ). Again, this is only supported for JDBC standard isolation levels, not for isolation levels specific to a particular JDBC driver.

### 7.12. Database Dialect

Although SQL is relatively standardized, each database vendor uses a subset and superset of ANSI SQL defined syntax. This is referred to as the database’s dialect. Hibernate handles variations across these dialects through its org.hibernate.dialect.Dialect class and the various subclasses for each database vendor.

In most cases Hibernate will be able to determine the proper Dialect to use by asking some questions of the JDBC Connection during bootstrap. For information on Hibernate’s ability to determine the proper Dialect to use (and your ability to influence that resolution), see [Dialect resolution](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#portability-dialectresolver).

If for some reason it is not able to determine the proper one or you want to use a custom Dialect, you will need to set the hibernate.dialect setting.

| *Table 4. Provided Dialects* | |
| --- | --- |
| **Dialect (short name)** | **Remarks** |
| Cache71 | Support for the Caché database, version 2007.1 |
| CUBRID | Support for the CUBRID database, version 8.3. May work with later versions. |
| DB2 | Support for the DB2 database, version 8.2. |
| DB297 | Support for the DB2 database, version 9.7. |
| DB2390 | Support for DB2 Universal Database for OS/390, also known as DB2/390. |
| DB2400 | Support for DB2 Universal Database for iSeries, also known as DB2/400. |
| DerbyTenFive | Support for the Derby database, version 10.5 |
| DerbyTenSix | Support for the Derby database, version 10.6 |
| DerbyTenSeven | Support for the Derby database, version 10.7 |
| Firebird | Support for the Firebird database |
| FrontBase | Support for the Frontbase database |
| H2 | Support for the H2 database |
| HANAColumnStore | Support for the SAP HANA database column store. This is the recommended dialect for the SAP HANA database. |
| HANARowStore | Support for the SAP HANA database row store |
| HSQL | Support for the HSQL (HyperSQL) database |
| Informix | Support for the Informix database |
| Ingres | Support for the Ingres database, version 9.2 |
| Ingres9 | Support for the Ingres database, version 9.3. May work with newer versions |
| Ingres10 | Support for the Ingres database, version 10. May work with newer versions |
| Interbase | Support for the Interbase database. |
| JDataStore | Support for the JDataStore database |
| McKoi | Support for the McKoi database |
| Mimer | Support for the Mimer database, version 9.2.1. May work with newer versions |
| MySQL5 | Support for the MySQL database, version 5.x |
| MySQL5InnoDB | Support for the MySQL database, version 5.x preferring the InnoDB storage engine when exporting tables. |
| MySQL57InnoDB | Support for the MySQL database, version 5.7 preferring the InnoDB storage engine when exporting tables. May work with newer versions |
| MariaDB | Support for the MariadB database. May work with newer versions |
| MariaDB53 | Support for the MariadB database, version 5.3 and newer. |
| Oracle8i | Support for the Oracle database, version 8i |
| Oracle9i | Support for the Oracle database, version 9i |
| Oracle10g | Support for the Oracle database, version 10g |
| Pointbase | Support for the Pointbase database |
| PostgresPlus | Support for the Postgres Plus database |
| PostgreSQL81 | Support for the PostgrSQL database, version 8.1 |
| PostgreSQL82 | Support for the PostgreSQL database, version 8.2 |
| PostgreSQL9 | Support for the PostgreSQL database, version 9. May work with later versions. |
| Progress | Support for the Progress database, version 9.1C. May work with newer versions. |
| SAPDB | Support for the SAPDB/MAXDB database. |
| SQLServer | Support for the SQL Server 2000 database |
| SQLServer2005 | Support for the SQL Server 2005 database |
| SQLServer2008 | Support for the SQL Server 2008 database |
| Sybase11 | Support for the Sybase database, up to version 11.9.2 |
| SybaseAnywhere | Support for the Sybase Anywhere database |
| SybaseASE15 | Support for the Sybase Adaptive Server Enterprise database, version 15 |
| SybaseASE157 | Support for the Sybase Adaptive Server Enterprise database, version 15.7. May work with newer versions. |
| Teradata | Support for the Teradata database |
| TimesTen | Support for the TimesTen database, version 5.1. May work with newer versions |

## 8. Transactions and concurrency control

It is important to understand that the term transaction has many different yet related meanings in regards to persistence and Object/Relational Mapping. In most use-cases these definitions align, but that is not always the case.

* Might refer to the physical transaction with the database.
* Might refer to the logical notion of a transaction as related to a persistence context.
* Might refer to the application notion of a Unit-of-Work, as defined by the archetypal pattern.

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|  | This documentation largely treats the physical and logic notions of a transaction as one-in-the-same. |

### 8.1. Physical Transactions

Hibernate uses the JDBC API for persistence. In the world of Java there are two well-defined mechanism for dealing with transactions in JDBC: JDBC itself and JTA. Hibernate supports both mechanisms for integrating with transactions and allowing applications to manage physical transactions.

Transaction handling per Session is handled by the org.hibernate.resource.transaction.spi.TransactionCoordinator contract, which are built by the org.hibernate.resource.transaction.spi.TransactionCoordinatorBuilder service.TransactionCoordinatorBuilder represents a strategy for dealing with transactions whereas TransactionCoordinator represents one instance of that strategy related to a Session. Which TransactionCoordinatorBuilder implementation to use is defined by the hibernate.transaction.coordinator\_class setting.

jdbc (the default for non-JPA applications)

Manages transactions via calls to java.sql.Connection

jta

Manages transactions via JTA. See [Java EE bootstrapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-jpa-compliant)

If a JPA application does not provide a setting for hibernate.transaction.coordinator\_class, Hibernate will automatically build the proper transaction coordinator based on the transaction type for the persistence unit.

If a non-JPA application does not provide a setting for hibernate.transaction.coordinator\_class, Hibernate will use jdbc as the default. This default will cause problems if the application actually uses JTA-based transactions. A non-JPA application that uses JTA-based transactions should explicitly set hibernate.transaction.coordinator\_class=jta or provide a custom org.hibernate.resource.transaction.TransactionCoordinatorBuilder that builds aorg.hibernate.resource.transaction.TransactionCoordinator that properly coordinates with JTA-based transactions.

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|  | For details on implementing a custom TransactionCoordinatorBuilder, or simply better understanding how it works, see the Integrations Guide. |

Hibernate uses JDBC connections and JTA resources directly, without adding any additional locking behavior. Hibernate does not lock objects in memory. The behavior defined by the isolation level of your database transactions does not change when you use Hibernate. The Hibernate Session acts as a transaction-scoped cache providing repeatable reads for lookup by identifier and queries that result in loading entities.

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|  | To reduce lock contention in the database, the physical database transaction needs to be as short as possible. Long database transactions prevent your application from scaling to a highly-concurrent load. Do not hold a database transaction open during end-user-level work, but open it after the end-user-level work is finished. This is concept is referred to as transactional write-behind. |

### 8.2. JTA configuration

Interaction with a JTA system is consolidated behind a single contract named org.hibernate.engine.transaction.jta.platform.spi.JtaPlatform which exposes access to the javax.transaction.TransactionManager and javax.transaction.UserTransaction for that system as well as exposing the ability to register javax.transaction.Synchronization instances, check transaction status, etc.

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|  | Generally, JtaPlatform will need access to JNDI to resolve the JTA TransactionManager, UserTransaction, etc. See [JNDI chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#jndi) for details on configuring access to JNDI. |

Hibernate tries to discover the JtaPlatform it should use through the use of another service named org.hibernate.engine.transaction.jta.platform.spi.JtaPlatformResolver. If that resolution does not work, or if you wish to provide a custom implementation you will need to specify the hibernate.transaction.jta.platformsetting. Hibernate provides many implementations of the JtaPlatform contract, all with short names:

Borland

JtaPlatform for the Borland Enterprise Server.

Bitronix

JtaPlatform for Bitronix.

JBossAS

JtaPlatform for Arjuna/JBossTransactions/Narayana when used within the JBoss/WildFly Application Server.

JBossTS

JtaPlatform for Arjuna/JBossTransactions/Narayana when used standalone.

JOnAS

JtaPlatform for JOTM when used within JOnAS.

JOTM

JtaPlatform for JOTM when used standalone.

JRun4

JtaPlatform for the JRun 4 Application Server.

OC4J

JtaPlatform for Oracle’s OC4J container.

Orion

JtaPlatform for the Orion Application Server.

Resin

JtaPlatform for the Resin Application Server.

SapNetWeaver

JtaPlatform for the SAP NetWeaver Application Server.

SunOne

JtaPlatform for the SunOne Application Server.

Weblogic

JtaPlatform for the Weblogic Application Server.

WebSphere

JtaPlatform for older versions of the WebSphere Application Server.

WebSphereExtended

JtaPlatform for newer versions of the WebSphere Application Server.

### 8.3. Hibernate Transaction API

Hibernate provides an API for helping to isolate applications from the differences in the underlying physical transaction system in use. Based on the configured TransactionCoordinatorBuilder, Hibernate will simply do the right thing when this transaction API is used by the application. This allows your applications and components to be more portable move around into different environments.

To use this API, you would obtain the org.hibernate.Transaction from the Session. Transaction allows for all the normal operations you’d expect: begin, commit and rollback, and it even exposes some cool methods like:

markRollbackOnly

that works in both JTA and JDBC

getTimeout and setTimeout

that again work in both JTA and JDBC

registerSynchronization

that allows you to register JTA Synchronizations even in non-JTA environments. In fact in both JTA and JDBC environments, these Synchronizations are kept locally by Hibernate. In JTA environments, Hibernate will only ever register one single Synchronization with the TransactionManager to avoid ordering problems.

Additionally, it exposes a getStatus method that returns an org.hibernate.resource.transaction.spi.TransactionStatus enum. This method checks with the underlying transaction system if needed, so care should be taken to minimize its use; it can have a big performance impact in certain JTA set ups.

Let’s take a look at using the Transaction API in the various environments.

*Example 354. Using Transaction API in JDBC*

StandardServiceRegistry serviceRegistry = new StandardServiceRegistryBuilder()

// "jdbc" is the default, but for explicitness

.applySetting( AvailableSettings.TRANSACTION\_COORDINATOR\_STRATEGY, "jdbc" )

.build();

Metadata metadata = new MetadataSources( serviceRegistry )

.addAnnotatedClass( Customer.class )

.getMetadataBuilder()

.build();

SessionFactory sessionFactory = metadata.getSessionFactoryBuilder()

.build();

Session session = sessionFactory.openSession();

try {

// calls Connection#setAutoCommit( false ) to

// signal start of transaction

session.getTransaction().begin();

session.createQuery( "UPDATE customer set NAME = 'Sir. '||NAME" )

.executeUpdate();

// calls Connection#commit(), if an error

// happens we attempt a rollback

session.getTransaction().commit();

}

catch ( Exception e ) {

// we may need to rollback depending on

// where the exception happened

if ( session.getTransaction().getStatus() == TransactionStatus.ACTIVE

|| session.getTransaction().getStatus() == TransactionStatus.MARKED\_ROLLBACK ) {

session.getTransaction().rollback();

}

// handle the underlying error

}

finally {

session.close();

sessionFactory.close();

}

*Example 355. Using Transaction API in JTA (CMT)*

StandardServiceRegistry serviceRegistry = new StandardServiceRegistryBuilder()

// "jdbc" is the default, but for explicitness

.applySetting( AvailableSettings.TRANSACTION\_COORDINATOR\_STRATEGY, "jta" )

.build();

Metadata metadata = new MetadataSources( serviceRegistry )

.addAnnotatedClass( Customer.class )

.getMetadataBuilder()

.build();

SessionFactory sessionFactory = metadata.getSessionFactoryBuilder()

.build();

// Note: depending on the JtaPlatform used and some optional settings,

// the underlying transactions here will be controlled through either

// the JTA TransactionManager or UserTransaction

Session session = sessionFactory.openSession();

try {

// Since we are in CMT, a JTA transaction would

// already have been started. This call essentially

// no-ops

session.getTransaction().begin();

Number customerCount = (Number) session.createQuery( "select count(c) from Customer c" ).uniqueResult();

// Since we did not start the transaction ( CMT ),

// we also will not end it. This call essentially

// no-ops in terms of transaction handling.

session.getTransaction().commit();

}

catch ( Exception e ) {

// again, the rollback call here would no-op (aside from

// marking the underlying CMT transaction for rollback only).

if ( session.getTransaction().getStatus() == TransactionStatus.ACTIVE

|| session.getTransaction().getStatus() == TransactionStatus.MARKED\_ROLLBACK ) {

session.getTransaction().rollback();

}

// handle the underlying error

}

finally {

session.close();

sessionFactory.close();

}

*Example 356. Using Transaction API in JTA (BMT)*

StandardServiceRegistry serviceRegistry = new StandardServiceRegistryBuilder()

// "jdbc" is the default, but for explicitness

.applySetting( AvailableSettings.TRANSACTION\_COORDINATOR\_STRATEGY, "jta" )

.build();

Metadata metadata = new MetadataSources( serviceRegistry )

.addAnnotatedClass( Customer.class )

.getMetadataBuilder()

.build();

SessionFactory sessionFactory = metadata.getSessionFactoryBuilder()

.build();

// Note: depending on the JtaPlatform used and some optional settings,

// the underlying transactions here will be controlled through either

// the JTA TransactionManager or UserTransaction

Session session = sessionFactory.openSession();

try {

// Assuming a JTA transaction is not already active,

// this call the TM/UT begin method. If a JTA

// transaction is already active, we remember that

// the Transaction associated with the Session did

// not "initiate" the JTA transaction and will later

// nop-op the commit and rollback calls...

session.getTransaction().begin();

session.persist( new Customer( ) );

Customer customer = (Customer) session.createQuery( "select c from Customer c" ).uniqueResult();

// calls TM/UT commit method, assuming we are initiator.

session.getTransaction().commit();

}

catch ( Exception e ) {

// we may need to rollback depending on

// where the exception happened

if ( session.getTransaction().getStatus() == TransactionStatus.ACTIVE

|| session.getTransaction().getStatus() == TransactionStatus.MARKED\_ROLLBACK ) {

// calls TM/UT commit method, assuming we are initiator;

// otherwise marks the JTA transaction for rollback only

session.getTransaction().rollback();

}

// handle the underlying error

}

finally {

session.close();

sessionFactory.close();

}

In the CMT case we really could have omitted all of the Transaction calls. But the point of the examples was to show that the Transaction API really does insulate your code from the underlying transaction mechanism. In fact, if you strip away the comments and the single configuration setting supplied at bootstrap, the code is exactly the same in all 3 examples. In other words, we could develop that code and drop it, as-is, in any of the 3 transaction environments.

The Transaction API tries hard to make the experience consistent across all environments. To that end, it generally defers to the JTA specification when there are differences (for example automatically trying rollback on a failed commit).

### 8.4. 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.spi.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](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/spi/CurrentSessionContext.html) for the org.hibernate.context.spi.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.internal.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](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/internal/JTASessionContext.html) for more details.

* org.hibernate.context.internal.ThreadLocalSessionContext:current sessions are tracked by thread of execution. See the [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/internal/ThreadLocalSessionContext.html) for more details.
* org.hibernate.context.internal.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. See the [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/internal/ManagedSessionContext.html) for details.

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.

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 Java SE 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 [Transactions and concurrency control](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#transactions) for more information and code examples.

The hibernate.current\_session\_context\_class configuration parameter defines which org.hibernate.context.spi.CurrentSessionContext implementation should be used. For backwards compatibility, if this configuration parameter is not set but a org.hibernate.engine.transaction.jta.platform.spi.JtaPlatform is configured, Hibernate will use the org.hibernate.context.internal.JTASessionContext.

### 8.5. Transactional patterns (and anti-patterns)

### 8.6. Session-per-operation anti-pattern

This is an anti-pattern of opening and closing a Session for each database call in a single thread. It is also an anti-pattern in terms of database transactions. Group your database calls into a planned sequence. In the same way, do not auto-commit after every SQL statement in your application. Hibernate disables, or expects the application server to disable, auto-commit mode immediately. Database transactions are never optional. All communication with a database must be encapsulated by a transaction. Avoid auto-commit behavior for reading data because many small transactions are unlikely to perform better than one clearly-defined unit of work, and are more difficult to maintain and extend.

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|  | Using auto-commit does not circumvent database transactions. Instead, when in auto-commit mode, JDBC drivers simply perform each call in an implicit transaction call. It is as if your application called commit after each and every JDBC call. |

### 8.7. Session-per-request pattern

This is the most common transaction pattern. The term request here relates to the concept of a system that reacts to a series of requests from a client/user. Web applications are a prime example of this type of system, though certainly not the only one. At the beginning of handling such a request, the application opens a Hibernate Session, starts a transaction, performs all data related work, ends the transaction and closes the Session. The crux of the pattern is the one-to-one relationship between the transaction and the Session.

Within this pattern there is a common technique of defining a current session to simplify the need of passing this Session around to all the application components that may need access to it. Hibernate provides support for this technique through the getCurrentSession method of the SessionFactory. The concept of a current session has to have a scope that defines the bounds in which the notion of current is valid. This is the purpose of the org.hibernate.context.spi.CurrentSessionContext contract.

There are 2 reliable defining scopes:

* First is a JTA transaction because it allows a callback hook to know when it is ending, which gives Hibernate a chance to close the Session and clean up. This is represented by the org.hibernate.context.internal.JTASessionContext implementation of the org.hibernate.context.spi.CurrentSessionContext contract. Using this implementation, a Session will be opened the first time getCurrentSession is called within that transaction.
* Secondly is this application request cycle itself. This is best represented with the org.hibernate.context.internal.ManagedSessionContext implementation of the org.hibernate.context.spi.CurrentSessionContext contract. Here an external component is responsible for managing the lifecycle and scoping of a current session. At the start of such a scope, ManagedSessionContext#bind()method is called passing in the Session. At the end, its unbind() method is called. Some common examples of such external components include:
  + javax.servlet.Filter implementation
  + AOP interceptor with a pointcut on the service methods
  + A proxy/interception container

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|  | The getCurrentSession() method has one downside in a JTA environment. If you use it, after\_statement connection release mode is also used by default. Due to a limitation of the JTA specification, Hibernate cannot automatically clean up any unclosed ScrollableResults or Iterator instances returned by scroll() or iterate(). Release the underlying database cursor by calling ScrollableResults#close() or Hibernate.close(Iterator) explicitly from a finally block. |

### 8.8. Conversations

The session-per-request pattern is not the only valid 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 is loaded in a particular Session and database transaction. The user is free to modify the objects.

The user uses a UI element to save their work after five minutes of editing. The modifications are made persistent. The user also expects to have exclusive access to the data during the edit session.

Even though we have multiple databases access here, from the point of view of the user, this series of steps represents a single unit of work. There are many ways to implement this in your application.

A first naive implementation might keep the Session and database transaction open while the user is editing, using database-level locks to prevent other users from modifying the same data and to guarantee isolation and atomicity. This is an anti-pattern because lock contention is a bottleneck which will prevent scalability in the future.

Several database transactions are used 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. These multiple database accesses can only be atomic as a whole if only one of these database transactions (typically the last one) stores the updated data. All others only read data. A common way to receive this data is through a wizard-style dialog spanning several request/response cycles. Hibernate includes some features which make this easy to implement.

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| Automatic Versioning | Hibernate can perform automatic optimistic concurrency control for you. It can automatically detect (at the end of the conversation) if a concurrent modification occurred during user think time. |
| 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 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 flush automatically, only explicitly. |

Session-per-request-with-detached-objects and session-per-conversation each have advantages and disadvantages.

### 8.9. Session-per-application

The session-per-application is also considered an anti-pattern. The Hibernate Session, like the JPA EntityManager, is not a thread-safe object and it is intended to be confined to a single thread at once. If the Session is shared among multiple threads, there will be race conditions as well as visibility issues , so beware of this.

An exception thrown by Hibernate means you have to rollback your database transaction and close the Sessionimmediately. 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 the [Batching chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#batch). Keeping a Session open for the duration of a user session also means a higher probability of stale data.

## 9. JNDI

Hibernate does optionally interact with JNDI on the application’s behalf. Generally, it does this when the application:

* has asked the SessionFactory be bound to JNDI
* has specified a DataSource to use by JNDI name
* is using JTA transactions and the JtaPlatform needs to do JNDI lookups for TransactionManager, UserTransaction, etc

All of these JNDI calls route through a single service whose role is org.hibernate.engine.jndi.spi.JndiService. The standard JndiService accepts a number of configuration settings

hibernate.jndi.class

names the javax.naming.InitialContext implementation class to use. See [javax.naming.Context#INITIAL\_CONTEXT\_FACTORY](https://docs.oracle.com/javase/8/docs/api/javax/naming/Context.html#INITIAL_CONTEXT_FACTORY)

hibernate.jndi.url

names the JNDI InitialContext connection url. See [javax.naming.Context.PROVIDER\_URL](https://docs.oracle.com/javase/8/docs/api/javax/naming/Context.html#PROVIDER_URL)

Any other settings prefixed with hibernate.jndi. will be collected and passed along to the JNDI provider.

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|  | The standard JndiService assumes that all JNDI calls are relative to the same InitialContext. If your application uses multiple naming servers for whatever reason, you will need a custom JndiService implementation to handle those details. |

## 10. Locking

In a relational database, locking refers to actions taken to prevent data from changing between the time it is read and the time is used.

Your locking strategy can be either optimistic or pessimistic.

Optimistic

[Optimistic locking](http://en.wikipedia.org/wiki/Optimistic_locking) assumes that multiple transactions can complete without affecting each other, and that therefore transactions can proceed without locking the data resources that they affect. Before committing, each transaction verifies that no other transaction has modified its data. If the check reveals conflicting modifications, the committing transaction rolls back.

Pessimistic

Pessimistic locking assumes that concurrent transactions will conflict with each other, and requires resources to be locked after they are read and only unlocked after the application has finished using the data.

Hibernate provides mechanisms for implementing both types of locking in your applications.

### 10.1. Optimistic

When your application uses long transactions or conversations that span several database transactions, you can store versioning data so that if the same entity is updated by two conversations, the last to commit changes is informed of the conflict, and does not override the other conversation’s work. This approach guarantees some isolation, but scales well and works particularly well in read-often-write-sometimes situations.

Hibernate provides two different mechanisms for storing versioning information, a dedicated version number or a timestamp.

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|  | A version or timestamp property can never be null for a detached instance. Hibernate detects any instance with a null version or timestamp as transient, regardless of other unsaved-value strategies that you specify. Declaring a nullable version or timestamp property is an easy way to avoid problems with transitive reattachment in Hibernate, especially useful if you use assigned identifiers or composite keys. |

#### 10.1.1. Mapping optimistic locking

JPA defines support for optimistic locking based on either a version (sequential numeric) or timestamp strategy. To enable this style of optimistic locking simply add the javax.persistence.Version to the persistent attribute that defines the optimistic locking value. According to JPA, the valid types for these attributes are limited to:

* int or Integer
* short or Short
* long or Long
* java.sql.Timestamp

However, Hibernate allows you to use even Java 8 Date/Time types, such as Instant.

*Example 357. @Version annotation mapping*

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@Column(name = "`name`")

private String name;

@Version

private long version;

//Getters and setters are omitted for brevity

}

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@Column(name = "`name`")

private String name;

@Version

private Timestamp version;

//Getters and setters are omitted for brevity

}

@Entity(name = "Person")

public static class Person {

@Id

@GeneratedValue

private Long id;

@Column(name = "`name`")

private String name;

@Version

private Instant version;

//Getters and setters are omitted for brevity

}

##### Dedicated version number

The version number mechanism for optimistic locking is provided through a @Version annotation.

*Example 358. @Version annotation*

@Version

private long version;

Here, the version property is mapped to the version column, and the entity manager uses it to detect conflicting updates, and prevent the loss of updates that would otherwise be overwritten by a last-commit-wins strategy.

The version column can be any kind of type, as long as you define and implement the appropriate UserVersionType.

Your application is forbidden from altering the version number set by Hibernate. To artificially increase the version number, see the documentation for properties LockModeType.OPTIMISTIC\_FORCE\_INCREMENT orLockModeType.PESSIMISTIC\_FORCE\_INCREMENT check in the Hibernate Entity Manager reference documentation.

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|  | If the version number is generated by the database, such as a trigger, use the annotation @org.hibernate.annotations.Generated(GenerationTime.ALWAYS) on the version attribute. |

##### Timestamp

Timestamps are a less reliable way of optimistic locking than version numbers, but can be used by applications for other purposes as well. Timestamping is automatically used if you the @Version annotation on a Date or Calendar property type.

*Example 359. Using timestamps for optimistic locking*

@Version

private Date version;

Hibernate can retrieve the timestamp value from the database or the JVM, by reading the value you specify for the @org.hibernate.annotations.Source annotation. The value can be either org.hibernate.annotations.SourceType.DB or org.hibernate.annotations.SourceType.VM. The default behavior is to use the database, and is also used if you don’t specify the annotation at all.

The timestamp can also be generated by the database instead of Hibernate if you use the @org.hibernate.annotations.Generated(GenerationTime.ALWAYS) or the @Source annotation.

*Example 360. Database-generated version timestamp mapping*

@Entity(name = "Person")

public static class Person {

@Id

private Long id;

private String firstName;

private String lastName;

@Version

@Source(value = SourceType.DB)

private Date version;

}

Now, when persisting a Person entity, Hibernate calls the database-specific current timestamp retrieval function:

*Example 361. Database-generated version timestamp example*

Person person = new Person();

person.setId( 1L );

person.setFirstName( "John" );

person.setLastName( "Doe" );

assertNull( person.getVersion() );

entityManager.persist( person );

assertNotNull( person.getVersion() );

CALL current\_timestamp()

INSERT INTO

Person

(firstName, lastName, version, id)

VALUES

(?, ?, ?, ?)

-- binding parameter [1] as [VARCHAR] - [John]

-- binding parameter [2] as [VARCHAR] - [Doe]

-- binding parameter [3] as [TIMESTAMP] - [2017-05-18 12:03:03.808]

-- binding parameter [4] as [BIGINT] - [1]

##### Excluding attributes

By default, every entity attribute modification is going to trigger a version incrementation. If there is an entity property which should not bump up the entity version, then you need to annotate it with the Hibernate [@OptimisticLock](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLock.html)annotation, as illustrated in the following example.

*Example 362. @OptimisticLock mapping example*

@Entity(name = "Phone")

public static class Phone {

@Id

private Long id;

@Column(name = "`number`")

private String number;

@OptimisticLock( excluded = true )

private long callCount;

@Version

private Long version;

//Getters and setters are omitted for brevity

public void incrementCallCount() {

this.callCount++;

}

}

This way, if one tread modifies the Phone number while a second thread increments the callCount attribute, the two concurrent transactions are not going to conflict as illustrated by the following example.

*Example 363. @OptimisticLock exlude attribute example*

doInJPA( this::entityManagerFactory, entityManager -> {

Phone phone = entityManager.find( Phone.class, 1L );

phone.setNumber( "+123-456-7890" );

doInJPA( this::entityManagerFactory, \_entityManager -> {

Phone \_phone = \_entityManager.find( Phone.class, 1L );

\_phone.incrementCallCount();

log.info( "Bob changes the Phone call count" );

} );

log.info( "Alice changes the Phone number" );

} );

-- Bob changes the Phone call count

update

Phone

set

callCount = 1,

"number" = '123-456-7890',

version = 0

where

id = 1

and version = 0

-- Alice changes the Phone number

update

Phone

set

callCount = 0,

"number" = '+123-456-7890',

version = 1

where

id = 1

and version = 0

When Bob changes the Phone entity callCount, the entity version is not bumped up. That’s why Alice’s UPDATE succeeds since the entity version is still 0, even if Bob has changed the record since Alice loaded it.

|  |  |
| --- | --- |
|  | Although there is no conflict between Bob and Alice, Alice’s UPDATE overrides Bob’s change to the callCount attribute.  For this reason, you should only use this feature if you can accommodate lost updates on the excluded entity properties. |

##### Versionless optimistic locking

Although the default @Version property optimistic locking mechanism is sufficient in many situations, sometimes, you need rely on the actual database row column values to prevent **lost updates**.

Hibernate supports a form of optimistic locking that does not require a dedicated "version attribute". This is also useful for use with modeling legacy schemas.

The idea is that you can get Hibernate to perform "version checks" using either all of the entity’s attributes, or just the attributes that have changed. This is achieved through the use of the [@OptimisticLocking](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLocking.html) annotation which defines a single attribute of type [org.hibernate.annotations.OptimisticLockType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLockType.html).

There are 4 available OptimisticLockTypes:

NONE

optimistic locking is disabled even if there is a @Version annotation present

VERSION (the default)

performs optimistic locking based on a @Version as described above

ALL

performs optimistic locking based on all fields as part of an expanded WHERE clause restriction for the UPDATE/DELETE SQL statements

DIRTY

performs optimistic locking based on dirty fields as part of an expanded WHERE clause restriction for the UPDATE/DELETE SQL statements

###### Versionless optimistic locking using OptimisticLockType.ALL

*Example 364. OptimisticLockType.ALL mapping example*

@Entity(name = "Person")

@OptimisticLocking(type = OptimisticLockType.ALL)

@DynamicUpdate

public static class Person {

@Id

private Long id;

@Column(name = "`name`")

private String name;

private String country;

private String city;

@Column(name = "created\_on")

private Timestamp createdOn;

//Getters and setters are omitted for brevity

}

When you need to modify the Person entity above:

*Example 365. OptimisticLockType.ALL update example*

Person person = entityManager.find( Person.class, 1L );

person.setCity( "Washington D.C." );

UPDATE

Person

SET

city=?

WHERE

id=?

AND city=?

AND country=?

AND created\_on=?

AND "name"=?

-- binding parameter [1] as [VARCHAR] - [Washington D.C.]

-- binding parameter [2] as [BIGINT] - [1]

-- binding parameter [3] as [VARCHAR] - [New York]

-- binding parameter [4] as [VARCHAR] - [US]

-- binding parameter [5] as [TIMESTAMP] - [2016-11-16 16:05:12.876]

-- binding parameter [6] as [VARCHAR] - [John Doe]

As you can see, all the columns of the associated database row are used in the WHERE clause. If any column has changed after the row was loaded, there won’t be any match, and a StaleStateException or an OptimisticLockException is going to be thrown.

|  |  |
| --- | --- |
|  | When using OptimisticLockType.ALL, you should also use @DynamicUpdate because the UPDATEstatement must take into consideration all the entity property values. |

###### Versionless optimistic locking using OptimisticLockType.DIRTY

The OptimisticLockType.DIRTY differs from OptimisticLockType.ALL in that it only takes into consideration the entity properties that have changed since the entity was loaded in the currently running Persistence Context.

*Example 366. OptimisticLockType.DIRTY mapping example*

@Entity(name = "Person")

@OptimisticLocking(type = OptimisticLockType.DIRTY)

@DynamicUpdate

@SelectBeforeUpdate

public static class Person {

@Id

private Long id;

@Column(name = "`name`")

private String name;

private String country;

private String city;

@Column(name = "created\_on")

private Timestamp createdOn;

//Getters and setters are omitted for brevity

}

When you need to modify the Person entity above:

*Example 367. OptimisticLockType.DIRTY update example*

Person person = entityManager.find( Person.class, 1L );

person.setCity( "Washington D.C." );

UPDATE

Person

SET

city=?

WHERE

id=?

and city=?

-- binding parameter [1] as [VARCHAR] - [Washington D.C.]

-- binding parameter [2] as [BIGINT] - [1]

-- binding parameter [3] as [VARCHAR] - [New York]

This time, only the database column that has changed was used in the WHERE clause.

|  |  |
| --- | --- |
|  | The main advantage of OptimisticLockType.DIRTY over OptimisticLockType.ALL and the default OptimisticLockType.VERSION used implicitly along with the @Version mapping, is that it allows you to minimize the risk of OptimisticLockException across non-overlapping entity property changes.  When using OptimisticLockType.DIRTY, you should also use @DynamicUpdate because the UPDATEstatement must take into consideration all the dirty entity property values, and also the @SelectBeforeUpdate annotation so that detached entities are properly handled by the[Session#update(entity)](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Session.html#update-java.lang.Object-) operation. |

### 10.2. Pessimistic

Typically, you only need to specify an isolation level for the JDBC connections and let the database handle locking issues. If you do need to obtain exclusive pessimistic locks or re-obtain locks at the start of a new transaction, Hibernate gives you the tools you need.

|  |  |
| --- | --- |
|  | Hibernate always uses the locking mechanism of the database, and never lock objects in memory. |

### 10.3. LockMode and LockModeType

Long before JPA 1.0, Hibernate already defined various explicit locking strategies through its LockMode enumeration. JPA comes with its own [LockModeType](http://docs.oracle.com/javaee/7/api/javax/persistence/LockModeType.html) enumeration which defines similar strategies as the Hibernate-native LockMode.

| LockModeType | LockMode | **Description** |
| --- | --- | --- |
| NONE | NONE | 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. |
| READ and OPTIMISTIC | READ | The entity version is checked towards the end of the currently running transaction. |
| WRITE and OPTIMISTIC\_FORCE\_INCREMENT | WRITE | The entity version is incremented automatically even if the entity has not changed. |
| PESSIMISTIC\_FORCE\_INCREMENT | PESSIMISTIC\_FORCE\_INCREMENT | The entity is locked pessimistically and its version is incremented automatically even if the entity has not changed. |
| PESSIMISTIC\_READ | PESSIMISTIC\_READ | The entity is locked pessimistically using a shared lock, if the database supports such a feature. Otherwise, an explicit lock is used. |
| PESSIMISTIC\_WRITE | PESSIMISTIC\_WRITE, UPGRADE | The entity is locked using an explicit lock. |
| PESSIMISTIC\_WRITE with a javax.persistence.lock.timeoutsetting of 0 | UPGRADE\_NOWAIT | The lock acquisition request fails fast if the row s already locked. |
| PESSIMISTIC\_WRITE with a javax.persistence.lock.timeoutsetting of -2 | UPGRADE\_SKIPLOCKED | The lock acquisition request skips the already locked rows. It uses a SELECT …​ FOR UPDATE SKIP LOCKED in Oracle and PostgreSQL 9.5, or SELECT …​ with (rowlock, updlock, readpast) in SQL Server. |

The explicit user request mentioned above occurs as a consequence of any of the following actions:

* a call to Session.load(), specifying a LockMode.
* a call to Session.lock().
* a call to Query.setLockMode().

If you call Session.load() with option UPGRADE, UPGRADE\_NOWAIT or UPGRADE\_SKIPLOCKED, and the requested object is not already loaded by the session, the object is loaded using SELECT …​ FOR UPDATE.

If you call load() for an object that is already loaded with a less restrictive lock than the one you request, Hibernate calls lock() for that object.

Session.lock() performs a version number check if the specified lock mode is READ, UPGRADE, UPGRADE\_NOWAIT or UPGRADE\_SKIPLOCKED. In the case of UPGRADE, UPGRADE\_NOWAIT or UPGRADE\_SKIPLOCKED, the SELECT …​ FOR UPDATEsyntax 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.

### 10.4. JPA locking query hints

JPA 2.0 introduced two query hints:

javax.persistence.lock.timeout

it gives the number of milliseconds a lock acquisition request will wait before throwing an exception

javax.persistence.lock.scope

defines the [scope](http://docs.oracle.com/javaee/7/api/javax/persistence/PessimisticLockScope.html) of the lock acquisition request. The scope can either be NORMAL (default value) or EXTENDED. The EXTENDED scope will cause a lock acquisition request to be passed to other owned table structured (e.g. @Inheritance(strategy=InheritanceType.JOINED), @ElementCollection)

*Example 368. javax.persistence.lock.timeout example*

entityManager.find(

Person.class, id, LockModeType.PESSIMISTIC\_WRITE,

Collections.singletonMap( "javax.persistence.lock.timeout", 200 )

);

SELECT explicitlo0\_.id AS id1\_0\_0\_,

explicitlo0\_."name" AS name2\_0\_0\_

FROM person explicitlo0\_

WHERE explicitlo0\_.id = 1

FOR UPDATE wait 2

|  |  |
| --- | --- |
|  | Not all JDBC database drivers support setting a timeout value for a locking request. If not supported, the Hibernate dialect ignores this query hint. |
|  | The javax.persistence.lock.scope is [not yet supported](https://hibernate.atlassian.net/browse/HHH-9636) as specified by the JPA standard. |

### 10.5. The buildLockRequest API

Traditionally, Hibernate offered the Session#lock() method for acquiring an optimistic or a pessimistic lock on a given entity. Because varying the locking options was difficult when using a single LockMode parameter, Hibernate has added the Session#buildLockRequest() method API.

The following example shows how to obtain shared database lock without waiting for the lock acquisition request.

*Example 369. buildLockRequest example*

Person person = entityManager.find( Person.class, id );

Session session = entityManager.unwrap( Session.class );

session

.buildLockRequest( LockOptions.NONE )

.setLockMode( LockMode.PESSIMISTIC\_READ )

.setTimeOut( LockOptions.NO\_WAIT )

.lock( person );

SELECT p.id AS id1\_0\_0\_ ,

p.name AS name2\_0\_0\_

FROM Person p

WHERE p.id = 1

SELECT id

FROM Person

WHERE id = 1

FOR SHARE NOWAIT

### 10.6. Follow-on-locking

When using Oracle, the [FOR UPDATE exclusive locking clause](https://docs.oracle.com/database/121/SQLRF/statements_10002.htm#SQLRF55371) cannot be used with:

* DISTINCT
* GROUP BY
* UNION
* inlined views (derived tables), therefore, affecting the legacy Oracle pagination mechanism as well.

For this reason, Hibernate uses secondary selects to lock the previously fetched entities.

*Example 370. Follow-on-locking example*

List<Person> persons = entityManager.createQuery(

"select DISTINCT p from Person p", Person.class)

.setLockMode( LockModeType.PESSIMISTIC\_WRITE )

.getResultList();

SELECT DISTINCT p.id as id1\_0\_, p."name" as name2\_0\_

FROM Person p

SELECT id

FROM Person

WHERE id = 1 FOR UPDATE

SELECT id

FROM Person

WHERE id = 1 FOR UPDATE

|  |  |
| --- | --- |
|  | To avoid the N+1 query problem, a separate query can be used to apply the lock using the associated entity identifiers. |

*Example 371. Secondary query entity locking*

List<Person> persons = entityManager.createQuery(

"select DISTINCT p from Person p", Person.class)

.getResultList();

entityManager.createQuery(

"select p.id from Person p where p in :persons")

.setLockMode( LockModeType.PESSIMISTIC\_WRITE )

.setParameter( "persons", persons )

.getResultList();

SELECT DISTINCT p.id as id1\_0\_, p."name" as name2\_0\_

FROM Person p

SELECT p.id as col\_0\_0\_

FROM Person p

WHERE p.id IN ( 1 , 2 )

FOR UPDATE

The lock request was moved from the original query to a secondary one which takes the previously fetched entities to lock their associated database records.

Prior to Hibernate 5.2.1, the the follow-on-locking mechanism was applied uniformly to any locking query executing on Oracle. Since 5.2.1, the Oracle Dialect tries to figure out if the current query demand the follow-on-locking mechanism.

Even more important is that you can overrule the default follow-on-locking detection logic and explicitly enable or disable it on a per query basis.

*Example 372. Disabling the follow-on-locking mechanism explicitly*

List<Person> persons = entityManager.createQuery(

"select p from Person p", Person.class)

.setMaxResults( 10 )

.unwrap( Query.class )

.setLockOptions(

new LockOptions( LockMode.PESSIMISTIC\_WRITE )

.setFollowOnLocking( false ) )

.getResultList();

SELECT \*

FROM (

SELECT p.id as id1\_0\_, p."name" as name2\_0\_

FROM Person p

)

WHERE rownum <= 10

FOR UPDATE

|  |  |
| --- | --- |
|  | The follow-on-locking mechanism should be explicitly enabled only if the current executing query fails because the FOR UPDATE clause cannot be applied, meaning that the Dialect resolving mechanism needs to be further improved. |

## 11. Fetching

Fetching, essentially, is the process of grabbing data from the database and making it available to the application. Tuning how an application does fetching is one of the biggest factors in determining how an application will perform. Fetching too much data, in terms of width (values/columns) and/or depth (results/rows), adds unnecessary overhead in terms of both JDBC communication and ResultSet processing. Fetching too little data might cause additional fetching to be needed. Tuning how an application fetches data presents a great opportunity to influence the application overall performance.

### 11.1. The basics

The concept of fetching breaks down into two different questions.

* When should the data be fetched? Now? Later?
* How should the data be fetched?

|  |  |
| --- | --- |
|  | "now" is generally termed eager or immediate. "later" is generally termed lazy or delayed. |

There are a number of scopes for defining fetching:

static

Static definition of fetching strategies is done in the mappings. The statically-defined fetch strategies is used in the absence of any dynamically defined strategies

SELECT

Performs a separate SQL select to load the data. This can either be EAGER (the second select is issued immediately) or LAZY (the second select is delayed until the data is needed). This is the strategy generally termed N+1.

JOIN

Inherently an EAGER style of fetching. The data to be fetched is obtained through the use of an SQL outer join.

BATCH

Performs a separate SQL select to load a number of related data items using an IN-restriction as part of the SQL WHERE-clause based on a batch size. Again, this can either be EAGER (the second select is issued immediately) or LAZY (the second select is delayed until the data is needed).

SUBSELECT

Performs a separate SQL select to load associated data based on the SQL restriction used to load the owner. Again, this can either be EAGER (the second select is issued immediately) or LAZY (the second select is delayed until the data is needed).

dynamic (sometimes referred to as runtime)

Dynamic definition is really use-case centric. There are multiple ways to define dynamic fetching:

fetch profiles

defined in mappings, but can be enabled/disabled on the Session.

HQL/JPQL

and both Hibernate and JPA Criteria queries have the ability to specify fetching, specific to said query.

entity graphs

Starting in Hibernate 4.2 (JPA 2.1) this is also an option.

### 11.2. Direct fetching vs entity queries

To see the difference between direct fetching and entity queries in regard to eagerly fetched associations, consider the following entities:

*Example 373. Domain model*

@Entity(name = "Department")

public static class Department {

@Id

private Long id;

//Getters and setters omitted for brevity

}

@Entity(name = "Employee")

public static class Employee {

@Id

private Long id;

@NaturalId

private String username;

@ManyToOne(fetch = FetchType.EAGER)

private Department department;

//Getters and setters omitted for brevity

}

The Employee entity has a @ManyToOne association to a Department which is fetched eagerly.

When issuing a direct entity fetch, Hibernate executed the following SQL query:

*Example 374. Direct fetching example*

Employee employee = entityManager.find( Employee.class, 1L );

select

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.username as username2\_1\_0\_,

d.id as id1\_0\_1\_

from

Employee e

left outer join

Department d

on e.department\_id=d.id

where

e.id = 1

The LEFT JOIN clause is added to the generated SQL query because this association is required to be fetched eagerly.

On the other hand, if you are using an entity query that does not contain a JOIN FETCH directive to the Departmentassociation:

*Example 375. Entity query fetching example*

Employee employee = entityManager.createQuery(

"select e " +

"from Employee e " +

"where e.id = :id", Employee.class)

.setParameter( "id", 1L )

.getSingleResult();

select

e.id as id1\_1\_,

e.department\_id as departme3\_1\_,

e.username as username2\_1\_

from

Employee e

where

e.id = 1

select

d.id as id1\_0\_0\_

from

Department d

where

d.id = 1

Hibernate uses a secondary select instead. This is because the entity query fetch policy cannot be overridden, so Hibernate requires a secondary select to ensure that the EAGER association is fetched prior to returning the result to the user.

|  |  |
| --- | --- |
|  | If you forget to JOIN FETCH all EAGER associations, Hibernate is going to issue a secondary select for each and every one of those which, in turn, can lean to N+1 query issues.  For this reason, you should prefer LAZY associations. |

### 11.3. Applying fetch strategies

Let’s consider these topics as it relates to an simple domain model and a few use cases.

*Example 376. Sample domain model*

@Entity(name = "Department")

public static class Department {

@Id

private Long id;

@OneToMany(mappedBy = "department")

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

@Entity(name = "Employee")

public static class Employee {

@Id

private Long id;

@NaturalId

private String username;

@Column(name = "pswd")

@ColumnTransformer(

read = "decrypt( 'AES', '00', pswd )",

write = "encrypt('AES', '00', ?)"

)

private String password;

private int accessLevel;

@ManyToOne(fetch = FetchType.LAZY)

private Department department;

@ManyToMany(mappedBy = "employees")

private List<Project> projects = new ArrayList<>();

//Getters and setters omitted for brevity

}

@Entity(name = "Project")

public class Project {

@Id

private Long id;

@ManyToMany

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

|  |  |
| --- | --- |
|  | The Hibernate recommendation is to statically mark all associations lazy and to use dynamic fetching strategies for eagerness. This is unfortunately at odds with the JPA specification which defines that all one-to-one and many-to-one associations should be eagerly fetched by default. Hibernate, as a JPA provider, honors that default. |

### 11.4. No fetching

For the first use case, consider the application login process for an Employee. Let’s assume that login only requires access to the Employee information, not Project nor Department information.

*Example 377. No fetching example*

Employee employee = entityManager.createQuery(

"select e " +

"from Employee e " +

"where " +

" e.username = :username and " +

" e.password = :password",

Employee.class)

.setParameter( "username", username)

.setParameter( "password", password)

.getSingleResult();

In this example, the application gets the Employee data. However, because all associations from Employee are declared as LAZY (JPA defines the default for collections as LAZY) no other data is fetched.

If the login process does not need access to the Employee information specifically, another fetching optimization here would be to limit the width of the query results.

*Example 378. No fetching (scalar) example*

Integer accessLevel = entityManager.createQuery(

"select e.accessLevel " +

"from Employee e " +

"where " +

" e.username = :username and " +

" e.password = :password",

Integer.class)

.setParameter( "username", username)

.setParameter( "password", password)

.getSingleResult();

### 11.5. Dynamic fetching via queries

For the second use case, consider a screen displaying the Projects for an Employee. Certainly access to the Employee is needed, as is the collection of Projects for that Employee. Information about Departments, other Employees or other Projects is not needed.

*Example 379. Dynamic JPQL fetching example*

Employee employee = entityManager.createQuery(

"select e " +

"from Employee e " +

"left join fetch e.projects " +

"where " +

" e.username = :username and " +

" e.password = :password",

Employee.class)

.setParameter( "username", username)

.setParameter( "password", password)

.getSingleResult();

*Example 380. Dynamic query fetching example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Employee> query = builder.createQuery( Employee.class );

Root<Employee> root = query.from( Employee.class );

root.fetch( "projects", JoinType.LEFT);

query.select(root).where(

builder.and(

builder.equal(root.get("username"), username),

builder.equal(root.get("password"), password)

)

);

Employee employee = entityManager.createQuery( query ).getSingleResult();

In this example we have an Employee and their Projects loaded in a single query shown both as an HQL query and a JPA Criteria query. In both cases, this resolves to exactly one database query to get all that information.

### 11.6. Dynamic fetching via JPA entity graph

JPA 2.1 introduced entity graphs so the application developer has more control over fetch plans.

*Example 381. Fetch graph example*

@Entity(name = "Employee")

@NamedEntityGraph(name = "employee.projects",

attributeNodes = @NamedAttributeNode("projects")

)

Employee employee = entityManager.find(

Employee.class,

userId,

Collections.singletonMap(

"javax.persistence.fetchgraph",

entityManager.getEntityGraph( "employee.projects" )

)

);

|  |  |
| --- | --- |
|  | Although the JPA standard specifies that you can override an EAGER fetching association at runtime using the javax.persistence.fetchgraph hint, currently, Hibernate does not implement this feature, so EAGER associations cannot be fetched lazily. For more info, check out the [HHH-8776](https://hibernate.atlassian.net/browse/HHH-8776) Jira issue.  When executing a JPQL query, if an EAGER association is omitted, Hibernate will issue a secondary select for every association needed to be fetched eagerly, which can lead dto N+1 query issues.  For this reason, it’s better to use LAZY associations, and only fetch them eagerly on a per-query basis. |

#### 11.6.1. JPA entity subgraphs

An entity graph specifies which attributes to be fetched, but it limited to a single entity only. To fetch associations from a child entity, you need to use the [@NamedSubgraph](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedSubgraph.html) annotation.

If we have a Project parent entity which has an employees child associations, and we’d like to fetch the departmentfor the Employee child association.

*Example 382. Fetch graph with a subgraph mapping*

@Entity(name = "Project")

@NamedEntityGraph(name = "project.employees",

attributeNodes = @NamedAttributeNode(

value = "employees",

subgraph = "project.employees.department"

),

subgraphs = @NamedSubgraph(

name = "project.employees.department",

attributeNodes = @NamedAttributeNode( "department" )

)

)

public static class Project {

@Id

private Long id;

@ManyToMany

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

When fetching this entity graph, Hibernate generates the following SQL query:

*Example 383. Fetch graph with a subgraph mapping*

Project project = doInJPA( this::entityManagerFactory, entityManager -> {

return entityManager.find(

Project.class,

1L,

Collections.singletonMap(

"javax.persistence.fetchgraph",

entityManager.getEntityGraph( "project.employees" )

)

);

} );

select

p.id as id1\_2\_0\_, e.id as id1\_1\_1\_, d.id as id1\_0\_2\_,

e.accessLevel as accessLe2\_1\_1\_,

e.department\_id as departme5\_1\_1\_,

decrypt( 'AES', '00', e.pswd ) as pswd3\_1\_1\_,

e.username as username4\_1\_1\_,

p\_e.projects\_id as projects1\_3\_0\_\_,

p\_e.employees\_id as employee2\_3\_0\_\_

from

Project p

inner join

Project\_Employee p\_e

on p.id=p\_e.projects\_id

inner join

Employee e

on p\_e.employees\_id=e.id

inner join

Department d

on e.department\_id=d.id

where

p.id = ?

-- binding parameter [1] as [BIGINT] - [1]

### 11.7. Dynamic fetching via Hibernate profiles

Suppose we wanted to leverage loading by natural-id to obtain the Employee information in the "projects for and employee" use-case. Loading by natural-id uses the statically defined fetching strategies, but does not expose a means to define load-specific fetching. So we would leverage a fetch profile.

*Example 384. Fetch profile example*

@Entity(name = "Employee")

@FetchProfile(

name = "employee.projects",

fetchOverrides = {

@FetchProfile.FetchOverride(

entity = Employee.class,

association = "projects",

mode = FetchMode.JOIN

)

}

)

session.enableFetchProfile( "employee.projects" );

Employee employee = session.bySimpleNaturalId( Employee.class ).load( username );

Here the Employee is obtained by natural-id lookup and the Employee’s Project data is fetched eagerly. If the Employee data is resolved from cache, the Project data is resolved on its own. However, if the Employee data is not resolved in cache, the Employee and Project data is resolved in one SQL query via join as we saw above.

### 11.8. Batch fetching

Hibernate offers the [@BatchSize](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/BatchSize.html) annotation, which can be used when fetching uninitialized entity proxies.

Considering the following entity mapping:

*Example 385. @BatchSize mapping example*

@Entity(name = "Department")

public static class Department {

@Id

private Long id;

@OneToMany(mappedBy = "department")

//@BatchSize(size = 5)

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

@Entity(name = "Employee")

public static class Employee {

@Id

private Long id;

@NaturalId

private String name;

@ManyToOne(fetch = FetchType.LAZY)

private Department department;

//Getters and setters omitted for brevity

}

Considering that we have previously fetched several Department entities, and now we need to initialize the employeesentity collection for each particular Department, the @BatchSize annotations allows us to load multiple Employeeentities in a single database roundtrip.

*Example 386. @BatchSize fetching example*

List<Department> departments = entityManager.createQuery(

"select d " +

"from Department d " +

"inner join d.employees e " +

"where e.name like 'John%'", Department.class)

.getResultList();

for ( Department department : departments ) {

log.infof(

"Department %d has {} employees",

department.getId(),

department.getEmployees().size()

);

}

SELECT

d.id as id1\_0\_

FROM

Department d

INNER JOIN

Employee employees1\_

ON d.id=employees1\_.department\_id

SELECT

e.department\_id as departme3\_1\_1\_,

e.id as id1\_1\_1\_,

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.name as name2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id IN (

0, 2, 3, 4, 5

)

SELECT

e.department\_id as departme3\_1\_1\_,

e.id as id1\_1\_1\_,

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.name as name2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id IN (

6, 7, 8, 9, 1

)

As you can see in the example above, there are only two SQL statements used to fetch the Employee entities associated to multiple Department entities.

|  |  |
| --- | --- |
|  | Without @BatchSize, you’d run into a N+1 query issue, so, instead of 2 SQL statements, there would be 10 queries needed for fetching the Employee child entities.  However, although @BatchSize is better than running into an N+1 query issue, most of the time, a DTO projection or a JOIN FETCH is a much better alternative since it allows you to fetch all the required data with a single query. |

### 11.9. The @Fetch annotation mapping

Besides the FetchType.LAZY or FetchType.EAGER JPA annotations, you can also use the Hibernate-specific @Fetchannotation that accepts one of the following FetchMode(s):

SELECT

The association is going to be fetched lazily using a secondary select for each individual entity, collection, or join load. It’s equivalent to JPA FetchType.LAZY fetching strategy.

JOIN

Use an outer join to load the related entities, collections or joins when using direct fetching. It’s equivalent to JPA FetchType.EAGER fetching strategy.

SUBSELECT

Available for collections only. When accessing a non-initialized collection, this fetch mode will trigger loading all elements of all collections of the same role for all owners associated with the persistence context using a single secondary select.

### 11.10. FetchMode.SELECT

To demonstrate how FetchMode.SELECT works, consider the following entity mapping:

*Example 387. FetchMode.SELECT mapping example*

@Entity(name = "Department")

public static class Department {

@Id

private Long id;

@OneToMany(mappedBy = "department", fetch = FetchType.LAZY)

@Fetch(FetchMode.SELECT)

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

@Entity(name = "Employee")

public static class Employee {

@Id

@GeneratedValue

private Long id;

@NaturalId

private String username;

@ManyToOne(fetch = FetchType.LAZY)

private Department department;

//Getters and setters omitted for brevity

}

Considering there are multiple Department entities, each one having multiple Employee entities, when executing the following test case, Hibernate fetches every uninitialized Employee collection using a secondary SELECT statement upon accessing the child collection for the first time:

*Example 388. FetchMode.SELECT mapping example*

List<Department> departments = entityManager.createQuery(

"select d from Department d", Department.class )

.getResultList();

log.infof( "Fetched %d Departments", departments.size());

for (Department department : departments ) {

assertEquals( 3, department.getEmployees().size() );

}

SELECT

d.id as id1\_0\_

FROM

Department d

-- Fetched 2 Departments

SELECT

e.department\_id as departme3\_1\_0\_,

e.id as id1\_1\_0\_,

e.id as id1\_1\_1\_,

e.department\_id as departme3\_1\_1\_,

e.username as username2\_1\_1\_

FROM

Employee e

WHERE

e.department\_id = 1

SELECT

e.department\_id as departme3\_1\_0\_,

e.id as id1\_1\_0\_,

e.id as id1\_1\_1\_,

e.department\_id as departme3\_1\_1\_,

e.username as username2\_1\_1\_

FROM

Employee e

WHERE

e.department\_id = 2

The more Department entities are fetched by the first query, the more secondary SELECT statements are executed to initialize the employees collections. Therefore, FetchMode.SELECT can lead to N+1 query issues.

### 11.11. FetchMode.SUBSELECT

To demonstrate how FetchMode.SUBSELECT works, we are going to modify the [FetchMode.SELECT mapping example](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-fetch-mode-select-mapping-example) to use FetchMode.SUBSELECT:

*Example 389. FetchMode.SUBSELECT mapping example*

@OneToMany(mappedBy = "department", fetch = FetchType.LAZY)

@Fetch(FetchMode.SUBSELECT)

private List<Employee> employees = new ArrayList<>();

Now, we are going to fetch all Department entities that match a given filtering criteria and then navigate their employees collections.

Hibernate is going to avoid the N+1 query issue by generating a single SQL statement to initialize all employeescollections for all Department entities that were previously fetched. Instead of using passing all entity identifiers, Hibernate simply reruns the previous query that fetched the Department entities.

*Example 390. FetchMode.SUBSELECT mapping example*

List<Department> departments = entityManager.createQuery(

"select d " +

"from Department d " +

"where d.name like :token", Department.class )

.setParameter( "token", "Department%" )

.getResultList();

log.infof( "Fetched %d Departments", departments.size());

for (Department department : departments ) {

assertEquals( 3, department.getEmployees().size() );

}

SELECT

d.id as id1\_0\_

FROM

Department d

where

d.name like 'Department%'

-- Fetched 2 Departments

SELECT

e.department\_id as departme3\_1\_1\_,

e.id as id1\_1\_1\_,

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.username as username2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id in (

SELECT

fetchmodes0\_.id

FROM

Department fetchmodes0\_

WHERE

d.name like 'Department%'

)

### 11.12. FetchMode.JOIN

To demonstrate how FetchMode.JOIN works, we are going to modify the [FetchMode.SELECT mapping example](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-fetch-mode-select-mapping-example) to useFetchMode.JOIN instead:

*Example 391. FetchMode.JOIN mapping example*

@OneToMany(mappedBy = "department")

@Fetch(FetchMode.JOIN)

private List<Employee> employees = new ArrayList<>();

Now, we are going to fetch one Department and navigate its employees collections.

|  |  |
| --- | --- |
|  | The reason why we are not using a JPQL query to fetch multiple Department entities is because the FetchMode.JOIN strategy would be overridden by the query fetching directive.  To fetch multiple relationships with a JPQL query, the JOIN FETCH directive must be used instead.  Therefore, FetchMode.JOIN is useful for when entities are fetched directly, via their identifier or natural-id.  Also, the FetchMode.JOIN acts as a FetchType.EAGER strategy. Even if we mark the association as FetchType.LAZY, the FetchMode.JOIN will load the association eagerly. |

Hibernate is going to avoid the secondary query by issuing an OUTER JOIN for the employees collection.

*Example 392. FetchMode.JOIN mapping example*

Department department = entityManager.find( Department.class, 1L );

log.infof( "Fetched department: %s", department.getId());

assertEquals( 3, department.getEmployees().size() );

SELECT

d.id as id1\_0\_0\_,

e.department\_id as departme3\_1\_1\_,

e.id as id1\_1\_1\_,

e.id as id1\_1\_2\_,

e.department\_id as departme3\_1\_2\_,

e.username as username2\_1\_2\_

FROM

Department d

LEFT OUTER JOIN

Employee e

on d.id = e.department\_id

WHERE

d.id = 1

-- Fetched department: 1

This time, there was no secondary query because the child collection was loaded along with the parent entity.

### 11.13. @LazyCollection

The [@LazyCollection](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyCollection.html) annotation is used to specify the lazy fetching behavior of a given collection. The possible values are given by the [LazyCollectionOption](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyCollectionOption.html) enumeration:

TRUE

Load it when the state is requested.

FALSE

Eagerly load it.

EXTRA

Prefer extra queries over full collection loading.

The TRUE and FALSE values are deprecated since you should be using the JPA [FetchType](http://docs.oracle.com/javaee/7/api/javax/persistence/FetchType.html) attribute of the [@ElementCollection](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-elementcollection), [@OneToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-onetomany), or [@ManyToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-manytomany) collection.

The EXTRA value has no equivalent in the JPA specification, and it’s used to avoid loading the entire collection even when the collection is accessed for the first time. Each element is fetched individually using a secondary query.

*Example 393. LazyCollectionOption.EXTRA mapping example*

@Entity(name = "Department")

public static class Department {

@Id

private Long id;

@OneToMany(mappedBy = "department", cascade = CascadeType.ALL)

@OrderColumn(name = "order\_id")

@LazyCollection( LazyCollectionOption.EXTRA )

private List<Employee> employees = new ArrayList<>();

//Getters and setters omitted for brevity

}

@Entity(name = "Employee")

public static class Employee {

@Id

private Long id;

@NaturalId

private String username;

@ManyToOne(fetch = FetchType.LAZY)

private Department department;

//Getters and setters omitted for brevity

}

|  |  |
| --- | --- |
|  | LazyCollectionOption.EXTRA only works for ordered collections, either List(s) that are annotated with @OrderColumn or Map(s).  For bags (e.g. regular List(s) of entities that do not preserve any certain ordering), the @LazyCollection(LazyCollectionOption.EXTRA)` behaves like any other FetchType.LAZY collection (the collection is fetched entirely upon being accessed for the first time). |

Now, considering we have the following entities:

*Example 394. LazyCollectionOption.EXTRA Domain Model example*

Department department = new Department();

department.setId( 1L );

entityManager.persist( department );

for (long i = 1; i <= 3; i++ ) {

Employee employee = new Employee();

employee.setId( i );

employee.setUsername( String.format( "user\_%d", i ) );

department.addEmployee(employee);

}

When fetching the employee collection entries by their position in the List, Hibernate generates the following SQL statements:

*Example 395. LazyCollectionOption.EXTRA fetching example*

Department department = entityManager.find(Department.class, 1L);

int employeeCount = department.getEmployees().size();

for(int i = 0; i < employeeCount; i++ ) {

log.infof( "Fetched employee: %s", department.getEmployees().get( i ).getUsername());

}

SELECT

max(order\_id) + 1

FROM

Employee

WHERE

department\_id = ?

-- binding parameter [1] as [BIGINT] - [1]

SELECT

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.username as username2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id=?

AND e.order\_id=?

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [INTEGER] - [0]

SELECT

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.username as username2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id=?

AND e.order\_id=?

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [INTEGER] - [1]

SELECT

e.id as id1\_1\_0\_,

e.department\_id as departme3\_1\_0\_,

e.username as username2\_1\_0\_

FROM

Employee e

WHERE

e.department\_id=?

AND e.order\_id=?

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [INTEGER] - [2]

|  |  |
| --- | --- |
|  | Therefore, the child entities were fetched one after the other without triggering a full collection initialization.  For this reason, caution is advised because LazyCollectionOption.EXTRA lazy collections are prone to N+1 query issues. |

## 12. Batching

### 12.1. JDBC batching

JDBC offers support for batching together SQL statements that can be represented as a single PreparedStatement. Implementation wise this generally means that drivers will send the batched operation to the server in one call, which can save on network calls to the database. Hibernate can leverage JDBC batching. The following settings control this behavior.

hibernate.jdbc.batch\_size

Controls the maximum number of statements Hibernate will batch together before asking the driver to execute the batch. Zero or a negative number disables this feature.

hibernate.jdbc.batch\_versioned\_data

Some JDBC drivers return incorrect row counts when a batch is executed. If your JDBC driver falls into this category this setting should be set to false. Otherwise, it is safe to enable this which will allow Hibernate to still batch the DML for versioned entities and still use the returned row counts for optimistic lock checks. Since 5.0, it defaults to true. Previously (versions 3.x and 4.x), it used to be false.

hibernate.jdbc.batch.builder

Names the implementation class used to manage batching capabilities. It is almost never a good idea to switch from Hibernate’s default implementation. But if you wish to, this setting would name the org.hibernate.engine.jdbc.batch.spi.BatchBuilder implementation to use.

hibernate.order\_updates

Forces Hibernate to order SQL updates by the entity type and the primary key value of the items being updated. This allows for more batching to be used. It will also result in fewer transaction deadlocks in highly concurrent systems. Comes with a performance hit, so benchmark before and after to see if this actually helps or hurts your application.

hibernate.order\_inserts

Forces Hibernate to order inserts to allow for more batching to be used. Comes with a performance hit, so benchmark before and after to see if this actually helps or hurts your application.

|  |  |
| --- | --- |
|  | Since version 5.2, Hibernate allows overriding the global JDBC batch size given by the hibernate.jdbc.batch\_size configuration property for a given Session. |

*Example 396. Hibernate specific JDBC batch size configuration on a per Session basis*

entityManager

.unwrap( Session.class )

.setJdbcBatchSize( 10 );

### 12.2. Session batching

The following example shows an anti-pattern for batch inserts.

*Example 397. Naive way to insert 100 000 entities with Hibernate*

EntityManager entityManager = null;

EntityTransaction txn = null;

try {

entityManager = entityManagerFactory().createEntityManager();

txn = entityManager.getTransaction();

txn.begin();

for ( int i = 0; i < 100\_000; i++ ) {

Person Person = new Person( String.format( "Person %d", i ) );

entityManager.persist( Person );

}

txn.commit();

} catch (RuntimeException e) {

if ( txn != null && txn.isActive()) txn.rollback();

throw e;

} finally {

if (entityManager != null) {

entityManager.close();

}

}

There are several problems associated with this example:

1. Hibernate caches all the newly inserted Customer instances in the session-level c1ache, so, when the transaction ends, 100 000 entities are managed by the persistence context. If the maximum memory allocated to the JVM is rather low, this example could fails with an OutOfMemoryException. The Java 1.8 JVM allocated either 1/4 of available RAM or 1Gb, which can easily accommodate 100 000 objects on the heap.
2. long-running transactions can deplete a connection pool so other transactions don’t get a chance to proceed.
3. JDBC batching is not enabled by default, so every insert statement requires a database roundtrip. To enable JDBC batching, set the hibernate.jdbc.batch\_size property to an integer between 10 and 50.

|  |  |
| --- | --- |
|  | Hibernate disables insert batching at the JDBC level transparently if you use an identity identifier generator. |

#### 12.2.1. Batch inserts

When you make new objects persistent, employ methods flush() and clear() to the session regularly, to control the size of the first-level cache.

*Example 398. Flushing and clearing the Session*

EntityManager entityManager = null;

EntityTransaction txn = null;

try {

entityManager = entityManagerFactory().createEntityManager();

txn = entityManager.getTransaction();

txn.begin();

int batchSize = 25;

for ( int i = 0; i < entityCount; ++i ) {

Person Person = new Person( String.format( "Person %d", i ) );

entityManager.persist( Person );

if ( i > 0 && i % batchSize == 0 ) {

//flush a batch of inserts and release memory

entityManager.flush();

entityManager.clear();

}

}

txn.commit();

} catch (RuntimeException e) {

if ( txn != null && txn.isActive()) txn.rollback();

throw e;

} finally {

if (entityManager != null) {

entityManager.close();

}

}

#### 12.2.2. Session scroll

When you retrieve and update data, flush() and clear() the session regularly. In addition, use method scroll() to take advantage of server-side cursors for queries that return many rows of data.

*Example 399. Using scroll()*

EntityManager entityManager = null;

EntityTransaction txn = null;

ScrollableResults scrollableResults = null;

try {

entityManager = entityManagerFactory().createEntityManager();

txn = entityManager.getTransaction();

txn.begin();

int batchSize = 25;

Session session = entityManager.unwrap( Session.class );

scrollableResults = session

.createQuery( "select p from Person p" )

.setCacheMode( CacheMode.IGNORE )

.scroll( ScrollMode.FORWARD\_ONLY );

int count = 0;

while ( scrollableResults.next() ) {

Person Person = (Person) scrollableResults.get( 0 );

processPerson(Person);

if ( ++count % batchSize == 0 ) {

//flush a batch of updates and release memory:

entityManager.flush();

entityManager.clear();

}

}

txn.commit();

} catch (RuntimeException e) {

if ( txn != null && txn.isActive()) txn.rollback();

throw e;

} finally {

if (scrollableResults != null) {

scrollableResults.close();

}

if (entityManager != null) {

entityManager.close();

}

}

|  |  |
| --- | --- |
|  | If left unclosed by the application, Hibernate will automatically close the underlying resources (e.g. ResultSet and PreparedStatement) used internally by the ScrollableResults when the current transaction is ended (either commit or rollback).  However, it is good practice to close the ScrollableResults explicitly. |

#### 12.2.3. StatelessSession

StatelessSession is a command-oriented API provided by Hibernate. Use it to stream 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.

Some of the things not provided by a StatelessSession include:

* a first-level cache
* interaction with any second-level or query cache
* transactional write-behind or automatic dirty checking

Limitations of StatelessSession:

* Operations performed using a stateless session never cascade to associated instances.
* Collections are ignored by a stateless session.
* Lazy loading of associations is not supported.
* 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.

*Example 400. Using a StatelessSession*

StatelessSession statelessSession = null;

Transaction txn = null;

ScrollableResults scrollableResults = null;

try {

SessionFactory sessionFactory = entityManagerFactory().unwrap( SessionFactory.class );

statelessSession = sessionFactory.openStatelessSession();

txn = statelessSession.getTransaction();

txn.begin();

scrollableResults = statelessSession

.createQuery( "select p from Person p" )

.scroll(ScrollMode.FORWARD\_ONLY);

while ( scrollableResults.next() ) {

Person Person = (Person) scrollableResults.get( 0 );

processPerson(Person);

statelessSession.update( Person );

}

txn.commit();

} catch (RuntimeException e) {

if ( txn != null && txn.getStatus() == TransactionStatus.ACTIVE) txn.rollback();

throw e;

} finally {

if (scrollableResults != null) {

scrollableResults.close();

}

if (statelessSession != null) {

statelessSession.close();

}

}

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 operate directly on database rows. They cause the corresponding SQL operations to be executed immediately. They have different semantics from the save(), saveOrUpdate(), and delete() operations defined by the Session interface.

### 12.3. Hibernate Query Language for DML

DML, or Data Manipulation Language, refers to SQL statements such as INSERT, UPDATE, and DELETE. Hibernate provides methods for bulk SQL-style DML statement execution, in the form of Hibernate Query Language (HQL).

#### 12.3.1. HQL/JPQL for UPDATE and DELETE

Both the Hibernate native Query Language and JPQL (Java Persistence Query Language) provide support for bulk UPDATE and DELETE.

*Example 401. Psuedo-syntax for UPDATE and DELETE statements using HQL*

UPDATE FROM EntityName e WHERE e.name = ?

DELETE FROM EntityName e WHERE e.name = ?

|  |  |
| --- | --- |
|  | The FROM and WHERE clauses are each optional, but it’s good practice to use them. |

The FROM clause can only refer to a single entity, which can be aliased. If the entity name is aliased, 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.

|  |  |
| --- | --- |
|  | Joins, either implicit or explicit, are prohibited in a bulk HQL query. You can use sub-queries in the WHERE clause, and the sub-queries themselves can contain joins. |

*Example 402. Executing a JPQL UPDATE, using the Query.executeUpdate()*

int updatedEntities = entityManager.createQuery(

"update Person p " +

"set p.name = :newName " +

"where p.name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

*Example 403. Executing an HQL UPDATE, using the Query.executeUpdate()*

int updatedEntities = session.createQuery(

"update Person " +

"set name = :newName " +

"where name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

In keeping with the EJB3 specification, HQL UPDATE statements, by default, do not effect the version or the timestamp property values for the affected entities. You can use a versioned update to force Hibernate to reset the version or timestamp property values, by adding the VERSIONED keyword after the UPDATE keyword.

*Example 404. Updating the version of timestamp*

int updatedEntities = session.createQuery(

"update versioned Person " +

"set name = :newName " +

"where name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

|  |  |
| --- | --- |
|  | If you use the VERSIONED statement, you cannot use custom version types, which use class org.hibernate.usertype.UserVersionType.  This feature is only available in HQL since it’s not standardized by JPA. |

*Example 405. A JPQL DELETE statement*

int deletedEntities = entityManager.createQuery(

"delete Person p " +

"where p.name = :name" )

.setParameter( "name", name )

.executeUpdate();

*Example 406. An HQL DELETE statement*

int deletedEntities = session.createQuery(

"delete Person " +

"where name = :name" )

.setParameter( "name", name )

.executeUpdate();

Method Query.executeUpdate() returns an int value, which 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 JPQL/HQL bulk operation might result in multiple SQL statements being executed, such as for joined-subclass. In the example of joined-subclass, a DELETE against one of the subclasses may actually result in deletes in the tables underlying the join, or further down the inheritance hierarchy.

#### 12.3.2. HQL syntax for INSERT

*Example 407. Pseudo-syntax for INSERT statements*

INSERT INTO EntityName

properties\_list

SELECT properties\_list

FROM ...

Only the INSERT INTO …​ SELECT …​ form is supported. You cannot specify explicit values to insert.

The properties\_list is analogous to the column specification in the SQL INSERT statement. For entities involved in mapped inheritance, you can only use properties directly defined on that given class-level in the properties\_list. Superclass properties are not allowed and subclass properties are irrelevant. In other words, INSERT statements are inherently non-polymorphic.

The SELECT statement can be any valid HQL select query, but the return types must match the types expected by the INSERT. Hibernate verifies the return types during query compilation, instead of expecting the database to check it. Problems might result from Hibernate types which are equivalent, rather than equal. One such example is a mismatch between a property defined as an org.hibernate.type.DateType and a property defined as an org.hibernate.type.TimestampType, even though the database may not make a distinction, or may be capable of handling the conversion.

If id property is not specified in the properties\_list, Hibernate generates a value automatically. Automatic generation is only available if you use ID generators which operate on the database. Otherwise, Hibernate throws an exception during parsing. Available in-database generators are org.hibernate.id.SequenceGenerator and its subclasses, and objects which implement org.hibernate.id.PostInsertIdentifierGenerator. The most notable exception is org.hibernate.id.TableHiLoGenerator, which 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.

*Example 408. HQL INSERT statement*

int insertedEntities = session.createQuery(

"insert into Partner (id, name) " +

"select p.id, p.name " +

"from Person p ")

.executeUpdate();

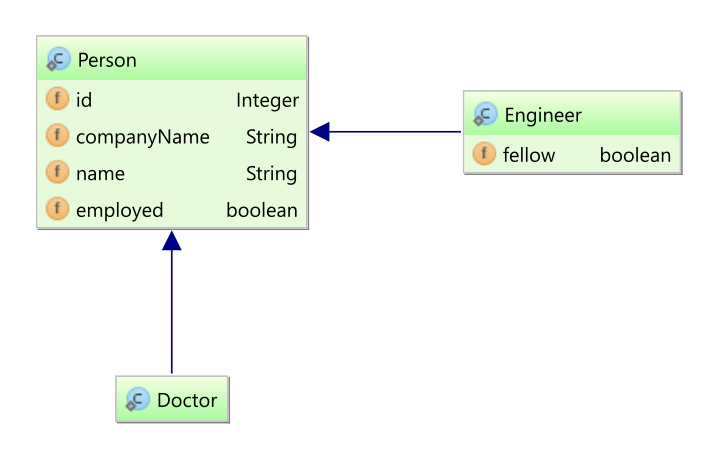
This section is only a brief overview of HQL. For more information, see [HQL](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql).

#### 12.3.3. Bulk-id strategies

This article is about the [HHH-11262](https://hibernate.atlassian.net/browse/HHH-11262) JIRA issue which now allows the bulk-id strategies to work even when you cannot create temporary tables.

##### Class diagram

Considering we have the following entities:



The Person entity is the base class of this entity inheritance model, and is mapped as follows:

*Example 409. Bulk-id base class entity*

@Entity(name = "Person")

@Inheritance(strategy = InheritanceType.JOINED)

public static class Person {

@Id

@GeneratedValue

private Long id;

private String name;

private boolean employed;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public boolean isEmployed() {

return employed;

}

public void setEmployed(boolean employed) {

this.employed = employed;

}

}

Both the Doctor and Engineer entity classes extend the Person base class:

*Example 410. Bulk-id subclass entities*

@Entity(name = "Doctor")

public static class Doctor extends Person {

}

@Entity(name = "Engineer")

public static class Engineer extends Person {

private boolean fellow;

public boolean isFellow() {

return fellow;

}

public void setFellow(boolean fellow) {

this.fellow = fellow;

}

}

##### Inheritance tree bulk processing

Now, when you try to execute a bulk entity delete query:

*Example 411. Bulk-id delete query example*

int updateCount = session.createQuery(

"delete from Person where employed = :employed" )

.setParameter( "employed", false )

.executeUpdate();

create temporary table

HT\_Person

(

id int4 not null,

companyName varchar(255) not null

)

insert

into

HT\_Person

select

p.id as id,

p.companyName as companyName

from

Person p

where

p.employed = ?

delete

from

Engineer

where

(

id, companyName

) IN (

select

id,

companyName

from

HT\_Person

)

delete

from

Doctor

where

(

id, companyName

) IN (

select

id,

companyName

from

HT\_Person

)

delete

from

Person

where

(

id, companyName

) IN (

select

id,

companyName

from

HT\_Person

)

HT\_Person is a temporary table that Hibernate creates to hold all the entity identifiers that are to be updated or deleted by the bulk id operation. The temporary table can be either global or local, depending on the underlying database capabilities.

##### Non-temporary table bulk-id strategies

As the [HHH-11262](https://hibernate.atlassian.net/browse/HHH-11262) issue describes, there are use cases when the application developer cannot use temporary tables because the database user lacks this privilege.

In this case, we defined several options which you can choose depending on your database capabilities:

* InlineIdsInClauseBulkIdStrategy
* InlineIdsSubSelectValueListBulkIdStrategy
* InlineIdsOrClauseBulkIdStrategy
* CteValuesListBulkIdStrategy

###### InlineIdsInClauseBulkIdStrategy

To use this strategy, you need to configure the following configuration property:

<property name="hibernate.hql.bulk\_id\_strategy"

value="org.hibernate.hql.spi.id.inline.InlineIdsInClauseBulkIdStrategy"

/>

Now, when running the previous test case, Hibernate generates the following SQL statements:

*Example 412. InlineIdsInClauseBulkIdStrategy delete entity query example*

select

p.id as id,

p.companyName as companyName

from

Person p

where

p.employed = ?

delete

from

Engineer

where

( id, companyName )

in (

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

)

delete

from

Doctor

where

( id, companyName )

in (

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

)

delete

from

Person

where

( id, companyName )

in (

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

)

So, the entity identifiers are selected first and used for each particular update or delete statement.

|  |  |
| --- | --- |
|  | The IN clause row value expression has long been supported by Oracle, PostgreSQL, and nowadays by MySQL 5.7. However, SQL Server 2014 does not support this syntax, so you’ll have to use a different strategy. |

###### InlineIdsSubSelectValueListBulkIdStrategy

To use this strategy, you need to configure the following configuration property:

<property name="hibernate.hql.bulk\_id\_strategy"

value="org.hibernate.hql.spi.id.inline.InlineIdsSubSelectValueListBulkIdStrategy"

/>

Now, when running the previous test case, Hibernate generates the following SQL statements:

*Example 413. InlineIdsSubSelectValueListBulkIdStrategy delete entity query example*

select

p.id as id,

p.companyName as companyName

from

Person p

where

p.employed = ?

delete

from

Engineer

where

( id, companyName ) in (

select

id,

companyName

from (

values

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

) as HT

(id, companyName)

)

delete

from

Doctor

where

( id, companyName ) in (

select

id,

companyName

from (

values

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

) as HT

(id, companyName)

)

delete

from

Person

where

( id, companyName ) in (

select

id,

companyName

from (

values

( 1,'Red Hat USA' ),

( 3,'Red Hat USA' ),

( 1,'Red Hat Europe' ),

( 3,'Red Hat Europe' )

) as HT

(id, companyName)

)

|  |  |
| --- | --- |
|  | The underlying database must support the VALUES list clause, like PostgreSQL or SQL Server 2008. However, this strategy requires the IN-clause row value expression for composite identifiers so you can use this strategy only with PostgreSQL. |

###### InlineIdsOrClauseBulkIdStrategy

To use this strategy, you need to configure the following configuration property:

<property name="hibernate.hql.bulk\_id\_strategy"

value="org.hibernate.hql.spi.id.inline.InlineIdsOrClauseBulkIdStrategy"

/>

Now, when running the previous test case, Hibernate generates the following SQL statements:

*Example 414. InlineIdsOrClauseBulkIdStrategy delete entity query example*

select

p.id as id,

p.companyName as companyName

from

Person p

where

p.employed = ?

delete

from

Engineer

where

( id = 1 and companyName = 'Red Hat USA' )

or ( id = 3 and companyName = 'Red Hat USA' )

or ( id = 1 and companyName = 'Red Hat Europe' )

or ( id = 3 and companyName = 'Red Hat Europe' )

delete

from

Doctor

where

( id = 1 and companyName = 'Red Hat USA' )

or ( id = 3 and companyName = 'Red Hat USA' )

or ( id = 1 and companyName = 'Red Hat Europe' )

or ( id = 3 and companyName = 'Red Hat Europe' )

delete

from

Person

where

( id = 1 and companyName = 'Red Hat USA' )

or ( id = 3 and companyName = 'Red Hat USA' )

or ( id = 1 and companyName = 'Red Hat Europe' )

or ( id = 3 and companyName = 'Red Hat Europe' )

|  |  |
| --- | --- |
|  | This strategy has the advantage of being supported by all the major relational database systems (e.g. Oracle, SQL Server, MySQL, and PostgreSQL). |

###### CteValuesListBulkIdStrategy

To use this strategy, you need to configure the following configuration property:

<property name="hibernate.hql.bulk\_id\_strategy"

value="org.hibernate.hql.spi.id.inline.CteValuesListBulkIdStrategy"

/>

Now, when running the previous test case, Hibernate generates the following SQL statements:

*Example 415. CteValuesListBulkIdStrategy delete entity query example*

select

p.id as id,

p.companyName as companyName

from

Person p

where

p.employed = ?

with HT\_Person (id,companyName ) as (

select id, companyName

from (

values

(?, ?),

(?, ?),

(?, ?),

(?, ?)

) as HT (id, companyName) )

delete

from

Engineer

where

( id, companyName ) in (

select

id, companyName

from

HT\_Person

)

with HT\_Person (id,companyName ) as (

select id, companyName

from (

values

(?, ?),

(?, ?),

(?, ?),

(?, ?)

) as HT (id, companyName) )

delete

from

Doctor

where

( id, companyName ) in (

select

id, companyName

from

HT\_Person

)

with HT\_Person (id,companyName ) as (

select id, companyName

from (

values

(?, ?),

(?, ?),

(?, ?),

(?, ?)

) as HT (id, companyName) )

delete

from

Person

where

( id, companyName ) in (

select

id, companyName

from

HT\_Person

)

|  |  |
| --- | --- |
|  | The underlying database must support the CTE (Common Table Expressions) that can be referenced from non-query statements as well, like PostgreSQL since 9.1 or SQL Server since 2005. The underlying database must also support the VALUES list clause, like PostgreSQL or SQL Server 2008.  However, this strategy requires the IN-clause row value expression for composite identifiers, so you can only use this strategy only with PostgreSQL. |

If you can use temporary tables, that’s probably the best choice. However, if you are not allowed to create temporary tables, you must pick one of these four strategies that works with your underlying database. Before making your mind, you should benchmark which one works best for your current workload. For instance, [CTE are optimization fences in PostgreSQL](http://blog.2ndquadrant.com/postgresql-ctes-are-optimization-fences/), so make sure you measure before taking a decision.

If you’re using Oracle or MySQL 5.7, you can choose either InlineIdsOrClauseBulkIdStrategy or InlineIdsInClauseBulkIdStrategy. For older version of MySQL, then you can only use InlineIdsOrClauseBulkIdStrategy.

If you’re using SQL Server, InlineIdsOrClauseBulkIdStrategy is the only option for you.

If you’re using PostgreSQL, then you have the luxury of choosing any of these four strategies.

## 13. Caching

At runtime, Hibernate handles moving data into and out of the second-level cache in response to the operations performed by the Session, which acts as a transaction-level cache of persistent data. Once an entity becomes managed, that object is added to the internal cache of the current persistence context (EntityManager or Session). The persistence context is also called the first-level cache, and it’s enabled by default.

It is possible to configure a JVM-level (SessionFactory-level) or even a cluster cache on a class-by-class and collection-by-collection basis.

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| --- | --- |
|  | Be aware that caches are not aware of changes made to the persistent store by other applications. They can, however, be configured to regularly expire cached data. |

### 13.1. Configuring second-level caching

Hibernate can integrate with various caching providers for the purpose of caching data outside the context of a particular Session. This section defines the settings which control this behavior.

#### 13.1.1. RegionFactory

org.hibernate.cache.spi.RegionFactory defines the integration between Hibernate and a pluggable caching provider. hibernate.cache.region.factory\_class is used to declare the provider to use. Hibernate comes with built-in support for the Java caching standard [JCache](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-jcache) and also two popular caching libraries: [Ehcache](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-ehcache) and [Infinispan](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan). Detailed information is provided later in this chapter.

#### 13.1.2. Caching configuration properties

Besides specific provider configuration, there are a number of configurations options on the Hibernate side of the integration that control various caching behaviors:

hibernate.cache.use\_second\_level\_cache

Enable or disable second level caching overall. Default is true, although the default region factory is NoCachingRegionFactory.

hibernate.cache.use\_query\_cache

Enable or disable second level caching of query results. Default is false.

hibernate.cache.query\_cache\_factory

Query result caching is handled by a special contract that deals with staleness-based invalidation of the results. The default implementation does not allow stale results at all. Use this for applications that would like to relax that. Names an implementation of org.hibernate.cache.spi.QueryCacheFactory

hibernate.cache.use\_minimal\_puts

Optimizes second-level cache operations to minimize writes, at the cost of more frequent reads. Providers typically set this appropriately.

hibernate.cache.region\_prefix

Defines a name to be used as a prefix to all second-level cache region names.

hibernate.cache.default\_cache\_concurrency\_strategy

In Hibernate second-level caching, all regions can be configured differently including the concurrency strategy to use when accessing that particular region. This setting allows to define a default strategy to be used. This setting is very rarely required as the pluggable providers do specify the default strategy to use. Valid values include:

* read-only,
* read-write,
* nonstrict-read-write,
* transactional

hibernate.cache.use\_structured\_entries

If true, forces Hibernate to store data in the second-level cache in a more human-friendly format. Can be useful if you’d like to be able to "browse" the data directly in your cache, but does have a performance impact.

hibernate.cache.auto\_evict\_collection\_cache

Enables or disables the automatic eviction of a bidirectional association’s collection cache entry when the association is changed just from the owning side. This is disabled by default, as it has a performance impact to track this state. However if your application does not manage both sides of bidirectional association where the collection side is cached, the alternative is to have stale data in that collection cache.

hibernate.cache.use\_reference\_entries

Enable direct storage of entity references into the second level cache for read-only or immutable entities.

hibernate.cache.keys\_factory

When storing entries into second-level cache as key-value pair, the identifiers can be wrapped into tuples <entity type, tenant, identifier> to guarantee uniqueness in case that second-level cache stores all entities in single space. These tuples are then used as keys in the cache. When the second-level cache implementation (incl. its configuration) guarantees that different entity types are stored separately and multi-tenancy is not used, you can omit this wrapping to achieve better performance. Currently, this property is only supported when Infinispan is configured as the second-level cache implementation. Valid values are:

* default (wraps identitifers in the tuple)
* simple (uses identifiers as keys without any wrapping)
* fully qualified class name that implements org.hibernate.cache.spi.CacheKeysFactory

### 13.2. Configuring second-level cache mappings

The cache mappings can be configured via JPA annotations or XML descriptors or using the Hibernate-specific mapping files.

By default, entities are not part of the second level cache and we recommend you to stick to this setting. However, you can override this by setting the shared-cache-mode element in your persistence.xml file or by using the javax.persistence.sharedCache.mode property in your configuration file. The following values are possible:

ENABLE\_SELECTIVE (Default and recommended value)

Entities are not cached unless explicitly marked as cacheable (with the [@Cacheable](https://docs.oracle.com/javaee/7/api/javax/persistence/Cacheable.html) annotation).

DISABLE\_SELECTIVE

Entities are cached unless explicitly marked as non-cacheable.

ALL

Entities are always cached even if marked as non-cacheable.

NONE

No entity is cached even if marked as cacheable. This option can make sense to disable second-level cache altogether.

The cache concurrency strategy used by default can be set globally via the hibernate.cache.default\_cache\_concurrency\_strategy configuration property. The values for this property are:

read-only

If your application needs to read, but not modify, instances of a persistent class, a read-only cache is the best choice. Application can still delete entities and these changes should be reflected in second-level cache so that the cache does not provide stale entities. Implementations may use performance optimizations based on the immutability of entities.

read-write

If the application needs to update data, a read-write cache might be appropriate. This strategy provides consistent access to single entity, but not a serializable transaction isolation level; e.g. when TX1 reads looks up an entity and does not find it, TX2 inserts the entity into cache and TX1 looks it up again, the new entity can be read in TX1.

nonstrict-read-write

Similar to read-write strategy but there might be occasional stale reads upon concurrent access to an entity. The choice of this strategy might be appropriate if the application rarely updates the same data simultaneously and strict transaction isolation is not required. Implementations may use performance optimizations that make use of the relaxed consistency guarantee.

transactional

Provides serializable transaction isolation level.

|  |  |
| --- | --- |
|  | Rather than using a global cache concurrency strategy, it is recommended to define this setting on a per entity basis. Use the [@org.hibernate.annotations.Cache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Cache.html) annotation for that. |

The @Cache annotation define three attributes:

usage

Defines the CacheConcurrencyStrategy

region

Defines a cache region where entries will be stored

include

If lazy properties should be included in the second level cache. The default value is all so lazy properties are cacheable. The other possible value is non-lazy so lazy properties are not cacheable.

### 13.3. Entity inheritance and second-level cache mapping

When using inheritance, the JPA @Cacheable and the Hibernate-specific @Cache annotations should be declared at the root-entity level only. That being said, it is not possible to customize the base class @Cacheable or @Cache definition in subclasses.

Although the JPA 2.1 specification says that the @Cacheable annotation could be overwritten by a subclass:

*The value of the Cacheable annotation is inherited by subclasses; it can be overridden by specifying Cacheable on a subclass.*

*— Section 11.1.7 of the JPA 2.1 Specification*

Hibernate requires that a given entity hierarchy share the same caching semantics.

The reasons why Hibernate requires that all entities belonging to an inheritance tree share the same caching definition can be summed as follows:

* from a performance perspective, adding an additional check on a per entity type level would slow the bootstrap process.
* providing different caching semantics for subclasses would violate the [Liskov substitution principle](https://en.wikipedia.org/wiki/Liskov_substitution_principle).

Assuming we have a base class, Payment and a subclass CreditCardPayment. If the Payment is not cacheable and the CreditCardPayment is cached, what should happen when executing the following code snippet:

Payment payment = entityManager.find(Payment.class, creditCardPaymentId);

CreditCardPayment creditCardPayment = (CreditCardPayment) CreditCardPayment;

In this particular case, the second level cache key is formed of the entity class name and the identifier:

keyToLoad = {org.hibernate.engine.spi.EntityKey@4712}

identifier = {java.lang.Long@4716} "2"

persister = {org.hibernate.persister.entity.SingleTableEntityPersister@4629}

"SingleTableEntityPersister(org.hibernate.userguide.model.Payment)"

Should Hibernate load the CreditCardPayment from the cache as indicated by the actual entity type, or it should not use the cache since the Payment is not supposed to be cached?

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| --- | --- |
|  | Because of all these intricacies, Hibernate only considers the base class @Cacheable and @Cachedefinition. |

### 13.4. Entity cache

*Example 416. Entity cache mapping*

@Entity(name = "Phone")

@Cacheable

@org.hibernate.annotations.Cache(usage = CacheConcurrencyStrategy.NONSTRICT\_READ\_WRITE)

public static class Phone {

@Id

@GeneratedValue

private Long id;

private String mobile;

@ManyToOne

private Person person;

@Version

private int version;

public Phone() {}

public Phone(String mobile) {

this.mobile = mobile;

}

public Long getId() {

return id;

}

public String getMobile() {

return mobile;

}

public Person getPerson() {

return person;

}

public void setPerson(Person person) {

this.person = person;

}

}

Hibernate stores cached entities in a dehydrated form, which is similar to the database representation. Aside from the foreign key column values of the @ManyToOne or @OneToOne child-side associations, entity relationships are not stored in the cache,

Once an entity is stored in the second-level cache, you can avoid a database hit and load the entity from the cache alone:

*Example 417. Loading entity using JPA*

Person person = entityManager.find( Person.class, 1L );

*Example 418. Loading entity using Hibernate native API*

Person person = session.get( Person.class, 1L );

The Hibernate second-level cache can also load entities by their [natural id](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid):

*Example 419. Hibernate natural id entity mapping*

@Entity(name = "Person")

@Cacheable

@org.hibernate.annotations.Cache(usage = CacheConcurrencyStrategy.READ\_WRITE)

public static class Person {

@Id

@GeneratedValue(strategy = GenerationType.AUTO)

private Long id;

private String name;

@NaturalId

@Column(name = "code", unique = true)

private String code;

public Person() {}

public Person(String name) {

this.name = name;

}

public Long getId() {

return id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public String getCode() {

return code;

}

public void setCode(String code) {

this.code = code;

}

}

*Example 420. Loading entity using Hibernate native natural id API*

Person person = session

.byNaturalId( Person.class )

.using( "code", "unique-code")

.load();

### 13.5. Collection cache

Hibernate can also cache collections, and the @Cache annotation must be on added to the collection property.

If the collection is made of value types (basic or embeddables mapped with @ElementCollection), the collection is stored as such. If the collection contains other entities (@OneToMany or @ManyToMany), the collection cache entry will store the entity identifiers only.

*Example 421. Collection cache mapping*

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@org.hibernate.annotations.Cache(usage = CacheConcurrencyStrategy.NONSTRICT\_READ\_WRITE)

private List<Phone> phones = new ArrayList<>( );

Collections are read-through, meaning they are cached upon being accessed for the first time:

*Example 422. Collection cache usage*

Person person = entityManager.find( Person.class, 1L );

person.getPhones().size();

Subsequent collection retrievals will use the cache instead of going to the database.

|  |  |
| --- | --- |
|  | The collection cache is not write-through so any modification will trigger a collection cache entry invalidation. On a subsequent access, the collection will be loaded from the database and re-cached. |

### 13.6. Query cache

Aside from caching entities and collections, Hibernate offers a query cache too. This is useful for frequently executed queries with fixed parameter values.

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|  | Caching of query results introduces some overhead in terms of your applications normal transactional processing. For example, if you cache results of a query against Person, Hibernate will need to keep track of when those results should be invalidated because changes have been committed against any Person entity.  That, coupled with the fact that most applications simply gain no benefit from caching query results, leads Hibernate to disable caching of query results by default. |

To use query caching, you will first need to enable it with the following configuration property:

*Example 423. Enabling query cache*

<property

name="hibernate.cache.use\_query\_cache"

value="true" />

As mentioned above, most queries do not benefit from caching or their results. So by default, individual queries are not cached even after enabling query caching. Each particular query that needs to be cached must be manually set as cacheable. This way, the query looks for existing cache results or adds the query results to the cache when being executed.

*Example 424. Caching query using JPA*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name = :name", Person.class)

.setParameter( "name", "John Doe")

.setHint( "org.hibernate.cacheable", "true")

.getResultList();

*Example 425. Caching query using Hibernate native API*

List<Person> persons = session.createQuery(

"select p " +

"from Person p " +

"where p.name = :name")

.setParameter( "name", "John Doe")

.setCacheable(true)

.list();

|  |  |
| --- | --- |
|  | The query cache does not cache the state of the actual entities in the cache; it caches only identifier values and results of value type.  Just as with collection caching, the query cache should always be used in conjunction with the second-level cache for those entities expected to be cached as part of a query result cache. |

#### 13.6.1. Query cache regions

This setting creates two new cache regions:

org.hibernate.cache.internal.StandardQueryCache

Holding the cached query results

org.hibernate.cache.spi.UpdateTimestampsCache

Holding timestamps of the most recent updates to queryable tables. These are used to validate the results as they are served from the query cache.

|  |  |
| --- | --- |
|  | If you configure your underlying cache implementation to use expiration, it’s very important that the timeout of the underlying cache region for the UpdateTimestampsCache is set to a higher value than the timeouts of any of the query caches.  In fact, we recommend that the UpdateTimestampsCache region is not configured for expiration (time-based) or eviction (size/memory-based) at all. Note that an LRU (Least Recently Used) cache eviction policy is never appropriate for this particular cache region. |

If you require fine-grained control over query cache expiration policies, you can specify a named cache region for a particular query.

*Example 426. Caching query in custom region using JPA*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.id > :id", Person.class)

.setParameter( "id", 0L)

.setHint( QueryHints.HINT\_CACHEABLE, "true")

.setHint( QueryHints.HINT\_CACHE\_REGION, "query.cache.person" )

.getResultList();

*Example 427. Caching query in custom region using Hibernate native API*

List<Person> persons = session.createQuery(

"select p " +

"from Person p " +

"where p.id > :id")

.setParameter( "id", 0L)

.setCacheable(true)

.setCacheRegion( "query.cache.person" )

.list();

If you want to force the query cache to refresh one of its regions (disregarding any cached results it finds there), you can use custom cache modes.

*Example 428. Using custom query cache mode with JPA*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.id > :id", Person.class)

.setParameter( "id", 0L)

.setHint( QueryHints.HINT\_CACHEABLE, "true")

.setHint( QueryHints.HINT\_CACHE\_REGION, "query.cache.person" )

.setHint( "javax.persistence.cache.storeMode", CacheStoreMode.REFRESH )

.getResultList();

*Example 429. Using custom query cache mode with Hibernate native API*

List<Person> persons = session.createQuery(

"select p " +

"from Person p " +

"where p.id > :id")

.setParameter( "id", 0L)

.setCacheable(true)

.setCacheRegion( "query.cache.person" )

.setCacheMode( CacheMode.REFRESH )

.list();

|  |  |
| --- | --- |
|  | When using [CacheStoreMode.REFRESH](http://docs.oracle.com/javaee/7/api/javax/persistence/CacheStoreMode.html#REFRESH) or [CacheMode.REFRESH](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/CacheMode.html#REFRESH) in conjunction with the region you have defined for the given query, Hibernate will selectively force the results cached in that particular region to be refreshed.  This is particularly useful in cases where underlying data may have been updated via a separate process and is a far more efficient alternative to bulk eviction of the region via SessionFactory eviction which looks as follows:  session.getSessionFactory().getCache().evictQueryRegion( "query.cache.person" ); |

### 13.7. Managing the cached data

Traditionally, Hibernate defined the [CacheMode](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/CacheMode.html) enumeration to describe the ways of interactions with the cached data. JPA split cache modes by storage ([CacheStoreMode](http://docs.oracle.com/javaee/7/api/javax/persistence/CacheStoreMode.html)) and retrieval ([CacheRetrieveMode](http://docs.oracle.com/javaee/7/api/javax/persistence/CacheRetrieveMode.html)).

The relationship between Hibernate and JPA cache modes can be seen in the following table:

| *Table 5. Cache modes relationships* | | |
| --- | --- | --- |
| **Hibernate** | **JPA** | **Description** |
| CacheMode.NORMAL | CacheStoreMode.USE and CacheRetrieveMode.USE | Default. Reads/writes data from/into cache |
| CacheMode.REFRESH | CacheStoreMode.REFRESH and CacheRetrieveMode.BYPASS | Doesn’t read from cache, but writes to the cache upon loading from the database |
| CacheMode.PUT | CacheStoreMode.USE and CacheRetrieveMode.BYPASS | Doesn’t read from cache, but writes to the cache as it reads from the database |
| CacheMode.GET | CacheStoreMode.BYPASS and CacheRetrieveMode.USE | Read from the cache, but doesn’t write to cache |
| CacheMode.IGNORE | CacheStoreMode.BYPASS and CacheRetrieveMode.BYPASS | Doesn’t read/write data from/into cache |

Setting the cache mode can be done either when loading entities directly or when executing a query.

*Example 430. Using custom cache modes with JPA*

Map<String, Object> hints = new HashMap<>( );

hints.put( "javax.persistence.cache.retrieveMode " , CacheRetrieveMode.USE );

hints.put( "javax.persistence.cache.storeMode" , CacheStoreMode.REFRESH );

Person person = entityManager.find( Person.class, 1L , hints);

*Example 431. Using custom cache modes with Hibernate native API*

session.setCacheMode( CacheMode.REFRESH );

Person person = session.get( Person.class, 1L );

The custom cache modes can be set for queries as well:

*Example 432. Using custom cache modes for queries with JPA*

List<Person> persons = entityManager.createQuery(

"select p from Person p", Person.class)

.setHint( QueryHints.HINT\_CACHEABLE, "true")

.setHint( "javax.persistence.cache.retrieveMode " , CacheRetrieveMode.USE )

.setHint( "javax.persistence.cache.storeMode" , CacheStoreMode.REFRESH )

.getResultList();

*Example 433. Using custom cache modes for queries with Hibernate native API*

List<Person> persons = session.createQuery(

"select p from Person p" )

.setCacheable( true )

.setCacheMode( CacheMode.REFRESH )

.list();

#### 13.7.1. Evicting cache entries

Because the second level cache is bound to the EntityManagerFactory or the SessionFactory, cache eviction must be done through these two interfaces.

JPA only supports entity eviction through the [javax.persistence.Cache](https://docs.oracle.com/javaee/7/api/javax/persistence/Cache.html) interface:

*Example 434. Evicting entities with JPA*

entityManager.getEntityManagerFactory().getCache().evict( Person.class );

Hibernate is much more flexible in this regard as it offers fine-grained control over what needs to be evicted. The [org.hibernate.Cache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Cache.html) interface defines various evicting strategies:

* entities (by their class or region)
* entities stored using the natural-id (by their class or region)
* collections (by the region, and it might take the collection owner identifier as well)
* queries (by region)

*Example 435. Evicting entities with Hibernate native API*

session.getSessionFactory().getCache().evictQueryRegion( "query.cache.person" );

### 13.8. Caching statistics

If you enable the hibernate.generate\_statistics configuration property, Hibernate will expose a number of metrics via SessionFactory.getStatistics(). Hibernate can even be configured to expose these statistics via JMX.

This way, you can get access to the [Statistics](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/stat/Statistics.html) class which comprises all sort of second-level cache metrics.

*Example 436. Caching statistics*

Statistics statistics = session.getSessionFactory().getStatistics();

SecondLevelCacheStatistics secondLevelCacheStatistics =

statistics.getSecondLevelCacheStatistics( "query.cache.person" );

long hitCount = secondLevelCacheStatistics.getHitCount();

long missCount = secondLevelCacheStatistics.getMissCount();

double hitRatio = (double) hitCount / ( hitCount + missCount );

### 13.9. JCache

|  |  |
| --- | --- |
|  | Use of the build-in integration for [JCache](https://jcp.org/en/jsr/detail?id=107) requires that the hibernate-jcache module jar (and all of its dependencies) are on the classpath. In addition a JCache implementation needs to be added as well. A list of compatible implementations can be found [on the JCP website](https://jcp.org/aboutJava/communityprocess/implementations/jsr107/index.html). An alternative source of compatible implementations can be found through [the JSR-107 test zoo](https://github.com/cruftex/jsr107-test-zoo). |

#### 13.9.1. RegionFactory

The hibernate-jcache module defines the following region factory: JCacheRegionFactory.

To use the JCacheRegionFactory, you need to specify the following configuration property:

*Example 437. JCacheRegionFactory configuration*

<property

name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.jcache.JCacheRegionFactory"/>

The JCacheRegionFactory configures a javax.cache.CacheManager.

#### 13.9.2. JCache CacheManager

JCache mandates that CacheManagers sharing the same URI and class loader be unique in JVM.

If you do not specify additional properties, the JCacheRegionFactory will load the default JCache provider and create the default CacheManager. Also, Caches will be created using the default javax.cache.configuration.MutableConfiguration.

In order to control which provider to use and specify configuration for the CacheManager and Caches you can use the following two properties:

*Example 438. JCache configuration*

<property

name="hibernate.javax.cache.provider"

value="org.ehcache.jsr107.EhcacheCachingProvider"/>

<property

name="hibernate.javax.cache.uri"

value="file:/path/to/ehcache.xml"/>

Only by specifying the second property hibernate.javax.cache.uri will you be able to have a CacheManager per SessionFactory.

### 13.10. Ehcache

This integration covers Ehcache 2.x, in order to use Ehcache 3.x as second level cache, refer to the [JCache integration](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-jcache).

|  |  |
| --- | --- |
|  | Use of the build-in integration for [Ehcache](http://www.ehcache.org/) requires that the hibernate-ehcache module jar (and all of its dependencies) are on the classpath. |

#### 13.10.1. RegionFactory

The hibernate-ehcache module defines two specific region factories: EhCacheRegionFactory and SingletonEhCacheRegionFactory.

##### EhCacheRegionFactory

To use the EhCacheRegionFactory, you need to specify the following configuration property:

*Example 439. EhCacheRegionFactory configuration*

<property

name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.ehcache.EhCacheRegionFactory"/>

The EhCacheRegionFactory configures a net.sf.ehcache.CacheManager for each SessionFactory, so the CacheManager is not shared among multiple SessionFactory instances in the same JVM.

##### SingletonEhCacheRegionFactory

To use the SingletonEhCacheRegionFactory, you need to specify the following configuration property:

*Example 440. SingletonEhCacheRegionFactory configuration*

<property

name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.ehcache.SingletonEhCacheRegionFactory"/>

The SingletonEhCacheRegionFactory configures a singleton net.sf.ehcache.CacheManager (see [CacheManager#create()](http://www.ehcache.org/apidocs/2.8.4/net/sf/ehcache/CacheManager.html#create%28%29)), shared among multiple SessionFactory instances in the same JVM.

|  |  |
| --- | --- |
|  | [Ehcache documentation](http://www.ehcache.org/documentation/2.8/integrations/hibernate#optional) recommends using multiple non-singleton CacheManager(s) when there are multiple Hibernate SessionFactory instances running in the same JVM. |

### 13.11. Infinispan

|  |  |
| --- | --- |
|  | Use of the build-in integration for [Infinispan](http://infinispan.org/) requires that the hibernate-infinispan module jar (and all of its dependencies) are on the classpath. |

How to configure Infinispan to be the second level cache provider varies slightly depending on the deployment scenario:

#### 13.11.1. Single Node Local

In standalone library mode, a JPA/Hibernate application runs inside a Java SE application or inside containers that don’t offer Infinispan integration.

Enabling Infinispan second level cache provider inside a JPA/Hibernate application that runs in single node is very straightforward. First, make sure the Hibernate Infinispan cache provider (and its dependencies) are available in the classpath, then modify the persistence.xml to include these properties:

<!-- Use Infinispan second level cache provider -->

<property name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.infinispan.InfinispanRegionFactory"/>

<!-- Optional: Force using local configuration when only using a single node.

Otherwise a clustered configuration is loaded. -->

<property name="hibernate.cache.infinispan.cfg"

value="org/hibernate/cache/infinispan/builder/infinispan-configs-local.xml"/>

Plugging in Infinispan as second-level cache provider requires at the bare minimum that hibernate.cache.region.factory\_class is set to an Infinispan region factory implementation. Normally, this is org.hibernate.cache.infinispan.InfinispanRegionFactory but other region factories are possible in alternative scenarios (see [Alternative Region Factory](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-region-factory) section for more info).

By default, the Infinispan second-level cache provider uses an Infinispan configuration that’s designed for clustered environments. However, since this section is focused on running Infinispan second-level cache provider in a single node, an Infinispan configuration designed for local environments is recommended. To enable that configuration, set hibernate.cache.infinispan.cfg to org/hibernate/cache/infinispan/builder/infinispan-configs-local.xmlvalue.

The next section focuses on analysing how the default local configuration works. Changing Infinispan configuration options can be done following the instructions in [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section.

##### Default Local Configuration

Infinispan second-level cache provider comes with a configuration designed for local, single node, environments. These are the characteristics of such configuration:

* Entities, collections, queries and timestamps are stored in non-transactional local caches.
* Entities and collections query caches are configured with the following eviction settings. You can change these settings on a per entity or collection basis or per individual entity or collection type. More information in the [Advanced Configuration](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#integrations:infinispan-2lc-advanced) section below.
  + Eviction wake up interval is 5 seconds.
  + Max number of entries are 10,000
  + Max idle time before expiration is 100 seconds
  + Default eviction algorithm is LRU, least recently used.
* No eviction/expiration is configured for timestamp caches, nor it’s allowed.

##### Local Cache Strategies

Before version 5.0, Infinispan only supported transactional and read-only strategies.

Starting with version 5.0, all cache strategies are supported: transactional, read-write, nonstrict-read-write and read-only.

#### 13.11.2. Multi Node Cluster

When running a JPA/Hibernate in a multi-node environment and enabling Infinispan second-level cache, it is necessary to cluster the second-level cache so that cache consistency can be guaranteed. Clustering the Infinispan second-level cache provider is as simple as adding the following properties:

<!-- Use Infinispan second level cache provider -->

<property name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.infinispan.InfinispanRegionFactory"/>

As with the standalone local mode, at the bare minimum the region factory has to be configured to point to an Infinispan region factory implementation.

However, the default Infinispan configuration used by the second-level cache provider is already configured to work in a cluster environment, so no need to add any extra properties.

The next section focuses on analysing how the default cluster configuration works. Changing Infinispan configuration options can be done following the instructions in [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section.

##### Default Cluster Configuration

Infinispan second-level cache provider default configuration is designed for multi-node clustered environments. The aim of this section is to explain the default settings for each of the different global data type caches (entity, collection, query and timestamps), why these were chosen and what are the available alternatives. These are the characteristics of such configuration:

* For all entities and collections, whenever a new entity or collection is read from database and needs to be cached, it’s only cached locally in order to reduce intra-cluster traffic. This option can be changed so that entities/collections are cached cluster wide, by switching the entity/collection cache to be replicated or distributed. How to change this option is explained in the [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section.
* All entities and collections are configured to use a synchronous invalidation as clustering mode. This means that when an entity is updated, the updated cache will send a message to the other members of the cluster telling them that the entity has been modified. Upon receipt of this message, the other nodes will remove this data from their local cache, if it was stored there. This option can be changed so that both local and remote nodes contain the updates by configuring entities or collections to use a replicated or distributed cache. With replicated caches all nodes would contain the update, whereas with distributed caches only a subset of the nodes. How to change this option is explained in the [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section.
* All entities and collections have initial state transfer disabled since there’s no need for it.
* Entities and collections are configured with the following eviction settings. You can change these settings on a per entity or collection basis or per individual entity or collection type. More information in the [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config)section below.
  + Eviction wake up interval is 5 seconds.
  + Max number of entries are 10,000
  + Max idle time before expiration is 100 seconds
  + Default eviction algorithm is LRU, least recently used.
* Assuming that query caching has been enabled for the persistence unit (see [query cache section](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-query)), the query cache is configured so that queries are only cached locally. Alternatively, you can configure query caching to use replication by selecting the replicated-query as query cache name. However, replication for query cache only makes sense if, and only if, all of this conditions are true:
  + Performing the query is quite expensive.
  + The same query is very likely to be repeatedly executed on different cluster nodes.
  + The query is unlikely to be invalidated out of the cache (Note: Hibernate must aggressively invalidate query results from the cache any time any instance of one of the entity types targeted by the query. All such query results are invalidated, even if the change made to the specific entity instance would not have affected the query result)
* query cache uses the same eviction/expiration settings as for entities/collections.
* query cache has initial state transfer disabled . It is not recommended that this is enabled.
* The timestamps cache is configured with asynchronous replication as clustering mode. Local or invalidated cluster modes are not allowed, since all cluster nodes must store all timestamps. As a result, no eviction/expiration is allowed for timestamp caches either.

|  |  |
| --- | --- |
|  | Asynchronous replication was selected as default for timestamps cache for performance reasons. A side effect of this choice is that when an entity/collection is updated, for a very brief period of time stale queries might be returned. It’s important to note that due to how Infinispan deals with asynchronous replication, stale queries might be found even query is done right after an entity/collection update on same node. The reason why asynchronous replication works this way is because there’s a single node that’s owner for a given key, and that enables changes to be applied in the same order in all nodes. Without it, it could happen that an older value could replace a newer value in certain nodes. |
|  | Hibernate must aggressively invalidate query results from the cache any time any instance of one of the entity types is modified. All cached query results referencing given entity type are invalidated, even if the change made to the specific entity instance would not have affected the query result. The timestamps cache plays here an important role - it contains last modification timestamp for each entity type. After a cached query results is loaded, its timestamp is compared to all timestamps of the entity types that are referenced in the query and if any of these is higher, the cached query result is discarded and the query is executed against DB. |

##### Cluster Cache Strategies

Before version 5.0, Infinispan only supported transactional and read-only strategies on top of transactional invalidation caches.

Since version 5.0, Infinispan currently supports all cache concurrency modes in cluster mode, although not all combinations of configurations are compatible:

* non-transactional invalidation caches are supported as well with read-write strategy. The actual setting of cache concurrency mode (read-write vs. transactional) is not honored, the appropriate strategy is selected based on the cache configuration (non-transactional vs. transactional).
* read-write mode is supported on non-transactional distributed/replicated caches, however, eviction should not be used in this configuration. Use of eviction can lead to consistency issues. Expiration (with reasonably long max-idle times) can be used.
* nonstrict-read-write mode is supported on non-transactional distributed/replicated caches, but the eviction should be turned off as well. In addition to that, the entities must use versioning. This mode mildly relaxes the consistency - between DB commit and end of transaction commit a stale read (see [example](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-stale-read-example)) may occur in another transaction. However this strategy uses less RPCs and can be more performant than the other ones.
* read-only mode is supported on both transactional and non-transactional invalidation caches and non-transactional distributed/replicated caches, but use of this mode currently does not bring any performance gains.

The available combinations are summarized in table below:

| *Table 6. Cache concurrency strategy/cache mode compatibility table* | | | |
| --- | --- | --- | --- |
| **Concurrency strategy** | **Cache transactions** | **Cache mode** | **Eviction** |
| transactional | transactional | invalidation | yes |
| read-write | non-transactional | invalidation | yes |
| read-write | non-transactional | distributed/replicated | no |
| nonstrict-read-write | non-transactional | distributed/replicated | no |

Changing caches to behave different to the default behaviour explained in previous section is explained in [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section.

*Example 441. Stale read with nonstrict-read-write strategy*

A=0 (non-cached), B=0 (cached in 2LC)

TX1: write A = 1, write B = 1

TX1: start commit

TX1: commit A, B in DB

TX2: read A = 1 (from DB), read B = 0 (from 2LC) // breaks transactional atomicity

TX1: update A, B in 2LC

TX1: end commit

Tx3: read A = 1, B = 1 // reads after TX1 commit completes are consistent again

#### 13.11.3. Alternative RegionFactory

In standalone environments or managed environments with no Infinispan integration, org.hibernate.cache.infinispan.InfinispanRegionFactory should be the choice for region factory implementation. However, it might be sometimes desirable for the Infinispan cache manager to be shared between different JPA/Hibernate applications, for example to share intra-cluster communications channels. In this case, the Infinispan cache manager could be bound into JNDI and the JPA/Hibernate applications could use an alternative region factory implementation:

*Example 442. JndiInfinispanRegionFactory configuration*

<property

name="hibernate.cache.region.factory\_class"

value="org.hibernate.cache.infinispan.JndiInfinispanRegionFactory" />

<property

name="hibernate.cache.infinispan.cachemanager"

value="java:CacheManager" />

#### 13.11.4. Inside Wildfly

In WildFly, Infinispan is the default second level cache provider for JPA/Hibernate. When using JPA in WildFly, region factory is automatically set upon configuring hibernate.cache.use\_second\_level\_cache=true (by default second-level cache is not used).

You can find details about its configuration in [the JPA reference guide](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/%7Bwildflydocroot%7D/JPA%20Reference%20Guide), in particular, in the [second level cache](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/%7Bwildflydocroot%7D/JPA%20Reference%20Guide#JPAReferenceGuide-UsingtheInfinispansecondlevelcache) section.

The default second-level cache configurations used by Wildfly match the configurations explained above both for local and clustered environments. So, an Infinispan based second-level cache should behave exactly the same standalone and within containers that provide Infinispan second-level cache as default for JPA/Hibernate.

|  |  |
| --- | --- |
|  | Remember that if deploying to Wildfly or Application Server, the way some Infinispan second level cache provider configuration is defined changes slightly because the properties must include deployment and persistence information. Check the [Configuration](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching-provider-infinispan-config) section for more details. |

#### 13.11.5. Configuration properties

As explained above, Infinispan second-level cache provider comes with default configuration in infinispan-config.xml that is suited for clustered use. If there’s only single JVM accessing the DB, you can use more performant infinispan-config-local.xml by setting the hibernate.cache.infinispan.cfg property. If you require further tuning of the cache, you can provide your own configuration. Caches that are not specified in the provided configuration will default to infinispan-config.xml (if the provided configuration uses clustering) or infinispan-config-local.xml.

|  |  |
| --- | --- |
|  | It is not possible to specify the configuration this way in WildFly. Cache configuration changes in Wildfly should be done either modifying the cache configurations inside the application server configuration, or creating new caches with the desired tweaks and plugging them accordingly. See examples below on how entity/collection specific configurations can be applied. |

*Example 443. Use custom Infinispan configuration*

<property

name="hibernate.cache.infinispan.cfg"

value="my-infinispan-configuration.xml" />

|  |  |
| --- | --- |
|  | If the cache is configured as transactional, InfinispanRegionFactory automatically sets transaction manager so that the TM used by Infinispan is the same as TM used by Hibernate. |

Cache configuration can differ for each type of data stored in the cache. In order to override the cache configuration template, use property hibernate.cache.infinispan.data-type.cfg where data-type can be one of:

entity

Entities indexed by @Id or @EmbeddedId attribute.

immutable-entity

Entities tagged with @Immutable annotation or set as mutable=false in mapping file.

naturalid

Entities indexed by their @NaturalId attribute.

collection

All collections.

timestamps

Mapping entity type → last modification timestamp. Used for query caching.

query

Mapping query → query result.

pending-puts

Auxiliary caches for regions using invalidation mode caches.

For specifying cache template for specific region, use region name instead of the data-type:

*Example 444. Use custom cache template*

<property

name="hibernate.cache.infinispan.entities.cfg"

value="custom-entities" />

<property

name="hibernate.cache.infinispan.query.cfg"

value="custom-query-cache" />

<property

name="hibernate.cache.infinispan.com.example.MyEntity.cfg"

value="my-entities" />

<property

name="hibernate.cache.infinispan.com.example.MyEntity.someCollection.cfg"

value="my-entities-some-collection" />

*Use custom cache template in Wildfly*

When applying entity/collection level changes inside JPA applications deployed in Wildfly, it is necessary to specify deployment name and persistence unit name:

<property

name="hibernate.cache.infinispan.\_war\_or\_ear\_name\_.\_unit\_name\_.com.example.MyEntity.cfg"

value="my-entities" />

<property

name="hibernate.cache.infinispan.\_war\_or\_ear\_name\_.\_unit\_name\_.com.example.MyEntity.someCollection.cfg"

value="my-entities-some-collection" />

|  |  |
| --- | --- |
|  | Cache configurations are used only as a template for the cache created for given region (usually each entity hierarchy or collection has its own region). It is not possible to use the same cache for different regions. |

Some options in the cache configuration can also be overridden directly through properties. These are:

hibernate.cache.infinispan.something.eviction.strategy

Available options are NONE, LRU and LIRS.

hibernate.cache.infinispan.something.eviction.max\_entries

Maximum number of entries in the cache.

hibernate.cache.infinispan.something.expiration.lifespan

Lifespan of entry from insert into cache (in milliseconds)

hibernate.cache.infinispan.something.expiration.max\_idle

Lifespan of entry from last read/modification (in milliseconds)

hibernate.cache.infinispan.something.expiration.wake\_up\_interval

Period of thread checking expired entries.

hibernate.cache.infinispan.statistics

Globally enables/disable Infinispan statistics collection, and their exposure via JMX.

Example:

<property name="hibernate.cache.infinispan.entity.eviction.strategy"

   value= "LRU"/>

<property name="hibernate.cache.infinispan.entity.eviction.wake\_up\_interval"

   value= "2000"/>

<property name="hibernate.cache.infinispan.entity.eviction.max\_entries"

   value= "5000"/>

<property name="hibernate.cache.infinispan.entity.expiration.lifespan"

   value= "60000"/>

<property name="hibernate.cache.infinispan.entity.expiration.max\_idle"

   value= "30000"/>

With the above configuration, you’re overriding whatever eviction/expiration settings were defined for the default entity cache name in the Infinispan cache configuration used, regardless of whether it’s the default one or user defined. More specifically, we’re defining the following:

* All entities to use LRU eviction strategy
* The eviction thread to wake up every 2 seconds (2000 milliseconds)
* The maximum number of entities for each entity type to be 5000 entries
* The lifespan of each entity instance to be 1 minute (600000 milliseconds).
* The maximum idle time for each entity instance to be 30 seconds (30000 milliseconds).

You can also override eviction/expiration settings on a per entity/collection type basis in such way that the overriden settings only afftect that particular entity (i.e. com.acme.Person) or collection type (i.e. com.acme.Person.addresses). Example:

<property name="hibernate.cache.infinispan.com.acme.Person.eviction.strategy"

   value= "LIRS"/>

Inside of Wildfly, same as with the entity/collection configuration override, eviction/expiration settings would also require deployment name and persistence unit information:

<property name="hibernate.cache.infinispan.\_war\_or\_ear\_name\_.\_unit\_name\_.com.acme.Person.eviction.strategy"

   value= "LIRS"/>

<property name="hibernate.cache.infinispan.\_war\_or\_ear\_name\_.\_unit\_name\_.com.acme.Person.expiration.lifespan"

   value= "65000"/>

|  |  |
| --- | --- |
|  | In versions prior to 5.1, hibernate.cache.infinispan.something.expiration.wake\_up\_intervalwas called hibernate.cache.infinispan.something.eviction.wake\_up\_interval. Eviction settings are checked upon each cache insert, it is expiration that needs to be triggered periodically. The old property still works, but its use is deprecated. |
|  | Property hibernate.cache.infinispan.use\_synchronization that allowed to register Infinispan as XA resource in the transaction has been deprecated in 5.0 and is not honored anymore. Infinispan 2LC must register as synchronizations on transactional caches. Also, non-transactional cache modes hook into the current JTA/JDBC transaction as synchronizations. |

#### 13.11.6. Remote Infinispan Caching

Lately, several questions ( [here](http://community.jboss.org/message/575814#575814) and [here](http://community.jboss.org/message/585841#585841) ) have appeared in the Infinispan user forums asking whether it’d be possible to have an Infinispan second level cache that instead of living in the same JVM as the Hibernate code, it resides in a remote server, i.e. an Infinispan Hot Rod server. It’s important to understand that trying to set up second level cache in this way is generally not a good idea for the following reasons:

* The purpose of a JPA/Hibernate second level cache is to store entities/collections recently retrieved from database or to maintain results of recent queries. So, part of the aim of the second level cache is to have data accessible locally rather than having to go to the database to retrieve it everytime this is needed. Hence, if you decide to set the second level cache to be remote as well, you’re losing one of the key advantages of the second level cache: the fact that the cache is local to the code that requires it.
* Setting a remote second level cache can have a negative impact in the overall performance of your application because it means that cache misses require accessing a remote location to verify whether a particular entity/collection/query is cached. With a local second level cache however, these misses are resolved locally and so they are much faster to execute than with a remote second level cache.

There are however some edge cases where it might make sense to have a remote second level cache, for example:

* You are having memory issues in the JVM where JPA/Hibernate code and the second level cache is running. Off loading the second level cache to remote Hot Rod servers could be an interesting way to separate systems and allow you find the culprit of the memory issues more easily.
* Your application layer cannot be clustered but you still want to run multiple application layer nodes. In this case, you can’t have multiple local second level cache instances running because they won’t be able to invalidate each other for example when data in the second level cache is updated. In this case, having a remote second level cache could be a way out to make sure your second level cache is always in a consistent state, will all nodes in the application layer pointing to it.
* Rather than having the second level cache in a remote server, you want to simply keep the cache in a separate VM still within the same machine. In this case you would still have the additional overhead of talking across to another JVM, but it wouldn’t have the latency of across a network.

The benefit of doing this is that:

* + Size the cache separate from the application, since the cache and the application server have very different memory profiles. One has lots of short lived objects, and the other could have lots of long lived objects.
  + To pin the cache and the application server onto different CPU cores (using numactl ), and even pin them to different physically memory based on the NUMA nodes.

## 14. 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.

### 14.1. Interceptors

The org.hibernate.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. The following example shows an Interceptor implementation that automatically logs when an entity is updated.

public static class LoggingInterceptor extends EmptyInterceptor {

@Override

public boolean onFlushDirty(

Object entity,

Serializable id,

Object[] currentState,

Object[] previousState,

String[] propertyNames,

Type[] types) {

LOGGER.debugv( "Entity {0}#{1} changed from {2} to {3}",

entity.getClass().getSimpleName(),

id,

Arrays.toString( previousState ),

Arrays.toString( currentState )

);

return super.onFlushDirty( entity, id, currentState,

previousState, propertyNames, types

);

}

}

|  |  |
| --- | --- |
|  | You can either implement Interceptor directly or extend org.hibernate.EmptyInterceptor. |

An Interceptor can be either Session-scoped or SessionFactory-scoped.

A Session-scoped interceptor is specified when a session is opened.

SessionFactory sessionFactory = entityManagerFactory.unwrap( SessionFactory.class );

Session session = sessionFactory

.withOptions()

.interceptor(new LoggingInterceptor() )

.openSession();

session.getTransaction().begin();

Customer customer = session.get( Customer.class, customerId );

customer.setName( "Mr. John Doe" );

//Entity Customer#1 changed from [John Doe, 0] to [Mr. John Doe, 0]

session.getTransaction().commit();

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 SessionFactory-scoped 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.

SessionFactory sessionFactory = new MetadataSources( new StandardServiceRegistryBuilder().build() )

.addAnnotatedClass( Customer.class )

.getMetadataBuilder()

.build()

.getSessionFactoryBuilder()

.applyInterceptor( new LoggingInterceptor() )

.build();

### 14.2. Native Event system

If you have to react to particular events in the persistence layer, you can also use the Hibernate event architecture. The event system can be used in place of or in addition to interceptors.

Many methods of the Session interface correlate to an event type. The full range of defined event types is declared as enum values on org.hibernate.event.spi.EventType. When a request is made of one of these methods, the Session generates an appropriate event and passes it to the configured event listener(s) for that type.

Applications 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 stateless; 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).

Here is an example of a custom load event listener:

*Example 445. Custom LoadListener example*

EntityManagerFactory entityManagerFactory = entityManagerFactory();

SessionFactoryImplementor sessionFactory = entityManagerFactory.unwrap( SessionFactoryImplementor.class );

sessionFactory

.getServiceRegistry()

.getService( EventListenerRegistry.class )

.prependListeners( EventType.LOAD, new SecuredLoadEntityListener() );

Customer customer = entityManager.find( Customer.class, customerId );

### 14.3. Mixing Events and Interceptors

When you want to customize the entity state transition behavior, you have to options:

1. you provide a custom Interceptor, which is taken into consideration by the default Hibernate event listeners. For example, the Interceptor#onSave() method is invoked by Hibernate AbstractSaveEventListener. Or, the Interceptor#onLoad() is called by the DefaultPreLoadEventListener.
2. you can replace any given default event listener with your own implementation. When doing this, you should probably extend the default listeners because otherwise you’d have to take care of all the low-level entity state transition logic. For example, if you replace the DefaultPreLoadEventListener with your own implementation, then, only if you call the Interceptor#onLoad() method explicitly, you can mix the custom load event listener with a custom Hibernate interceptor.

### 14.4. Hibernate declarative security

Usually, declarative security in Hibernate applications is managed in a session facade layer. Hibernate allows certain actions to be authorized via JACC and 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 JACC authorization. Again, see [Event Listener Registration](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-event-listener-registration) for the details.

Below is an example of an appropriate org.hibernate.integrator.spi.Integrator implementation for this purpose.

*Example 446. JACC listener registration example*

public static class JaccIntegrator implements ServiceContributingIntegrator {

private static final Logger log = Logger.getLogger( JaccIntegrator.class );

private static final DuplicationStrategy DUPLICATION\_STRATEGY =

new DuplicationStrategy() {

@Override

public boolean areMatch(Object listener, Object original) {

return listener.getClass().equals( original.getClass() ) &&

JaccSecurityListener.class.isInstance( original );

}

@Override

public Action getAction() {

return Action.KEEP\_ORIGINAL;

}

};

@Override

public void prepareServices(

StandardServiceRegistryBuilder serviceRegistryBuilder) {

boolean isSecurityEnabled = serviceRegistryBuilder

.getSettings().containsKey( AvailableSettings.JACC\_ENABLED );

final JaccService jaccService = isSecurityEnabled ?

new StandardJaccServiceImpl() : new DisabledJaccServiceImpl();

serviceRegistryBuilder.addService( JaccService.class, jaccService );

}

@Override

public void integrate(

Metadata metadata,

SessionFactoryImplementor sessionFactory,

SessionFactoryServiceRegistry serviceRegistry) {

doIntegration(

serviceRegistry

.getService( ConfigurationService.class ).getSettings(),

// pass no permissions here, because atm actually injecting the

// permissions into the JaccService is handled on SessionFactoryImpl via

// the org.hibernate.boot.cfgxml.spi.CfgXmlAccessService

null,

serviceRegistry

);

}

private void doIntegration(

Map properties,

JaccPermissionDeclarations permissionDeclarations,

SessionFactoryServiceRegistry serviceRegistry) {

boolean isSecurityEnabled = properties

.containsKey( AvailableSettings.JACC\_ENABLED );

if ( ! isSecurityEnabled ) {

log.debug( "Skipping JACC integration as it was not enabled" );

return;

}

final String contextId = (String) properties

.get( AvailableSettings.JACC\_CONTEXT\_ID );

if ( contextId == null ) {

throw new IntegrationException( "JACC context id must be specified" );

}

final JaccService jaccService = serviceRegistry

.getService( JaccService.class );

if ( jaccService == null ) {

throw new IntegrationException( "JaccService was not set up" );

}

if ( permissionDeclarations != null ) {

for ( GrantedPermission declaration : permissionDeclarations

.getPermissionDeclarations() ) {

jaccService.addPermission( declaration );

}

}

final EventListenerRegistry eventListenerRegistry =

serviceRegistry.getService( EventListenerRegistry.class );

eventListenerRegistry.addDuplicationStrategy( DUPLICATION\_STRATEGY );

eventListenerRegistry.prependListeners(

EventType.PRE\_DELETE, new JaccPreDeleteEventListener() );

eventListenerRegistry.prependListeners(

EventType.PRE\_INSERT, new JaccPreInsertEventListener() );

eventListenerRegistry.prependListeners(

EventType.PRE\_UPDATE, new JaccPreUpdateEventListener() );

eventListenerRegistry.prependListeners(

EventType.PRE\_LOAD, new JaccPreLoadEventListener() );

}

@Override

public void disintegrate(SessionFactoryImplementor sessionFactory,

SessionFactoryServiceRegistry serviceRegistry) {

// nothing to do

}

}

You must also decide how to configure your JACC provider. Consult your JACC provider documentation.

### 14.5. JPA Callbacks

JPA also defines a more limited set of callbacks through annotations.

| *Table 7. Callback annotations* | |
| --- | --- |
| **Type** | **Description** |
| @PrePersist | Executed before the entity manager persist operation is actually executed or cascaded. This call is synchronous with the persist operation. |
| @PreRemove | Executed before the entity manager remove operation is actually executed or cascaded. This call is synchronous with the remove operation. |
| @PostPersist | Executed after the entity manager persist operation is actually executed or cascaded. This call is invoked after the database INSERT is executed. |
| @PostRemove | Executed after the entity manager remove operation is actually executed or cascaded. This call is synchronous with the remove operation. |
| @PreUpdate | Executed before the database UPDATE operation. |
| @PostUpdate | Executed after the database UPDATE operation. |
| @PostLoad | Executed after an entity has been loaded into the current persistence context or an entity has been refreshed. |

There are two available approaches defined for specifying callback handling:

* The first approach is to annotate methods on the entity itself to receive notification of particular entity life cycle event(s).
* The second is to use a separate entity listener class. An entity listener is a stateless class with a no-arg constructor. The callback annotations are placed on a method of this class instead of the entity class. The entity listener class is then associated with the entity using the javax.persistence.EntityListeners annotation

*Example 447. Example of specifying JPA callbacks*

@Entity

@EntityListeners( LastUpdateListener.class )

public static class Person {

@Id

private Long id;

private String name;

private Date dateOfBirth;

@Transient

private long age;

private Date lastUpdate;

public void setLastUpdate(Date lastUpdate) {

this.lastUpdate = lastUpdate;

}

/\*\*

\* Set the transient property at load time based on a calculation.

\* Note that a native Hibernate formula mapping is better for this purpose.

\*/

@PostLoad

public void calculateAge() {

age = ChronoUnit.YEARS.between( LocalDateTime.ofInstant(

Instant.ofEpochMilli( dateOfBirth.getTime()), ZoneOffset.UTC),

LocalDateTime.now()

);

}

}

public static class LastUpdateListener {

@PreUpdate

@PrePersist

public void setLastUpdate( Person p ) {

p.setLastUpdate( new Date() );

}

}

These approaches can be mixed, meaning you can use both together.

Regardless of whether the callback method is defined on the entity or on an entity listener, it must have a void-return signature. The name of the method is irrelevant as it is the placement of the callback annotations that makes the method a callback. In the case of callback methods defined on the entity class, the method must additionally have a no-argument signature. For callback methods defined on an entity listener class, the method must have a single argument signature; the type of that argument can be either java.lang.Object (to facilitate attachment to multiple entities) or the specific entity type.

A callback method can throw a RuntimeException. If the callback method does throw a RuntimeException, then the current transaction, if any, must be rolled back.

A callback method must not invoke EntityManager or Query methods!

It is possible that multiple callback methods are defined for a particular lifecycle event. When that is the case, the defined order of execution is well defined by the JPA spec (specifically section 3.5.4):

* Any default listeners associated with the entity are invoked first, in the order they were specified in the XML. See the javax.persistence.ExcludeDefaultListeners annotation.
* Next, entity listener class callbacks associated with the entity hierarchy are invoked, in the order they are defined in the EntityListeners. If multiple classes in the entity hierarchy define entity listeners, the listeners defined for a superclass are invoked before the listeners defined for its subclasses. See the `javax.persistence.ExcludeSuperclassListener`s annotation.
* Lastly, callback methods defined on the entity hierarchy are invoked. If a callback type is annotated on both an entity and one or more of its superclasses without method overriding, both would be called, the most general superclass first. An entity class is also allowed to override a callback method defined in a superclass in which case the super callback would not get invoked; the overriding method would get invoked provided it is annotated.

### 14.6. Default entity listeners

The JPA specification allows you to define a default entity listener which is going to be applied for every entity in that particular system. Default entity listeners can only be defined in XML mapping files.

*Example 448. Default event listner mapping*

public class DefaultEntityListener {

public void onPersist(Object entity) {

if ( entity instanceof BaseEntity ) {

BaseEntity baseEntity = (BaseEntity) entity;

baseEntity.setCreatedOn( now() );

}

}

public void onUpdate(Object entity) {

if ( entity instanceof BaseEntity ) {

BaseEntity baseEntity = (BaseEntity) entity;

baseEntity.setUpdatedOn( now() );

}

}

private Timestamp now() {

return Timestamp.from(

LocalDateTime.now().toInstant( ZoneOffset.UTC )

);

}

}

<entity-mappings xmlns="http://xmlns.jcp.org/xml/ns/persistence/orm"

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/persistence/orm

http://xmlns.jcp.org/xml/ns/persistence/orm\_2\_1.xsd"

version="2.1">

<persistence-unit-metadata>

<persistence-unit-defaults>

<entity-listeners>

<entity-listener

class="org.hibernate.userguide.events.DefaultEntityListener">

<pre-persist method-name="onPersist"/>

<pre-update method-name="onUpdate"/>

</entity-listener>

</entity-listeners>

</persistence-unit-defaults>

</persistence-unit-metadata>

</entity-mappings>

Considering that all entities extend the BaseEntity class:

@MappedSuperclass

public abstract class BaseEntity {

private Timestamp createdOn;

private Timestamp updatedOn;

public Timestamp getCreatedOn() {

return createdOn;

}

void setCreatedOn(Timestamp createdOn) {

this.createdOn = createdOn;

}

public Timestamp getUpdatedOn() {

return updatedOn;

}

void setUpdatedOn(Timestamp updatedOn) {

this.updatedOn = updatedOn;

}

}

@Entity(name = "Person")

public static class Person extends BaseEntity {

@Id

private Long id;

private String name;

//Getters and setters omitted for brevity

}

@Entity(name = "Book")

public static class Book extends BaseEntity {

@Id

private Long id;

private String title;

@ManyToOne

private Person author;

//Getters and setters omitted for brevity

}

When persisting a Person or Book entity, the createdOn is going to be set by the onPersist method of the DefaultEntityListener.

*Example 449. Default event listner persist event*

Person author = new Person();

author.setId( 1L );

author.setName( "Vlad Mihalcea" );

entityManager.persist( author );

Book book = new Book();

book.setId( 1L );

book.setTitle( "High-Performance Java Persistence" );

book.setAuthor( author );

entityManager.persist( book );

insert

into

Person

(createdOn, updatedOn, name, id)

values

(?, ?, ?, ?)

-- binding parameter [1] as [TIMESTAMP] - [2017-06-08 19:23:48.224]

-- binding parameter [2] as [TIMESTAMP] - [null]

-- binding parameter [3] as [VARCHAR] - [Vlad Mihalcea]

-- binding parameter [4] as [BIGINT] - [1]

insert

into

Book

(createdOn, updatedOn, author\_id, title, id)

values

(?, ?, ?, ?, ?)

-- binding parameter [1] as [TIMESTAMP] - [2017-06-08 19:23:48.246]

-- binding parameter [2] as [TIMESTAMP] - [null]

-- binding parameter [3] as [BIGINT] - [1]

-- binding parameter [4] as [VARCHAR] - [High-Performance Java Persistence]

-- binding parameter [5] as [BIGINT] - [1]

When updating a Person or Book entity, the updatedOn is going to be set by the onUpdate method of the DefaultEntityListener.

*Example 450. Default event listner update event*

Person author = entityManager.find( Person.class, 1L );

author.setName( "Vlad-Alexandru Mihalcea" );

Book book = entityManager.find( Book.class, 1L );

book.setTitle( "High-Performance Java Persistence 2nd Edition" );

update

Person

set

createdOn=?,

updatedOn=?,

name=?

where

id=?

-- binding parameter [1] as [TIMESTAMP] - [2017-06-08 19:23:48.224]

-- binding parameter [2] as [TIMESTAMP] - [2017-06-08 19:23:48.316]

-- binding parameter [3] as [VARCHAR] - [Vlad-Alexandru Mihalcea]

-- binding parameter [4] as [BIGINT] - [1]

update

Book

set

createdOn=?,

updatedOn=?,

author\_id=?,

title=?

where

id=?

-- binding parameter [1] as [TIMESTAMP] - [2017-06-08 19:23:48.246]

-- binding parameter [2] as [TIMESTAMP] - [2017-06-08 19:23:48.317]

-- binding parameter [3] as [BIGINT] - [1]

-- binding parameter [4] as [VARCHAR] - [High-Performance Java Persistence 2nd Edition]

-- binding parameter [5] as [BIGINT] - [1]

#### 14.6.1. Exclude default entity listeners

If you already registered a default entity listener, but you don’t want to apply it to a particular entity, you can use the[@ExcludeDefaultListeners](http://docs.oracle.com/javaee/7/api/javax/persistence/ExcludeDefaultListeners.html) and [@ExcludeSuperclassListeners](http://docs.oracle.com/javaee/7/api/javax/persistence/ExcludeSuperclassListeners.html) JPA annotations.

@ExcludeDefaultListeners instructs the current class to ignore the default entity listeners for the current entity while @ExcludeSuperclassListeners is used to ignore the default entity listeners propagated to the BaseEntity super-class.

*Example 451. Exclude default event listner mapping*

@Entity(name = "Publisher")

@ExcludeDefaultListeners

@ExcludeSuperclassListeners

public static class Publisher extends BaseEntity {

@Id

private Long id;

private String name;

//Getters and setters omitted for brevity

}

When persisting a Publisher entity, the createdOn is not going to be set by the onPersist method of the DefaultEntityListener because the Publisher entity was marked with the @ExcludeDefaultListeners and @ExcludeSuperclassListeners annotations.

*Example 452. Excluding default event listner events*

Publisher publisher = new Publisher();

publisher.setId( 1L );

publisher.setName( "Amazon" );

entityManager.persist( publisher );

insert

into

Publisher

(createdOn, updatedOn, name, id)

values

(?, ?, ?, ?)

-- binding parameter [1] as [TIMESTAMP] - [null]

-- binding parameter [2] as [TIMESTAMP] - [null]

-- binding parameter [3] as [VARCHAR] - [Amazon]

-- binding parameter [4] as [BIGINT] - [1]

## 15. HQL and JPQL

The Hibernate Query Language (HQL) and Java Persistence Query Language (JPQL) are both object model focused query languages similar in nature to SQL. JPQL is a heavily-inspired-by subset of HQL. A JPQL query is always a valid HQL query, the reverse is not true however.

Both HQL and JPQL are non-type-safe ways to perform query operations. Criteria queries offer a type-safe approach to querying. See [Criteria](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria) for more information.

### 15.1. Query API

### 15.2. Examples domain model

To better understand the further HQL and JPQL examples, it’s time to familiarize the domain model entities that are used in all the examples features in this chapter.

*Example 453. Examples domain model*

@NamedQueries({

@NamedQuery(

name = "get\_person\_by\_name",

query = "select p from Person p where name = :name"

)

,

@NamedQuery(

name = "get\_read\_only\_person\_by\_name",

query = "select p from Person p where name = :name",

hints = {

@QueryHint(

name = "org.hibernate.readOnly",

value = "true"

)

}

)

})

@NamedStoredProcedureQueries(

@NamedStoredProcedureQuery(

name = "sp\_person\_phones",

procedureName = "sp\_person\_phones",

parameters = {

@StoredProcedureParameter(

name = "personId",

type = Long.class,

mode = ParameterMode.IN

),

@StoredProcedureParameter(

name = "personPhones",

type = Class.class,

mode = ParameterMode.REF\_CURSOR

)

}

)

)

@Entity

public class Person {

@Id

@GeneratedValue

private Long id;

private String name;

private String nickName;

private String address;

@Temporal(TemporalType.TIMESTAMP )

private Date createdOn;

@OneToMany(mappedBy = "person", cascade = CascadeType.ALL)

@OrderColumn(name = "order\_id")

private List<Phone> phones = new ArrayList<>();

@ElementCollection

@MapKeyEnumerated(EnumType.STRING)

private Map<AddressType, String> addresses = new HashMap<>();

@Version

private int version;

//Getters and setters are omitted for brevity

}

public enum AddressType {

HOME,

OFFICE

}

@Entity

public class Partner {

@Id

@GeneratedValue

private Long id;

private String name;

@Version

private int version;

//Getters and setters are omitted for brevity

}

@Entity

public class Phone {

@Id

private Long id;

@ManyToOne(fetch = FetchType.LAZY)

private Person person;

@Column(name = "phone\_number")

private String number;

@Enumerated(EnumType.STRING)

@Column(name = "phone\_type")

private PhoneType type;

@OneToMany(mappedBy = "phone", cascade = CascadeType.ALL, orphanRemoval = true)

private List<Call> calls = new ArrayList<>( );

@OneToMany(mappedBy = "phone")

@MapKey(name = "timestamp")

@MapKeyTemporal(TemporalType.TIMESTAMP )

private Map<Date, Call> callHistory = new HashMap<>();

@ElementCollection

private List<Date> repairTimestamps = new ArrayList<>( );

//Getters and setters are omitted for brevity

}

public enum PhoneType {

LAND\_LINE,

MOBILE;

}

@Entity

@Table(name = "phone\_call")

public class Call {

@Id

@GeneratedValue

private Long id;

@ManyToOne

private Phone phone;

@Column(name = "call\_timestamp")

private Date timestamp;

private int duration;

//Getters and setters are omitted for brevity

}

@Entity

@Inheritance(strategy = InheritanceType.JOINED)

public class Payment {

@Id

@GeneratedValue

private Long id;

private BigDecimal amount;

private boolean completed;

@ManyToOne

private Person person;

//Getters and setters are omitted for brevity

}

@Entity

public class CreditCardPayment extends Payment {

}

@Entity

public class WireTransferPayment extends Payment {

}

### 15.3. JPA Query API

In JPA the query is represented by javax.persistence.Query or javax.persistence.TypedQuery as obtained from the EntityManager. The create an inline Query or TypedQuery, you need to use the EntityManager#createQuerymethod. For named queries, the EntityManager#createNamedQuery method is needed.

*Example 454. Obtaining a JPA Query or a TypedQuery reference*

Query query = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name"

);

TypedQuery<Person> typedQuery = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name", Person.class

);

*Example 455. Obtaining a JPA Query or a TypedQuery reference for a named query*

@NamedQuery(

name = "get\_person\_by\_name",

query = "select p from Person p where name = :name"

)

Query query = entityManager.createNamedQuery( "get\_person\_by\_name" );

TypedQuery<Person> typedQuery = entityManager.createNamedQuery(

"get\_person\_by\_name", Person.class

);

Hibernate offers a specific [@NamedQuery](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedQuery.html) annotation which provides ways to configure various query features, like flush mode, cacheability, time out interval.

*Example 456. Obtaining a Hibernate Query or a TypedQuery reference for a named query*

@NamedQueries({

@NamedQuery(

name = "get\_phone\_by\_number",

query = "select p " +

"from Phone p " +

"where p.number = :number",

timeout = 1,

readOnly = true

)

})

Phone phone = entityManager

.createNamedQuery( "get\_phone\_by\_number", Phone.class )

.setParameter( "number", "123-456-7890" )

.getSingleResult();

The Query interface can then be used to control the execution of the query. For example, we may want to specify an execution timeout or control caching.

*Example 457. Basic JPA Query usage*

Query query = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

// timeout - in milliseconds

.setHint( "javax.persistence.query.timeout", 2000 )

// flush only at commit time

.setFlushMode( FlushModeType.COMMIT );

For complete details, see the Query [Javadocs](http://docs.oracle.com/javaee/7/api/javax/persistence/Query.html). Many of the settings controlling the execution of the query are defined as hints. JPA defines some standard hints (like timeout in the example), but most are provider specific. Relying on provider specific hints limits your applications portability to some degree.

javax.persistence.query.timeout

Defines the query timeout, in milliseconds.

javax.persistence.fetchgraph

Defines a fetchgraph EntityGraph. Attributes explicitly specified as AttributeNodes are treated as FetchType.EAGER(via join fetch or subsequent select). For details, see the EntityGraph discussions in [Fetching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching).

javax.persistence.loadgraph

Defines a loadgraph EntityGraph. Attributes explicitly specified as AttributeNodes are treated as FetchType.EAGER (via join fetch or subsequent select). Attributes that are not specified are treated as FetchType.LAZY or FetchType.EAGERdepending on the attribute’s definition in metadata. For details, see the EntityGraph discussions in [Fetching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching).

org.hibernate.cacheMode

Defines the CacheMode to use. See org.hibernate.query.Query#setCacheMode.

org.hibernate.cacheable

Defines whether the query is cacheable. true/false. See org.hibernate.query.Query#setCacheable.

org.hibernate.cacheRegion

For queries that are cacheable, defines a specific cache region to use. See org.hibernate.query.Query#setCacheRegion.

org.hibernate.comment

Defines the comment to apply to the generated SQL. See org.hibernate.query.Query#setComment.

org.hibernate.fetchSize

Defines the JDBC fetch-size to use. See org.hibernate.query.Query#setFetchSize

org.hibernate.flushMode

Defines the Hibernate-specific FlushMode to use. See org.hibernate.query.Query#setFlushMode. If possible, prefer using javax.persistence.Query#setFlushMode instead.

org.hibernate.readOnly

Defines that entities and collections loaded by this query should be marked as read-only. See org.hibernate.query.Query#setReadOnly

The final thing that needs to happen before the query can be executed is to bind the values for any defined parameters. JPA defines a simplified set of parameter binding methods. Essentially it supports setting the parameter value (by name/position) and a specialized form for Calendar/Date types additionally accepting a TemporalType.

*Example 458. JPA name parameter binding*

Query query = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" );

// For generic temporal field types (e.g. `java.util.Date`, `java.util.Calendar`)

// we also need to provide the associated `TemporalType`

Query query = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.createdOn > :timestamp" )

.setParameter( "timestamp", timestamp, TemporalType.DATE );

JPQL-style positional parameters are declared using a question mark followed by an ordinal - ?1, ?2. The ordinals start with 1. Just like with named parameters, positional parameters can also appear multiple times in a query.

*Example 459. JPA positional parameter binding*

Query query = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like ?1" )

.setParameter( 1, "J%" );

|  |  |
| --- | --- |
|  | It’s good practice not to mix forms in a given query. |

In terms of execution, JPA Query offers 2 different methods for retrieving a result set.

* Query#getResultList() - executes the select query and returns back the list of results.
* Query#getSingleResult() - executes the select query and returns a single result. If there were more than one result an exception is thrown.

*Example 460. JPA getResultList() result*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.getResultList();

*Example 461. JPA getSingleResult()*

Person person = (Person) entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.getSingleResult();

### 15.4. Hibernate Query API

In Hibernate, the HQL query is represented as org.hibernate.query.Query which is obtained from a Session. If the HQL is a named query, Session#getNamedQuery would be used; otherwise Session#createQuery is needed.

*Example 462. Obtaining a Hibernate Query*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name"

);

*Example 463. Obtaining a Hibernate Query reference for a named query*

org.hibernate.query.Query query = session.getNamedQuery( "get\_person\_by\_name" );

|  |  |
| --- | --- |
|  | Not only was the JPQL syntax heavily inspired by HQL, but many of the JPA APIs were heavily inspired by Hibernate too. The two Query contracts are very similar. |

The Query interface can then be used to control the execution of the query. For example, we may want to specify an execution timeout or control caching.

*Example 464. Basic Query usage - Hibernate*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

// timeout - in seconds

.setTimeout( 2 )

// write to L2 caches, but do not read from them

.setCacheMode( CacheMode.REFRESH )

// assuming query cache was enabled for the SessionFactory

.setCacheable( true )

// add a comment to the generated SQL if enabled via the hibernate.use\_sql\_comments configuration property

.setComment( "+ INDEX(p idx\_person\_name)" );

For complete details, see the [Query](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Query.html) Javadocs.

|  |  |
| --- | --- |
|  | Query hints here are database query hints. They are added directly to the generated SQL according to Dialect#getQueryHintString.  The JPA notion of query hints, on the other hand, refer to hints that target the provider (Hibernate). So even though they are called the same, be aware they have a very different purpose. Also, be aware that Hibernate query hints generally make the application non-portable across databases unless the code adding them first checks the Dialect. |

Flushing is covered in detail in [Flushing](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#flushing). Locking is covered in detail in [Locking](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking). The concept of read-only state is covered in [Persistence Contexts](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc).

Hibernate also allows an application to hook into the process of building the query results via the org.hibernate.transform.ResultTransformer contract. See its [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/transform/ResultTransformer.html) as well as the Hibernate-provided implementations for additional details.

The last thing that needs to happen before we can execute the query is to bind the values for any parameters defined in the query. Query defines many overloaded methods for this purpose. The most generic form takes the value as well as the Hibernate Type.

*Example 465. Hibernate name parameter binding*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%", StringType.INSTANCE );

Hibernate generally understands the expected type of the parameter given its context in the query. In the previous example since we are using the parameter in a LIKE comparison against a String-typed attribute Hibernate would automatically infer the type; so the above could be simplified.

*Example 466. Hibernate name parameter binding (inferred type)*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" );

There are also short hand forms for binding common types such as strings, booleans, integers, etc.

*Example 467. Hibernate name parameter binding (short forms)*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name " +

" and p.createdOn > :timestamp" )

.setParameter( "name", "J%" )

.setParameter( "timestamp", timestamp, TemporalType.TIMESTAMP);

HQL-style positional parameters follow JDBC positional parameter syntax. They are declared using ? without a following ordinal. There is no way to relate two such positional parameters as being "the same" aside from binding the same value to each.

*Example 468. Hibernate positional parameter binding*

org.hibernate.query.Query query = session.createQuery(

"select p " +

"from Person p " +

"where p.name like ? " )

.setParameter( 0, "J%" );

|  |  |
| --- | --- |
|  | This form should be considered deprecated and may be removed in the near future. |

In terms of execution, Hibernate offers 4 different methods. The 2 most commonly used are

* Query#list - executes the select query and returns back the list of results.
* Query#uniqueResult - executes the select query and returns the single result. If there were more than one result an exception is thrown.

*Example 469. Hibernate list() result*

List<Person> persons = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.list();

It is also possible to extract a single result from a Query.

*Example 470. Hibernate uniqueResult()*

Person person = (Person) session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.uniqueResult();

|  |  |
| --- | --- |
|  | If the unique result is used often and the attributes upon which it is based are unique, you may want to consider mapping a natural-id and using the natural-id loading API. See the [Natural Ids](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid) for more information on this topic. |

#### 15.4.1. Query scrolling

Hibernate offers additional, specialized methods for scrolling the query and handling results using a server-side cursor.

Query#scroll works in tandem with the JDBC notion of a scrollable ResultSet.

The Query#scroll method is overloaded:

* Then main form accepts a single argument of type org.hibernate.ScrollMode which indicates the type of scrolling to be used. See the [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/ScrollMode.html) for the details on each.
* The second form takes no argument and will use the ScrollMode indicated by Dialect#defaultScrollMode.

Query#scroll returns a org.hibernate.ScrollableResults which wraps the underlying JDBC (scrollable) ResultSet and provides access to the results. Unlike a typical forward-only ResultSet, the ScrollableResults allows you to navigate the ResultSet in any direction.

*Example 471. Scrolling through a ResultSet containing entities*

try ( ScrollableResults scrollableResults = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.scroll()

) {

while(scrollableResults.next()) {

Person person = (Person) scrollableResults.get()[0];

process(person);

}

}

|  |  |
| --- | --- |
|  | Since this form holds the JDBC ResultSet open, the application should indicate when it is done with the ScrollableResults by calling its close() method (as inherited from java.io.Closeable so that ScrollableResults will work with [try-with-resources](https://docs.oracle.com/javase/tutorial/essential/exceptions/tryResourceClose.html) blocks).  If left unclosed by the application, Hibernate will automatically close the underlying resources (e.g. ResultSet and PreparedStatement) used internally by the ScrollableResults when the current transaction is ended (either commit or rollback).  However, it is good practice to close the ScrollableResults explicitly. |
|  | If you plan to use Query#scroll with collection fetches it is important that your query explicitly order the results so that the JDBC results contain the related rows sequentially. |

Hibernate also supports Query#iterate, which is intended for loading entities when it is known that the loaded entries are already stored in the second-level cache. The idea behind iterate is that just the matching identifiers will be obtained in the SQL query. From these the identifiers are resolved by second-level cache lookup. If these second-level cache lookups fail, additional queries will need to be issued against the database.

|  |  |
| --- | --- |
|  | This operation can perform significantly better for loading large numbers of entities that for certain already exist in the second-level cache. In cases where many of the entities do not exist in the second-level cache, this operation will almost definitely perform worse. |

The Iterator returned from Query#iterate is actually a specially typed Iterator: org.hibernate.engine.HibernateIterator. It is specialized to expose a close() method (again, inherited from java.io.Closeable). When you are done with this Iterator you should close it, either by casting to HibernateIterator or Closeable, or by calling [Hibernate#close(java.util.Iterator)](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Hibernate.html#close-java.util.Iterator-).

Since 5.2, Hibernate offers support for returning a Stream which can be later used to transform the underlying ResultSet.

Internally, the stream() behaves like a Query#scroll and the underlying result is backed by a ScrollableResults.

Fetching a projection using the Query#stream method can be done as follows:

*Example 472. Hibernate stream() using a projection result type*

try ( Stream<Object[]> persons = session.createQuery(

"select p.name, p.nickName " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.stream() ) {

persons

.map( row -> new PersonNames(

(String) row[0],

(String) row[1] ) )

.forEach( this::process );

}

When fetching a single result, like a Person entity, instead of a Stream<Object[]>, Hibernate is going to figure out the actual type, so the result is a Stream<Person>.

*Example 473. Hibernate stream() using an entity result type*

try( Stream<Person> persons = session.createQuery(

"select p " +

"from Person p " +

"where p.name like :name" )

.setParameter( "name", "J%" )

.stream() ) {

Map<Phone, List<Call>> callRegistry = persons

.flatMap( person -> person.getPhones().stream() )

.flatMap( phone -> phone.getCalls().stream() )

.collect( Collectors.groupingBy( Call::getPhone ) );

process(callRegistry);

}

|  |  |
| --- | --- |
|  | Just like with ScrollableResults, you should always close a Hibernate Stream either explicitly or using a [try-with-resources](https://docs.oracle.com/javase/tutorial/essential/exceptions/tryResourceClose.html) block. |

### 15.5. 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 and org.hibernate.eg.Foo are different, as are foo.barSet and foo.BARSET.

|  |  |
| --- | --- |
|  | This documentation uses lowercase keywords as convention in examples. |

### 15.6. Statement types

Both HQL and JPQL allow SELECT, UPDATE and DELETE statements to be performed. HQL additionally allows INSERTstatements, in a form similar to a SQL INSERT FROM SELECT.

|  |  |
| --- | --- |
|  | Care should be taken as to when a UPDATE or DELETE statement is executed.  *Caution should be used when executing bulk update or delete operations because they may result in inconsistencies between the database and the entities in the active persistence context. In general, bulk update and delete operations should only be performed within a transaction in a new persistence con text or before fetching or accessing entities whose state might be affected by such operations.*  *— Section 4.10 of the JPA 2.0 Specification* |

### 15.7. Select statements

The [BNF](https://en.wikipedia.org/wiki/Backus%E2%80%93Naur_Form) for SELECT statements in HQL is:

select\_statement :: =

[select\_clause]

from\_clause

[where\_clause]

[groupby\_clause]

[having\_clause]

[orderby\_clause]

The simplest possible HQL SELECT statement is of the form:

List<Person> persons = session.createQuery(

"from Person" )

.list();

|  |  |
| --- | --- |
|  | The select statement in JPQL is exactly the same as for HQL except that JPQL requires a select\_clause, whereas HQL does not.  List<Person> persons = entityManager.createQuery(  "select p " +  "from Person p", Person.class )  .getResultList();  Even though HQL does not require the presence of a select\_clause, it is generally good practice to include one. For simple queries the intent is clear and so the intended result of the select\_clause is east to infer. But on more complex queries that is not always the case.  It is usually better to explicitly specify intent. Hibernate does not actually enforce that a select\_clause be present even when parsing JPQL queries, however applications interested in JPA portability should take heed of this. |

### 15.8. Update statements

The BNF for UPDATE statements is the same in HQL and JPQL:

update\_statement ::=

update\_clause [where\_clause]

update\_clause ::=

UPDATE entity\_name [[AS] identification\_variable]

SET update\_item {, update\_item}\*

update\_item ::=

[identification\_variable.]{state\_field | single\_valued\_object\_field} = new\_value

new\_value ::=

scalar\_expression | simple\_entity\_expression | NULL

UPDATE statements, by default, do not effect the version or the timestamp attribute values for the affected entities.

However, you can force Hibernate to set the version or timestamp attribute values through the use of a versioned update. This is achieved by adding the VERSIONED keyword after the UPDATE keyword.

|  |  |
| --- | --- |
|  | This is a Hibernate specific feature and will not work in a portable manner.  Custom version types, org.hibernate.usertype.UserVersionType, are not allowed in conjunction with a update versioned statement. |

An UPDATE statement is executed using the executeUpdate() of either org.hibernate.query.Query or javax.persistence.Query. The method is named for those familiar with the JDBC executeUpdate() on java.sql.PreparedStatement.

The int value returned by the 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. Using a JOINED inheritance hierarchy, 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 tables "in between".

*Example 474. UPDATE query statements*

int updatedEntities = entityManager.createQuery(

"update Person p " +

"set p.name = :newName " +

"where p.name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

int updatedEntities = session.createQuery(

"update Person " +

"set name = :newName " +

"where name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

int updatedEntities = session.createQuery(

"update versioned Person " +

"set name = :newName " +

"where name = :oldName" )

.setParameter( "oldName", oldName )

.setParameter( "newName", newName )

.executeUpdate();

|  |  |
| --- | --- |
|  | Neither UPDATE nor DELETE statements allow implicit joins. Their form already disallows explicit joins too. |

### 15.9. Delete statements

The BNF for DELETE statements is the same in HQL and JPQL:

delete\_statement ::=

delete\_clause [where\_clause]

delete\_clause ::=

DELETE FROM entity\_name [[AS] identification\_variable]

A DELETE statement is also executed using the executeUpdate() method of either org.hibernate.query.Query or javax.persistence.Query.

### 15.10. Insert statements

HQL adds the ability to define INSERT statements as well.

|  |  |
| --- | --- |
|  | There is no JPQL equivalent to this. |

The BNF for an HQL INSERT statement is:

insert\_statement ::=

insert\_clause select\_statement

insert\_clause ::=

INSERT INTO entity\_name (attribute\_list)

attribute\_list ::=

state\_field[, state\_field ]\*

The attribute\_list is analogous to the column specification in the SQL INSERT statement. For entities involved in mapped inheritance, only attributes directly defined on the named entity can be used in the attribute\_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 relegate to the database. This may cause problems between Hibernate Types which are equivalent as opposed to equal. For example, this might cause lead to issues with mismatches between an attribute mapped as a org.hibernate.type.DateType and an attribute 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 attribute, the insert statement gives you two options. You can either explicitly specify the id property in the attribute\_list, in which case its value is taken from the corresponding select expression, or omit it from the attribute\_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 optimistic locking attributes, the insert statement again gives you two options. You can either specify the attribute in the attribute\_list in which case its value is taken from the corresponding select expressions, or omit it from the attribute\_list in which case the seed value defined by the corresponding org.hibernate.type.VersionType is used.

*Example 475. INSERT query statements*

int insertedEntities = session.createQuery(

"insert into Partner (id, name) " +

"select p.id, p.name " +

"from Person p ")

.executeUpdate();

### 15.11. The FROM clause

The FROM clause is responsible defining the scope of object model types available to the rest of the query. It also is responsible for defining all the "identification variables" available to the rest of the query.

### 15.12. Identification variables

Identification variables are often referred to as aliases. References to object model classes in the FROM clause can be associated with an identification variable that can then be used to refer to that type throughout the rest of the query.

In most cases declaring an identification variable is optional, though it is usually good practice to declare them.

An identification variable must follow the rules for Java identifier validity.

According to JPQL, identification variables must be treated as case-insensitive. Good practice says you should use the same case throughout a query to refer to a given identification variable. In other words, JPQL says they can be case-insensitive and so Hibernate must be able to treat them as such, but this does not make it good practice.

### 15.13. Root entity references

A root entity reference, or what JPA calls a range variable declaration, is specifically a reference to a mapped entity type from the application. It cannot name component/ embeddable types. And associations, including collections, are handled in a different manner, as later discussed.

The BNF for a root entity reference is:

root\_entity\_reference ::=

entity\_name [AS] identification\_variable

*Example 476. Simple query example*

List<Person> persons = entityManager.createQuery(

"select p " +

"from org.hibernate.userguide.model.Person p", Person.class )

.getResultList();

We see that the query is defining a root entity reference to the org.hibernate.userguide.model.Person object model type. Additionally, it declares an alias of p to that org.hibernate.userguide.model.Person reference, which is the identification variable.

Usually, the root entity reference represents just the entity name rather than the entity class FQN (fully-qualified name). By default, the entity name is the unqualified entity class name, here Person

*Example 477. Simple query using entity name for root entity reference*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p", Person.class )

.getResultList();

Multiple root entity references can also be specified, even when naming the same entity.

*Example 478. Simple query using multiple root entity references*

List<Object[]> persons = entityManager.createQuery(

"select distinct pr, ph " +

"from Person pr, Phone ph " +

"where ph.person = pr and ph is not null", Object[].class)

.getResultList();

List<Person> persons = entityManager.createQuery(

"select distinct pr1 " +

"from Person pr1, Person pr2 " +

"where pr1.id <> pr2.id " +

" and pr1.address = pr2.address " +

" and pr1.createdOn < pr2.createdOn", Person.class )

.getResultList();

### 15.14. Explicit joins

The FROM clause can also contain explicit relationship joins using the join keyword. These joins can be either inner or left outer style joins.

*Example 479. Explicit inner join examples*

List<Person> persons = entityManager.createQuery(

"select distinct pr " +

"from Person pr " +

"join pr.phones ph " +

"where ph.type = :phoneType", Person.class )

.setParameter( "phoneType", PhoneType.MOBILE )

.getResultList();

// same query but specifying join type as 'inner' explicitly

List<Person> persons = entityManager.createQuery(

"select distinct pr " +

"from Person pr " +

"inner join pr.phones ph " +

"where ph.type = :phoneType", Person.class )

.setParameter( "phoneType", PhoneType.MOBILE )

.getResultList();

*Example 480. Explicit left (outer) join examples*

List<Person> persons = entityManager.createQuery(

"select distinct pr " +

"from Person pr " +

"left join pr.phones ph " +

"where ph is null " +

" or ph.type = :phoneType", Person.class )

.setParameter( "phoneType", PhoneType.LAND\_LINE )

.getResultList();

// functionally the same query but using the 'left outer' phrase

List<Person> persons = entityManager.createQuery(

"select distinct pr " +

"from Person pr " +

"left outer join pr.phones ph " +

"where ph is null " +

" or ph.type = :phoneType", Person.class )

.setParameter( "phoneType", PhoneType.LAND\_LINE )

.getResultList();

HQL also defines a WITH clause to qualify the join conditions.

|  |  |
| --- | --- |
|  | This is specific to HQL. JPQL defines the ON clause for this feature. |

*Example 481. HQL WITH clause join example*

List<Object[]> personsAndPhones = session.createQuery(

"select pr.name, ph.number " +

"from Person pr " +

"left join pr.phones ph with ph.type = :phoneType " )

.setParameter( "phoneType", PhoneType.LAND\_LINE )

.list();

*Example 482. JPQL ON clause join example*

List<Object[]> personsAndPhones = entityManager.createQuery(

"select pr.name, ph.number " +

"from Person pr " +

"left join pr.phones ph on ph.type = :phoneType " )

.setParameter( "phoneType", PhoneType.LAND\_LINE )

.getResultList();

|  |  |
| --- | --- |
|  | The important distinction is that in the generated SQL the conditions of the WITH/ON clause are made part of the ON clause in the generated SQL, as opposed to the other queries in this section where the HQL/JPQL conditions are made part of the WHERE clause in the generated SQL. |

The distinction in this specific example is probably not that significant. The with clause is sometimes necessary for more complicated queries.

Explicit joins may reference association or component/embedded attributes. In the case of component/embedded attributes, the join is simply logical and does not correlate to a physical (SQL) join. For further information about collection-valued association references, see [Collection member references](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-collection-valued-associations).

An important use case for explicit joins is to define FETCH JOINS which override the laziness of the joined association. As an example, given an entity named Person with a collection-valued association named phones, the JOIN FETCH will also load the child collection in the same SQL query:

*Example 483. Fetch join example*

// functionally the same query but using the 'left outer' phrase

List<Person> persons = entityManager.createQuery(

"select distinct pr " +

"from Person pr " +

"left join fetch pr.phones ", Person.class )

.getResultList();

As you can see from the example, a fetch join is specified by injecting the keyword fetch after the keyword join. In the example, we used a left outer join because we also wanted to return customers who have no orders.

Inner joins can also be fetched, but inner joins filter out the root entity. In the example, using an inner join instead would have resulted in customers without any orders being filtered out of the result.

|  |  |
| --- | --- |
|  | Fetch joins are not valid in sub-queries.  Care should be taken when fetch joining a collection-valued association which is in any way further restricted (the fetched collection will be restricted too). For this reason, it is usually considered best practice not to assign an identification variable to fetched joins except for the purpose of specifying nested fetch joins.  Fetch joins should not be used in paged queries (e.g. setFirstResult() or setMaxResults()), nor should they be used with the scroll() or iterate() features. |

### 15.15. Implicit joins (path expressions)

Another means of adding to the scope of object model types available to the query is through the use of implicit joins or path expressions.

*Example 484. Simple implicit join example*

List<Phone> phones = entityManager.createQuery(

"select ph " +

"from Phone ph " +

"where ph.person.address = :address ", Phone.class )

.setParameter( "address", address )

.getResultList();

// same as

List<Phone> phones = entityManager.createQuery(

"select ph " +

"from Phone ph " +

"join ph.person pr " +

"where pr.address = :address ", Phone.class )

.setParameter( "address", address)

.getResultList();

An implicit join always starts from an identification variable, followed by the navigation operator ( . ), followed by an attribute for the object model type referenced by the initial identification variable. In the example, the initial identification variable is ph which refers to the Phone entity. The ph.person reference then refers to the personattribute of the Phone entity. person is an association type so we further navigate to its age attribute.

|  |  |
| --- | --- |
|  | If the attribute represents an entity association (non-collection) or a component/embedded, that reference can be further navigated. Basic values and collection-valued associations cannot be further navigated. |

As shown in the example, implicit joins can appear outside the FROM clause. However, they affect the FROM clause.

|  |  |
| --- | --- |
|  | Implicit joins are always treated as inner joins.  Multiple references to the same implicit join always refer to the same logical and physical (SQL) join. |

*Example 485. Reused implicit join*

List<Phone> phones = entityManager.createQuery(

"select ph " +

"from Phone ph " +

"where ph.person.address = :address " +

" and ph.person.createdOn > :timestamp", Phone.class )

.setParameter( "address", address )

.setParameter( "timestamp", timestamp )

.getResultList();

//same as

List<Phone> phones = entityManager.createQuery(

"select ph " +

"from Phone ph " +

"inner join ph.person pr " +

"where pr.address = :address " +

" and pr.createdOn > :timestamp", Phone.class )

.setParameter( "address", address )

.setParameter( "timestamp", timestamp )

.getResultList();

Just as with explicit joins, implicit joins may reference association or component/embedded attributes. For further information about collection-valued association references, see [Collection member references](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-collection-valued-associations).

In the case of component/embedded attributes, the join is simply logical and does not correlate to a physical (SQL) join. Unlike explicit joins, however, implicit joins may also reference basic state fields as long as the path expression ends there.

### 15.16. Distinct

For JPQL and HQL, DISTINCT has two meanings:

1. It can be passed to the database so that duplicates are removed from a result set
2. It can be used to filter out the same parent entity references when join fetching a child collection

#### 15.16.1. Using DISTINCT with SQL projections

For SQL projections, DISTINCT needs to be passed to the database because the duplicated entries need to be filtered out before being returned to the database client.

*Example 486. Using DISTINCT with projection queries example*

List<String> lastNames = entityManager.createQuery(

"select distinct p.lastName " +

"from Person p", String.class)

.getResultList();

When running the query above, Hibernate generates the following SQL query:

SELECT DISTINCT

p.last\_name as col\_0\_0\_

FROM person p

For this particular use case, passing the DISTINCT keyword from JPQL/HQL to the database is the right thing to do.

#### 15.16.2. Using DISTINCT with entity queries

DISTINCT can also be used to filter out entity object references when fetching a child association along with the parent entities.

*Example 487. Using DISTINCT with entity queries example*

List<Person> authors = entityManager.createQuery(

"select distinct p " +

"from Person p " +

"left join fetch p.books", Person.class)

.getResultList();

In this case, DISTINCT is used because there can be multiple Books entities associated to a given Person. If in the database there are 3 Persons in the database and each person has 2 Books, without DISTINCT this query will return 6 Persons since the SQL-level result-set size is given by the number of joined Book records.

However, the DISTINCT keyword is passed to the database as well:

SELECT DISTINCT

p.id as id1\_1\_0\_,

b.id as id1\_0\_1\_,

p.first\_name as first\_na2\_1\_0\_,

p.last\_name as last\_nam3\_1\_0\_,

b.author\_id as author\_i3\_0\_1\_,

b.title as title2\_0\_1\_,

b.author\_id as author\_i3\_0\_0\_\_,

b.id as id1\_0\_0\_\_

FROM person p

LEFT OUTER JOIN book b ON p.id=b.author\_id

In this case, the DISTINCT SQL keyword is undesirable since it does a redundant result set sorting, as explained [in this blog post](http://in.relation.to/2016/08/04/introducing-distinct-pass-through-query-hint/). To fix this issue, Hibernate 5.2.2 added support for the HINT\_PASS\_DISTINCT\_THROUGH entity query hint:

*Example 488. Using DISTINCT with entity queries example*

List<Person> authors = entityManager.createQuery(

"select distinct p " +

"from Person p " +

"left join fetch p.books", Person.class)

.setHint( QueryHints.HINT\_PASS\_DISTINCT\_THROUGH, false )

.getResultList();

With this entity query hint, Hibernate will not pass the DISTINCT keyword to the SQL query:

SELECT

p.id as id1\_1\_0\_,

b.id as id1\_0\_1\_,

p.first\_name as first\_na2\_1\_0\_,

p.last\_name as last\_nam3\_1\_0\_,

b.author\_id as author\_i3\_0\_1\_,

b.title as title2\_0\_1\_,

b.author\_id as author\_i3\_0\_0\_\_,

b.id as id1\_0\_0\_\_

FROM person p

LEFT OUTER JOIN book b ON p.id=b.author\_id

When using the HINT\_PASS\_DISTINCT\_THROUGH entity query hint, Hibernate can still remove the duplicated parent-side entities from the query result.

### 15.17. Collection member references

References to collection-valued associations actually refer to the values of that collection.

*Example 489. Collection references example*

List<Phone> phones = entityManager.createQuery(

"select ph " +

"from Person pr " +

"join pr.phones ph " +

"join ph.calls c " +

"where pr.address = :address " +

" and c.duration > :duration", Phone.class )

.setParameter( "address", address )

.setParameter( "duration", duration )

.getResultList();

// alternate syntax

List<Phone> phones = session.createQuery(

"select pr " +

"from Person pr, " +

"in (pr.phones) ph, " +

"in (ph.calls) c " +

"where pr.address = :address " +

" and c.duration > :duration" )

.setParameter( "address", address )

.setParameter( "duration", duration )

.list();

In the example, the identification variable ph actually refers to the object model type Phone, which is the type of the elements of the Person#phones association.

The example also shows the alternate syntax for specifying collection association joins using the IN syntax. Both forms are equivalent. Which form an application chooses to use is simply a matter of taste.

### 15.18. Special case - qualified path expressions

We said earlier that collection-valued associations actually refer to the values of that collection. Based on the type of collection, there are also available a set of explicit qualification expressions.

*Example 490. Qualified collection references example*

@OneToMany(mappedBy = "phone")

@MapKey(name = "timestamp")

@MapKeyTemporal(TemporalType.TIMESTAMP )

private Map<Date, Call> callHistory = new HashMap<>();

// select all the calls (the map value) for a given Phone

List<Call> calls = entityManager.createQuery(

"select ch " +

"from Phone ph " +

"join ph.callHistory ch " +

"where ph.id = :id ", Call.class )

.setParameter( "id", id )

.getResultList();

// same as above

List<Call> calls = entityManager.createQuery(

"select value(ch) " +

"from Phone ph " +

"join ph.callHistory ch " +

"where ph.id = :id ", Call.class )

.setParameter( "id", id )

.getResultList();

// select all the Call timestamps (the map key) for a given Phone

List<Date> timestamps = entityManager.createQuery(

"select key(ch) " +

"from Phone ph " +

"join ph.callHistory ch " +

"where ph.id = :id ", Date.class )

.setParameter( "id", id )

.getResultList();

// select all the Call and their timestamps (the 'Map.Entry') for a given Phone

List<Map.Entry<Date, Call>> callHistory = entityManager.createQuery(

"select entry(ch) " +

"from Phone ph " +

"join ph.callHistory ch " +

"where ph.id = :id " )

.setParameter( "id", id )

.getResultList();

// Sum all call durations for a given Phone of a specific Person

Long duration = entityManager.createQuery(

"select sum(ch.duration) " +

"from Person pr " +

"join pr.phones ph " +

"join ph.callHistory ch " +

"where ph.id = :id " +

" and index(ph) = :phoneIndex", Long.class )

.setParameter( "id", id )

.setParameter( "phoneIndex", phoneIndex )

.getSingleResult();

VALUE

Refers to the collection value. Same as not specifying a qualifier. Useful to explicitly show intent. Valid for any type of collection-valued reference.

INDEX

According to HQL rules, this is valid for both Maps and Lists which specify a javax.persistence.OrderColumnannotation to refer to the Map key or the List position (aka the OrderColumn value). JPQL however, reserves this for use in the List case and adds KEY for the Map case. Applications interested in JPA provider portability should be aware of this distinction.

KEY

Valid only for Maps. Refers to the map’s key. If the key is itself an entity, it can be further navigated.

ENTRY

Only valid for Maps. Refers to the map’s logical java.util.Map.Entry tuple (the combination of its key and value).ENTRY is only valid as a terminal path and it’s applicable to the SELECT clause only.

See [Collection-related expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-collection-expressions) for additional details on collection related expressions.

### 15.19. Polymorphism

HQL and JPQL queries are inherently polymorphic.

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p ", Payment.class )

.getResultList();

This query names the Payment entity explicitly. However, all subclasses of Payment are also available to the query. So if the CreditCardPayment and WireTransferPayment entities extend the Payment class, all three types would be available to the entity query, and the query would return instances of all three.

|  |  |
| --- | --- |
|  | This can be altered by using either the org.hibernate.annotations.Polymorphism annotation (global, and Hibernate-specific) or limiting them using in the query itself using an entity type expression.  The HQL query from java.lang.Object is totally valid! It returns every object of every type defined in your application. |

### 15.20. Expressions

Essentially expressions are references that resolve to basic or tuple values.

### 15.21. Identification variable

See [The FROM clause](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-from-clause).

### 15.22. Path expressions

Again, see [The FROM clause](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-from-clause).

### 15.23. Literals

String literals are enclosed in single quotes. To escape a single quote within a string literal, use double single quotes.

*Example 491. String literals examples*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like 'Joe'", Person.class)

.getResultList();

// Escaping quotes

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like 'Joe''s'", Person.class)

.getResultList();

Numeric literals are allowed in a few different forms.

*Example 492. Numeric literal examples*

// simple integer literal

Person person = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.id = 1", Person.class)

.getSingleResult();

// simple integer literal, typed as a long

Person person = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.id = 1L", Person.class)

.getSingleResult();

// decimal notation

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration > 100.5", Call.class )

.getResultList();

// decimal notation, typed as a float

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration > 100.5F", Call.class )

.getResultList();

// scientific notation

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration > 1e+2", Call.class )

.getResultList();

// scientific notation, typed as a float

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration > 1e+2F", Call.class )

.getResultList();

|  |  |
| --- | --- |
|  | In the scientific notation form, the E is case-insensitive.  Specific typing can be achieved through the use of the same suffix approach specified by Java. So, L denotes a long, D denotes a double, F denotes a float. The actual suffix is case-insensitive.  The boolean literals are TRUE and FALSE, again case-insensitive.  Enums can even be referenced as literals. The fully-qualified enum class name must be used. HQL can also handle constants in the same manner, though JPQL does not define that as supported.  Entity names can also be used as literal. See [Entity type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-entity-type-exp).  Date/time literals can be specified using the JDBC escape syntax:   * {d 'yyyy-mm-dd'} for dates * {t 'hh:mm:ss'} for times * {ts 'yyyy-mm-dd hh:mm:ss[.millis]'} (millis optional) for timestamps.   These Date/time literals only work if you JDBC drivers supports them. |

### 15.24. Arithmetic

Arithmetic operations also represent valid expressions.

*Example 493. Numeric arithmetic examples*

// select clause date/time arithmetic operations

Long duration = entityManager.createQuery(

"select sum(ch.duration) \* :multiplier " +

"from Person pr " +

"join pr.phones ph " +

"join ph.callHistory ch " +

"where ph.id = 1L ", Long.class )

.setParameter( "multiplier", 1000L )

.getSingleResult();

// select clause date/time arithmetic operations

Integer years = entityManager.createQuery(

"select year( current\_date() ) - year( p.createdOn ) " +

"from Person p " +

"where p.id = 1L", Integer.class )

.getSingleResult();

// where clause arithmetic operations

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where year( current\_date() ) - year( p.createdOn ) > 1", Person.class )

.getResultList();

The following rules apply to the result of arithmetic operations:

* If either of the operands is Double/double, the result is a Double
* else, if either of the operands is Float/float, the result is a Float
* else, if either operand is BigDecimal, the result is BigDecimal
* else, if either operand is BigInteger, the result is BigInteger (except for division, in which case the result type is not further defined)
* else, if either operand is Long/long, the result is Long (except for division, in which case the result type is not further defined)
* else, (the assumption being that both operands are of integral type) the result is Integer (except for division, in which case the result type is not further defined)

Date arithmetic is also supported, albeit in a more limited fashion. This is due partially to differences in database support and partially to the lack of support for INTERVAL definition in the query language itself.

### 15.25. Concatenation (operation)

HQL defines a concatenation operator in addition to supporting the concatenation (CONCAT) function. This is not defined by JPQL, so portable applications should avoid it use. The concatenation operator is taken from the SQL concatenation operator (e.g ||).

*Example 494. Concatenation operation example*

String name = entityManager.createQuery(

"select 'Customer ' || p.name " +

"from Person p " +

"where p.id = 1", String.class )

.getSingleResult();

See [Scalar functions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-exp-functions) for details on the concat() function

### 15.26. Aggregate functions

Aggregate functions are also valid expressions in HQL and JPQL. The semantic is the same as their SQL counterpart. The supported aggregate functions are:

COUNT (including distinct/all qualifiers)

The result type is always Long.

AVG

The result type is always Double.

MIN

The result type is the same as the argument type.

MAX

The result type is the same as the argument type.

SUM

The result type of the SUM() function depends on the type of the values being summed. For integral values (other than BigInteger), the result type is Long.

For floating point values (other than BigDecimal) the result type is Double. For BigInteger values, the result type is BigInteger. For BigDecimal values, the result type is BigDecimal.

*Example 495. Aggregate function examples*

Object[] callStatistics = entityManager.createQuery(

"select " +

" count(c), " +

" sum(c.duration), " +

" min(c.duration), " +

" max(c.duration), " +

" avg(c.duration) " +

"from Call c ", Object[].class )

.getSingleResult();

Long phoneCount = entityManager.createQuery(

"select count( distinct c.phone ) " +

"from Call c ", Long.class )

.getSingleResult();

List<Object[]> callCount = entityManager.createQuery(

"select p.number, count(c) " +

"from Call c " +

"join c.phone p " +

"group by p.number", Object[].class )

.getResultList();

Aggregations often appear with grouping. For information on grouping see [Group by](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-group-by).

### 15.27. Scalar functions

Both HQL and JPQL define some standard functions that are available regardless of the underlying database in use. HQL can also understand additional functions defined by the Dialect as well as the application.

### 15.28. JPQL standardized functions

Here is the list of functions defined as supported by JPQL. Applications interested in remaining portable between JPA providers should stick to these functions.

CONCAT

String concatenation function. Variable argument length of 2 or more string values to be concatenated together.

List<String> callHistory = entityManager.createQuery(

"select concat( p.number, ' : ' , cast(c.duration as string) ) " +

"from Call c " +

"join c.phone p", String.class )

.getResultList();

SUBSTRING

Extracts a portion of a string value. The second argument denotes the starting position, where 1 is the first character of the string. The third (optional) argument denotes the length.

List<String> prefixes = entityManager.createQuery(

"select substring( p.number, 1, 2 ) " +

"from Call c " +

"join c.phone p", String.class )

.getResultList();

UPPER

Upper cases the specified string

List<String> names = entityManager.createQuery(

"select upper( p.name ) " +

"from Person p ", String.class )

.getResultList();

LOWER

Lower cases the specified string

List<String> names = entityManager.createQuery(

"select lower( p.name ) " +

"from Person p ", String.class )

.getResultList();

TRIM

Follows the semantics of the SQL trim function.

List<String> names = entityManager.createQuery(

"select trim( p.name ) " +

"from Person p ", String.class )

.getResultList();

LENGTH

Returns the length of a string.

List<Integer> lengths = entityManager.createQuery(

"select length( p.name ) " +

"from Person p ", Integer.class )

.getResultList();

LOCATE

Locates a string within another string. The third argument (optional) is used to denote a position from which to start looking.

List<Integer> sizes = entityManager.createQuery(

"select locate( 'John', p.name ) " +

"from Person p ", Integer.class )

.getResultList();

ABS

Calculates the mathematical absolute value of a numeric value.

List<Integer> abs = entityManager.createQuery(

"select abs( c.duration ) " +

"from Call c ", Integer.class )

.getResultList();

MOD

Calculates the remainder of dividing the first argument by the second.

List<Integer> mods = entityManager.createQuery(

"select mod( c.duration, 10 ) " +

"from Call c ", Integer.class )

.getResultList();

SQRT

Calculates the mathematical square root of a numeric value.

List<Double> sqrts = entityManager.createQuery(

"select sqrt( c.duration ) " +

"from Call c ", Double.class )

.getResultList();

CURRENT\_DATE

Returns the database current date.

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.timestamp = current\_date", Call.class )

.getResultList();

CURRENT\_TIME

Returns the database current time.

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.timestamp = current\_time", Call.class )

.getResultList();

CURRENT\_TIMESTAMP

Returns the database current timestamp.

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.timestamp = current\_timestamp", Call.class )

.getResultList();

### 15.29. HQL functions

Beyond the JPQL standardized functions, HQL makes some additional functions available regardless of the underlying database in use.

BIT\_LENGTH

Returns the length of binary data.

List<Number> bits = entityManager.createQuery(

"select bit\_length( c.duration ) " +

"from Call c ", Number.class )

.getResultList();

CAST

Performs a SQL cast. The cast target should name the Hibernate mapping type to use. See the [data types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-provided) chapter on for more information.

List<String> durations = entityManager.createQuery(

"select cast( c.duration as string ) " +

"from Call c ", String.class )

.getResultList();

EXTRACT

Performs a SQL extraction on datetime values. An extraction extracts parts of the datetime (the year, for example).

List<Integer> years = entityManager.createQuery(

"select extract( YEAR from c.timestamp ) " +

"from Call c ", Integer.class )

.getResultList();

See the abbreviated forms below.

YEAR

Abbreviated extract form for extracting the year.

List<Integer> years = entityManager.createQuery(

"select year( c.timestamp ) " +

"from Call c ", Integer.class )

.getResultList();

MONTH

Abbreviated extract form for extracting the month.

DAY

Abbreviated extract form for extracting the day.

HOUR

Abbreviated extract form for extracting the hour.

MINUTE

Abbreviated extract form for extracting the minute.

SECOND

Abbreviated extract form for extracting the second.

STR

Abbreviated form for casting a value as character data.

List<String> timestamps = entityManager.createQuery(

"select str( c.timestamp ) " +

"from Call c ", String.class )

.getResultList();

List<String> timestamps = entityManager.createQuery(

"select str( cast(duration as float) / 60, 4, 2 ) " +

"from Call c ", String.class )

.getResultList();

### 15.30. Non-standardized functions

Hibernate Dialects can register additional functions known to be available for that particular database product. These functions are also available in HQL (and JPQL, though only when using Hibernate as the JPA provider obviously). However, they would only be available when using that database Dialect. Applications that aim for database portability should avoid using functions in this category.

Application developers can also supply their own set of functions. This would usually represent either custom SQL functions or aliases for snippets of SQL. Such function declarations are made by using the addSqlFunction() method of org.hibernate.cfg.Configuration.

### 15.31. Collection-related expressions

There are a few specialized expressions for working with collection-valued associations. Generally, these are just abbreviated forms or other expressions for the sake of conciseness.

SIZE

Calculate the size of a collection. Equates to a subquery!

MAXELEMENT

Available for use on collections of basic type. Refers to the maximum value as determined by applying the max SQL aggregation.

MAXINDEX

Available for use on indexed collections. Refers to the maximum index (key/position) as determined by applying the max SQL aggregation.

MINELEMENT

Available for use on collections of basic type. Refers to the minimum value as determined by applying the min SQL aggregation.

MININDEX

Available for use on indexed collections. Refers to the minimum index (key/position) as determined by applying the min SQL aggregation.

ELEMENTS

Used to refer to the elements of a collection as a whole. Only allowed in the where clause. Often used in conjunction with ALL, ANY or SOME restrictions.

INDICES

Similar to elements except that indices refers to the collections indices (keys/positions) as a whole.

*Example 496. Collection-related expressions examples*

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where maxelement( p.calls ) = :call", Phone.class )

.setParameter( "call", call )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where minelement( p.calls ) = :call", Phone.class )

.setParameter( "call", call )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where maxindex( p.phones ) = 0", Person.class )

.getResultList();

// the above query can be re-written with member of

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where :phone member of p.phones", Person.class )

.setParameter( "phone", phone )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where :phone = some elements ( p.phones )", Person.class )

.setParameter( "phone", phone )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where exists elements ( p.phones )", Person.class )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where current\_date() > key( p.callHistory )", Phone.class )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where current\_date() > all elements( p.repairTimestamps )", Phone.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where 1 in indices( p.phones )", Person.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where size( p.phones ) = 2", Person.class )

.getResultList();

Elements of indexed collections (arrays, lists, and maps) can be referred to by index operator.

*Example 497. Index operator examples*

// indexed lists

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.phones[ 0 ].type = 'LAND\_LINE'", Person.class )

.getResultList();

// maps

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.addresses[ 'HOME' ] = :address", Person.class )

.setParameter( "address", address)

.getResultList();

//max index in list

List<Person> persons = entityManager.createQuery(

"select pr " +

"from Person pr " +

"where pr.phones[ maxindex(pr.phones) ].type = 'LAND\_LINE'", Person.class )

.getResultList();

See also [Special case - qualified path expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-collection-qualification) as there is a good deal of overlap.

### 15.32. Entity type

We can also refer to the type of an entity as an expression. This is mainly useful when dealing with entity inheritance hierarchies. The type can expressed using a TYPE function used to refer to the type of an identification variable representing an entity. The name of the entity also serves as a way to refer to an entity type. Additionally, the entity type can be parameterized, in which case the entity’s Java Class reference would be bound as the parameter value.

*Example 498. Entity type expression examples*

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p " +

"where type(p) = CreditCardPayment", Payment.class )

.getResultList();

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p " +

"where type(p) = :type", Payment.class )

.setParameter( "type", WireTransferPayment.class)

.getResultList();

|  |  |
| --- | --- |
|  | HQL also has a legacy form of referring to an entity type, though that legacy form is considered deprecated in favor of TYPE. The legacy form would have used p.class in the examples rather than type(p). It is mentioned only for completeness. |

### 15.33. CASE expressions

Both the simple and searched forms are supported, as well as the two SQL defined abbreviated forms (NULLIF and COALESCE)

### 15.34. Simple CASE expressions

The simple form has the following syntax:

CASE {operand} WHEN {test\_value} THEN {match\_result} ELSE {miss\_result} END

*Example 499. Simple case expression example*

List<String> nickNames = entityManager.createQuery(

"select " +

" case p.nickName " +

" when 'NA' " +

" then '<no nick name>' " +

" else p.nickName " +

" end " +

"from Person p", String.class )

.getResultList();

// same as above

List<String> nickNames = entityManager.createQuery(

"select coalesce(p.nickName, '<no nick name>') " +

"from Person p", String.class )

.getResultList();

### 15.35. Searched CASE expressions

The searched form has the following syntax:

CASE [ WHEN {test\_conditional} THEN {match\_result} ]\* ELSE {miss\_result} END

*Example 500. Searched case expression example*

List<String> nickNames = entityManager.createQuery(

"select " +

" case " +

" when p.nickName is null " +

" then " +

" case " +

" when p.name is null " +

" then '<no nick name>' " +

" else p.name " +

" end" +

" else p.nickName " +

" end " +

"from Person p", String.class )

.getResultList();

// coalesce can handle this more succinctly

List<String> nickNames = entityManager.createQuery(

"select coalesce( p.nickName, p.name, '<no nick name>' ) " +

"from Person p", String.class )

.getResultList();

### 15.36. NULLIF expressions

NULLIF is an abbreviated CASE expression that returns NULL if its operands are considered equal.

*Example 501. NULLIF example*

List<String> nickNames = entityManager.createQuery(

"select nullif( p.nickName, p.name ) " +

"from Person p", String.class )

.getResultList();

// equivalent CASE expression

List<String> nickNames = entityManager.createQuery(

"select " +

" case" +

" when p.nickName = p.name" +

" then null" +

" else p.nickName" +

" end " +

"from Person p", String.class )

.getResultList();

### 15.37. COALESCE expressions

COALESCE is an abbreviated CASE expression that returns the first non-null operand. We have seen a number of COALESCE examples above.

### 15.38. The SELECT clause

The SELECT clause identifies which objects and values to return as the query results. The expressions discussed in [Expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-expressions) are all valid select expressions, except where otherwise noted. See the section [Hibernate Query API](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-api) for information on handling the results depending on the types of values specified in the SELECT clause.

There is a particular expression type that is only valid in the select clause. Hibernate calls this "dynamic instantiation". JPQL supports some of that feature and calls it a "constructor expression".

So rather than dealing with the Object[] (again, see [Hibernate Query API](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-api)) here we are wrapping the values in a type-safe java object that will be returned as the results of the query.

*Example 502. Dynamic HQL and JPQL instantiation example*

public class CallStatistics {

private final long count;

private final long total;

private final int min;

private final int max;

private final double abg;

public CallStatistics(long count, long total, int min, int max, double abg) {

this.count = count;

this.total = total;

this.min = min;

this.max = max;

this.abg = abg;

}

//Getters and setters omitted for brevity

}

CallStatistics callStatistics = entityManager.createQuery(

"select new org.hibernate.userguide.hql.CallStatistics(" +

" count(c), " +

" sum(c.duration), " +

" min(c.duration), " +

" max(c.duration), " +

" avg(c.duration)" +

") " +

"from Call c ", CallStatistics.class )

.getSingleResult();

|  |  |
| --- | --- |
|  | The class reference must be fully qualified and it must have a matching constructor. |
|  | The class here need not be mapped. If it does represent an entity, the resulting instances are returned in the NEW state (not managed!). |

HQL supports additional "dynamic instantiation" features. First, the query can specify to return a List rather than an Object[] for scalar results:

*Example 503. Dynamic instantiation example - list*

List<List> phoneCallDurations = entityManager.createQuery(

"select new list(" +

" p.number, " +

" c.duration " +

") " +

"from Call c " +

"join c.phone p ", List.class )

.getResultList();

The results from this query will be a List<List> as opposed to a List<Object[]>

HQL also supports wrapping the scalar results in a Map.

*Example 504. Dynamic instantiation example - map*

List<Map> phoneCallTotalDurations = entityManager.createQuery(

"select new map(" +

" p.number as phoneNumber , " +

" sum(c.duration) as totalDuration, " +

" avg(c.duration) as averageDuration " +

") " +

"from Call c " +

"join c.phone p " +

"group by p.number ", Map.class )

.getResultList();

The results from this query will be a List<Map<String, Object>> as opposed to a List<Object[]>. The keys of the map are defined by the aliases given to the select expressions. If the user doesn’t assign aliases, the key will be the index of each particular result set column (e.g. 0, 1, 2, etc).

### 15.39. Predicates

Predicates form the basis of the where clause, the having clause and searched case expressions. They are expressions which resolve to a truth value, generally TRUE or FALSE, although boolean comparisons involving NULL generally resolve to UNKNOWN.

### 15.40. Relational comparisons

Comparisons involve one of the comparison operators: =, >, >=, <, <=, <>. HQL also defines != as a comparison operator synonymous with <>. The operands should be of the same type.

*Example 505. Relational comparison examples*

// numeric comparison

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration < 30 ", Call.class )

.getResultList();

// string comparison

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like 'John%' ", Person.class )

.getResultList();

// datetime comparison

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.createdOn > '1950-01-01' ", Person.class )

.getResultList();

// enum comparison

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where p.type = 'MOBILE' ", Phone.class )

.getResultList();

// boolean comparison

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p " +

"where p.completed = true ", Payment.class )

.getResultList();

// boolean comparison

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p " +

"where type(p) = WireTransferPayment ", Payment.class )

.getResultList();

// entity value comparison

List<Object[]> phonePayments = entityManager.createQuery(

"select p " +

"from Payment p, Phone ph " +

"where p.person = ph.person ", Object[].class )

.getResultList();

Comparisons can also involve subquery qualifiers: ALL, ANY, SOME. SOME and ANY are synonymous.

The ALL qualifier resolves to true if the comparison is true for all of the values in the result of the subquery. It resolves to false if the subquery result is empty.

*Example 506. ALL subquery comparison qualifier example*

// select all persons with all calls shorter than 50 seconds

List<Person> persons = entityManager.createQuery(

"select distinct p.person " +

"from Phone p " +

"join p.calls c " +

"where 50 > all ( " +

" select duration" +

" from Call" +

" where phone = p " +

") ", Person.class )

.getResultList();

The ANY/SOME qualifier resolves to true if the comparison is true for some of (at least one of) the values in the result of the subquery. It resolves to false if the subquery result is empty.

### 15.41. Nullness predicate

Check a value for nullness. Can be applied to basic attribute references, entity references and parameters. HQL additionally allows it to be applied to component/embeddable types.

*Example 507. Nullness checking examples*

// select all persons with a nickname

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.nickName is not null", Person.class )

.getResultList();

// select all persons without a nickname

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.nickName is null", Person.class )

.getResultList();

### 15.42. Like predicate

Performs a like comparison on string values. The syntax is:

like\_expression ::=

string\_expression

[NOT] LIKE pattern\_value

[ESCAPE escape\_character]

The semantics follow that of the SQL like expression. The pattern\_value is the pattern to attempt to match in the string\_expression. Just like SQL, pattern\_value can use \_ and % as wildcards. The meanings are the same. The \_symbol matches any single character and % matches any number of characters.

*Example 508. Like predicate examples*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like 'Jo%'", Person.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name not like 'Jo%'", Person.class )

.getResultList();

The optional escape 'escape character' is used to specify an escape character used to escape the special meaning of \_ and % in the pattern\_value. This is useful when needing to search on patterns including either \_ or %.

The syntax is formed as follows: 'like\_predicate' escape 'escape\_symbol' So, if | is the escape symbol and we want to match all stored procedures prefixed with Dr\_, the like criteria becomes: 'Dr|\_%' escape '|':

*Example 509. Like with escape symbol*

// find any person with a name starting with "Dr\_"

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name like 'Dr|\_%' escape '|'", Person.class )

.getResultList();

### 15.43. Between predicate

Analogous to the SQL BETWEEN expression, it checks if the value is within boundaries. All the operands should have comparable types.

*Example 510. Between predicate examples*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"join p.phones ph " +

"where p.id = 1L and index(ph) between 0 and 3", Person.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.createdOn between '1999-01-01' and '2001-01-02'", Person.class )

.getResultList();

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"where c.duration between 5 and 20", Call.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.name between 'H' and 'M'", Person.class )

.getResultList();

### 15.44. In predicate

IN predicates performs a check that a particular value is in a list of values. Its syntax is:

in\_expression ::=

single\_valued\_expression [NOT] IN single\_valued\_list

single\_valued\_list ::=

constructor\_expression | (subquery) | collection\_valued\_input\_parameter

constructor\_expression ::= (expression[, expression]\*)

The types of the single\_valued\_expression and the individual values in the single\_valued\_list must be consistent.

JPQL limits the valid types here to string, numeric, date, time, timestamp, and enum types, and , in JPQL, single\_valued\_expression can only refer to:

* "state fields", which is its term for simple attributes. Specifically this excludes association and component/embedded attributes.
* entity type expressions. See [Entity type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-entity-type-exp)

In HQL, single\_valued\_expression can refer to a far more broad set of expression types. Single-valued association are allowed, and so are component/embedded attributes, although that feature depends on the level of support for tuple or "row value constructor syntax" in the underlying database. Additionally, HQL does not limit the value type in any way, though application developers should be aware that different types may incur limited support based on the underlying database vendor. This is largely the reason for the JPQL limitations.

The list of values can come from a number of different sources. In the constructor\_expression and collection\_valued\_input\_parameter, the list of values must not be empty; it must contain at least one value.

*Example 511. In predicate examples*

List<Payment> payments = entityManager.createQuery(

"select p " +

"from Payment p " +

"where type(p) in ( CreditCardPayment, WireTransferPayment )", Payment.class )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where type in ( 'MOBILE', 'LAND\_LINE' )", Phone.class )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select p " +

"from Phone p " +

"where type in :types", Phone.class )

.setParameter( "types", Arrays.asList( PhoneType.MOBILE, PhoneType.LAND\_LINE ) )

.getResultList();

List<Phone> phones = entityManager.createQuery(

"select distinct p " +

"from Phone p " +

"where p.person.id in (" +

" select py.person.id " +

" from Payment py" +

" where py.completed = true and py.amount > 50 " +

")", Phone.class )

.getResultList();

// Not JPQL compliant!

List<Phone> phones = entityManager.createQuery(

"select distinct p " +

"from Phone p " +

"where p.person in (" +

" select py.person " +

" from Payment py" +

" where py.completed = true and py.amount > 50 " +

")", Phone.class )

.getResultList();

// Not JPQL compliant!

List<Payment> payments = entityManager.createQuery(

"select distinct p " +

"from Payment p " +

"where ( p.amount, p.completed ) in (" +

" (50, true )," +

" (100, true )," +

" (5, false )" +

")", Payment.class )

.getResultList();

### 15.45. Exists predicate

Exists expressions test the existence of results from a subquery. The affirmative form returns true if the subquery result contains values. The negated form returns true if the subquery result is empty.

### 15.46. Empty collection predicate

The IS [NOT] EMPTY expression applies to collection-valued path expressions. It checks whether the particular collection has any associated values.

*Example 512. Empty collection expression examples*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.phones is empty", Person.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where p.phones is not empty", Person.class )

.getResultList();

### 15.47. Member-of collection predicate

The [NOT] MEMBER [OF] expression applies to collection-valued path expressions. It checks whether a value is a member of the specified collection.

*Example 513. Member-of collection expression examples*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where 'Home address' member of p.addresses", Person.class )

.getResultList();

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"where 'Home address' not member of p.addresses", Person.class )

.getResultList();

### 15.48. NOT predicate operator

The NOT operator is used to negate the predicate that follows it. If that following predicate is true, the NOT resolves to false.

|  |  |
| --- | --- |
|  | If the predicate is true, NOT resolves to false. If the predicate is unknown (e.g. NULL), the NOT resolves to unknown as well. |

### 15.49. AND predicate operator

The AND operator is used to combine 2 predicate expressions. The result of the AND expression is true if and only if both predicates resolve to true. If either predicates resolves to unknown, the AND expression resolves to unknown as well. Otherwise, the result is false.

### 15.50. OR predicate operator

The OR operator is used to combine 2 predicate expressions. The result of the OR expression is true if one predicate resolves to true. If both predicates resolve to unknown, the OR expression resolves to unknown. Otherwise, the result is false.

### 15.51. The WHERE clause

The WHERE clause of a query is made up of predicates which assert whether values in each potential row match the current filtering criteria. Thus, the where clause restricts the results returned from a select query and limits the scope of update and delete queries.

### 15.52. Group by

The GROUP BY clause allows building aggregated results for various value groups. As an example, consider the following queries:

*Example 514. Group by example*

Long totalDuration = entityManager.createQuery(

"select sum( c.duration ) " +

"from Call c ", Long.class )

.getSingleResult();

List<Object[]> personTotalCallDurations = entityManager.createQuery(

"select p.name, sum( c.duration ) " +

"from Call c " +

"join c.phone ph " +

"join ph.person p " +

"group by p.name", Object[].class )

.getResultList();

//It's even possible to group by entities!

List<Object[]> personTotalCallDurations = entityManager.createQuery(

"select p, sum( c.duration ) " +

"from Call c " +

"join c.phone ph " +

"join ph.person p " +

"group by p", Object[].class )

.getResultList();

The first query retrieves the complete total of all orders. The second retrieves the total for each customer, grouped by each customer.

In a grouped query, the where clause applies to the non-aggregated values (essentially it determines whether rows will make it into the aggregation). The HAVING clause also restricts results, but it operates on the aggregated values. In the [Group by example](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#hql-group-by-example), we retrieved Call duration totals for all persons. If that ended up being too much data to deal with, we might want to restrict the results to focus only on customers with a summed total of more than 1000:

*Example 515. Having example*

List<Object[]> personTotalCallDurations = entityManager.createQuery(

"select p.name, sum( c.duration ) " +

"from Call c " +

"join c.phone ph " +

"join ph.person p " +

"group by p.name " +

"having sum( c.duration ) > 1000", Object[].class )

.getResultList();

The HAVING clause follows the same rules as the WHERE clause and is also made up of predicates. HAVING is applied after the groupings and aggregations have been done, while the WHERE clause is applied before.

### 15.53. Order by

The results of the query can also be ordered. The ORDER BY clause is used to specify the selected values to be used to order the result. The types of expressions considered valid as part of the ORDER BY clause include:

* state fields
* component/embeddable attributes
* scalar expressions such as arithmetic operations, functions, etc.
* identification variable declared in the select clause for any of the previous expression types

Additionally, JPQL says that all values referenced in the ORDER BY clause must be named in the SELECT clause. HQL does not mandate that restriction, but applications desiring database portability should be aware that not all databases support referencing values in the ORDER BY clause that are not referenced in the select clause.

Individual expressions in the order-by can be qualified with either ASC (ascending) or DESC (descending) to indicated the desired ordering direction. Null values can be placed in front or at the end of the sorted set using NULLS FIRST or NULLS LAST clause respectively.

*Example 516. Order by example*

List<Person> persons = entityManager.createQuery(

"select p " +

"from Person p " +

"order by p.name", Person.class )

.getResultList();

List<Object[]> personTotalCallDurations = entityManager.createQuery(

"select p.name, sum( c.duration ) as total " +

"from Call c " +

"join c.phone ph " +

"join ph.person p " +

"group by p.name " +

"order by total", Object[].class )

.getResultList();

### 15.54. Read-only entities

As explained in [entity immutability](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-immutability) section, fetching entities in read-only mode is much more efficient than fetching read-write entities. Even if the entities are mutable, you can still fetch them in read-only mode, and benefit from reducing the memory footprint and speeding up the flushing process.

Read-only entities are skipped by the dirty checking mechanism as illustrated by the following example:

*Example 517. Read-only entities query example*

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"join c.phone p " +

"where p.number = :phoneNumber ", Call.class )

.setParameter( "phoneNumber", "123-456-7890" )

.setHint( "org.hibernate.readOnly", true )

.getResultList();

calls.forEach( c -> c.setDuration( 0 ) );

SELECT c.id AS id1\_5\_ ,

c.duration AS duration2\_5\_ ,

c.phone\_id AS phone\_id4\_5\_ ,

c.call\_timestamp AS call\_tim3\_5\_

FROM phone\_call c

INNER JOIN phone p ON c.phone\_id = p.id

WHERE p.phone\_number = '123-456-7890'

As you can see, there is no SQL UPDATE being executed.

You can also pass the read-only hint to named queries using the JPA [@QueryHint](http://docs.oracle.com/javaee/7/api/javax/persistence/QueryHint.html) annotation.

*Example 518. Fetching read-only entities using a named query and the read-only hint*

@NamedQuery(

name = "get\_read\_only\_person\_by\_name",

query = "select p from Person p where name = :name",

hints = {

@QueryHint(

name = "org.hibernate.readOnly",

value = "true"

)

}

)

The Hibernate native API offers a Query#setReadOnly method, as an alternative to using a JPA query hint:

*Example 519. Read-only entities native query example*

List<Call> calls = entityManager.createQuery(

"select c " +

"from Call c " +

"join c.phone p " +

"where p.number = :phoneNumber ", Call.class )

.setParameter( "phoneNumber", "123-456-7890" )

.unwrap( org.hibernate.query.Query.class )

.setReadOnly( true )

.getResultList();

## 16. Criteria

Criteria queries offer a type-safe alternative to HQL, JPQL and native SQL queries.

|  |  |
| --- | --- |
|  | Hibernate offers an older, legacy org.hibernate.Criteria API which should be considered deprecated. No feature development will target those APIs. Eventually, Hibernate-specific criteria features will be ported as extensions to the JPA javax.persistence.criteria.CriteriaQuery. For details on the org.hibernate.Criteria API, see [Legacy Hibernate Criteria Queries](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#appendix-legacy-criteria).  This chapter will focus on the JPA APIs for declaring type-safe criteria queries. |

Criteria queries are a programmatic, type-safe way to express a query. They are type-safe in terms of using interfaces and classes to represent various structural parts of a query such as the query itself, the select clause, or an order-by, etc. They can also be type-safe in terms of referencing attributes as we will see in a bit. Users of the older Hibernate org.hibernate.Criteria query API will recognize the general approach, though we believe the JPA API to be superior as it represents a clean look at the lessons learned from that API.

Criteria queries are essentially an object graph, where each part of the graph represents an increasing (as we navigate down this graph) more atomic part of query. The first step in performing a criteria query is building this graph. The javax.persistence.criteria.CriteriaBuilder interface is the first thing with which you need to become acquainted to begin using criteria queries. Its role is that of a factory for all the individual pieces of the criteria. You obtain a javax.persistence.criteria.CriteriaBuilder instance by calling the getCriteriaBuilder() method of either javax.persistence.EntityManagerFactory or javax.persistence.EntityManager.

The next step is to obtain a javax.persistence.criteria.CriteriaQuery. This is accomplished using one of the three methods on javax.persistence.criteria.CriteriaBuilder for this purpose:

* <T> CriteriaQuery<T> createQuery( Class<T> resultClass )
* CriteriaQuery<Tuple> createTupleQuery()
* CriteriaQuery<Object> createQuery()

Each serves a different purpose depending on the expected type of the query results.

|  |  |
| --- | --- |
|  | Chapter 6 Criteria API of the JPA Specification already contains a decent amount of reference material pertaining to the various parts of a criteria query. So rather than duplicate all that content here, let’s instead look at some of the more widely anticipated usages of the API. |

### 16.1. Typed criteria queries

The type of the criteria query (aka the <T>) indicates the expected types in the query result. This might be an entity, an Integer, or any other object.

### 16.2. Selecting an entity

This is probably the most common form of query. The application wants to select entity instances.

*Example 520. Selecting the root entity*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Person> criteria = builder.createQuery( Person.class );

Root<Person> root = criteria.from( Person.class );

criteria.select( root );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<Person> persons = entityManager.createQuery( criteria ).getResultList();

The example uses createQuery() passing in the Person class reference as the results of the query will be Personobjects.

|  |  |
| --- | --- |
|  | The call to the CriteriaQuery#select method in this example is unnecessary because root will be the implied selection since we have only a single query root. It was done here only for completeness of an example.  The Person\_.name reference is an example of the static form of JPA Metamodel reference. We will use that form exclusively in this chapter. See the documentation for the [Hibernate JPA Metamodel Generator](https://docs.jboss.org/hibernate/orm/5.2/topical/html/metamodelgen/MetamodelGenerator.html) for additional details on the JPA static Metamodel. |

### 16.3. Selecting an expression

The simplest form of selecting an expression is selecting a particular attribute from an entity. But this expression might also represent an aggregation, a mathematical operation, etc.

*Example 521. Selecting an attribute*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<String> criteria = builder.createQuery( String.class );

Root<Person> root = criteria.from( Person.class );

criteria.select( root.get( Person\_.nickName ) );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<String> nickNames = entityManager.createQuery( criteria ).getResultList();

In this example, the query is typed as java.lang.String because that is the anticipated type of the results (the type of the Person#nickName attribute is java.lang.String). Because a query might contain multiple references to the Person entity, attribute references always need to be qualified. This is accomplished by the Root#get method call.

### 16.4. Selecting multiple values

There are actually a few different ways to select multiple values using criteria queries. We will explore two options here, but an alternative recommended approach is to use tuples as described in [Tuple criteria queries](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-tuple), or consider a wrapper query, see [Selecting a wrapper](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-wrapper) for details.

*Example 522. Selecting an array*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Object[]> criteria = builder.createQuery( Object[].class );

Root<Person> root = criteria.from( Person.class );

Path<Long> idPath = root.get( Person\_.id );

Path<String> nickNamePath = root.get( Person\_.nickName);

criteria.select( builder.array( idPath, nickNamePath ) );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<Object[]> idAndNickNames = entityManager.createQuery( criteria ).getResultList();

Technically this is classified as a typed query, but you can see from handling the results that this is sort of misleading. Anyway, the expected result type here is an array.

The example then uses the array method of javax.persistence.criteria.CriteriaBuilder which explicitly combines individual selections into a javax.persistence.criteria.CompoundSelection.

*Example 523. Selecting an array using multiselect*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Object[]> criteria = builder.createQuery( Object[].class );

Root<Person> root = criteria.from( Person.class );

Path<Long> idPath = root.get( Person\_.id );

Path<String> nickNamePath = root.get( Person\_.nickName);

criteria.multiselect( idPath, nickNamePath );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<Object[]> idAndNickNames = entityManager.createQuery( criteria ).getResultList();

Just as we saw in [Selecting an array](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect-array-explicit-example) we have a typed criteria query returning an Object array. Both queries are functionally equivalent. This second example uses the multiselect() method which behaves slightly differently based on the type given when the criteria query was first built, but, in this case, it says to select and return an Object[].

### 16.5. Selecting a wrapper

Another alternative to [Selecting multiple values](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect) is to instead select an object that will "wrap" the multiple values. Going back to the example query there, rather than returning an array of [Person#id, Person#nickName], instead declare a class that holds these values and use that as a return object.

*Example 524. Selecting a wrapper*

public class PersonWrapper {

private final Long id;

private final String nickName;

public PersonWrapper(Long id, String nickName) {

this.id = id;

this.nickName = nickName;

}

public Long getId() {

return id;

}

public String getNickName() {

return nickName;

}

}

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<PersonWrapper> criteria = builder.createQuery( PersonWrapper.class );

Root<Person> root = criteria.from( Person.class );

Path<Long> idPath = root.get( Person\_.id );

Path<String> nickNamePath = root.get( Person\_.nickName);

criteria.select( builder.construct( PersonWrapper.class, idPath, nickNamePath ) );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<PersonWrapper> wrappers = entityManager.createQuery( criteria ).getResultList();

First, we see the simple definition of the wrapper object we will be using to wrap our result values. Specifically, notice the constructor and its argument types. Since we will be returning PersonWrapper objects, we use PersonWrapper as the type of our criteria query.

This example illustrates the use of the javax.persistence.criteria.CriteriaBuilder method construct which is used to build a wrapper expression. For every row in the result we are saying we would like a PersonWrapper instantiated with the remaining arguments by the matching constructor. This wrapper expression is then passed as the select.

### 16.6. Tuple criteria queries

A better approach to [Selecting multiple values](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect) is to use either a wrapper (which we just saw in [Selecting a wrapper](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-wrapper)) or using the javax.persistence.Tuple contract.

*Example 525. Selecting a tuple*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Tuple> criteria = builder.createQuery( Tuple.class );

Root<Person> root = criteria.from( Person.class );

Path<Long> idPath = root.get( Person\_.id );

Path<String> nickNamePath = root.get( Person\_.nickName);

criteria.multiselect( idPath, nickNamePath );

criteria.where( builder.equal( root.get( Person\_.name ), "John Doe" ) );

List<Tuple> tuples = entityManager.createQuery( criteria ).getResultList();

for ( Tuple tuple : tuples ) {

Long id = tuple.get( idPath );

String nickName = tuple.get( nickNamePath );

}

//or using indices

for ( Tuple tuple : tuples ) {

Long id = (Long) tuple.get( 0 );

String nickName = (String) tuple.get( 1 );

}

This example illustrates accessing the query results through the javax.persistence.Tuple interface. The example uses the explicit createTupleQuery() of javax.persistence.criteria.CriteriaBuilder. An alternate approach is to use createQuery( Tuple.class ).

Again we see the use of the multiselect() method, just like in [Selecting an array using multiselect](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect-array-implicit-example). The difference here is that the type of the javax.persistence.criteria.CriteriaQuery was defined as javax.persistence.Tupleso the compound selections, in this case, are interpreted to be the tuple elements.

The javax.persistence.Tuple contract provides three forms of access to the underlying elements:

typed

The [Selecting a tuple](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-tuple-example) example illustrates this form of access in the tuple.get( idPath ) and tuple.get( nickNamePath ) calls. This allows typed access to the underlying tuple values based on the javax.persistence.TupleElement expressions used to build the criteria.

positional

Allows access to the underlying tuple values based on the position. The simple Object get(int position) form is very similar to the access illustrated in [Selecting an array](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect-array-explicit-example) and [Selecting an array using multiselect](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-typedquery-multiselect-array-implicit-example). The <X> X get(int position, Class<X> type form allows typed positional access, but based on the explicitly supplied type which the tuple value must be type-assignable to.

aliased

Allows access to the underlying tuple values based an (optionally) assigned alias. The example query did not apply an alias. An alias would be applied via the alias method on javax.persistence.criteria.Selection. Just like positional access, there is both a typed (Object get(String alias)) and an untyped (<X> X get(String alias, Class<X> typeform.

### 16.7. FROM clause

A CriteriaQuery object defines a query over one or more entity, embeddable, or basic abstract schema types. The root objects of the query are entities, from which the other types are reached by navigation.

— JPA Specification, section 6.5.2 Query Roots, pg 262

|  |  |
| --- | --- |
|  | All the individual parts of the FROM clause (roots, joins, paths) implement the javax.persistence.criteria.From interface. |

### 16.8. Roots

Roots define the basis from which all joins, paths and attributes are available in the query. A root is always an entity type. Roots are defined and added to the criteria by the overloaded from methods on javax.persistence.criteria.CriteriaQuery:

*Example 526. Root methods*

<X> Root<X> from( Class<X> );

<X> Root<X> from( EntityType<X> );

*Example 527. Adding a root example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Person> criteria = builder.createQuery( Person.class );

Root<Person> root = criteria.from( Person.class );

Criteria queries may define multiple roots, the effect of which is to create a Cartesian Product between the newly added root and the others. Here is an example defining a Cartesian Product between Person and Partner entities:

*Example 528. Adding multiple roots example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Tuple> criteria = builder.createQuery( Tuple.class );

Root<Person> personRoot = criteria.from( Person.class );

Root<Partner> partnerRoot = criteria.from( Partner.class );

criteria.multiselect( personRoot, partnerRoot );

Predicate personRestriction = builder.and(

builder.equal( personRoot.get( Person\_.address ), address ),

builder.isNotEmpty( personRoot.get( Person\_.phones ) )

);

Predicate partnerRestriction = builder.and(

builder.like( partnerRoot.get( Partner\_.name ), prefix ),

builder.equal( partnerRoot.get( Partner\_.version ), 0 )

);

criteria.where( builder.and( personRestriction, partnerRestriction ) );

List<Tuple> tuples = entityManager.createQuery( criteria ).getResultList();

### 16.9. Joins

Joins allow navigation from other javax.persistence.criteria.From to either association or embedded attributes. Joins are created by the numerous overloaded join methods of the javax.persistence.criteria.From interface.

*Example 529. Join example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Phone> criteria = builder.createQuery( Phone.class );

Root<Phone> root = criteria.from( Phone.class );

// Phone.person is a @ManyToOne

Join<Phone, Person> personJoin = root.join( Phone\_.person );

// Person.addresses is an @ElementCollection

Join<Person, String> addressesJoin = personJoin.join( Person\_.addresses );

criteria.where( builder.isNotEmpty( root.get( Phone\_.calls ) ) );

List<Phone> phones = entityManager.createQuery( criteria ).getResultList();

### 16.10. Fetches

Just like in HQL and JPQL, criteria queries can specify that associated data be fetched along with the owner. Fetches are created by the numerous overloaded fetch methods of the javax.persistence.criteria.From interface.

*Example 530. Join fetch example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Phone> criteria = builder.createQuery( Phone.class );

Root<Phone> root = criteria.from( Phone.class );

// Phone.person is a @ManyToOne

Fetch<Phone, Person> personFetch = root.fetch( Phone\_.person );

// Person.addresses is an @ElementCollection

Fetch<Person, String> addressesJoin = personFetch.fetch( Person\_.addresses );

criteria.where( builder.isNotEmpty( root.get( Phone\_.calls ) ) );

List<Phone> phones = entityManager.createQuery( criteria ).getResultList();

|  |  |
| --- | --- |
|  | Technically speaking, embedded attributes are always fetched with their owner. However in order to define the fetching of Phone#addresses we needed a javax.persistence.criteria.Fetch because element collections are LAZY by default. |

### 16.11. Path expressions

|  |  |
| --- | --- |
|  | Roots, joins and fetches are themselves paths as well. |

### 16.12. Using parameters

*Example 531. Parameters example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Person> criteria = builder.createQuery( Person.class );

Root<Person> root = criteria.from( Person.class );

ParameterExpression<String> nickNameParameter = builder.parameter( String.class );

criteria.where( builder.equal( root.get( Person\_.nickName ), nickNameParameter ) );

TypedQuery<Person> query = entityManager.createQuery( criteria );

query.setParameter( nickNameParameter, "JD" );

List<Person> persons = query.getResultList();

Use the parameter method of javax.persistence.criteria.CriteriaBuilder to obtain a parameter reference. Then use the parameter reference to bind the parameter value to the javax.persistence.Query.

### 16.13. Using group by

*Example 532. Group by example*

CriteriaBuilder builder = entityManager.getCriteriaBuilder();

CriteriaQuery<Tuple> criteria = builder.createQuery( Tuple.class );

Root<Person> root = criteria.from( Person.class );

criteria.groupBy(root.get("address"));

criteria.multiselect(root.get("address"), builder.count(root));

List<Tuple> tuples = entityManager.createQuery( criteria ).getResultList();

for ( Tuple tuple : tuples ) {

String name = (String) tuple.get( 0 );

Long count = (Long) tuple.get( 1 );

}

## 17. Native SQL Queries

You may also express queries in the native SQL dialect of your database. This is useful if you want to utilize database specific features such as window functions, Common Table Expressions (CTE) or the CONNECT BY option in Oracle. It also provides a clean migration path from a direct SQL/JDBC based application to Hibernate/JPA. Hibernate also allows you to specify handwritten SQL (including stored procedures) for all create, update, delete, and retrieve operations.

### 17.1. Creating a native query using JPA

Execution of native SQL queries is controlled via the NativeQuery interface, which is obtained by calling Session.createNativeQuery(). The following sections describe how to use this API for querying.

### 17.2. Scalar queries

The most basic SQL query is to get a list of scalars (column) values.

*Example 533. JPA native query selecting all columns*

List<Object[]> persons = entityManager.createNativeQuery(

"SELECT \* FROM Person" )

.getResultList();

*Example 534. JPA native query with a custom column selection*

List<Object[]> persons = entityManager.createNativeQuery(

"SELECT id, name FROM Person" )

.getResultList();

for(Object[] person : persons) {

Number id = (Number) person[0];

String name = (String) person[1];

}

*Example 535. Hibernate native query selecting all columns*

List<Object[]> persons = session.createNativeQuery(

"SELECT \* FROM Person" )

.list();

*Example 536. Hibernate native query with a custom column selection*

List<Object[]> persons = session.createNativeQuery(

"SELECT id, name FROM Person" )

.list();

for(Object[] person : persons) {

Number id = (Number) person[0];

String name = (String) person[1];

}

These will return a List of Object arrays ( Object[] ) with scalar values for each column in the PERSON table. Hibernate will use java.sql.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():

*Example 537. Hibernate native query with explicit result set selection*

List<Object[]> persons = session.createNativeQuery(

"SELECT \* FROM Person" )

.addScalar( "id", LongType.INSTANCE )

.addScalar( "name", StringType.INSTANCE )

.list();

for(Object[] person : persons) {

Long id = (Long) person[0];

String name = (String) person[1];

}

Although it still returns an Object arrays, this query will not use the ResultSetMetadata anymore since it explicitly gets the id and name columns as respectively a BigInteger and a String from the underlying ResultSet. This also means that only these two columns will be returned, even though the query is still using \* and the ResultSet contains more than the three listed columns.

It is possible to leave out the type information for all or some of the scalars.

*Example 538. Hibernate native query with result set selection that’s a partially explicit*

List<Object[]> persons = session.createNativeQuery(

"SELECT \* FROM Person" )

.addScalar( "id", LongType.INSTANCE )

.addScalar( "name" )

.list();

for(Object[] person : persons) {

Long id = (Long) person[0];

String name = (String) person[1];

}

This is essentially the same query as before, but now ResultSetMetaData is used to determine the type of name, 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.

### 17.3. Entity queries

The above queries were all about returning scalar values, basically returning the raw values from the ResultSet.

*Example 539. JPA native query selecting entities*

List<Person> persons = entityManager.createNativeQuery(

"SELECT \* FROM Person", Person.class )

.getResultList();

*Example 540. Hibernate native query selecting entities*

List<Person> persons = session.createNativeQuery(

"SELECT \* FROM Person" )

.addEntity( Person.class )

.list();

Assuming that Person is mapped as a class with the columns id, name, nickName, address, createdOn and version, the following query will also return a List where each element is a Person entity.

*Example 541. JPA native query selecting entities with explicit result set*

List<Person> persons = entityManager.createNativeQuery(

"SELECT id, name, nickName, address, createdOn, version " +

"FROM Person", Person.class )

.getResultList();

*Example 542. Hibernate native query selecting entities with explicit result set*

List<Person> persons = session.createNativeQuery(

"SELECT id, name, nickName, address, createdOn, version " +

"FROM Person" )

.addEntity( Person.class )

.list();

### 17.4. Handling associations and collections

If the entity is mapped with a many-to-one or a child-side one-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.

*Example 543. JPA native query selecting entities with many-to-one association*

List<Phone> phones = entityManager.createNativeQuery(

"SELECT id, phone\_number, phone\_type, person\_id " +

"FROM Phone", Phone.class )

.getResultList();

*Example 544. Hibernate native query selecting entities with many-to-one association*

List<Phone> phones = session.createNativeQuery(

"SELECT id, phone\_number, phone\_type, person\_id " +

"FROM Phone" )

.addEntity( Phone.class )

.list();

This will allow the Phone#person to function properly since the many-to-one or one-to-one association is going to use a Proxy that will be initialized when being navigated for the first time.

It is possible to eagerly join the Phone and the Person entities to avoid the possible extra roundtrip for initializing the many-to-one association.

*Example 545. Hibernate native query selecting entities with joined many-to-one association*

List<Object[]> tuples = session.createNativeQuery(

"SELECT \* " +

"FROM Phone ph " +

"JOIN Person pr ON ph.person\_id = pr.id" )

.addEntity("phone", Phone.class )

.addJoin( "pr", "phone.person")

.list();

for(Object[] tuple : tuples) {

Phone phone = (Phone) tuple[0];

Person person = (Person) tuple[1];

assertNotNull( person.getName() );

}

SELECT

\*

FROM

Phone ph

JOIN

Person pr

ON ph.person\_id = pr.id

|  |  |
| --- | --- |
|  | As seen in the associated SQL query, Hibernate manages to construct the entity hierarchy without requiring any extra database roundtrip. |

By default, when using the addJoin() method, the result set will contain both entities that are joined. To construct the entity hierarchy, you need to use a ROOT\_ENTITY or DISTINCT\_ROOT\_ENTITY ResultTransformer.

*Example 546. Hibernate native query selecting entities with joined many-to-one association and ResultTransformer*

List<Person> persons = session.createNativeQuery(

"SELECT \* " +

"FROM Phone ph " +

"JOIN Person pr ON ph.person\_id = pr.id" )

.addEntity("phone", Phone.class )

.addJoin( "pr", "phone.person")

.setResultTransformer( Criteria.ROOT\_ENTITY )

.list();

for(Person person : persons) {

person.getPhones();

}

|  |  |
| --- | --- |
|  | Because of the ROOT\_ENTITY ResultTransformer, this query will return the parent-side as root entities. |

Notice that you added an alias name pr 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. the Phone#calls one-to-many association).

*Example 547. JPA native query selecting entities with joined one-to-many association*

List<Phone> phones = entityManager.createNativeQuery(

"SELECT \* " +

"FROM Phone ph " +

"JOIN phone\_call c ON c.phone\_id = ph.id", Phone.class )

.getResultList();

for(Phone phone : phones) {

List<Call> calls = phone.getCalls();

}

SELECT \*

FROM phone ph

JOIN call c ON c.phone\_id = ph.id

*Example 548. Hibernate native query selecting entities with joined one-to-many association*

List<Object[]> tuples = session.createNativeQuery(

"SELECT \* " +

"FROM Phone ph " +

"JOIN phone\_call c ON c.phone\_id = ph.id" )

.addEntity("phone", Phone.class )

.addJoin( "c", "phone.calls")

.list();

for(Object[] tuple : tuples) {

Phone phone = (Phone) tuple[0];

Call call = (Call) tuple[1];

}

SELECT \*

FROM phone ph

JOIN call c ON c.phone\_id = ph.id

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.

### 17.5. 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 otherwise throws NonUniqueDiscoveredSqlAliasException.

*Example 549. JPA native query selecting entities with the same column names*

List<Object> entities = entityManager.createNativeQuery(

"SELECT \* " +

"FROM Person pr, Partner pt " +

"WHERE pr.name = pt.name" )

.getResultList();

*Example 550. Hibernate native query selecting entities with the same column names*

List<Object> entities = session.createNativeQuery(

"SELECT \* " +

"FROM Person pr, Partner pt " +

"WHERE pr.name = pt.name" )

.list();

The query was intended to return all Person and Partner instances with the same name. The query fails because there is a conflict of names since the two entities are mapped to the same column names (e.g. id, name, version). Also, on some databases the returned column aliases will most likely be on the form pr.id, pr.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:

*Example 551. Hibernate native query selecting entities with the same column names and aliases*

List<Object> entities = session.createNativeQuery(

"SELECT {pr.\*}, {pt.\*} " +

"FROM Person pr, Partner pt " +

"WHERE pr.name = pt.name" )

.addEntity( "pr", Person.class)

.addEntity( "pt", Partner.class)

.list();

|  |  |
| --- | --- |
|  | There’s no such equivalent in JPA because the Query interface doesn’t define an addEntity method equivalent. |

The {pr.**} and**{pt.} notation used above is 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.

### 17.6. 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 8. Alias injection names* | | |
| --- | --- | --- |
| **Description** | **Syntax** | **Example** |
| A simple property | {[aliasname].[propertyname] | A\_NAME as {item.name} |
| A composite property | {[aliasname].[componentname].[propertyname]} | CURRENCY as {item.amount.currency}, VALUE as {item.amount.value} |
| Discriminator of an entity | {[aliasname].class} | DISC as {item.class} |
| All properties of an entity | {[aliasname].\*} | {item.\*} |
| A collection key | {[aliasname].key} | ORGID as {coll.key} |
| The id of an collection | {[aliasname].id} | EMPID as {coll.id} |
| The element of an collection | {[aliasname].element} | XID as {coll.element} |
| property of the element in the collection | {[aliasname].element.[propertyname]} | NAME as {coll.element.name} |
| All properties of the element in the collection | {[aliasname].element.\*} | {coll.element.\*} |
| All properties of the collection | {[aliasname].\*} | {coll.\*} |

### 17.7. Returning DTOs (Data Transfer Objects)

It is possible to apply a ResultTransformer to native SQL queries, allowing it to return non-managed entities.

*Example 552. Hibernate native query selecting DTOs*

public class PersonSummaryDTO {

private Number id;

private String name;

public Number getId() {

return id;

}

public void setId(Number id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

}

List<PersonSummaryDTO> dtos = session.createNativeQuery(

"SELECT p.id as \"id\", p.name as \"name\" " +

"FROM Person p")

.setResultTransformer( Transformers.aliasToBean( PersonSummaryDTO.class ) )

.list();

|  |  |
| --- | --- |
|  | There’s no such equivalent in JPA because the Query interface doesn’t define a setResultTransformer method equivalent. |

The above query will return a list of PersonSummaryDTO which has been instantiated and injected the values of id and name into its corresponding properties or fields.

### 17.8. Handling inheritance

Native SQL queries which query for entities that are mapped as part of an inheritance must include all properties for the base class and all its subclasses.

*Example 553. Hibernate native query selecting subclasses*

List<CreditCardPayment> payments = session.createNativeQuery(

"SELECT \* " +

"FROM Payment p " +

"JOIN CreditCardPayment cp on cp.id = p.id" )

.addEntity( CreditCardPayment.class )

.list();

|  |  |
| --- | --- |
|  | There’s no such equivalent in JPA because the Query interface doesn’t define an addEntity method equivalent. |

### 17.9. Parameters

Native SQL queries support positional as well as named parameters:

*Example 554. JPA native query with parameters*

List<Person> persons = entityManager.createNativeQuery(

"SELECT \* " +

"FROM Person " +

"WHERE name like :name", Person.class )

.setParameter("name", "J%")

.getResultList();

*Example 555. Hibernate native query with parameters*

List<Person> persons = session.createNativeQuery(

"SELECT \* " +

"FROM Person " +

"WHERE name like :name" )

.addEntity( Person.class )

.setParameter("name", "J%")

.list();

### 17.10. Named SQL queries

Named SQL queries can also be defined during mapping and called in exactly the same way as a named HQL query. In this case, you do not need to call addEntity() anymore.

JPA defines the javax.persistence.NamedNativeQuery annotation for this purpose, and the Hibernate org.hibernate.annotations.NamedNativeQuery annotation extends it and adds the following attributes:

flushMode()

The flush mode for the query. By default, it uses the current Persistence Context flush mode.

cacheable()

Whether the query (results) is cacheable or not. By default, queries are not cached.

cacheRegion()

If the query results are cacheable, name the query cache region to use.

fetchSize()

The number of rows fetched by the JDBC Driver per database trip. The default value is given by the JDBC driver.

timeout()

The query timeout (in seconds). By default, there’s no timeout.

callable()

Does the SQL query represent a call to a procedure/function? Default is false.

comment()

A comment added to the SQL query for tuning the execution plan.

cacheMode()

The cache mode used for this query. This refers to entities/collections returned by the query. The default value is CacheModeType.NORMAL.

readOnly()

Whether the results should be read-only. By default, queries are not read-only so entities are stored in the Persistence Context.

#### 17.10.1. Named SQL queries selecting scalar values

To fetch a single column of given table, the named query looks as follows:

*Example 556. Single scalar value NamedNativeQuery*

@NamedNativeQuery(

name = "find\_person\_name",

query =

"SELECT name " +

"FROM Person "

),

*Example 557. JPA named native query selecting a scalar value*

List<String> names = entityManager.createNamedQuery(

"find\_person\_name" )

.getResultList();

*Example 558. Hibernate named native query selecting a scalar value*

List<String> names = session.getNamedQuery(

"find\_person\_name" )

.list();

Selecting multiple scalar values is done like this:

*Example 559. Multiple scalar values NamedNativeQuery*

@NamedNativeQuery(

name = "find\_person\_name\_and\_nickName",

query =

"SELECT " +

" name, " +

" nickName " +

"FROM Person "

),

Without specifying an explicit result type, Hibernate will assume an Object array:

*Example 560. JPA named native query selecting multiple scalar values*

List<Object[]> tuples = entityManager.createNamedQuery(

"find\_person\_name\_and\_nickName" )

.getResultList();

for(Object[] tuple : tuples) {

String name = (String) tuple[0];

String nickName = (String) tuple[1];

}

*Example 561. Hibernate named native query selecting multiple scalar values*

List<Object[]> tuples = session.getNamedQuery(

"find\_person\_name\_and\_nickName" )

.list();

for(Object[] tuple : tuples) {

String name = (String) tuple[0];

String nickName = (String) tuple[1];

}

It’s possible to use a DTO to store the resulting scalar values:

*Example 562. DTO to store multiple scalar values*

public class PersonNames {

private final String name;

private final String nickName;

public PersonNames(String name, String nickName) {

this.name = name;

this.nickName = nickName;

}

public String getName() {

return name;

}

public String getNickName() {

return nickName;

}

}

*Example 563. Multiple scalar values NamedNativeQuery with ConstructorResult*

@NamedNativeQuery(

name = "find\_person\_name\_and\_nickName\_dto",

query =

"SELECT " +

" name, " +

" nickName " +

"FROM Person ",

resultSetMapping = "name\_and\_nickName\_dto"

),

@SqlResultSetMapping(

name = "name\_and\_nickName\_dto",

classes = @ConstructorResult(

targetClass = PersonNames.class,

columns = {

@ColumnResult(name = "name"),

@ColumnResult(name = "nickName")

}

)

)

*Example 564. JPA named native query selecting multiple scalar values into a DTO*

List<PersonNames> personNames = entityManager.createNamedQuery(

"find\_person\_name\_and\_nickName\_dto" )

.getResultList();

*Example 565. Hibernate named native query selecting multiple scalar values into a DTO*

List<PersonNames> personNames = session.getNamedQuery(

"find\_person\_name\_and\_nickName\_dto" )

.list();

You can also use the [@NamedNativeQuery](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedNativeQuery.html) Hibernate annotation to customize the named query using various configurations such as fetch mode, cacheability, time out interval.

*Example 566. Multiple scalar values using ConstructorResult and Hibernate NamedNativeQuery*

@NamedNativeQueries({

@NamedNativeQuery(

name = "get\_person\_phone\_count",

query = "SELECT pr.name AS name, count(\*) AS phoneCount " +

"FROM Phone p " +

"JOIN Person pr ON pr.id = p.person\_id " +

"GROUP BY pr.name",

resultSetMapping = "person\_phone\_count",

timeout = 1,

readOnly = true

),

})

@SqlResultSetMapping(

name = "person\_phone\_count",

classes = @ConstructorResult(

targetClass = PersonPhoneCount.class,

columns = {

@ColumnResult(name = "name"),

@ColumnResult(name = "phoneCount")

}

)

)

*Example 567. Hibernate NamedNativeQuery named native query selecting multiple scalar values into a DTO*

List<PersonPhoneCount> personNames = session.getNamedNativeQuery(

"get\_person\_phone\_count")

.getResultList();

#### 17.10.2. Named SQL queries selecting entities

Considering the following named query:

*Example 568. Single-entity NamedNativeQuery*

@NamedNativeQuery(

name = "find\_person\_by\_name",

query =

"SELECT " +

" p.id AS \"id\", " +

" p.name AS \"name\", " +

" p.nickName AS \"nickName\", " +

" p.address AS \"address\", " +

" p.createdOn AS \"createdOn\", " +

" p.version AS \"version\" " +

"FROM Person p " +

"WHERE p.name LIKE :name",

resultClass = Person.class

),

The result set mapping declares the entities retrieved by this native query. Each field of the entity is bound to an SQL alias (or column name). All fields of the entity including the ones of subclasses and the foreign key columns of related entities have to be present in the SQL query. Field definitions are optional provided that they map to the same column name as the one declared on the class property.

Executing this named native query can be done as follows:

*Example 569. JPA named native entity query*

List<Person> persons = entityManager.createNamedQuery(

"find\_person\_by\_name" )

.setParameter("name", "J%")

.getResultList();

*Example 570. Hibernate named native entity query*

List<Person> persons = session.getNamedQuery(

"find\_person\_by\_name" )

.setParameter("name", "J%")

.list();

To join multiple entities, you need to use a SqlResultSetMapping for each entity the SQL query is going to fetch.

*Example 571. Joined-entities NamedNativeQuery*

@NamedNativeQuery(

name = "find\_person\_with\_phones\_by\_name",

query =

"SELECT " +

" pr.id AS \"pr.id\", " +

" pr.name AS \"pr.name\", " +

" pr.nickName AS \"pr.nickName\", " +

" pr.address AS \"pr.address\", " +

" pr.createdOn AS \"pr.createdOn\", " +

" pr.version AS \"pr.version\", " +

" ph.id AS \"ph.id\", " +

" ph.person\_id AS \"ph.person\_id\", " +

" ph.phone\_number AS \"ph.number\", " +

" ph.phone\_type AS \"ph.type\" " +

"FROM Person pr " +

"JOIN Phone ph ON pr.id = ph.person\_id " +

"WHERE pr.name LIKE :name",

resultSetMapping = "person\_with\_phones"

)

@SqlResultSetMapping(

name = "person\_with\_phones",

entities = {

@EntityResult(

entityClass = Person.class,

fields = {

@FieldResult( name = "id", column = "pr.id" ),

@FieldResult( name = "name", column = "pr.name" ),

@FieldResult( name = "nickName", column = "pr.nickName" ),

@FieldResult( name = "address", column = "pr.address" ),

@FieldResult( name = "createdOn", column = "pr.createdOn" ),

@FieldResult( name = "version", column = "pr.version" ),

}

),

@EntityResult(

entityClass = Phone.class,

fields = {

@FieldResult( name = "id", column = "ph.id" ),

@FieldResult( name = "person", column = "ph.person\_id" ),

@FieldResult( name = "number", column = "ph.number" ),

@FieldResult( name = "type", column = "ph.type" ),

}

)

}

),

*Example 572. JPA named native entity query with joined associations*

List<Object[]> tuples = entityManager.createNamedQuery(

"find\_person\_with\_phones\_by\_name" )

.setParameter("name", "J%")

.getResultList();

for(Object[] tuple : tuples) {

Person person = (Person) tuple[0];

Phone phone = (Phone) tuple[1];

}

*Example 573. Hibernate named native entity query with joined associations*

List<Object[]> tuples = session.getNamedQuery(

"find\_person\_with\_phones\_by\_name" )

.setParameter("name", "J%")

.list();

for(Object[] tuple : tuples) {

Person person = (Person) tuple[0];

Phone phone = (Phone) tuple[1];

}

Finally, if the association to a related entity involve a composite primary key, a @FieldResult element should be used for each foreign key column. The @FieldResult name is composed of the property name for the relationship, followed by a dot ("."), followed by the name or the field or property of the primary key. For this example, the following entities are going to be used:

*Example 574. Entity associations with composite keys and named native queries*

@Embeddable

public class Dimensions {

private int length;

private int width;

public int getLength() {

return length;

}

public void setLength(int length) {

this.length = length;

}

public int getWidth() {

return width;

}

public void setWidth(int width) {

this.width = width;

}

}

@Embeddable

public class Identity implements Serializable {

private String firstname;

private String lastname;

public String getFirstname() {

return firstname;

}

public void setFirstname(String firstname) {

this.firstname = firstname;

}

public String getLastname() {

return lastname;

}

public void setLastname(String lastname) {

this.lastname = lastname;

}

public boolean equals(Object o) {

if ( this == o ) return true;

if ( o == null || getClass() != o.getClass() ) return false;

final Identity identity = (Identity) o;

if ( !firstname.equals( identity.firstname ) ) return false;

if ( !lastname.equals( identity.lastname ) ) return false;

return true;

}

public int hashCode() {

int result;

result = firstname.hashCode();

result = 29 \* result + lastname.hashCode();

return result;

}

}

@Entity

public class Captain {

@EmbeddedId

private Identity id;

public Identity getId() {

return id;

}

public void setId(Identity id) {

this.id = id;

}

}

@Entity

@NamedNativeQueries({

@NamedNativeQuery(name = "find\_all\_spaceships",

query =

"SELECT " +

" name as \"name\", " +

" model, " +

" speed, " +

" lname as lastn, " +

" fname as firstn, " +

" length, " +

" width, " +

" length \* width as surface, " +

" length \* width \* 10 as volume " +

"FROM SpaceShip",

resultSetMapping = "spaceship"

)

})

@SqlResultSetMapping(

name = "spaceship",

entities = @EntityResult(

entityClass = SpaceShip.class,

fields = {

@FieldResult(name = "name", column = "name"),

@FieldResult(name = "model", column = "model"),

@FieldResult(name = "speed", column = "speed"),

@FieldResult(name = "captain.lastname", column = "lastn"),

@FieldResult(name = "captain.firstname", column = "firstn"),

@FieldResult(name = "dimensions.length", column = "length"),

@FieldResult(name = "dimensions.width", column = "width"),

}

),

columns = {

@ColumnResult(name = "surface"),

@ColumnResult(name = "volume")

}

)

public class SpaceShip {

@Id

private String name;

private String model;

private double speed;

@ManyToOne(fetch = FetchType.LAZY)

@JoinColumns({

@JoinColumn(name = "fname", referencedColumnName = "firstname"),

@JoinColumn(name = "lname", referencedColumnName = "lastname")

})

private Captain captain;

private Dimensions dimensions;

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public String getModel() {

return model;

}

public void setModel(String model) {

this.model = model;

}

public double getSpeed() {

return speed;

}

public void setSpeed(double speed) {

this.speed = speed;

}

public Captain getCaptain() {

return captain;

}

public void setCaptain(Captain captain) {

this.captain = captain;

}

public Dimensions getDimensions() {

return dimensions;

}

public void setDimensions(Dimensions dimensions) {

this.dimensions = dimensions;

}

}

*Example 575. JPA named native entity query with joined associations and composite keys*

List<Object[]> tuples = entityManager.createNamedQuery(

"find\_all\_spaceships" )

.getResultList();

for(Object[] tuple : tuples) {

SpaceShip spaceShip = (SpaceShip) tuple[0];

Number surface = (Number) tuple[1];

Number volume = (Number) tuple[2];

}

*Example 576. Hibernate named native entity query with joined associations and composite keys*

List<Object[]> tuples = session.getNamedQuery(

"find\_all\_spaceships" )

.list();

for(Object[] tuple : tuples) {

SpaceShip spaceShip = (SpaceShip) tuple[0];

Number surface = (Number) tuple[1];

Number volume = (Number) tuple[2];

}

### 17.11. Resolving global catalog and schema in native SQL queries

When using multiple database catalogs and schemas, Hibernate offers the possibility of setting a global catalog or schema so that you don’t have to declare it explicitly for every entity.

*Example 577. Setting global catalog and schema*

<property name="hibernate.default\_catalog" value="crm"/>

<property name="hibernate.default\_schema" value="analytics"/>

This way, we can imply the global **crm** catalog and **analytics** schema in every JPQL, HQL or Criteria API query.

However, for native queries, the SQL query is passed as is, therefore you need to explicitly set the global catalog and schema whenever you are referencing a database table. Fortunately, Hibernate allows you to resolve the current global catalog and schema using the following placeholders:

{h-catalog}

resolves the current hibernate.default\_catalog configuration property value.

{h-schema}

resolves the current hibernate.default\_schema configuration property value.

{h-domain}

resolves the current hibernate.default\_catalog and hibernate.default\_schema configuration property values (e.g. catalog.schema).

Withe these placeholders, you can imply the catalog, schema, or both catalog and schema for every native query.

So, when running the following native query:

@NamedNativeQuery(

name = "last\_30\_days\_hires",

query =

"select \* " +

"from {h-domain}person " +

"where age(hired\_on) < '30 days'",

resultClass = Person.class

)

Hibernate is going to resolve the {h-domain} placeholder according to the values of the default catalog and schema:

SELECT \*

FROM crm.analytics.person

WHERE age(hired\_on) < '30 days'

### 17.12. Using stored procedures for querying

Hibernate provides support for queries via stored procedures and functions. A stored procedure arguments are declared using the IN parameter type, and the result can be either marked with an OUT parameter type, a REF\_CURSOR or it could just return the result like a function.

*Example 578. MySQL stored procedure with OUT parameter type*

statement.executeUpdate(

"CREATE PROCEDURE sp\_count\_phones (" +

" IN personId INT, " +

" OUT phoneCount INT " +

") " +

"BEGIN " +

" SELECT COUNT(\*) INTO phoneCount " +

" FROM Phone p " +

" WHERE p.person\_id = personId; " +

"END"

);

To use this stored procedure, you can execute the following JPA 2.1 query:

*Example 579. Calling a MySQL stored procedure with OUT parameter type using JPA*

StoredProcedureQuery query = entityManager.createStoredProcedureQuery( "sp\_count\_phones");

query.registerStoredProcedureParameter( "personId", Long.class, ParameterMode.IN);

query.registerStoredProcedureParameter( "phoneCount", Long.class, ParameterMode.OUT);

query.setParameter("personId", 1L);

query.execute();

Long phoneCount = (Long) query.getOutputParameterValue("phoneCount");

*Example 580. Calling a MySQL stored procedure with OUT parameter type using Hibernate*

Session session = entityManager.unwrap( Session.class );

ProcedureCall call = session.createStoredProcedureCall( "sp\_count\_phones" );

call.registerParameter( "personId", Long.class, ParameterMode.IN ).bindValue( 1L );

call.registerParameter( "phoneCount", Long.class, ParameterMode.OUT );

Long phoneCount = (Long) call.getOutputs().getOutputParameterValue( "phoneCount" );

assertEquals( Long.valueOf( 2 ), phoneCount );

If the stored procedure outputs the result directly without an OUT parameter type:

*Example 581. MySQL stored procedure without an OUT parameter type*

statement.executeUpdate(

"CREATE PROCEDURE sp\_phones(IN personId INT) " +

"BEGIN " +

" SELECT \* " +

" FROM Phone " +

" WHERE person\_id = personId; " +

"END"

);

You can retrieve the results of the aforementioned MySQL stored procedure as follows:

*Example 582. Calling a MySQL stored procedure and fetching the result set without an OUT parameter type using JPA*

StoredProcedureQuery query = entityManager.createStoredProcedureQuery( "sp\_phones");

query.registerStoredProcedureParameter( 1, Long.class, ParameterMode.IN);

query.setParameter(1, 1L);

List<Object[]> personComments = query.getResultList();

*Example 583. Calling a MySQL stored procedure and fetching the result set without an OUT parameter type using Hibernate*

Session session = entityManager.unwrap( Session.class );

ProcedureCall call = session.createStoredProcedureCall( "sp\_phones" );

call.registerParameter( 1, Long.class, ParameterMode.IN ).bindValue( 1L );

Output output = call.getOutputs().getCurrent();

List<Object[]> personComments = ( (ResultSetOutput) output ).getResultList();

For a REF\_CURSOR result sets, we’ll consider the following Oracle stored procedure:

*Example 584. Oracle REF\_CURSOR stored procedure*

statement.executeUpdate(

"CREATE OR REPLACE PROCEDURE sp\_person\_phones ( " +

" personId IN NUMBER, " +

" personPhones OUT SYS\_REFCURSOR ) " +

"AS " +

"BEGIN " +

" OPEN personPhones FOR " +

" SELECT \*" +

" FROM phone " +

" WHERE person\_id = personId; " +

"END;"

);

|  |  |
| --- | --- |
|  | REF\_CURSOR result sets are only supported by Oracle and PostgreSQL because other database systems JDBC drivers don’t support this feature. |

This function can be called using the standard Java Persistence API:

*Example 585. Calling an Oracle REF\_CURSOR stored procedure using JPA*

StoredProcedureQuery query = entityManager.createStoredProcedureQuery( "sp\_person\_phones" );

query.registerStoredProcedureParameter( 1, Long.class, ParameterMode.IN );

query.registerStoredProcedureParameter( 2, Class.class, ParameterMode.REF\_CURSOR );

query.setParameter( 1, 1L );

query.execute();

List<Object[]> postComments = query.getResultList();

*Example 586. Calling an Oracle REF\_CURSOR stored procedure using Hibernate*

Session session = entityManager.unwrap(Session.class);

ProcedureCall call = session.createStoredProcedureCall( "sp\_person\_phones");

call.registerParameter(1, Long.class, ParameterMode.IN).bindValue(1L);

call.registerParameter(2, Class.class, ParameterMode.REF\_CURSOR);

Output output = call.getOutputs().getCurrent();

List<Object[]> postComments = ( (ResultSetOutput) output ).getResultList();

assertEquals(2, postComments.size());

If the database defines an SQL function:

*Example 587. MySQL function*

statement.executeUpdate(

"CREATE FUNCTION fn\_count\_phones(personId integer) " +

"RETURNS integer " +

"DETERMINISTIC " +

"READS SQL DATA " +

"BEGIN " +

" DECLARE phoneCount integer; " +

" SELECT COUNT(\*) INTO phoneCount " +

" FROM Phone p " +

" WHERE p.person\_id = personId; " +

" RETURN phoneCount; " +

"END"

);

Because the current StoredProcedureQuery implementation doesn’t yet support SQL functions, we need to use the JDBC syntax.

|  |  |
| --- | --- |
|  | This limitation is acknowledged and will be addressed by the [HHH-10530](https://hibernate.atlassian.net/browse/HHH-10530) issue. |

*Example 588. Calling a MySQL function*

final AtomicReference<Integer> phoneCount = new AtomicReference<>();

Session session = entityManager.unwrap( Session.class );

session.doWork( connection -> {

try (CallableStatement function = connection.prepareCall(

"{ ? = call fn\_count\_phones(?) }" )) {

function.registerOutParameter( 1, Types.INTEGER );

function.setInt( 2, 1 );

function.execute();

phoneCount.set( function.getInt( 1 ) );

}

} );

|  |  |
| --- | --- |
|  | Stored procedure queries cannot be paged with setFirstResult()/setMaxResults().  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, so everything else will be discarded.  For SQL Server, if you can enable SET NOCOUNT ON in your procedure it will probably be more efficient, but this is not a requirement. |

### 17.13. Using named queries to call stored procedures

Just like with SQL statements, you can also use named queries to call stored procedures. For this purpose, JPA defines the [@NamedStoredProcedureQuery](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedStoredProcedureQuery.html) annotation.

*Example 589. Oracle REF\_CURSOR named query stored procedure*

@NamedStoredProcedureQueries(

@NamedStoredProcedureQuery(

name = "sp\_person\_phones",

procedureName = "sp\_person\_phones",

parameters = {

@StoredProcedureParameter(

name = "personId",

type = Long.class,

mode = ParameterMode.IN

),

@StoredProcedureParameter(

name = "personPhones",

type = Class.class,

mode = ParameterMode.REF\_CURSOR

)

}

)

)

Calling this stored procedure is straightforward, as illustrated by the following example.

*Example 590. Calling an Oracle REF\_CURSOR stored procedure using a JPA named query*

List<Object[]> postComments = entityManager

.createNamedStoredProcedureQuery( "sp\_person\_phones" )

.setParameter( "personId", 1L )

.getResultList();

### 17.14. Custom SQL for create, update, and delete

Hibernate can use custom SQL for create, update, and delete operations. The SQL can be overridden at the statement level or individual column level. This section describes statement overrides. For columns, see [Column transformers: read and write expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-read-and-write).

The following example shows how to define custom SQL operations using annotations. @SQLInsert, @SQLUpdate and @SQLDelete override the INSERT, UPDATE, DELETE statements of a given entity. For the SELECT clause, a @Loader must be defined along with a @NamedNativeQuery used for loading the underlying table record.

For collections, Hibernate allows defining a custom @SQLDeleteAll which is used for removing all child records associated with a given parent entity. To filter collections, the @Where annotation allows customizing the underlying SQL WHERE clause.

*Example 591. Custom CRUD*

@Entity(name = "Person")

@SQLInsert(

sql = "INSERT INTO person (name, id, valid) VALUES (?, ?, true) ",

check = ResultCheckStyle.COUNT

)

@SQLUpdate(

sql = "UPDATE person SET name = ? where id = ? ")

@SQLDelete(

sql = "UPDATE person SET valid = false WHERE id = ? ")

@Loader(namedQuery = "find\_valid\_person")

@NamedNativeQueries({

@NamedNativeQuery(

name = "find\_valid\_person",

query = "SELECT id, name " +

"FROM person " +

"WHERE id = ? and valid = true",

resultClass = Person.class

)

})

public static class Person {

@Id

@GeneratedValue

private Long id;

private String name;

@ElementCollection

@SQLInsert(

sql = "INSERT INTO person\_phones (person\_id, phones, valid) VALUES (?, ?, true) ")

@SQLDeleteAll(

sql = "UPDATE person\_phones SET valid = false WHERE person\_id = ?")

@Where( clause = "valid = true" )

private List<String> phones = new ArrayList<>();

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public List<String> getPhones() {

return phones;

}

}

In the example above, the entity is mapped so that entries are soft-deleted (the records are not removed from the database, but instead, a flag marks the row validity). The Person entity benefits from custom INSERT, UPDATE, and DELETE statements which update the valid column accordingly. The custom @Loader is used to retrieve only Personrows that are valid.

The same is done for the phones collection. The @SQLDeleteAll and the SQLInsert queries are used whenever the collection is modified.

|  |  |
| --- | --- |
|  | You also call a store procedure using the custom CRUD statements; the only requirement is to set the callable attribute to true. |

To check that the execution happens correctly, Hibernate allows you to define one of those three strategies:

* none: no check is performed; the store procedure is expected to fail upon constraint violations
* count: use of row-count returned by the executeUpdate() method call to check that the update was successful
* param: like count but using a CallableStatement output parameter.

To define the result check style, use the check parameter.

|  |  |
| --- | --- |
|  | The parameter order is important and is defined by the order Hibernate handles properties. You can see the expected order by enabling debug logging, so Hibernate can print out the static SQL that is used to create, update, delete etc. entities.  To see the expected sequence, remember to not include your custom SQL through annotations or mapping files as that will override the Hibernate generated static sql. |

Overriding SQL statements for secondary tables is also possible using @org.hibernate.annotations.Table and the sqlInsert, sqlUpdate, sqlDelete attributes.

*Example 592. Overriding SQL statements for secondary tables*

@Entity(name = "Person")

@Table(name = "person")

@SQLInsert(

sql = "INSERT INTO person (name, id, valid) VALUES (?, ?, true) "

)

@SQLDelete(

sql = "UPDATE person SET valid = false WHERE id = ? "

)

@SecondaryTable(name = "person\_details",

pkJoinColumns = @PrimaryKeyJoinColumn(name = "person\_id"))

@org.hibernate.annotations.Table(

appliesTo = "person\_details",

sqlInsert = @SQLInsert(

sql = "INSERT INTO person\_details (image, person\_id, valid) VALUES (?, ?, true) ",

check = ResultCheckStyle.COUNT

),

sqlDelete = @SQLDelete(

sql = "UPDATE person\_details SET valid = false WHERE person\_id = ? "

)

)

@Loader(namedQuery = "find\_valid\_person")

@NamedNativeQueries({

@NamedNativeQuery(

name = "find\_valid\_person",

query = "select " +

" p.id, " +

" p.name, " +

" pd.image " +

"from person p " +

"left outer join person\_details pd on p.id = pd.person\_id " +

"where p.id = ? and p.valid = true and pd.valid = true",

resultClass = Person.class

)

})

public static class Person {

@Id

@GeneratedValue

private Long id;

private String name;

@Column(name = "image", table = "person\_details")

private byte[] image;

public Long getId() {

return id;

}

public void setId(Long id) {

this.id = id;

}

public String getName() {

return name;

}

public void setName(String name) {

this.name = name;

}

public byte[] getImage() {

return image;

}

public void setImage(byte[] image) {

this.image = image;

}

}

|  |  |
| --- | --- |
|  | The SQL is directly executed in your database, so you can use any dialect you like. This will, however, reduce the portability of your mapping if you use database specific SQL. |

You can also use stored procedures for customizing the CRUD statements.

Assuming the following stored procedure:

*Example 593. Oracle stored procedure to soft-delete a given entity*

statement.executeUpdate(

"CREATE OR REPLACE PROCEDURE sp\_delete\_person ( " +

" personId IN NUMBER ) " +

"AS " +

"BEGIN " +

" UPDATE person SET valid = 0 WHERE id = personId; " +

"END;"

);}

The entity can use this stored procedure to soft-delete the entity in question:

*Example 594. Customizing the entity delete statement to use the Oracle stored procedure= instead*

@SQLDelete(

sql = "{ call sp\_delete\_person( ? ) } ",

callable = true

)

|  |  |
| --- | --- |
|  | You need to set the callable attribute when using a stored procedure instead of an SQL statement. |

## 18. Spatial

### 18.1. Overview

Hibernate Spatial was originally developed as a generic extension to Hibernate for handling geographic data. Since 5.0, Hibernate Spatial is now part of the Hibernate ORM project, and it allows you to deal with geographic data in a standardized way.

Hibernate Spatial provides a standardized, cross-database interface to geographic data storage and query functions. It supports most of the functions described by the OGC Simple Feature Specification. Supported databases are: Oracle 10g/11g, PostgreSql/PostGIS, MySQL, Microsoft SQL Server and H2/GeoDB.

Spatial data types are not part of the Java standard library, and they are absent from the JDBC specification. Over the years [JTS](http://tsusiatsoftware.net/jts/main.html) has emerged the de facto standard to fill this gap. JTS is an implementation of the [Simple Feature Specification (SFS)](https://portal.opengeospatial.org/files/?artifact_id=829). Many databases on the other hand implement the SQL/MM - Part 3: Spatial Data specification - a related, but broader specification. The biggest difference is that SFS is limited to 2D geometries in the projected plane (although JTS supports 3D coordinates), whereas SQL/MM supports 2-, 3- or 4-dimensional coordinate spaces.

Hibernate Spatial supports two different geometry models: [JTS](http://tsusiatsoftware.net/jts/main.html) and [geolatte-geom](https://github.com/GeoLatte/geolatte-geom). As already mentioned, JTS is the de facto standard. Geolatte-geom (also written by the lead developer of Hibernate Spatial) is a more recent library that supports many features specified in SQL/MM but not available in JTS (such as support for 4D geometries, and support for extended WKT/WKB formats). Geolatte-geom also implements encoders/decoders for the database native types. Geolatte-geom has good interoperability with JTS. Converting a Geolatte geometry to a JTS `geometry, for instance, doesn’t require copying of the coordinates. It also delegates spatial processing to JTS.

Whether you use JTS or Geolatte-geom, Hibernate spatial maps the database spatial types to your geometry model of choice. It will, however, always use Geolatte-geom to decode the database native types.

Hibernate Spatial also makes a number of spatial functions available in HQL and in the Criteria Query API. These functions are specified in both SQL/MM as SFS, and are commonly implemented in databases with spatial support (see [Hibernate Spatial dialect function support](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#spatial-configuration-dialect-features))

### 18.2. Configuration

Hibernate Spatial requires some configuration prior to start using it.

#### 18.2.1. Dependency

You need to include the hibernate-spatial dependency in your build environment. For Maven, you need to add the following dependency:

*Example 595. Maven dependency*

<dependency>

<groupId>org.hibernate</groupId>

<artifactId>hibernate-spatial</artifactId>

<version>${hibernate.version}</version>

</dependency>

#### 18.2.2. Dialects

Hibernate Spatial extends the Hibernate ORM dialects so that the spatial functions of the database are made available within HQL and JPQL. So, for instance, instead of using the PostgreSQL82Dialect, we use the Hibernate Spatial extension of that dialect which is the PostgisDialect.

*Example 596. Specifying a spatial dialect*

<property

name="hibernate.dialect"

value="org.hibernate.spatial.dialect.postgis.PostgisDialect"

/>

Not all databases support all the functions defined by Hibernate Spatial. The table below provides an overview of the functions provided by each database. If the function is defined in the [Simple Feature Specification](https://portal.opengeospatial.org/files/?artifact_id=829), the description references the relevant section.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Table 9. Hibernate Spatial dialect function support* | | | | | | |
| Function | Description | PostgresSQL | Oracle 10g/11g | MySQL | SQLServer | GeoDB (H2) |
| Basic functions on Geometry |  |  |  |  |  |  |
| int dimension(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| String geometrytype(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| int srid(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| Geometry envelope(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| String astext(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| byte[] asbinary(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| boolean isempty(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| boolean issimple(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| Geometry boundary(Geometry) | SFS §2.1.1.1 |  |  |  |  |  |
| Functions for testing Spatial Relations between geometric objects |  |  |  |  |  |  |
| boolean equals(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean disjoint(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean intersects(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean touches(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean crosses(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean within(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean contains(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean overlaps(Geometry, Geometry) | SFS §2.1.1.2 |  |  |  |  |  |
| boolean relate(Geometry, Geometry, String) | SFS §2.1.1.2 |  |  |  |  |  |
| Functions that support Spatial Analysis |  |  |  |  |  |  |
| double distance(Geometry, Geometry) | SFS §2.1.1.3 |  |  |  |  |  |
| Geometry buffer(Geometry, double) | SFS §2.1.1.3 |  |  |  |  |  |
| Geometry convexhull(Geometry) | SFS §2.1.1.3 |  |  |  |  |  |
| Geometry intersection(Geometry, Geometry) | SFS §2.1.1.3 |  |  |  |  |  |
| Geometry geomunion(Geometry, Geometry) | SFS §2.1.1.3 (renamed from union) |  |  |  |  |  |
| Geometry difference(Geometry, Geometry) | SFS §2.1.1.3 |  |  |  |  |  |
| Geometry symdifference(Geometry, Geometry) | SFS §2.1.1.3 |  |  |  |  |  |
| Common non-SFS functions |  |  |  |  |  |  |
| boolean dwithin(Geometry, Geometry, double) | Returns true if the geometries are within the specified distance of one another |  |  |  |  |  |
| Geometry transform(Geometry, int) | Returns a new geometry with its coordinates transformed to the SRID referenced by the integer parameter |  |  |  |  |  |
| Spatial aggregate Functions |  |  |  |  |  |  |
| Geometry extent(Geometry) | Returns a bounding box that bounds the set of returned geometries |  |  |  |  |  |

Postgis

For Postgis from versions 1.3 and later, the best dialect to use is org.hibernate.spatial.dialect.postgis.PostgisDialect.

This translates the HQL spatial functions to the Postgis SQL/MM-compliant functions. For older, pre v1.3 versions of Postgis, which are not SQL/MM compliant, the dialect org.hibernate.spatial.dialect.postgis.PostgisNoSQLMM is provided.

MySQL

There are several dialects for MySQL:

MySQLSpatialDialect

a spatially-extended version of Hibernate MySQLDialect

MySQL5SpatialDialect

a spatially-extended version of Hibernate MySQL5Dialect

MySQLSpatial56Dialect

a spatially-extended version of Hibernate MySQL55Dialect.

|  |  |
| --- | --- |
|  | MySQL versions before 5.6.1 had only limited support for spatial operators. Most operators only took account of the minimum bounding rectangles (MBR) of the geometries, and not the geometries themselves.  This changed in version 5.6.1 were MySQL introduced ST\_\* spatial operators. The dialect MySQLSpatial56Dialect uses these newer, more precise operators.  These dialects may therefore produce results that differ from that of the other spatial dialects.  For more information, see this page in the MySQL reference guide (esp. the section [Functions That Test Spatial Relations Between Geometry Objects](https://dev.mysql.com/doc/refman/5.7/en/spatial-relation-functions.html)) |

Oracle10g/11g

There is currently only one Oracle spatial dialect: OracleSpatial10gDialect which extends the Hibernate dialect Oracle10gDialect. This dialect has been tested on both Oracle 10g and Oracle 11g with the SDO\_GEOMETRY spatial database type.

This dialect is the only dialect that can be configured using these Hibernate properties:

hibernate.spatial.connection\_finder

the fully-qualified classname for the Connection finder for this Dialect (see below).

|  |  |
| --- | --- |
|  | *The ConnectionFinder interface*  The SDOGeometryType requires access to an OracleConnection object wehen converting a geometry to SDO\_GEOMETRY. In some environments, however, the OracleConnection is not available (e.g. because a Java EE container or connection pool proxy wraps the connection object in its own Connection implementation). A ConnectionFinder knows how to retrieve the OracleConnection from the wrapper or proxy Connection object that is passed into prepared statements.  The default implementation will, when the passed object is not already an OracleConnection, attempt to retrieve the OracleConnection by recursive reflection. It will search for methods that return Connectionobjects, execute these methods and check the result. If the result is of type OracleConnection the object is returned, otherwise it recurses on it.  In may cases this strategy will suffice. If not, you can provide your own implementation of this interface on the class path, and configure it in the hibernate.spatial.connection\_finder property. Note that implementations must be thread-safe and have a default no-args constructor. |

SQL Server

The dialect SqlServer2008Dialect supports the GEOMETRY type in SQL Server 2008 and later.

|  |  |
| --- | --- |
|  | The GEOGRAPHY type is not currently supported. |

GeoDB (H2)

The GeoDBDialect supports the GeoDB a spatial extension of the H2 in-memory database.

|  |  |
| --- | --- |
|  | The dialect has been tested with GeoDB version 0.7 |

### 18.3. Types

Hibernate Spatial comes with the following types:

jts\_geometry

Handled by org.hibernate.spatial.JTSGeometryType it maps a database geometry column type to a com.vividsolutions.jts.geom.Geometry entity property type.

geolatte\_geometry

Handled by org.hibernate.spatial.GeolatteGeometryType, it maps a database geometry column type to an org.geolatte.geom.Geometry entity property type.

It suffices to declare a property as either a JTS or an Geolatte-geom Geometry and Hibernate Spatial will map it using the relevant type.

Here is an example using JTS:

*Example 597. Type mapping*

import com.vividsolutions.jts.geom.Point;

@Entity(name = "Event")

public static class Event {

@Id

private Long id;

private String name;

private Point location;

//Getters and setters are omitted for brevity

}

We can now treat spatial geometries like any other type.

*Example 598. Creating a Point*

Event event = new Event();

event.setId( 1L);

event.setName( "Hibernate ORM presentation");

Point point = geometryFactory.createPoint( new Coordinate( 10, 5 ) );

event.setLocation( point );

entityManager.persist( event );

Spatial Dialects defines many query functions that are available both in HQL and JPQL queries. Below we show how we could use the within function to find all objects within a given spatial extent or window.

*Example 599. Querying the geometry*

Polygon window = geometryFactory.createPolygon( coordinates );

Event event = entityManager.createQuery(

"select e " +

"from Event e " +

"where within(e.location, :window) = true", Event.class)

.setParameter("window", window)

.getSingleResult();

## 19. Multitenancy

### 19.1. What is multitenancy?

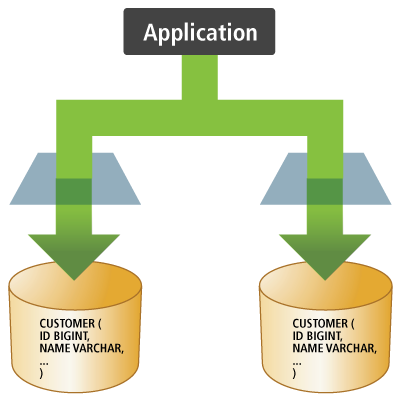
The term multitenancy, in general, is applied to software development to indicate an architecture in which a single running instance of an application simultaneously serves multiple clients (tenants). This is highly common in SaaS solutions. Isolating information (data, customizations, etc.) pertaining to the various tenants is a particular challenge in these systems. This includes the data owned by each tenant stored in the database. It is this last piece, sometimes called multitenant data, on which we will focus.

### 19.2. Multitenant data approaches

There are three main approaches to isolating information in these multitenant systems which go hand-in-hand with different database schema definitions and JDBC setups.

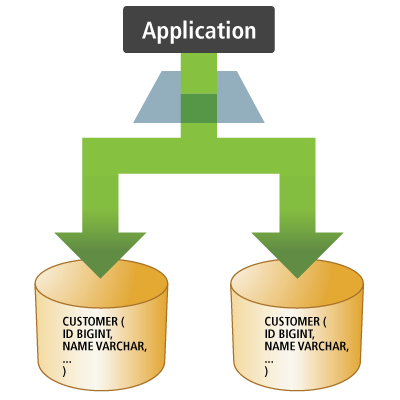
|  |  |
| --- | --- |
|  | Each approach has pros and cons as well as specific techniques and considerations. Such topics are beyond the scope of this documentation. Many resources exist which delve into these other topics, like [this one](http://msdn.microsoft.com/en-us/library/aa479086.aspx) which does a great job of covering these topics. |

#### 19.2.1. Separate database



Each tenant’s data is kept in a physically separate database instance. JDBC Connections would point specifically to each database so any pooling would be per-tenant. A general application approach, here, would be to define a JDBC Connection pool per-tenant and to select the pool to use based on the tenant identifier associated with the currently logged in user.

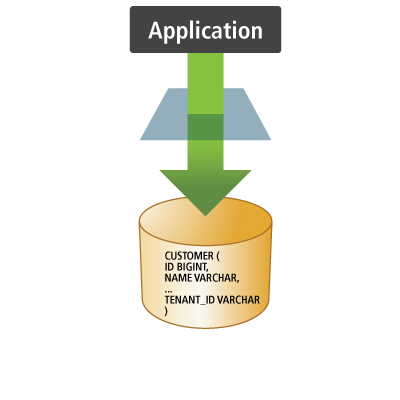
#### 19.2.2. Separate schema



Each tenant’s data is kept in a distinct database schema on a single database instance. There are two different ways to define JDBC Connections here:

* Connections could point specifically to each schema as we saw with the Separate database approach. This is an option provided that the driver supports naming the default schema in the connection URL or if the pooling mechanism supports naming a schema to use for its Connections. Using this approach, we would have a distinct JDBC Connection pool per-tenant where the pool to use would be selected based on the "tenant identifier" associated with the currently logged in user.
* Connections could point to the database itself (using some default schema) but the Connections would be altered using the SQL SET SCHEMA (or similar) command. Using this approach, we would have a single JDBC Connection pool for use to service all tenants, but before using the Connection, it would be altered to reference the schema named by the "tenant identifier" associated with the currently logged in user.

### 19.3. Partitioned (discriminator) data



All data is kept in a single database schema. The data for each tenant is partitioned by the use of partition value or discriminator. The complexity of this discriminator might range from a simple column value to a complex SQL formula. Again, this approach would use a single Connection pool to service all tenants. However, in this approach, the application needs to alter each and every SQL statement sent to the database to reference the "tenant identifier" discriminator.

### 19.4. Multitenancy in Hibernate

Using Hibernate with multitenant data comes down to both an API and then integration piece(s). As usual, Hibernate strives to keep the API simple and isolated from any underlying integration complexities. The API is really just defined by passing the tenant identifier as part of opening any session.

*Example 600. Specifying tenant identifier from SessionFactory*

private void doInSession(String tenant, Consumer<Session> function) {

Session session = null;

Transaction txn = null;

try {

session = sessionFactory

.withOptions()

.tenantIdentifier( tenant )

.openSession();

txn = session.getTransaction();

txn.begin();

function.accept(session);

txn.commit();

} catch (Throwable e) {

if ( txn != null ) txn.rollback();

throw e;

} finally {

if (session != null) {

session.close();

}

}

}

Additionally, when specifying the configuration, an org.hibernate.MultiTenancyStrategy should be named using the hibernate.multiTenancy setting. Hibernate will perform validations based on the type of strategy you specify. The strategy here correlates to the isolation approach discussed above.

NONE

(the default) No multitenancy is expected. In fact, it is considered an error if a tenant identifier is specified when opening a session using this strategy.

SCHEMA

Correlates to the separate schema approach. It is an error to attempt to open a session without a tenant identifier using this strategy. Additionally, a MultiTenantConnectionProvider must be specified.

DATABASE

Correlates to the separate database approach. It is an error to attempt to open a session without a tenant identifier using this strategy. Additionally, a MultiTenantConnectionProvider must be specified.

DISCRIMINATOR

Correlates to the partitioned (discriminator) approach. It is an error to attempt to open a session without a tenant identifier using this strategy. This strategy is not yet implemented and you can follow its progress via the [HHH-6054 Jira issue](https://hibernate.atlassian.net/browse/HHH-6054).

#### 19.4.1. MultiTenantConnectionProvider

When using either the DATABASE or SCHEMA approach, Hibernate needs to be able to obtain Connections in a tenant-specific manner.

That is the role of the MultiTenantConnectionProvider contract. Application developers will need to provide an implementation of this contract.

Most of its methods are extremely self-explanatory. The only ones which might not be are getAnyConnection and releaseAnyConnection. It is important to note also that these methods do not accept the tenant identifier. Hibernate uses these methods during startup to perform various configuration, mainly via the java.sql.DatabaseMetaDataobject.

The MultiTenantConnectionProvider to use can be specified in a number of ways:

* Use the hibernate.multi\_tenant\_connection\_provider setting. It could name a MultiTenantConnectionProvider instance, a MultiTenantConnectionProvider implementation class reference or a MultiTenantConnectionProvider implementation class name.
* Passed directly to the org.hibernate.boot.registry.StandardServiceRegistryBuilder.
* If none of the above options match, but the settings do specify a hibernate.connection.datasource value, Hibernate will assume it should use the specific DataSourceBasedMultiTenantConnectionProviderImplimplementation which works on a number of pretty reasonable assumptions when running inside of an app server and using one javax.sql.DataSource per tenant. See its [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/connections/spi/DataSourceBasedMultiTenantConnectionProviderImpl.html) for more details.

The following example portrays a MultiTenantConnectionProvider implementation that handles multiple ConnectionProviders.

*Example 601. A MultiTenantConnectionProvider implementation*

public class ConfigurableMultiTenantConnectionProvider

extends AbstractMultiTenantConnectionProvider {

private final Map<String, ConnectionProvider> connectionProviderMap =

new HashMap<>( );

public ConfigurableMultiTenantConnectionProvider(

Map<String, ConnectionProvider> connectionProviderMap) {

this.connectionProviderMap.putAll( connectionProviderMap );

}

@Override

protected ConnectionProvider getAnyConnectionProvider() {

return connectionProviderMap.values().iterator().next();

}

@Override

protected ConnectionProvider selectConnectionProvider(String tenantIdentifier) {

return connectionProviderMap.get( tenantIdentifier );

}

}

The ConfigurableMultiTenantConnectionProvider can be set up as follows:

*Example 602. A MultiTenantConnectionProvider implementation*

private void init() {

registerConnectionProvider( FRONT\_END\_TENANT );

registerConnectionProvider( BACK\_END\_TENANT );

Map<String, Object> settings = new HashMap<>( );

settings.put( AvailableSettings.MULTI\_TENANT, multiTenancyStrategy() );

settings.put( AvailableSettings.MULTI\_TENANT\_CONNECTION\_PROVIDER,

new ConfigurableMultiTenantConnectionProvider( connectionProviderMap ) );

sessionFactory = sessionFactory(settings);

}

protected void registerConnectionProvider(String tenantIdentifier) {

Properties properties = properties();

properties.put( Environment.URL,

tenantUrl(properties.getProperty( Environment.URL ), tenantIdentifier) );

DriverManagerConnectionProviderImpl connectionProvider =

new DriverManagerConnectionProviderImpl();

connectionProvider.configure( properties );

connectionProviderMap.put( tenantIdentifier, connectionProvider );

}

When using multitenancy, it’s possible to save an entity with the same identifier across different tenants:

*Example 603. A MultiTenantConnectionProvider implementation*

doInSession( FRONT\_END\_TENANT, session -> {

Person person = new Person( );

person.setId( 1L );

person.setName( "John Doe" );

session.persist( person );

} );

doInSession( BACK\_END\_TENANT, session -> {

Person person = new Person( );

person.setId( 1L );

person.setName( "John Doe" );

session.persist( person );

} );

#### 19.4.2. CurrentTenantIdentifierResolver

org.hibernate.context.spi.CurrentTenantIdentifierResolver is a contract for Hibernate to be able to resolve what the application considers the current tenant identifier. The implementation to use is either passed directly to Configuration via its setCurrentTenantIdentifierResolver method. It can also be specified via the hibernate.tenant\_identifier\_resolver setting.

There are two situations where CurrentTenantIdentifierResolver is used:

* The first situation is when the application is using the org.hibernate.context.spi.CurrentSessionContextfeature in conjunction with multitenancy. In the case of the current-session feature, Hibernate will need to open a session if it cannot find an existing one in scope. However, when a session is opened in a multitenant environment, the tenant identifier has to be specified. This is where the CurrentTenantIdentifierResolver comes into play; Hibernate will consult the implementation you provide to determine the tenant identifier to use when opening the session. In this case, it is required that a CurrentTenantIdentifierResolver is supplied.
* The other situation is when you do not want to have to explicitly specify the tenant identifier all the time. If a CurrentTenantIdentifierResolver has been specified, Hibernate will use it to determine the default tenant identifier to use when opening the session.

Additionally, if the CurrentTenantIdentifierResolver implementation returns true for its validateExistingCurrentSessions method, Hibernate will make sure any existing sessions that are found in scope have a matching tenant identifier. This capability is only pertinent when the CurrentTenantIdentifierResolver is used in current-session settings.

#### 19.4.3. Caching

Multitenancy support in Hibernate works seamlessly with the Hibernate second level cache. The key used to cache data encodes the tenant identifier.

|  |  |
| --- | --- |
|  | Currently, schema export will not really work with multitenancy. That may not change.  The JPA expert group is in the process of defining multitenancy support for an upcoming version of the specification. |

## 20. OSGi

### 20.1. OSGi Specification and Environment

Hibernate targets the OSGi 4.3 spec or later. It was necessary to start with 4.3, over 4.2, due to our dependency on OSGi’s BundleWiring for entity/mapping scanning.

Hibernate supports three types of configurations within OSGi.

1. Container-Managed JPA [Container-Managed JPA](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#osgi-managed-jpa)
2. Unmanaged JPA [Unmanaged JPA](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#osgi-unmanaged-jpa)
3. Unmanaged Native [Unmanaged Native](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#osgi-unmanaged-native)

### 20.2. hibernate-osgi

Rather than embed OSGi capabilities into hibernate-core, and sub-modules, hibernate-osgi was created. It’s purposefully separated, isolating all OSGi dependencies. It provides an OSGi-specific ClassLoader (aggregates the container’s ClassLoader with core and EntityManager ClassLoader`s), JPA persistence provider, `SessionFactory/EntityManagerFactory bootstrapping, entities/mappings scanner, and service management.

### 20.3. features.xml

Apache Karaf environments tend to make heavy use of its "features" concept, where a feature is a set of order-specific bundles focused on a concise capability. These features are typically defined in a features.xml file. Hibernate produces and releases its own features.xml that defines a core hibernate-orm, as well as additional features for optional functionality (caching, Envers, etc.). This is included in the binary distribution, as well as deployed to the JBoss Nexus repository (using the org.hibernate groupId and hibernate-osgi with the karaf.xml classifier).

Note that our features are versioned using the same ORM artifact versions they wrap. Also, note that the features are heavily tested against Karaf 3.0.3 as a part of our PaxExam-based integration tests. However, they’ll likely work on other versions as well.

hibernate-osgi, theoretically, supports a variety of OSGi containers, such as Equinox. In that case, please use `features.xm`l as a reference for necessary bundles to activate and their correct ordering. However, note that Karaf starts a number of bundles automatically, several of which would need to be installed manually on alternatives.

### 20.4. QuickStarts/Demos

All three configurations have a QuickStart/Demo available in the [hibernate-demos](https://github.com/hibernate/hibernate-demos) project:

### 20.5. Container-Managed JPA

The Enterprise OSGi specification includes container-managed JPA. The container is responsible for discovering persistence units in bundles and automatically creating the EntityManagerFactory (one EntityManagerFactory per PersistenceUnit). It uses the JPA provider (hibernate-osgi) that has registered itself with the OSGi PersistenceProvider service.

### 20.6. Enterprise OSGi JPA Container

In order to utilize container-managed JPA, an Enterprise OSGi JPA container must be active in the runtime. In Karaf, this means Aries JPA, which is included out-of-the-box (simply activate the jpa and transaction features). Originally, we intended to include those dependencies within our own features.xml. However, after guidance from the Karaf and Aries teams, it was pulled out. This allows Hibernate OSGi to be portable and not be directly tied to Aries versions, instead having the user choose which to use.

That being said, the QuickStart/Demo projects include a sample [features.xml](https://github.com/hibernate/hibernate-demos/tree/master/hibernate-orm/osgi/managed-jpa/features.xml) showing which features need activated in Karaf in order to support this environment. As mentioned, use this purely as a reference!

### 20.7. persistence.xml

Similar to any other JPA setup, your bundle must include a persistence.xml file. This is typically located in META-INF.

### 20.8. DataSource

Typical Enterprise OSGi JPA usage includes a DataSource installed in the container. Your bundle’s persistence.xmlcalls out the DataSource through JNDI. For example, you could install the following H2 DataSource. You can deploy the DataSource manually (Karaf has a deploy dir), or through a "blueprint bundle" (blueprint:file:/[PATH]/datasource-h2.xml).

*Example 604. datasource-h2.xml*

<?xml version="1.0" encoding="UTF-8"?>

<!--

First install the H2 driver using:

> install -s mvn:com.h2database/h2/1.3.163

Then copy this file to the deploy folder

-->

<blueprint xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

<bean id="dataSource" class="org.h2.jdbcx.JdbcDataSource">

<property name="URL" value="jdbc:h2:mem:db1;DB\_CLOSE\_DELAY=-1;MVCC=TRUE"/>

<property name="user" value="sa"/>

<property name="password" value=""/>

</bean>

<service interface="javax.sql.DataSource" ref="dataSource">

<service-properties>

<entry key="osgi.jndi.service.name" value="jdbc/h2ds"/>

</service-properties>

</service>

</blueprint>

That DataSource is then used by your persistence.xml persistence-unit. The following works in Karaf, but the names may need tweaked in alternative containers.

*Example 605. META-INF/persistence.xml*

<jta-data-source>osgi:service/javax.sql.DataSource/(osgi.jndi.service.name=jdbc/h2ds)</jta-data-source>

### 20.9. Bundle Package Imports

Your bundle’s manifest will need to import, at a minimum,

* javax.persistence
* org.hibernate.proxy and javassist.util.proxy, due to Hibernate’s ability to return proxies for lazy initialization (Javassist enhancement occurs on the entity’s ClassLoader during runtime).

### 20.10. Obtaining an EntityManger

The easiest, and most supported, method of obtaining an EntityManager utilizes OSGi’s OSGI-INF/blueprint/blueprint.xml in your bundle. The container takes the name of your persistence unit, then automatically injects an EntityManager instance into your given bean attribute.

*Example 606. OSGI-INF/blueprint/blueprint.xml*

<?xml version="1.0" encoding="UTF-8"?>

<blueprint xmlns:jpa="http://aries.apache.org/xmlns/jpa/v1.0.0"

xmlns:tx="http://aries.apache.org/xmlns/transactions/v1.0.0"

default-activation="eager"

xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

<!-- This gets the container-managed EntityManager and injects it into the DataPointServiceImpl bean.

Assumes DataPointServiceImpl has an "entityManager" field with a getter and setter. -->

<bean id="dpService" class="org.hibernate.osgitest.DataPointServiceImpl">

<jpa:context unitname="managed-jpa" property="entityManager"/>

<tx:transaction method="\*" value="Required"/>

</bean>

<service ref="dpService" interface="org.hibernate.osgitest.DataPointService"/>

</blueprint>

### 20.11. Unmanaged JPA

Hibernate also supports the use of JPA, unmanaged by the OSGi container. The client bundle is responsible for managing the EntityManagerFactory and `EntityManager`s.

### 20.12. persistence.xml

Similar to any other JPA setup, your bundle must include a persistence.xml file. This is typically located in META-INF.

### 20.13. Bundle Package Imports

Your bundle’s manifest will need to import, at a minimum,

* javax.persistence
* org.hibernate.proxy and javassist.util.proxy, due to Hibernate’s ability to return proxies for lazy initialization (Javassist enhancement occurs on the entity’s ClassLoader during runtime)
* JDBC driver package (example: org.h2)
* org.osgi.framework, necessary to discover the EntityManagerFactory (described below)

### 20.14. Obtaining an EntityMangerFactory

hibernate-osgi registers an OSGi service, using the JPA PersistenceProvider interface name, that bootstraps and creates an EntityManagerFactory specific for OSGi environments.

|  |  |
| --- | --- |
|  | It is VITAL that your EntityManagerFactory be obtained through the service, rather than creating it manually. The service handles the OSGi ClassLoader, discovered extension points, scanning, etc. Manually creating an EntityManagerFactory is guaranteed to NOT work during runtime! |

*Example 607. Discover/Use EntityManagerFactory*

public class HibernateUtil {

private EntityManagerFactory emf;

public EntityManager getEntityManager() {

return getEntityManagerFactory().createEntityManager();

}

private EntityManagerFactory getEntityManagerFactory() {

if ( emf == null ) {

Bundle thisBundle = FrameworkUtil.getBundle(

HibernateUtil.class

);

BundleContext context = thisBundle.getBundleContext();

ServiceReference serviceReference = context.getServiceReference(

PersistenceProvider.class.getName()

);

PersistenceProvider persistenceProvider = ( PersistenceProvider ) context

.getService(

serviceReference

);

emf = persistenceProvider.createEntityManagerFactory(

"YourPersistenceUnitName",

null

);

}

return emf;

}

}

### 20.15. Unmanaged Native

Native Hibernate use is also supported. The client bundle is responsible for managing the SessionFactory and `Session`s.

### 20.16. Bundle Package Imports

Your bundle’s manifest will need to import, at a minimum,

* javax.persistence
* org.hibernate.proxy and javassist.util.proxy, due to Hibernate’s ability to return proxies for lazy initialization (Javassist enhancement occurs on the entity’s ClassLoader during runtime)
* JDBC driver package (example: org.h2)
* org.osgi.framework, necessary to discover the SessionFactory (described below)
* org.hibernate.\* packages, as necessary (ex: cfg, criterion, service, etc.)

### 20.17. Obtaining an SessionFactory

hibernate-osgi registers an OSGi service, using the SessionFactory interface name, that bootstraps and creates a SessionFactory specific for OSGi environments.

|  |  |
| --- | --- |
|  | It is VITAL that your SessionFactory be obtained through the service, rather than creating it manually. The service handles the OSGi ClassLoader, discovered extension points, scanning, etc. Manually creating a SessionFactory is guaranteed to NOT work during runtime! |

*Example 608. Discover/Use SessionFactory*

public class HibernateUtil {

private SessionFactory sf;

public Session getSession() {

return getSessionFactory().openSession();

}

private SessionFactory getSessionFactory() {

if ( sf == null ) {

Bundle thisBundle = FrameworkUtil.getBundle(

HibernateUtil.class

);

BundleContext context = thisBundle.getBundleContext();

ServiceReference sr = context.getServiceReference(

SessionFactory.class.getName()

);

sf = ( SessionFactory ) context.getService( sr );

}

return sf;

}

}

### 20.18. Optional Modules

The [unmanaged-native](https://github.com/hibernate/hibernate-demos/tree/master/hibernate-orm/osgi/unmanaged-native) demo project displays the use of optional Hibernate modules. Each module adds additional dependency bundles that must first be activated, either manually or through an additional feature. As of ORM 4.2, Envers is fully supported. Support for C3P0, Proxool, EhCache, and Infinispan were added in 4.3, however none of their 3rd party libraries currently work in OSGi (lots of ClassLoader problems, etc.). We’re tracking the issues in JIRA.

### 20.19. Extension Points

Multiple contracts exist to allow applications to integrate with and extend Hibernate capabilities. Most apps utilize JDK services to provide their implementations. hibernate-osgi supports the same extensions through OSGi services. Implement and register them in any of the three configurations. hibernate-osgi will discover and integrate them during EntityManagerFactory/SessionFactory bootstrapping. Supported extension points are as follows. The specified interface should be used during service registration.

org.hibernate.integrator.spi.Integrator

(as of 4.2)

org.hibernate.boot.registry.selector.StrategyRegistrationProvider

(as of 4.3)

org.hibernate.boot.model.TypeContributor

(as of 4.3)

JTA’s

javax.transaction.TransactionManager and javax.transaction.UserTransaction (as of 4.2), however these are typically provided by the OSGi container.

The easiest way to register extension point implementations is through a blueprint.xml file. Add OSGI-INF/blueprint/blueprint.xml to your classpath. Envers' blueprint is a great example:

*Example 609. Example extension point registrations in blueprint.xml*

<!--

~ Hibernate, Relational Persistence for Idiomatic Java

~

~ License: GNU Lesser General Public License (LGPL), version 2.1 or later.

~ See the lgpl.txt file in the root directory or <http://www.gnu.org/licenses/lgpl-2.1.html>.

-->

<blueprint default-activation="eager"

xmlns="http://www.osgi.org/xmlns/blueprint/v1.0.0">

<bean id="integrator" class="org.hibernate.envers.boot.internal.EnversIntegrator"/>

<service ref="integrator" interface="org.hibernate.integrator.spi.Integrator"/>

<bean id="typeContributor"

class="org.hibernate.envers.boot.internal.TypeContributorImpl"/>

<service ref="typeContributor" interface="org.hibernate.boot.model.TypeContributor"/>

</blueprint>

Extension points can also be registered programmatically with BundleContext#registerService, typically within your BundleActivator#start.

### 20.20. Caveats

* Technically, multiple persistence units are supported by Enterprise OSGi JPA and unmanaged Hibernate JPA use. However, we cannot currently support this in OSGi. In Hibernate 4, only one instance of the OSGi-specific ClassLoader is used per Hibernate bundle, mainly due to heavy use of static TCCL utilities. We hope to support one OSGi ClassLoader per persistence unit in Hibernate 5.
* Scanning is supported to find non-explicitly listed entities and mappings. However, they MUST be in the same bundle as your persistence unit (fairly typical anyway). Our OSGi ClassLoader only considers the "requesting bundle" (hence the requirement on using services to create EntityManagerFactory/SessionFactory), rather than attempting to scan all available bundles. This is primarily for versioning considerations, collision protections, etc.
* Some containers (ex: Aries) always return true for PersistenceUnitInfo#excludeUnlistedClasses, even if your persistence.xml explicitly has exclude-unlisted-classes set to false. They claim it’s to protect JPA providers from having to implement scanning ("we handle it for you"), even though we still want to support it in many cases. The work around is to set hibernate.archive.autodetection to, for example, hbm,class. This tells hibernate to ignore the excludeUnlistedClasses value and scan for \*.hbm.xml and entities regardless.
* Scanning does not currently support annotated packages on package-info.java.
* Currently, Hibernate OSGi is primarily tested using Apache Karaf and Apache Aries JPA. Additional testing is needed with Equinox, Gemini, and other container providers.
* Hibernate ORM has many dependencies that do not currently provide OSGi manifests. The QuickStart tutorials make heavy use of 3rd party bundles (SpringSource, ServiceMix) or the wrap:…​ operator.

## 21. Envers

### 21.1. Basics

To audit changes that are performed on an entity, you only need two things:

* the hibernate-envers jar on the classpath,
* an @Audited annotation on the entity.

|  |  |
| --- | --- |
|  | Unlike in previous versions, you no longer need to specify listeners in the Hibernate configuration file. Just putting the Envers jar on the classpath is enough because listeners will be registered automatically. |

And that’s all. You can create, modify and delete the entities as always.

If you look at the generated schema for your entities, or at the data persisted by Hibernate, you will notice that there are no changes. However, for each audited entity, a new table is introduced - entity\_table\_AUD, which stores the historical data, whenever you commit a transaction.

|  |  |
| --- | --- |
|  | Envers automatically creates audit tables if hibernate.hbm2ddl.auto option is set to create, create-drop or update. Appropriate DDL statements can also be generated with an Ant task in [Generating Envers schema with Hibernate hbm2ddl tool](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-generateschema). |

Considering we have a Customer entity, when annotating it with the Audited annotation, Hibernate is going to generate the following tables using the hibernate.hbm2ddl.auto schema tool:

*Example 610. Basic Envers entity mapping*

@Audited

@Entity(name = "Customer")

public static class Customer {

@Id

private Long id;

private String firstName;

private String lastName;

@Temporal( TemporalType.TIMESTAMP )

@Column(name = "created\_on")

@CreationTimestamp

private Date createdOn;

//Getters and setters are omitted for brevity

}

create table Customer (

id bigint not null,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

primary key (id)

)

create table Customer\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

primary key (id, REV)

)

create table REVINFO (

REV integer generated by default as identity,

REVTSTMP bigint,

primary key (REV)

)

alter table Customer\_AUD

add constraint FK5ecvi1a0ykunrriib7j28vpdj

foreign key (REV)

references REVINFO

Instead of annotating the whole class and auditing all properties, you can annotate only some persistent properties with @Audited. This will cause only these properties to be audited.

Now, considering the previous Customer entity, let’s see how Envers auditing works when inserting, updating, and deleting the entity in question.

*Example 611. Auditing the entity INSERT operation*

Customer customer = new Customer();

customer.setId( 1L );

customer.setFirstName( "John" );

customer.setLastName( "Doe" );

entityManager.persist( customer );

insert

into

Customer

(created\_on, firstName, lastName, id)

values

(?, ?, ?, ?)

-- binding parameter [1] as [TIMESTAMP] - [Mon Jul 24 17:21:32 EEST 2017]

-- binding parameter [2] as [VARCHAR] - [John]

-- binding parameter [3] as [VARCHAR] - [Doe]

-- binding parameter [4] as [BIGINT] - [1]

insert

into

REVINFO

(REV, REVTSTMP)

values

(?, ?)

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [BIGINT] - [1500906092803]

insert

into

Customer\_AUD

(REVTYPE, created\_on, firstName, lastName, id, REV)

values

(?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [INTEGER] - [0]

-- binding parameter [2] as [TIMESTAMP] - [Mon Jul 24 17:21:32 EEST 2017]

-- binding parameter [3] as [VARCHAR] - [John]

-- binding parameter [4] as [VARCHAR] - [Doe]

-- binding parameter [5] as [BIGINT] - [1]

-- binding parameter [6] as [INTEGER] - [1]

*Example 612. Auditing the entity UPDATE operation*

Customer customer = entityManager.find( Customer.class, 1L );

customer.setLastName( "Doe Jr." );

update

Customer

set

created\_on=?,

firstName=?,

lastName=?

where

id=?

-- binding parameter [1] as [TIMESTAMP] - [2017-07-24 17:21:32.757]

-- binding parameter [2] as [VARCHAR] - [John]

-- binding parameter [3] as [VARCHAR] - [Doe Jr.]

-- binding parameter [4] as [BIGINT] - [1]

insert

into

REVINFO

(REV, REVTSTMP)

values

(?, ?)

-- binding parameter [1] as [BIGINT] - [2]

-- binding parameter [2] as [BIGINT] - [1500906092853]

insert

into

Customer\_AUD

(REVTYPE, created\_on, firstName, lastName, id, REV)

values

(?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [TIMESTAMP] - [2017-07-24 17:21:32.757]

-- binding parameter [3] as [VARCHAR] - [John]

-- binding parameter [4] as [VARCHAR] - [Doe Jr.]

-- binding parameter [5] as [BIGINT] - [1]

-- binding parameter [6] as [INTEGER] - [2]

*Example 613. Auditing the entity DELETE operation*

Customer customer = entityManager.getReference( Customer.class, 1L );

entityManager.remove( customer );

delete

from

Customer

where

id = ?

-- binding parameter [1] as [BIGINT] - [1]

insert

into

REVINFO

(REV, REVTSTMP)

values

(?, ?)

-- binding parameter [1] as [BIGINT] - [3]

-- binding parameter [2] as [BIGINT] - [1500906092876]

insert

into

Customer\_AUD

(REVTYPE, created\_on, firstName, lastName, id, REV)

values

(?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [INTEGER] - [2]

-- binding parameter [2] as [TIMESTAMP] - [null]

-- binding parameter [3] as [VARCHAR] - [null]

-- binding parameter [4] as [VARCHAR] - [null]

-- binding parameter [5] as [BIGINT] - [1]

-- binding parameter [6] as [INTEGER] - [3]

The REVTYPE column value is taken from the [RevisionType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/envers/RevisionType.html) Enum.

|  |  |  |
| --- | --- | --- |
| *Table 10. REVTYPE column values* | | |
| Database column value | Associated RevisionType Enum value | Description |
| 0 | ADD | A database table row was inserted. |
| 1 | MOD | A database table row was updated. |
| 2 | DEL | A database table row was deleted. |

The audit (history) of an entity can be accessed using the AuditReader interface, which can be obtained having an open EntityManager or Session via the AuditReaderFactory.

*Example 614. Getting a list of revisions for the Customer entity*

List<Number> revisions = doInJPA( this::entityManagerFactory, entityManager -> {

return AuditReaderFactory.get( entityManager ).getRevisions(

Customer.class,

1L

);

} );

select

c.REV as col\_0\_0\_

from

Customer\_AUD c

cross join

REVINFO r

where

c.id = ?

and c.REV = r.REV

order by

c.REV asc

-- binding parameter [1] as [BIGINT] - [1]

Using the previously fetched revisions, we can now inspect the state of the Customer entity at that particular revision:

*Example 615. Getting the first revision for the Customer entity*

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, revisions.get( 0 ) )

.getSingleResult();

assertEquals("Doe", customer.getLastName());

select

c.id as id1\_1\_,

c.REV as REV2\_1\_,

c.REVTYPE as REVTYPE3\_1\_,

c.created\_on as created\_4\_1\_,

c.firstName as firstNam5\_1\_,

c.lastName as lastName6\_1\_

from

Customer\_AUD c

where

c.REV = (

select

max( c\_max.REV )

from

Customer\_AUD c\_max

where

c\_max.REV <= ?

and c.id = c\_max.id

)

and c.REVTYPE <> ?

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

When executing the aforementioned SQL query, there are two parameters:

revision\_number

The first parameter marks the revision number we are interested in or the latest one that exist up to this particular revision.

revision\_type

The second parameter specifies that we are not interested in DEL RevisionType so that deleted entries are filtered out.

The same goes for the second revision associated to the UPDATE statement.

*Example 616. Getting the second revision for the Customer entity*

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, revisions.get( 1 ) )

.getSingleResult();

assertEquals("Doe Jr.", customer.getLastName());

For the deleted entity revision, Envers throws a NoResultException since the entity was no longer valid at that revision.

*Example 617. Getting the third revision for the Customer entity*

try {

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, revisions.get( 2 ) )

.getSingleResult();

fail("The Customer was deleted at this revision: " + revisions.get( 2 ));

}

catch (NoResultException expected) {

}

You can use the [forEntitiesAtRevision(Class<T> cls, String entityName, Number revision, boolean includeDeletions)](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/envers/query/AuditQueryCreator.html#forEntitiesAtRevision-java.lang.Class-java.lang.String-java.lang.Number-boolean-) method to get the deleted entity revision so that, instead of a NoResultException, all attributes, except for the entity identifier, are going to be null.

*Example 618. Getting the third revision for the Customer entity without getting a NoResultException*

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision(

Customer.class,

Customer.class.getName(),

revisions.get( 2 ),

true )

.getSingleResult();

assertEquals( Long.valueOf( 1L ), customer.getId() );

assertNull( customer.getFirstName() );

assertNull( customer.getLastName() );

assertNull( customer.getCreatedOn() );

See the [Javadocs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/envers/AuditReader.html) for details on other functionality offered.

### 21.2. Configuration Properties

It is possible to configure various aspects of Hibernate Envers behavior, such as table names, etc.

**org.hibernate.envers.audit\_table\_prefix**

String that will be prepended to the name of an audited entity to create the name of the entity and that will hold audit information.

**org.hibernate.envers.audit\_table\_suffix** (default: \_AUD)

String that will be appended to the name of an audited entity to create the name of the entity and that will hold audit information.

If you audit an entity with a table name Person, in the default setting Envers will generate a Person\_AUD table to store historical data.

**org.hibernate.envers.revision\_field\_name** (default: REV)

Name of a field in the audit entity that will hold the revision number.

**org.hibernate.envers.revision\_type\_field\_name** (default: REVTYPE )

Name of a field in the audit entity that will hold the type of the revision (currently, this can be: add, mod, del).

**org.hibernate.envers.revision\_on\_collection\_change** (default: true )

Should a revision be generated when a not-owned relation field changes (this can be either a collection in a one-to-many relation, or the field using mappedBy attribute in a one-to-one relation).

**org.hibernate.envers.do\_not\_audit\_optimistic\_locking\_field** (default: true )

When true, properties to be used for optimistic locking, annotated with @Version, will not be automatically audited (their history won’t be stored; it normally doesn’t make sense to store it).

**org.hibernate.envers.store\_data\_at\_delete** (default: false )

Should the entity data be stored in the revision when the entity is deleted (instead of only storing the id and all other properties as null).

This is not normally needed, as the data is present in the last-but-one revision. Sometimes, however, it is easier and more efficient to access it in the last revision (then the data that the entity contained before deletion is stored twice).

**org.hibernate.envers.default\_schema** (default: null - same schema as table being audited)

The default schema name that should be used for audit tables.

Can be overridden using the @AuditTable( schema="…​" ) annotation.

If not present, the schema will be the same as the schema of the table being audited.

**org.hibernate.envers.default\_catalog** (default: null - same catalog as table being audited)

The default catalog name that should be used for audit tables.

Can be overridden using the @AuditTable( catalog="…​" ) annotation.

If not present, the catalog will be the same as the catalog of the normal tables.

**org.hibernate.envers.audit\_strategy**(default: org.hibernate.envers.strategy.DefaultAuditStrategy )

The audit strategy that should be used when persisting audit data. The default stores only the revision, at which an entity was modified.

An alternative, the org.hibernate.envers.strategy.ValidityAuditStrategy stores both the start revision and the end revision. Together these define when an audit row was valid, hence the name ValidityAuditStrategy.

**org.hibernate.envers.audit\_strategy\_validity\_end\_rev\_field\_name** (default: REVEND)

The column name that will hold the end revision number in audit entities. This property is only valid if the validity audit strategy is used.

**org.hibernate.envers.audit\_strategy\_validity\_store\_revend\_timestamp**(default: false )

Should the timestamp of the end revision be stored, until which the data was valid, in addition to the end revision itself. This is useful to be able to purge old Audit records out of a relational database by using table partitioning.

Partitioning requires a column that exists within the table. This property is only evaluated if the ValidityAuditStrategy is used.

**org.hibernate.envers.audit\_strategy\_validity\_revend\_timestamp\_field\_name**(default: REVEND\_TSTMP )

Column name of the timestamp of the end revision until which the data was valid. Only used if the ValidityAuditStrategy is used, and org.hibernate.envers.audit\_strategy\_validity\_store\_revend\_timestamp evaluates to true

**org.hibernate.envers.use\_revision\_entity\_with\_native\_id** (default: true )

Boolean flag that determines the strategy of revision number generation. Default implementation of revision entity uses native identifier generator.

If current database engine does not support identity columns, users are advised to set this property to false.

In this case revision numbers are created by preconfigured org.hibernate.id.enhanced.SequenceStyleGenerator. See: org.hibernate.envers.DefaultRevisionEntity and org.hibernate.envers.enhanced.SequenceIdRevisionEntity.

**org.hibernate.envers.track\_entities\_changed\_in\_revision** (default: false )

Should entity types, that have been modified during each revision, be tracked. The default implementation creates REVCHANGES table that stores entity names of modified persistent objects. Single record encapsulates the revision identifier (foreign key to REVINFO table) and a string value. For more information, refer to [Tracking entity names modified during revisions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-modified-entities-revchanges) and [Querying for entity types modified in a given revision](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-modified-entities-queries).

**org.hibernate.envers.global\_with\_modified\_flag** (default: false, can be individually overridden with @Audited( withModifiedFlag=true ) )

Should property modification flags be stored for all audited entities and all properties.

When set to true, for all properties an additional boolean column in the audit tables will be created, filled with information if the given property changed in the given revision.

When set to false, such column can be added to selected entities or properties using the @Audited annotation.

For more information, refer to [Tracking entity changes at property level](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-properties-changes) and [Querying for revisions of entity that modified a given property](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-properties-changes-queries).

**org.hibernate.envers.modified\_flag\_suffix** (default: \_MOD )

The suffix for columns storing "Modified Flags".

For example: a property called "age", will by default get modified flag with column name "age\_MOD".

**org.hibernate.envers.embeddable\_set\_ordinal\_field\_name** (default: SETORDINAL )

Name of column used for storing ordinal of the change in sets of embeddable elements.

**org.hibernate.envers.cascade\_delete\_revision** (default: false )

While deleting revision entry, remove data of associated audited entities. Requires database support for cascade row removal.

**org.hibernate.envers.allow\_identifier\_reuse** (default: false )

Guarantees proper validity audit strategy behavior when application reuses identifiers of deleted entities. Exactly one row with null end date exists for each identifier.

**org.hibernate.envers.original\_id\_prop\_name** (default: originalId )

Specifies the composite-id key property name used by the audit table mappings.

|  |  |
| --- | --- |
|  | The following configuration options have been added recently and should be regarded as experimental:   1. org.hibernate.envers.track\_entities\_changed\_in\_revision 2. org.hibernate.envers.using\_modified\_flag 3. org.hibernate.envers.modified\_flag\_suffix 4. org.hibernate.envers.original\_id\_prop\_name |

### 21.3. Additional mapping annotations

The name of the audit table can be set on a per-entity basis, using the @AuditTable annotation. It may be tedious to add this annotation to every audited entity, so if possible, it’s better to use a prefix/suffix.

If you have a mapping with secondary tables, audit tables for them will be generated in the same way (by adding the prefix and suffix). If you wish to overwrite this behavior, you can use the @SecondaryAuditTable and @SecondaryAuditTables annotations.

If you’d like to override auditing behavior of some fields/properties inherited from @MappedSuperclass or in an embedded component, you can apply the @AuditOverride annotation on the subtype or usage site of the component.

If you want to audit a relation mapped with @OneToMany and @JoinColumn, please see [Mapping exceptions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-mappingexceptions) for a description of the additional @AuditJoinTable annotation that you’ll probably want to use.

If you want to audit a relation, where the target entity is not audited (that is the case for example with dictionary-like entities, which don’t change and don’t have to be audited), just annotate it with @Audited( targetAuditMode = RelationTargetAuditMode.NOT\_AUDITED ). Then, while reading historic versions of your entity, the relation will always point to the "current" related entity. By default Envers throws javax.persistence.EntityNotFoundException when "current" entity does not exist in the database. Apply @NotFound( action = NotFoundAction.IGNORE ) annotation to silence the exception and assign null value instead. The hereby solution causes implicit eager loading of to-one relations.

If you’d like to audit properties of a superclass of an entity, which are not explicitly audited (they don’t have the @Audited annotation on any properties or on the class), you can set the @AuditOverride( forClass = SomeEntity.class, isAudited = true/false ) annotation.

|  |  |
| --- | --- |
|  | The @Audited annotation also features an auditParents attribute but it’s now deprecated in favor of @AuditOverride, |

### 21.4. Choosing an audit strategy

After the basic configuration, it is important to choose the audit strategy that will be used to persist and retrieve audit information. There is a trade-off between the performance of persisting and the performance of querying the audit information. Currently, there are two audit strategies.

1. The default audit strategy persists the audit data together with a start revision. For each row inserted, updated or deleted in an audited table, one or more rows are inserted in the audit tables, together with the start revision of its validity. Rows in the audit tables are never updated after insertion. Queries of audit information use subqueries to select the applicable rows in the audit tables.

|  |  |
| --- | --- |
|  | These subqueries are notoriously slow and difficult to index. |

1. The alternative is a validity audit strategy. This strategy stores the start-revision and the end-revision of audit information. For each row inserted, updated or deleted in an audited table, one or more rows are inserted in the audit tables, together with the start revision of its validity. But at the same time the end-revision field of the previous audit rows (if available) are set to this revision. Queries on the audit information can then use 'between start and end revision' instead of subqueries as used by the default audit strategy.

The consequence of this strategy is that persisting audit information will be a bit slower because of the extra updates involved, but retrieving audit information will be a lot faster.

|  |  |
| --- | --- |
|  | This can be improved even further by adding extra indexes. |

#### 21.4.1. Configuring the ValidityAuditStrategy

To better visualize how the ValidityAuditStrategy, consider the following exercise where we replay the previous audit logging example for the Customer entity.

First, you need to configure the ValidityAuditStrategy:

*Example 619. Configuring the ValidityAuditStrategy*

options.put(

EnversSettings.AUDIT\_STRATEGY,

ValidityAuditStrategy.class.getName()

);

If, you’re using the persistence.xml configuration file, then the mapping will looks as follows:

<property

name="org.hibernate.envers.audit\_strategy"

value="org.hibernate.envers.strategy.ValidityAuditStrategy"

/>

Once you configured the ValidityAuditStrategy, the following schema is going to be automatically generated:

*Example 620. Envers schema for the ValidityAuditStrategy*

create table Customer (

id bigint not null,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

primary key (id)

)

create table Customer\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

REVEND integer,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

primary key (id, REV)

)

create table REVINFO (

REV integer generated by default as identity,

REVTSTMP bigint,

primary key (REV)

)

alter table Customer\_AUD

add constraint FK5ecvi1a0ykunrriib7j28vpdj

foreign key (REV)

references REVINFO

alter table Customer\_AUD

add constraint FKqd4fy7ww1yy95wi4wtaonre3f

foreign key (REVEND)

references REVINFO

As you can see, the REVEND column is added as well as its Foreign key to the REVINFO table.

When rerunning thee previous Customer audit log queries against the ValidityAuditStrategy, we get the following results:

*Example 621. Getting the first revision for the Customer entity*

select

c.id as id1\_1\_,

c.REV as REV2\_1\_,

c.REVTYPE as REVTYPE3\_1\_,

c.REVEND as REVEND4\_1\_,

c.created\_on as created\_5\_1\_,

c.firstName as firstNam6\_1\_,

c.lastName as lastName7\_1\_

from

Customer\_AUD c

where

c.REV <= ?

and c.REVTYPE <> ?

and (

c.REVEND > ?

or c.REVEND is null

)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [1]

|  |  |
| --- | --- |
|  | Compared to the default strategy, the ValidityAuditStrategy generates simpler queries that can render better execution plans. |

### 21.5. Revision Log

When Envers starts a new revision, it creates a new revision entity which stores information about the revision.

By default, that includes just:

revision number

An integral value (int/Integer or long/Long). Essentially the primary key of the revision

revision timestamp

Either a long/Long or java.util.Date value representing the instant at which the revision was made. When using a java.util.Date, instead of a long/Long for the revision timestamp, take care not to store it to a column data type which will loose precision.

Envers handles this information as an entity. By default it uses its own internal class to act as the entity, mapped to the REVINFO table. You can, however, supply your own approach to collecting this information which might be useful to capture additional details such as who made a change or the ip address from which the request came. There are two things you need to make this work:

1. First, you will need to tell Envers about the entity you wish to use. Your entity must use the @org.hibernate.envers.RevisionEntity annotation. It must define the two attributes described above annotated with @org.hibernate.envers.RevisionNumber and @org.hibernate.envers.RevisionTimestamp, respectively. You can extend from org.hibernate.envers.DefaultRevisionEntity, if you wish, to inherit all these required behaviors.

Simply add the custom revision entity as you do your normal entities and Envers will **find it**.

|  |  |
| --- | --- |
|  | It is an error for there to be multiple entities marked as @org.hibernate.envers.RevisionEntity |

1. Second, you need to tell Envers how to create instances of your revision entity which is handled by the [newRevision( Object revisionEntity )](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/envers/RevisionListener.html#newRevision-java.lang.Object-) method of the org.hibernate.envers.RevisionListener interface.

You tell Envers your custom org.hibernate.envers.RevisionListener implementation to use by specifying it on the @org.hibernate.envers.RevisionEntity annotation, using the value attribute. If your RevisionListenerclass is inaccessible from @RevisionEntity (e.g. it exists in a different module), set org.hibernate.envers.revision\_listener property to its fully qualified class name. Class name defined by the configuration parameter overrides revision entity’s value attribute.

Considering we have a CurrentUser utility which stores the current logged user:

*Example 622. CurrentUser utility*

public static class CurrentUser {

public static final CurrentUser INSTANCE = new CurrentUser();

private static final ThreadLocal<String> storage = new ThreadLocal<>();

public void logIn(String user) {

storage.set( user );

}

public void logOut() {

storage.remove();

}

public String get() {

return storage.get();

}

}

Now, we need to provide a custom @RevisionEntity to store the currently logged user

*Example 623. Custom @RevisionEntity example*

@Entity(name = "CustomRevisionEntity")

@Table(name = "CUSTOM\_REV\_INFO")

@RevisionEntity( CustomRevisionEntityListener.class )

public static class CustomRevisionEntity extends DefaultRevisionEntity {

private String username;

public String getUsername() {

return username;

}

public void setUsername( String username ) {

this.username = username;

}

}

With the custom RevisionEntity implementation in place, we only need to provide the RevisionEntityimplementation which acts as a factory of RevisionEntity instances.

*Example 624. Custom @RevisionListener example*

public static class CustomRevisionEntityListener implements RevisionListener {

public void newRevision( Object revisionEntity ) {

CustomRevisionEntity customRevisionEntity =

( CustomRevisionEntity ) revisionEntity;

customRevisionEntity.setUsername(

CurrentUser.INSTANCE.get()

);

}

}

When generating the database schema, Envers creates the following RevisionEntity table:

*Example 625. Auto-generated RevisionEntity Envers table*

create table CUSTOM\_REV\_INFO (

id integer not null,

timestamp bigint not null,

username varchar(255),

primary key (id)

)

You can see the username column in place.

Now, when inserting a Customer entity, Envers generates the following statements:

*Example 626. Auditing using the custom @RevisionEntity instance*

CurrentUser.INSTANCE.logIn( "Vlad Mihalcea" );

doInJPA( this::entityManagerFactory, entityManager -> {

Customer customer = new Customer();

customer.setId( 1L );

customer.setFirstName( "John" );

customer.setLastName( "Doe" );

entityManager.persist( customer );

} );

CurrentUser.INSTANCE.logOut();

insert

into

Customer

(created\_on, firstName, lastName, id)

values

(?, ?, ?, ?)

-- binding parameter [1] as [TIMESTAMP] - [Thu Jul 27 15:45:00 EEST 2017]

-- binding parameter [2] as [VARCHAR] - [John]

-- binding parameter [3] as [VARCHAR] - [Doe]

-- binding parameter [4] as [BIGINT] - [1]

insert

into

CUSTOM\_REV\_INFO

(timestamp, username, id)

values

(?, ?, ?)

-- binding parameter [1] as [BIGINT] - [1501159500888]

-- binding parameter [2] as [VARCHAR] - [Vlad Mihalcea]

-- binding parameter [3] as [INTEGER] - [1]

insert

into

Customer\_AUD

(REVTYPE, created\_on, firstName, lastName, id, REV)

values

(?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [INTEGER] - [0]

-- binding parameter [2] as [TIMESTAMP] - [Thu Jul 27 15:45:00 EEST 2017]

-- binding parameter [3] as [VARCHAR] - [John]

-- binding parameter [4] as [VARCHAR] - [Doe]

-- binding parameter [5] as [BIGINT] - [1]

-- binding parameter [6] as [INTEGER] - [1]

As demonstrated by the example above, the username is properly set and propagated to the CUSTOM\_REV\_INFO table.

|  |  |
| --- | --- |
|  | **This strategy is deprecated since version 5.2 as an alternative is going to be provided in Hibernate Envers 6.0.**  An alternative method to using the org.hibernate.envers.RevisionListener is to instead call the[~~getCurrentRevision( Class<T> revisionEntityClass, boolean persist )~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/envers/AuditReader.html#getCurrentRevision-java.lang.Class-boolean-) method of the org.hibernate.envers.AuditReader interface to obtain the current revision, and fill it with desired information.  The method accepts a persist parameter indicating whether the revision entity should be persisted prior to returning from this method:  true  ensures that the returned entity has access to its identifier value (revision number), but the revision entity will be persisted regardless of whether there are any audited entities changed.  false  means that the revision number will be null, but the revision entity will be persisted only if some audited entities have changed. |

### 21.6. Tracking entity names modified during revisions

By default, entity types that have been changed in each revision are not being tracked. This implies the necessity to query all tables storing audited data in order to retrieve changes made during specified revision. Envers provides a simple mechanism that creates REVCHANGES table which stores entity names of modified persistent objects. Single record encapsulates the revision identifier (foreign key to REVINFO table) and a string value.

Tracking of modified entity names can be enabled in three different ways:

1. Set org.hibernate.envers.track\_entities\_changed\_in\_revision parameter to true. In this case org.hibernate.envers.DefaultTrackingModifiedEntitiesRevisionEntity will be implicitly used as the revision log entity.
2. Create a custom revision entity that extends org.hibernate.envers.DefaultTrackingModifiedEntitiesRevisionEntity class.
3. @Entity(name = "CustomTrackingRevisionEntity")
4. @Table(name = "TRACKING\_REV\_INFO")
5. @RevisionEntity
6. public static class CustomTrackingRevisionEntity
7. extends DefaultTrackingModifiedEntitiesRevisionEntity {

}

1. Mark an appropriate field of a custom revision entity with @org.hibernate.envers.ModifiedEntityNamesannotation. The property is required to be of Set<String> type.
2. @Entity(name = "CustomTrackingRevisionEntity")
3. @Table(name = "TRACKING\_REV\_INFO")
4. @RevisionEntity
5. public static class CustomTrackingRevisionEntity extends DefaultRevisionEntity {
6. @ElementCollection
7. @JoinTable(
8. name = "REVCHANGES",
9. joinColumns = @JoinColumn( name = "REV" )
10. )
11. @Column( name = "ENTITYNAME" )
12. @ModifiedEntityNames
13. private Set<String> modifiedEntityNames = new HashSet<>();
14. public Set<String> getModifiedEntityNames() {
15. return modifiedEntityNames;
16. }

}

Considering we have a Customer entity illustrated by the following example:

*Example 627. Customer entity before renaming*

@Audited

@Entity(name = "Customer")

public static class Customer {

@Id

private Long id;

private String firstName;

private String lastName;

@Temporal( TemporalType.TIMESTAMP )

@Column(name = "created\_on")

@CreationTimestamp

private Date createdOn;

//Getters and setters are omitted for brevity

}

If the Customer entity class name is changed to ApplicationCustomer, Envers is going to insert a new record in the REVCHANGES table with the previous entity class name:

*Example 628. Customer entity after renaming*

@Audited

@Entity(name = "Customer")

public static class ApplicationCustomer {

@Id

private Long id;

private String firstName;

private String lastName;

@Temporal( TemporalType.TIMESTAMP )

@Column(name = "created\_on")

@CreationTimestamp

private Date createdOn;

//Getters and setters are omitted for brevity

}

insert

into

REVCHANGES

(REV, ENTITYNAME)

values

(?, ?)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [VARCHAR] - [org.hibernate.userguide.envers.EntityTypeChangeAuditTest$Customer]

Users, that have chosen one of the approaches listed above, can retrieve all entities modified in a specified revision by utilizing API described in [Querying for entity types modified in a given revision](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-modified-entities-queries).

Users are also allowed to implement custom mechanism of tracking modified entity types. In this case, they shall pass their own implementation of org.hibernate.envers.EntityTrackingRevisionListener interface as the value of @org.hibernate.envers.RevisionEntity annotation.

EntityTrackingRevisionListener interface exposes one method that notifies whenever audited entity instance has been added, modified or removed within current revision boundaries.

*Example 629. The EntityTrackingRevisionListener implementation*

public static class CustomTrackingRevisionListener implements EntityTrackingRevisionListener {

@Override

public void entityChanged(Class entityClass,

String entityName,

Serializable entityId,

RevisionType revisionType,

Object revisionEntity ) {

String type = entityClass.getName();

( (CustomTrackingRevisionEntity) revisionEntity ).addModifiedEntityType( type );

}

@Override

public void newRevision( Object revisionEntity ) {

}

}

The CustomTrackingRevisionListener adds the fully-qualified class name to the modifiedEntityTypes attribute of the CustomTrackingRevisionEntity.

*Example 630. The RevisionEntity using the custom EntityTrackingRevisionListener*

@Entity(name = "CustomTrackingRevisionEntity")

@Table(name = "TRACKING\_REV\_INFO")

@RevisionEntity( CustomTrackingRevisionListener.class )

public static class CustomTrackingRevisionEntity {

@Id

@GeneratedValue

@RevisionNumber

private int customId;

@RevisionTimestamp

private long customTimestamp;

@OneToMany(

mappedBy="revision",

cascade={

CascadeType.PERSIST,

CascadeType.REMOVE

}

)

private Set<EntityType> modifiedEntityTypes = new HashSet<>();

public Set<EntityType> getModifiedEntityTypes() {

return modifiedEntityTypes;

}

public void addModifiedEntityType(String entityClassName ) {

modifiedEntityTypes.add( new EntityType( this, entityClassName ) );

}

}

The CustomTrackingRevisionEntity contains a @OneToMany list of ModifiedTypeRevisionEntity

*Example 631. The EntityType encapsulatets the entity type name before a class name modification*

@Entity(name = "EntityType")

public static class EntityType {

@Id

@GeneratedValue

private Integer id;

@ManyToOne

private CustomTrackingRevisionEntity revision;

private String entityClassName;

private EntityType() {

}

public EntityType(CustomTrackingRevisionEntity revision, String entityClassName) {

this.revision = revision;

this.entityClassName = entityClassName;

}

//Getters and setters are omitted for brevity

}

Now, when fetching the CustomTrackingRevisionEntity, you cna get access to the previous entity class name.

*Example 632. Getting the EntityType through the CustomTrackingRevisionEntity*

AuditReader auditReader = AuditReaderFactory.get( entityManager );

List<Number> revisions = auditReader.getRevisions(

ApplicationCustomer.class,

1L

);

CustomTrackingRevisionEntity revEntity = auditReader.findRevision(

CustomTrackingRevisionEntity.class,

revisions.get( 0 )

);

Set<EntityType> modifiedEntityTypes = revEntity.getModifiedEntityTypes();

assertEquals( 1, modifiedEntityTypes.size() );

EntityType entityType = modifiedEntityTypes.iterator().next();

assertEquals(

Customer.class.getName(),

entityType.getEntityClassName()

);

### 21.7. Tracking entity changes at property level

By default, the only information stored by Envers are revisions of modified entities. This approach lets user create audit queries based on historical values of entity properties. Sometimes it is useful to store additional metadata for each revision, when you are interested also in the type of changes, not only about the resulting values.

The feature described in [Tracking entity names modified during revisions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-modified-entities-revchanges) makes it possible to tell which entities were modified in a given revision.

The feature described here takes it one step further. Modification Flags enable Envers to track which properties of audited entities were modified in a given revision.

Tracking entity changes at property level can be enabled by:

1. setting org.hibernate.envers.global\_with\_modified\_flag configuration property to true. This global switch will cause adding modification flags to be stored for all audited properties of all audited entities.
2. using @Audited( withModifiedFlag=true ) on a property or on an entity.

The trade-off coming with this functionality is an increased size of audit tables and a very little, almost negligible, performance drop during audit writes. This is due to the fact that every tracked property has to have an accompanying boolean column in the schema that stores information about the property modifications. Of course it is Envers job to fill these columns accordingly - no additional work by the developer is required. Because of costs mentioned, it is recommended to enable the feature selectively, when needed with use of the granular configuration means described above.

*Example 633. Mapping for tracking entity changes at property level*

@Audited(withModifiedFlag = true)

@Entity(name = "Customer")

public static class Customer {

@Id

private Long id;

private String firstName;

private String lastName;

@Temporal( TemporalType.TIMESTAMP )

@Column(name = "created\_on")

@CreationTimestamp

private Date createdOn;

//Getters and setters are omitted for brevity

}

create table Customer\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

created\_on timestamp,

createdOn\_MOD boolean,

firstName varchar(255),

firstName\_MOD boolean,

lastName varchar(255),

lastName\_MOD boolean,

primary key (id, REV)

)

As you can see, every property features a \_MOD column (e.g. createdOn\_MOD) in the audit log.

*Example 634. Tracking entity changes at property level example*

Customer customer = entityManager.find( Customer.class, 1L );

customer.setLastName( "Doe Jr." );

update

Customer

set

created\_on = ?,

firstName = ?,

lastName = ?

where

id = ?

-- binding parameter [1] as [TIMESTAMP] - [2017-07-31 15:58:20.342]

-- binding parameter [2] as [VARCHAR] - [John]

-- binding parameter [3] as [VARCHAR] - [Doe Jr.]

-- binding parameter [4] as [BIGINT] - [1]

insert

into

REVINFO

(REV, REVTSTMP)

values

(null, ?)

-- binding parameter [1] as [BIGINT] - [1501505900439]

insert

into

Customer\_AUD

(REVTYPE, created\_on, createdOn\_MOD, firstName, firstName\_MOD, lastName, lastName\_MOD, id, REV)

values

(?, ?, ?, ?, ?, ?, ?, ?, ?)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [TIMESTAMP] - [2017-07-31 15:58:20.342]

-- binding parameter [3] as [BOOLEAN] - [false]

-- binding parameter [4] as [VARCHAR] - [John]

-- binding parameter [5] as [BOOLEAN] - [false]

-- binding parameter [6] as [VARCHAR] - [Doe Jr.]

-- binding parameter [7] as [BOOLEAN] - [true]

-- binding parameter [8] as [BIGINT] - [1]

-- binding parameter [9] as [INTEGER] - [2]

To see how "Modified Flags" can be utilized, check out the very simple query API that uses them: [Querying for revisions of entity that modified a given property](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-properties-changes-queries).

### 21.8. Queries

You can think of historic data as having two dimensions:

horizontal

The state of the database at a given revision. Thus, you can query for entities as they were at revision N.

vertical

The revisions, at which entities changed. Hence, you can query for revisions, in which a given entity changed.

The queries in Envers are similar to Hibernate Criteria queries, so if you are common with them, using Envers queries will be much easier.

The main limitation of the current queries implementation is that you cannot traverse relations. You can only specify constraints on the ids of the related entities, and only on the "owning" side of the relation. This however will be changed in future releases.

|  |  |
| --- | --- |
|  | The queries on the audited data will be in many cases much slower than corresponding queries on "live" data, as, especially for the default audit strategy, they involve correlated subselects.  Queries are improved both in terms of speed and possibilities, when using the validity audit strategy, which stores both start and end revisions for entities. See [Configuring the ValidityAuditStrategy](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-audit-ValidityAuditStrategy). |

### 21.9. Querying for entities of a class at a given revision

The entry point for this type of queries is:

*Example 635. Getting the Customer entity at a given revision*

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, revisions.get( 0 ) )

.getSingleResult();

assertEquals("Doe", customer.getLastName());

### 21.10. Querying for entities using filtering criteria

You can then specify constraints, which should be met by the entities returned, by adding restrictions, which can be obtained using the AuditEntity factory class.

For example, to select only entities where the firstName property is equal to "John":

*Example 636. Getting the Customer audit log with a given firstName attribute value*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, true )

.add( AuditEntity.property( "firstName" ).eq( "John" ) )

.getResultList();

assertEquals(2, customers.size());

assertEquals( "Doe", customers.get( 0 ).getLastName() );

assertEquals( "Doe Jr.", customers.get( 1 ).getLastName() );

And, to select only entities whose relationships are related to a given entity, you can use either the target entity or its identifier.

*Example 637. Getting the Customer entities whose address attribute matches the given entity reference*

Address address = entityManager.getReference( Address.class, 1L );

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, true )

.add( AuditEntity.property( "address" ).eq( address ) )

.getResultList();

assertEquals(2, customers.size());

select

c.id as id1\_3\_,

c.REV as REV2\_3\_,

c.REVTYPE as REVTYPE3\_3\_,

c.REVEND as REVEND4\_3\_,

c.created\_on as created\_5\_3\_,

c.firstName as firstNam6\_3\_,

c.lastName as lastName7\_3\_,

c.address\_id as address\_8\_3\_

from

Customer\_AUD c

where

c.address\_id = ?

order by

c.REV asc

-- binding parameter [1] as [BIGINT] - [1]

The same SQL is generated even if we provide the identifier instead of the target entity reference.

*Example 638. Getting the Customer entities whose address identifier matches the given entity identifier*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, true )

.add( AuditEntity.relatedId( "address" ).eq( 1L ) )

.getResultList();

assertEquals(2, customers.size());

Apart for strict equality matching, you can also use an IN clause to provide multiple entity identifiers:

*Example 639. Getting the Customer entities whose address identifier matches one of the given entity identifiers*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, true )

.add( AuditEntity.relatedId( "address" ).in( new Object[] { 1L, 2L } ) )

.getResultList();

assertEquals(2, customers.size());

select

c.id as id1\_3\_,

c.REV as REV2\_3\_,

c.REVTYPE as REVTYPE3\_3\_,

c.REVEND as REVEND4\_3\_,

c.created\_on as created\_5\_3\_,

c.firstName as firstNam6\_3\_,

c.lastName as lastName7\_3\_,

c.address\_id as address\_8\_3\_

from

Customer\_AUD c

where

c.address\_id in (

? , ?

)

order by

c.REV asc

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [BIGINT] - [2]

You can limit the number of results, order them, and set aggregations and projections (except grouping) in the usual way. When your query is complete, you can obtain the results by calling the getSingleResult() or getResultList()methods.

A full query, can look for example like this:

*Example 640. Getting the Customer entities using filtering and pagination*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, true )

.addOrder( AuditEntity.property( "lastName" ).desc() )

.add( AuditEntity.relatedId( "address" ).eq( 1L ) )

.setFirstResult( 1 )

.setMaxResults( 2 )

.getResultList();

assertEquals(1, customers.size());

select

c.id as id1\_3\_,

c.REV as REV2\_3\_,

c.REVTYPE as REVTYPE3\_3\_,

c.REVEND as REVEND4\_3\_,

c.created\_on as created\_5\_3\_,

c.firstName as firstNam6\_3\_,

c.lastName as lastName7\_3\_,

c.address\_id as address\_8\_3\_

from

Customer\_AUD c

where

c.address\_id = ?

order by

c.lastName desc

limit ?

offset ?

### 21.11. Querying for revisions, at which entities of a given class changed

The entry point for this type of queries is:

AuditQuery query = AuditReaderFactory.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, false, true );

You can add constraints to this query in the same way as to the previous one.

There are some additional possibilities:

1. using AuditEntity.revisionNumber() you can specify constraints, projections and order on the revision number, in which the audited entity was modified
2. similarly, using AuditEntity.revisionProperty( propertyName ) you can specify constraints, projections and order on a property of the revision entity, corresponding to the revision in which the audited entity was modified
3. AuditEntity.revisionType() gives you access as above to the type of the revision (ADD, MOD, DEL).

Using these methods, you can order the query results by revision number, set projection or constraint the revision number to be greater or less than a specified value, etc. For example, the following query will select the smallest revision number, at which entity of class MyEntity with id entityId has changed, after revision number 2:

Number revision = (Number) AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, false, true )

.addProjection( AuditEntity.revisionNumber().min() )

.add( AuditEntity.id().eq( 1L ) )

.add( AuditEntity.revisionNumber().gt( 2 ) )

.getSingleResult();

The second additional feature you can use in queries for revisions is the ability to maximize/minimize a property.

For example, if you want to select the smallest possibler revision at which the value of the createdOn attribute was larger then a given value, you can run the following query:

Number revision = (Number) AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, false, true )

.addProjection( AuditEntity.revisionNumber().min() )

.add( AuditEntity.id().eq( 1L ) )

.add(

AuditEntity.property( "createdOn" )

.minimize()

.add( AuditEntity.property( "createdOn" )

.ge(

Timestamp.from(

LocalDateTime.now()

.minusDays( 1 )

.toInstant( ZoneOffset.UTC )

)

)

)

)

.getSingleResult();

The minimize() and maximize() methods return a criteria, to which you can add constraints, which must be met by the entities with the maximized/minimized properties.

You probably also noticed that there are two boolean parameters, passed when creating the query.

selectEntitiesOnly

The first parameter is only valid when you don’t set an explicit projection.

If true, the result of the query will be a list of entities (which changed at revisions satisfying the specified constraints).

If false, the result will be a list of three element arrays:

* the first element will be the changed entity instance.
* the second will be an entity containing revision data (if no custom entity is used, this will be an instance of DefaultRevisionEntity).
* the third will be the type of the revision (one of the values of the RevisionType enumeration: ADD, MOD, DEL).

selectDeletedEntities

The second parameter specifies if revisions, in which the entity was deleted should be included in the results.

If yes, such entities will have the revision type DEL and all attributes, except the id, will be set to null.

Another useful feature is AggregatedAuditExpression#computeAggregationInInstanceContext(). This can be used to create an aggregate query based on the entity instance primary key.

For example, if you wanted to locate all customers but only wanted to retrieve the instances with the maximum revision number, you would use the following query:

List<Customer> results = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, true, false )

.add( AuditEntity.revisionNumber().maximize().computeAggregationInInstanceContext() )

.getResultList();

In other words, the result set would contain a list of Customer instances, one per primary key. Each instance would hold the audited property data at the maximum revision number for each Customer primary key.

### 21.12. Querying for revisions of entity that modified a given property

For the two types of queries described above it’s possible to use special Audit criteria called hasChanged() and hasNotChanged() that makes use of the functionality described in [Tracking entity changes at property level](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-properties-changes).

Let’s have a look at various queries that can benefit from these two criteria.

First, you must make sure that your entity can track modification flags:

*Example 641. Valid only when audit logging tracks entity attribute modification flags*

@Audited( withModifiedFlag = true )

The following query will return all revisions of the Customer entity with the given id, for which the lastName property has changed.

*Example 642. Getting all Customer revisions for which the lastName attribute has changed*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, false, true )

.add( AuditEntity.id().eq( 1L ) )

.add( AuditEntity.property( "lastName" ).hasChanged() )

.getResultList();

select

c.id as id1\_3\_0\_,

c.REV as REV2\_3\_0\_,

defaultrev1\_.REV as REV1\_4\_1\_,

c.REVTYPE as REVTYPE3\_3\_0\_,

c.REVEND as REVEND4\_3\_0\_,

c.created\_on as created\_5\_3\_0\_,

c.createdOn\_MOD as createdO6\_3\_0\_,

c.firstName as firstNam7\_3\_0\_,

c.firstName\_MOD as firstNam8\_3\_0\_,

c.lastName as lastName9\_3\_0\_,

c.lastName\_MOD as lastNam10\_3\_0\_,

c.address\_id as address11\_3\_0\_,

c.address\_MOD as address12\_3\_0\_,

defaultrev1\_.REVTSTMP as REVTSTMP2\_4\_1\_

from

Customer\_AUD c cross

join

REVINFO defaultrev1\_

where

c.id = ?

and c.lastName\_MOD = ?

and c.REV=defaultrev1\_.REV

order by

c.REV asc

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [BOOLEAN] - [true]

Using this query we won’t get all other revisions in which lastName wasn’t touched. From the SQL query you can see that the lastName\_MOD column is being used in the WHERE clause, hence the aforementioned requirement for tracking modification flags.

Of course, nothing prevents user from combining hasChanged condition with some additional criteria.

*Example 643. Getting all Customer revisions for which the lastName attribute has changed and the firstName attribute has not changed*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forRevisionsOfEntity( Customer.class, false, true )

.add( AuditEntity.id().eq( 1L ) )

.add( AuditEntity.property( "lastName" ).hasChanged() )

.add( AuditEntity.property( "firstName" ).hasNotChanged() )

.getResultList();

select

c.id as id1\_3\_0\_,

c.REV as REV2\_3\_0\_,

defaultrev1\_.REV as REV1\_4\_1\_,

c.REVTYPE as REVTYPE3\_3\_0\_,

c.REVEND as REVEND4\_3\_0\_,

c.created\_on as created\_5\_3\_0\_,

c.createdOn\_MOD as createdO6\_3\_0\_,

c.firstName as firstNam7\_3\_0\_,

c.firstName\_MOD as firstNam8\_3\_0\_,

c.lastName as lastName9\_3\_0\_,

c.lastName\_MOD as lastNam10\_3\_0\_,

c.address\_id as address11\_3\_0\_,

c.address\_MOD as address12\_3\_0\_,

defaultrev1\_.REVTSTMP as REVTSTMP2\_4\_1\_

from

Customer\_AUD c cross

join

REVINFO defaultrev1\_

where

c.id=?

and c.lastName\_MOD=?

and c.firstName\_MOD=?

and c.REV=defaultrev1\_.REV

order by

c.REV asc

-- binding parameter [1] as [BIGINT] - [1]

-- binding parameter [2] as [BOOLEAN] - [true]

-- binding parameter [3] as [BOOLEAN] - [false]

To get the Customer entities changed at a given revisionNumber with lastName modified and firstName untouched, we have to use the forEntitiesModifiedAtRevision query:

*Example 644. Getting the Customer entity for a given revision if the lastName attribute has changed and the firstName attribute has not changed*

Customer customer = (Customer) AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesModifiedAtRevision( Customer.class, 2 )

.add( AuditEntity.id().eq( 1L ) )

.add( AuditEntity.property( "lastName" ).hasChanged() )

.add( AuditEntity.property( "firstName" ).hasNotChanged() )

.getSingleResult();

select

c.id as id1\_3\_,

c.REV as REV2\_3\_,

c.REVTYPE as REVTYPE3\_3\_,

c.REVEND as REVEND4\_3\_,

c.created\_on as created\_5\_3\_,

c.createdOn\_MOD as createdO6\_3\_,

c.firstName as firstNam7\_3\_,

c.firstName\_MOD as firstNam8\_3\_,

c.lastName as lastName9\_3\_,

c.lastName\_MOD as lastNam10\_3\_,

c.address\_id as address11\_3\_,

c.address\_MOD as address12\_3\_

from

Customer\_AUD c

where

c.REV=?

and c.id=?

and c.lastName\_MOD=?

and c.firstName\_MOD=?

-- binding parameter [1] as [INTEGER] - [2]

-- binding parameter [2] as [BIGINT] - [1]

-- binding parameter [3] as [BOOLEAN] - [true]

-- binding parameter [4] as [BOOLEAN] - [false]

### 21.13. Querying for entity types modified in a given revision

|  |  |
| --- | --- |
|  | The methods described below can be used only when the default mechanism of tracking changed entity types is enabled (see [Tracking entity names modified during revisions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-tracking-modified-entities-revchanges)). |

This basic query allows retrieving entity names and corresponding Java classes changed in a specified revision:

*Example 645. Retrieving entity names and corresponding Java classes changed in a specified revision*

assertEquals(

"org.hibernate.userguide.envers.EntityTypeChangeAuditTest$Customer",

AuditReaderFactory

.get( entityManager )

.getCrossTypeRevisionChangesReader()

.findEntityTypes( 1 )

.iterator().next()

.getFirst()

);

assertEquals(

"org.hibernate.userguide.envers.EntityTypeChangeAuditTest$ApplicationCustomer",

AuditReaderFactory

.get( entityManager )

.getCrossTypeRevisionChangesReader()

.findEntityTypes( 2 )

.iterator().next()

.getFirst()

);

Other queries (also accessible from org.hibernate.envers.CrossTypeRevisionChangesReader):

List<Object> findEntities( Number )

Returns snapshots of all audited entities changed (added, updated and removed) in a given revision. Executes N+1 SQL queries, where N is a number of different entity classes modified within specified revision.

List<Object> findEntities( Number, RevisionType )

Returns snapshots of all audited entities changed (added, updated or removed) in a given revision filtered by modification type. Executes N+1 SQL queries, where N is a number of different entity classes modified within specified revision.

Map<RevisionType, List<Object>> findEntitiesGroupByRevisionType( Number )

Returns a map containing lists of entity snapshots grouped by modification operation (e.g. addition, update and removal). Executes 3N+1 SQL queries, where N is a number of different entity classes modified within specified revision.

### 21.14. Querying for entities using entity relation joins

|  |  |
| --- | --- |
|  | Relation join queries are considered experimental and may change in future releases. |

Audit queries support the ability to apply constraints, projections, and sort operations based on entity relations. In order to traverse entity relations through an audit query, you must use the relation traversal API with a join type.

|  |  |
| --- | --- |
|  | Relation joins can be applied to many-to-one and many-to-one mappings only when using JoinType.LEFT or JoinType.INNER. |

The basis for creating an entity relation join query is as follows:

*Example 646. INNER JOIN entity audit query*

AuditQuery innerJoinAuditQuery = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.INNER );

*Example 647. LEFT JOIN entity audit query*

AuditQuery innerJoinAuditQuery = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.LEFT );

Like any other query, constraints may be added to restrict the results.

For example, to find a Customers entities at a given revision whose addresses are in România, you can use the following query:

*Example 648. Filtering the join relation with a WHERE clause predicate*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.INNER )

.add( AuditEntity.property( "country" ).eq( "România" ) )

.getResultList();

select

c.id as id1\_3\_,

c.REV as REV2\_3\_,

c.REVTYPE as REVTYPE3\_3\_,

c.REVEND as REVEND4\_3\_,

c.created\_on as created\_5\_3\_,

c.firstName as firstNam6\_3\_,

c.lastName as lastName7\_3\_,

c.address\_id as address\_8\_3\_

from

Customer\_AUD c

inner join

Address\_AUD a

on (

c.address\_id=a.id

or (

c.address\_id is null

)

and (

a.id is null

)

)

where

c.REV<=?

and c.REVTYPE<>?

and (

c.REVEND>?

or c.REVEND is null

)

and a.REV<=?

and a.country=?

and (

a.REVEND>?

or a.REVEND is null

)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [1]

-- binding parameter [4] as [INTEGER] - [1]

-- binding parameter [5] as [VARCHAR] - [România]

-- binding parameter [6] as [INTEGER] - [1]

It is also possible to traverse beyond the first relation in an entity graph.

For example, to find all Customer entities at a given revision with the country attribute of the address property being România:

*Example 649. Filtering a nested join relation with a WHERE clause predicate*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.INNER )

.traverseRelation( "country", JoinType.INNER )

.add( AuditEntity.property( "name" ).eq( "România" ) )

.getResultList();

assertEquals( 1, customers.size() );

select

cu.id as id1\_5\_,

cu.REV as REV2\_5\_,

cu.REVTYPE as REVTYPE3\_5\_,

cu.REVEND as REVEND4\_5\_,

cu.created\_on as created\_5\_5\_,

cu.firstName as firstNam6\_5\_,

cu.lastName as lastName7\_5\_,

cu.address\_id as address\_8\_5\_

from

Customer\_AUD cu

inner join

Address\_AUD a

on (

cu.address\_id=a.id

or (

cu.address\_id is null

)

and (

a.id is null

)

)

inner join

Country\_AUD co

on (

a.country\_id=co.id

or (

a.country\_id is null

)

and (

co.id is null

)

)

where

cu.REV<=?

and cu.REVTYPE<>?

and (

cu.REVEND>?

or cu.REVEND is null

)

and a.REV<=?

and (

a.REVEND>?

or a.REVEND is null

)

and co.REV<=?

and co.name=?

and (

co.REVEND>?

or co.REVEND is null

)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [1]

-- binding parameter [4] as [INTEGER] - [1]

-- binding parameter [5] as [INTEGER] - [1]

-- binding parameter [6] as [INTEGER] - [1]

-- binding parameter [7] as [VARCHAR] - [România]

-- binding parameter [8] as [INTEGER] - [1]

Constraints may also be added to the properties of nested joined relations, such as testing for null.

For example, the following query illustrates how to find all Customer entities at a given revision having the address in Cluj-Napoca or the address does not have any country entity reference:

*Example 650. Filtering a join relation using multiple predicates*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.LEFT, "a" )

.add(

AuditEntity.or(

AuditEntity.property( "a", "city" ).eq( "Cluj-Napoca" ),

AuditEntity.relatedId( "country" ).eq( null )

)

)

.getResultList();

select

c.id as id1\_5\_,

c.REV as REV2\_5\_,

c.REVTYPE as REVTYPE3\_5\_,

c.REVEND as REVEND4\_5\_,

c.created\_on as created\_5\_5\_,

c.firstName as firstNam6\_5\_,

c.lastName as lastName7\_5\_,

c.address\_id as address\_8\_5\_

from

Customer\_AUD c

left outer join

Address\_AUD a

on (

c.address\_id=a.id

or (

c.address\_id is null

)

and (

a.id is null

)

)

where

c.REV<=?

and c.REVTYPE<>?

and (

c.REVEND>?

or c.REVEND is null

)

and (

a.REV is null

or a.REV<=?

and (

a.REVEND>?

or a.REVEND is null

)

)

and (

a.city=?

or a.country\_id is null

)

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [1]

-- binding parameter [4] as [INTEGER] - [1]

-- binding parameter [5] as [INTEGER] - [1]

-- binding parameter [6] as [VARCHAR] - [Cluj-Napoca]

|  |  |
| --- | --- |
|  | Queries can use the up method to navigate back up the entity graph. |

Disjunction criterion may also be applied to relation join queries.

For example, the following query will find all Customer entities at a given revision where the country name is Româniaor that the Customer lives in Cluj-Napoca:

*Example 651. Filtering a nested join relation using multiple predicates*

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, 1 )

.traverseRelation( "address", JoinType.INNER, "a" )

.traverseRelation( "country", JoinType.INNER, "cn" )

.up()

.up()

.add(

AuditEntity.disjunction()

.add( AuditEntity.property( "a", "city" ).eq( "Cluj-Napoca" ) )

.add( AuditEntity.property( "cn", "name" ).eq( "România" ) )

)

.addOrder( AuditEntity.property( "createdOn" ).asc() )

.getResultList();

select

cu.id as id1\_5\_,

cu.REV as REV2\_5\_,

cu.REVTYPE as REVTYPE3\_5\_,

cu.REVEND as REVEND4\_5\_,

cu.created\_on as created\_5\_5\_,

cu.firstName as firstNam6\_5\_,

cu.lastName as lastName7\_5\_,

cu.address\_id as address\_8\_5\_

from

Customer\_AUD cu

inner join

Address\_AUD a

on (

cu.address\_id=a.id

or (

cu.address\_id is null

)

and (

a.id is null

)

)

inner join

Country\_AUD co

on (

a.country\_id=co.id

or (

a.country\_id is null

)

and (

co.id is null

)

)

where

cu.REV<=?

and cu.REVTYPE<>?

and (

cu.REVEND>?

or cu.REVEND is null

)

and (

a.city=?

or co.name=?

)

and a.REV<=?

and (

a.REVEND>?

or a.REVEND is null

)

and co.REV<=?

and (

co.REVEND>?

or co.REVEND is null

)

order by

cu.created\_on asc

-- binding parameter [1] as [INTEGER] - [1]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [1]

-- binding parameter [4] as [VARCHAR] - [Cluj-Napoca]

-- binding parameter [5] as [VARCHAR] - [România]

-- binding parameter [6] as [INTEGER] - [1]

-- binding parameter [7] as [INTEGER] - [1]

-- binding parameter [8] as [INTEGER] - [1]

-- binding parameter [9] as [INTEGER] - [1]

Lastly, this example illustrates how related entity properties can be compared in a single constraint.

Assuming, the Customer and the Address were previously changed as follows:

*Example 652. Changing the Address to match the Country name*

Customer customer = entityManager.createQuery(

"select c " +

"from Customer c " +

"join fetch c.address a " +

"join fetch a.country " +

"where c.id = :id", Customer.class )

.setParameter( "id", 1L )

.getSingleResult();

customer.setLastName( "Doe Sr." );

customer.getAddress().setCity(

customer.getAddress().getCountry().getName()

);

The following query shows how to find the Customer entities where the city property of the address attribute equals the name of the associated country attribute.

*Example 653. Filtering a nested join relation using multiple predicates*

List<Number> revisions = AuditReaderFactory.get( entityManager ).getRevisions(

Customer.class,

1L

);

List<Customer> customers = AuditReaderFactory

.get( entityManager )

.createQuery()

.forEntitiesAtRevision( Customer.class, revisions.get( revisions.size() - 1 ) )

.traverseRelation( "address", JoinType.INNER, "a" )

.traverseRelation( "country", JoinType.INNER, "cn" )

.up()

.up()

.add( AuditEntity.property( "a", "city" ).eqProperty( "cn", "name" ) )

.getResultList();

select

cu.id as id1\_5\_,

cu.REV as REV2\_5\_,

cu.REVTYPE as REVTYPE3\_5\_,

cu.REVEND as REVEND4\_5\_,

cu.created\_on as created\_5\_5\_,

cu.firstName as firstNam6\_5\_,

cu.lastName as lastName7\_5\_,

cu.address\_id as address\_8\_5\_

from

Customer\_AUD cu

inner join

Address\_AUD a

on (

cu.address\_id=a.id

or (

cu.address\_id is null

)

and (

a.id is null

)

)

inner join

Country\_AUD cr

on (

a.country\_id=cr.id

or (

a.country\_id is null

)

and (

cr.id is null

)

)

where

cu.REV<=?

and cu.REVTYPE<>?

and a.city=cr.name

and (

cu.REVEND>?

or cu.REVEND is null

)

and a.REV<=?

and (

a.REVEND>?

or a.REVEND is null

)

and cr.REV<=?

and (

cr.REVEND>?

or cr.REVEND is null

)

-- binding parameter [1] as [INTEGER] - [2]

-- binding parameter [2] as [INTEGER] - [2]

-- binding parameter [3] as [INTEGER] - [2]

-- binding parameter [4] as [INTEGER] - [2]

-- binding parameter [5] as [INTEGER] - [2]

-- binding parameter [6] as [INTEGER] - [2]

-- binding parameter [7] as [INTEGER] - [2]

### 21.15. Conditional auditing

Envers persists audit data in reaction to various Hibernate events (e.g. post update, post insert, and so on), using a series of event listeners from the org.hibernate.envers.event.spi package. By default, if the Envers jar is in the classpath, the event listeners are auto-registered with Hibernate.

Conditional auditing can be implemented by overriding some of the Envers event listeners. To use customized Envers event listeners, the following steps are needed:

1. Turn off automatic Envers event listeners registration by setting the hibernate.envers.autoRegisterListenersHibernate property to false.
2. Create subclasses for appropriate event listeners. For example, if you want to conditionally audit entity insertions, extend the org.hibernate.envers.event.spi.EnversPostInsertEventListenerImpl class. Place the conditional-auditing logic in the subclasses, call the super method if auditing should be performed.
3. Create your own implementation of org.hibernate.integrator.spi.Integrator, similar to org.hibernate.envers.boot.internal.EnversIntegrator. Use your event listener classes instead of the default ones.
4. For the integrator to be automatically used when Hibernate starts up, you will need to add a META-INF/services/org.hibernate.integrator.spi.Integrator file to your jar. The file should contain the fully qualified name of the class implementing the interface.

|  |  |
| --- | --- |
|  | The use of hibernate.listeners.envers.autoRegister has been deprecated. A new configuration setting hibernate.envers.autoRegisterListeners should be used instead. |

### 21.16. Understanding the Envers Schema

For each audited entity (that is, for each entity containing at least one audited field), an audit table is created. By default, the audit table’s name is created by adding an "\_AUD" suffix to the original table name, but this can be overridden by specifying a different suffix/prefix in the configuration properties or per-entity using the @org.hibernate.envers.AuditTable annotation.

The audit table contains the following columns:

id

id of the original entity (this can be more then one column in the case of composite primary keys)

revision number

an integer, which matches to the revision number in the revision entity table.

revision type

The org.hibernate.envers.RevisionType enumeration ordinal stating if the change represent an INSERT, UPDATE or DELETE.

audited fields

properties from the original entity being audited

The primary key of the audit table is the combination of the original id of the entity and the revision number, so there can be at most one historic entry for a given entity instance at a given revision.

The current entity data is stored in the original table and in the audit table. This is a duplication of data, however as this solution makes the query system much more powerful, and as memory is cheap, hopefully this won’t be a major drawback for the users.

A row in the audit table with entity id ID, revision N and data D means: entity with id ID has data D from revision Nupwards. Hence, if we want to find an entity at revision M, we have to search for a row in the audit table, which has the revision number smaller or equal to M, but as large as possible. If no such row is found, or a row with a "deleted" marker is found, it means that the entity didn’t exist at that revision.

The "revision type" field can currently have three values: 0, 1 and 2, which means ADD, MOD and DEL, respectively. A row with a revision of type DEL will only contain the id of the entity and no data (all fields NULL), as it only serves as a marker saying "this entity was deleted at that revision".

Additionally, there is a revision entity table which contains the information about the global revision. By default the generated table is named REVINFO and contains just two columns: ID and TIMESTAMP. A row is inserted into this table on each new revision, that is, on each commit of a transaction, which changes audited data. The name of this table can be configured, the name of its columns as well as adding additional columns can be achieved as discussed in [Revision Log](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-revisionlog).

|  |  |
| --- | --- |
|  | While global revisions are a good way to provide correct auditing of relations, some people have pointed out that this may be a bottleneck in systems, where data is very often modified.  One viable solution is to introduce an option to have an entity "locally revisioned", that is revisions would be created for it independently. This woulld not enable correct versioning of relations, but it would work without the REVINFO table.  Another possibility is to introduce a notion of "revisioning groups", which would group entities sharing the same revision numbering. Each such group would have to consist of one or more strongly connected components belonging to the entity graph induced by relations between entities.  Your opinions on the subject are very welcome on the forum. |

### 21.17. Generating Envers schema with Hibernate hbm2ddl tool

If you would like to generate the database schema file with Hibernate, you simply need to use the hbm2ddl too.

This task will generate the definitions of all entities, both of which are audited by Envers and those which are not.

See the [Schema generation](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#schema-generation) chapter for more info.

For the following entities, Hibernate is going to generate the following database schema:

*Example 654. Filtering a nested join relation using multiple predicates*

@Audited

@Entity(name = "Customer")

public static class Customer {

@Id

private Long id;

private String firstName;

private String lastName;

@Temporal( TemporalType.TIMESTAMP )

@Column(name = "created\_on")

@CreationTimestamp

private Date createdOn;

@ManyToOne(fetch = FetchType.LAZY)

private Address address;

//Getters and setters omitted for brevity

}

@Audited

@Entity(name = "Address")

public static class Address {

@Id

private Long id;

@ManyToOne(fetch = FetchType.LAZY)

private Country country;

private String city;

private String street;

private String streetNumber;

//Getters and setters omitted for brevity

}

@Audited

@Entity(name = "Country")

public static class Country {

@Id

private Long id;

private String name;

//Getters and setters omitted for brevity

}

create table Address (

id bigint not null,

city varchar(255),

street varchar(255),

streetNumber varchar(255),

country\_id bigint,

primary key (id)

)

create table Address\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

REVEND integer,

city varchar(255),

street varchar(255),

streetNumber varchar(255),

country\_id bigint,

primary key (id, REV)

)

create table Country (

id bigint not null,

name varchar(255),

primary key (id)

)

create table Country\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

REVEND integer,

name varchar(255),

primary key (id, REV)

)

create table Customer (

id bigint not null,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

address\_id bigint,

primary key (id)

)

create table Customer\_AUD (

id bigint not null,

REV integer not null,

REVTYPE tinyint,

REVEND integer,

created\_on timestamp,

firstName varchar(255),

lastName varchar(255),

address\_id bigint,

primary key (id, REV)

)

create table REVINFO (

REV integer generated by default as identity,

REVTSTMP bigint,

primary key (REV)

)

alter table Address

add constraint FKpr4rl83u5fv832kdihl6w3kii

foreign key (country\_id)

references Country

alter table Address\_AUD

add constraint FKgwp5sek4pjb4awy66sp184hrv

foreign key (REV)

references REVINFO

alter table Address\_AUD

add constraint FK52pqkpismfxg2b9tmwtncnk0d

foreign key (REVEND)

references REVINFO

alter table Country\_AUD

add constraint FKrix4g8hm9ui6sut5sy86ujggr

foreign key (REV)

references REVINFO

alter table Country\_AUD

add constraint FKpjeqmdccv22y1lbtswjb84ghi

foreign key (REVEND)

references REVINFO

alter table Customer

add constraint FKfok4ytcqy7lovuiilldbebpd9

foreign key (address\_id)

references Address

alter table Customer\_AUD

add constraint FK5ecvi1a0ykunrriib7j28vpdj

foreign key (REV)

references REVINFO

alter table Customer\_AUD

add constraint FKqd4fy7ww1yy95wi4wtaonre3f

foreign key (REVEND)

references REVINFO

### 21.18. Mapping exceptions

#### 21.18.1. What isn’t and will not be supported

Bags are not supported because they can contain non-unique elements. Persisting, a bag of `String`s violates the relational database principle that each table is a set of tuples.

In case of bags, however (which require a join table), if there is a duplicate element, the two tuples corresponding to the elements will be the same. Hibernate allows this, however Envers (or more precisely: the database connector) will throw an exception when trying to persist two identical elements because of a unique constraint violation.

There are at least two ways out if you need bag semantics:

1. use an indexed collection, with the @javax.persistence.OrderColumn annotation
2. provide a unique id for your elements with the @CollectionId annotation.

#### 21.18.2. What isn’t and will be supported

1. Bag style collections with a @CollectionId identifier column (see [HHH-3950](https://hibernate.atlassian.net/browse/HHH-3950)).

### 21.19. @OneToMany with @JoinColumn

When a collection is mapped using these two annotations, Hibernate doesn’t generate a join table. Envers, however, has to do this so that when you read the revisions in which the related entity has changed, you don’t get false results.

To be able to name the additional join table, there is a special annotation: @AuditJoinTable, which has similar semantics to JPA @JoinTable.

One special case are relations mapped with @OneToMany with @JoinColumn on the one side, and @ManyToOne and @JoinColumn( insertable=false, updatable=false) on the many side. Such relations are, in fact, bidirectional, but the owning side is the collection.

To properly audit such relations with Envers, you can use the @AuditMappedBy annotation. It enables you to specify the reverse property (using the mappedBy element). In case of indexed collections, the index column must also be mapped in the referenced entity (using @Column( insertable=false, updatable=false ), and specified using positionMappedBy. This annotation will affect only the way Envers works. Please note that the annotation is experimental and may change in the future.

### 21.20. Advanced: Audit table partitioning

### 21.21. Benefits of audit table partitioning

Because audit tables tend to grow indefinitely, they can quickly become really large. When the audit tables have grown to a certain limit (varying per RDBMS and/or operating system) it makes sense to start using table partitioning. SQL table partitioning offers a lot of advantages including, but certainly not limited to:

1. Improved query performance by selectively moving rows to various partitions (or even purging old rows)
2. Faster data loads, index creation, etc.

### 21.22. Suitable columns for audit table partitioning

Generally, SQL tables must be partitioned on a column that exists within the table. As a rule it makes sense to use either the end revision or the end revision timestamp column for partitioning of audit tables.

|  |  |
| --- | --- |
|  | End revision information is not available for the default AuditStrategy.  Therefore the following Envers configuration options are required:  org.hibernate.envers.audit\_strategy = org.hibernate.envers.strategy.ValidityAuditStrategy  org.hibernate.envers.audit\_strategy\_validity\_store\_revend\_timestamp = true  Optionally, you can also override the default values using following properties:  org.hibernate.envers.audit\_strategy\_validity\_end\_rev\_field\_name  org.hibernate.envers.audit\_strategy\_validity\_revend\_timestamp\_field\_name  For more information, see [Configuration Properties](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#envers-configuration). |

The reason why the end revision information should be used for audit table partitioning is based on the assumption that audit tables should be partitioned on an 'increasing level of relevancy', like so:

1. A couple of partitions with audit data that is not very (or no longer) relevant. This can be stored on slow media, and perhaps even be purged eventually.
2. Some partitions for audit data that is potentially relevant.
3. One partition for audit data that is most likely to be relevant. This should be stored on the fastest media, both for reading and writing.

### 21.23. Audit table partitioning example

In order to determine a suitable column for the 'increasing level of relevancy', consider a simplified example of a salary registration for an unnamed agency.

Currently, the salary table contains the following rows for a certain person X:

| *Table 11. Salaries table* | |
| --- | --- |
| **Year** | **Salary (USD)** |
| 2006 | 3300 |
| 2007 | 3500 |
| 2008 | 4000 |
| 2009 | 4500 |

The salary for the current fiscal year (2010) is unknown. The agency requires that all changes in registered salaries for a fiscal year are recorded (i.e. an audit trail). The rationale behind this is that decisions made at a certain date are based on the registered salary at that time. And at any time it must be possible reproduce the reason why a certain decision was made at a certain date.

The following audit information is available, sorted on in order of occurrence:

| *Table 12. Salaries - audit table* | | | | |
| --- | --- | --- | --- | --- |
| **Year** | **Revision type** | **Revision timestamp** | **Salary (USD)** | **End revision timestamp** |
| 2006 | ADD | 2007-04-01 | 3300 | null |
| 2007 | ADD | 2008-04-01 | 35 | 2008-04-02 |
| 2007 | MOD | 2008-04-02 | 3500 | null |
| 2008 | ADD | 2009-04-01 | 3700 | 2009-07-01 |
| 2008 | MOD | 2009-07-01 | 4100 | 2010-02-01 |
| 2008 | MOD | 2010-02-01 | 4000 | null |
| 2009 | ADD | 2010-04-01 | 4500 | null |

### 21.24. Determining a suitable partitioning column

To partition this data, the level of relevancy must be defined. Consider the following:

1. For fiscal year 2006 there is only one revision. It has the oldest revision timestamp of all audit rows, but should still be regarded as relevant because it’s the latest modification for this fiscal year in the salary table (its end revision timestamp is null).

Also, note that it would be very unfortunate if in 2011 there would be an update of the salary for fiscal year 2006 (which is possible in until at least 10 years after the fiscal year), and the audit information would have been moved to a slow disk (based on the age of the revision timestamp). Remember that, in this case, Envers will have to update the end revision timestamp of the most recent audit row.

1. There are two revisions in the salary of fiscal year 2007 which both have nearly the same revision timestamp and a different end revision timestamp.

On first sight, it is evident that the first revision was a mistake and probably not relevant. The only relevant revision for 2007 is the one with end revision timestamp null.

Based on the above, it is evident that only the end revision timestamp is suitable for audit table partitioning. The revision timestamp is not suitable.

### 21.25. Determining a suitable partitioning scheme

A possible partitioning scheme for the salary table would be as follows:

end revision timestamp year = 2008

This partition contains audit data that is not very (or no longer) relevant.

end revision timestamp year = 2009

This partition contains audit data that is potentially relevant.

end revision timestamp year >= 2010 or null

This partition contains the most relevant audit data.

This partitioning scheme also covers the potential problem of the update of the end revision timestamp, which occurs if a row in the audited table is modified. Even though Envers will update the end revision timestamp of the audit row to the system date at the instant of modification, the audit row will remain in the same partition (the 'extension bucket').

And sometime in 2011, the last partition (or 'extension bucket') is split into two new partitions:

1. end revision timestamp year = 2010:: This partition contains audit data that is potentially relevant (in 2011).
2. end revision timestamp year >= 2011 or null:: This partition contains the most interesting audit data and is the new 'extension bucket'.

### 21.26. Envers links

1. [Hibernate main page](http://hibernate.org/)
2. [Forum](http://community.jboss.org/en/envers?view=discussions)
3. [JIRA issue tracker](https://hibernate.atlassian.net/) (when adding issues concerning Envers, be sure to select the "envers" component!)
4. [HipChat channel](https://hibernate.hipchat.com/chat/room/1238636)
5. [FAQ](https://community.jboss.org/wiki/EnversFAQ)

## 22. Database Portability Considerations

### 22.1. 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.

### 22.2. Dialect

The first line of portability for Hibernate is the dialect, which is a specialization of the org.hibernate.dialect.Dialectcontract. 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.

### 22.3. 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, expect that this resolution was limited to databases Hibernate know about ahead of time and was in no way configurable or overrideable.

Starting with version 3.3, Hibernate has a fare 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.DialectResolverwhich 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.

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).

### 22.4. 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 identitygeneration 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 that the entity be associated with the session (e.g. like via save() or persist()) , regardless of current transactional semantics.

|  |  |
| --- | --- |
|  | Hibernate was changed slightly, once the implications of this were better understood, so now the insert could be delayed in cases where this is feasible.  The underlying issue is that the actual semantics of the application itself changes in these cases. |

Starting with version 3.2.3, Hibernate comes with a set of [enhanced](http://in.relation.to/2082.lace) identifier generators targeting portability in a much different way.

|  |  |
| --- | --- |
|  | There are specifically 2 bundled enhancedgenerators:   * 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.

### 22.5. Database functions

|  |  |
| --- | --- |
|  | This is an area in Hibernate in need of improvement. In terms of portability concerns, this function handling currently works pretty well in HQL, however, it is quite lacking in all other aspects. |

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.

|  |  |
| --- | --- |
|  | 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. |

### 22.6. Type mappings

TODO: document the following as well

#### 22.6.1. BLOB/CLOB mappings

#### 22.6.2. Boolean mappings

JPA portability

* HQL/JPQL differences
* naming strategies
* basic types
* simple id types
* generated id types
* composite ids and many-to-one
* "embedded composite identifiers"

## 23. Configurations

### 23.1. Strategy configurations

Many configuration settings define pluggable strategies that Hibernate uses for various purposes. The configuration of many of these strategy type settings accept definition in various forms. The documentation of such configuration settings refer here. The types of forms available in such cases include:

short name (if defined)

Certain built-in strategy implementations have a corresponding short name.

strategy instance

An instance of the strategy implementation to use can be specified

strategy Class reference

A java.lang.Class reference of the strategy implementation to use

strategy Class name

The class name (java.lang.String) of the strategy implementation to use

### 23.2. General Configuration

**hibernate.dialect** (e.g. org.hibernate.dialect.PostgreSQL94Dialect)

The classname of a Hibernate [Dialect](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/dialect/Dialect.html) from which Hibernate can generate SQL optimized for a particular relational database.

In most cases Hibernate can choose the correct [Dialect](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/dialect/Dialect.html) implementation based on the JDBC metadata returned by the JDBC driver.

**hibernate.current\_session\_context\_class** (e.g. jta, thread, managed, or a custom class implementing org.hibernate.context.spi.CurrentSessionContext)

Supply a custom strategy for the scoping of the current Session.

The definition of what exactly current means is controlled by the [CurrentSessionContext](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/spi/CurrentSessionContext.html) implementation in use.

Note that for backwards compatibility, if a [CurrentSessionContext](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/spi/CurrentSessionContext.html) is not configured but JTA is configured this will default to the [JTASessionContext](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/internal/JTASessionContext.html).

### 23.3. Database connection properties

**hibernate.connection.driver\_class** or **javax.persistence.jdbc.driver** (e.g. org.postgresql.Driver)

Names the JDBC Driver class name.

**hibernate.connection.url** or **javax.persistence.jdbc.url** (e.g. jdbc:postgresql:hibernate\_orm\_test)

Names the JDBC connection URL.

**hibernate.connection.username** or **javax.persistence.jdbc.user**

Names the JDBC connection user name.

**hibernate.connection.password** or **javax.persistence.jdbc.password**

Names the JDBC connection password.

**hibernate.connection.isolation** (e.g. REPEATABLE\_READ or Connection.TRANSACTION\_REPEATABLE\_READ)

Names the JDBC connection transaction isolation level.

**hibernate.connection.autocommit** (e.g. true or false (default value))

Names the initial autocommit mode for JDBC Connections returned from a connection pool created in certain ConnectionProvider impl.

See discussion of hibernate.connection.provider\_disables\_autocommit as well.

**hibernate.connection.provider\_disables\_autocommit** (e.g. true or false (default value))

Indicates a promise by the user that Connections that Hibernate obtains from the configured ConnectionProvider have auto-commit disabled when they are obtained from that provider, whether that provider is backed by a DataSource or some other Connection pooling mechanism. Generally this occurs when:

* Hibernate is configured to get Connections from an underlying DataSource, and that DataSource is already configured to disable auto-commit on its managed Connections
* Hibernate is configured to get Connections from a non-DataSource connection pool and that connection pool is already configured to disable auto-commit. For the Hibernate provided implementation this will depend on the value of hibernate.connection.autocommit setting.

Hibernate uses this assurance as an opportunity to opt-out of certain operations that may have a performance impact (although this impact is general negligible). Specifically, when a transaction is started via the Hibernate or JPA transaction APIs Hibernate will generally immediately acquire a Connection from the provider and:

* check whether the Connection is initially in auto-commit mode via a call to Connection#getAutocommit to know how to clean up the Connection when released.
* start a JDBC transaction by calling Connection#setAutocommit(false)

We can skip both of those steps if we know that the ConnectionProvider will always return Connections with auto-commit disabled. That is the purpose of this setting. By setting it to true, the Connection acquisition can be delayed until the first SQL statement is needed to be executed. The connection acquisition delay allows you to reduce the database connection lease time, therefore allowing you to increase the transaction throughput.

It is **inappropriate** to set this value to true when the Connections Hibernate gets from the provider do not, in fact, have auto-commit disabled.

Doing so will lead to Hibernate executing SQL operations outside of any JDBC/SQL transaction.

**hibernate.connection.datasource**

Either a javax.sql.DataSource instance or a JNDI name under which to locate the DataSource.

For JNDI names, ses also hibernate.jndi.class, hibernate.jndi.url, hibernate.jndi.

**hibernate.connection**

Names a prefix used to define arbitrary JDBC connection properties. These properties are passed along to the JDBC provider when creating a connection.

**hibernate.connection.provider\_class** (e.g. org.hibernate.hikaricp.internal. HikariCPConnectionProvider)

Names the [ConnectionProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/connections/spi/ConnectionProvider.html) to use for obtaining JDBC connections.

Can reference:

* an instance of ConnectionProvider
* a Class<? extends ConnectionProvider object reference
* a fully qualified name of a class implementing ConnectionProvider

The term class appears in the setting name due to legacy reasons; however it can accept instances.

**hibernate.jndi.class**

Names the JNDI javax.naming.InitialContext class.

**hibernate.jndi.url** (e.g. java:global/jdbc/default)

Names the JNDI provider/connection url.

**hibernate.jndi**

Names a prefix used to define arbitrary JNDI javax.naming.InitialContext properties.

These properties are passed along to javax.naming.InitialContext#InitialContext(java.util.Hashtable)

**hibernate.connection.acquisition\_mode** (e.g. immediate)

Specifies how Hibernate should acquire JDBC connections. The possible values are given by org.hibernate.ConnectionAcquisitionMode.

Should generally only configure this or hibernate.connection.release\_mode, not both.

**hibernate.connection.release\_mode** (e.g. auto (default value))

Specifies how Hibernate should release JDBC connections. The possible values are given by the current transaction mode (after\_transaction for JDBC transactions and after\_statement for JTA transactions).

Should generally only configure this or hibernate.connection.acquisition\_mode, not both.

#### 23.3.1. Hibernate internal connection pool options

**hibernate.connection.initial\_pool\_size** (e.g. 1 (default value))

Minimum number of connections for the built-in Hibernate connection pool.

**hibernate.connection.pool\_size** (e.g. 20 (default value))

Maximum number of connections for the built-in Hibernate connection pool.

**hibernate.connection.pool\_validation\_interval** (e.g. 30 (default value))

The number of seconds between two consecutive pool validations. During validation, the pool size can increase or decreases based on the connection acquisition request count.

### 23.4. c3p0 properties

**hibernate.c3p0.min\_size** (e.g. 1)

Minimum size of C3P0 connection pool. Refers to [c3p0 minPoolSize setting](http://www.mchange.com/projects/c3p0/#minPoolSize).

**hibernate.c3p0.max\_size** (e.g. 5)

Maximum size of C3P0 connection pool. Refers to [c3p0 maxPoolSize setting](http://www.mchange.com/projects/c3p0/#maxPoolSize).

**hibernate.c3p0.timeout** (e.g. 30)

Maximum idle time for C3P0 connection pool. Refers to [c3p0 maxIdleTime setting](http://www.mchange.com/projects/c3p0/#maxIdleTime).

**hibernate.c3p0.max\_statements** (e.g. 5)

Maximum size of C3P0 statement cache. Refers to [c3p0 maxStatements setting](http://www.mchange.com/projects/c3p0/#maxStatements).

**hibernate.c3p0.acquire\_increment** (e.g. 2)

Number of connections acquired at a time when there’s no connection available in the pool. Refers to [c3p0 acquireIncrement setting](http://www.mchange.com/projects/c3p0/#acquireIncrement).

**hibernate.c3p0.idle\_test\_period** (e.g. 5)

Idle time before a C3P0 pooled connection is validated. Refers to [c3p0 idleConnectionTestPeriod setting](http://www.mchange.com/projects/c3p0/#idleConnectionTestPeriod).

**hibernate.c3p0**

A setting prefix used to indicate additional c3p0 properties that need to be passed to the underlying c3p0 connection pool.

### 23.5. Mapping Properties

#### 23.5.1. Table qualifying options

**hibernate.default\_catalog** (e.g. A catalog name)

Qualifies unqualified table names with the given catalog in generated SQL.

**hibernate.default\_schema** (e.g. A schema name)

Qualify unqualified table names with the given schema or tablespace in generated SQL.

**hibernate.schema\_name\_resolver** (e.g. The fully qualified name of an [org.hibernate.engine.jdbc.env.spi.SchemaNameResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/env/spi/SchemaNameResolver.html) implementation class)

By default, Hibernate uses the [org.hibernate.dialect.Dialect#getSchemaNameResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/dialect/Dialect.html#getSchemaNameResolver--). You can customize how the schema name is resolved by providing a custom implementation of the [SchemaNameResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/env/spi/SchemaNameResolver.html) interface.

#### 23.5.2. Identifier options

**hibernate.id.new\_generator\_mappings** (e.g. true (default value) or false)

Setting which indicates whether or not the new [IdentifierGenerator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/id/IdentifierGenerator.html) are used for AUTO, TABLE and SEQUENCE.

Existing applications may want to disable this (set it false) for upgrade compatibility from 3.x and 4.x to 5.x.

**hibernate.use\_identifier\_rollback** (e.g. true or false (default value))

If true, generated identifier properties are reset to default values when objects are deleted.

**hibernate.id.optimizer.pooled.preferred** (e.g. none, hilo, legacy-hilo, pooled (default value), pooled-lo, pooled-lotl or a fully-qualified name of the [Optimizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/id/enhanced/Optimizer.html) implementation)

When a generator specified an increment-size and an optimizer was not explicitly specified, which of the pooledoptimizers should be preferred?

#### 23.5.3. Quoting options

**hibernate.globally\_quoted\_identifiers** (e.g. true or false (default value))

Should all database identifiers be quoted.

**hibernate.globally\_quoted\_identifiers\_skip\_column\_definitions** (e.g. true or false (default value))

Assuming hibernate.globally\_quoted\_identifiers is true, this allows the global quoting to skip column-definitions as defined by javax.persistence.Column, javax.persistence.JoinColumn, etc, and while it avoids column-definitions being quoted due to global quoting, they can still be explicitly quoted in the annotation/xml mappings.

**hibernate.auto\_quote\_keyword** (e.g. true or false (default value))

Specifies whether to automatically quote any names that are deemed keywords.

#### 23.5.4. Discriminator options

**hibernate.discriminator.implicit\_for\_joined** (e.g. true or false (default value))

The legacy behavior of Hibernate is to not use discriminators for joined inheritance (Hibernate does not need the discriminator). However, some JPA providers do need the discriminator for handling joined inheritance so, in the interest of portability, this capability has been added to Hibernate too.

Because want to make sure that legacy applications continue to work as well, that puts us in a bind in terms of how to handle implicit discriminator mappings. The solution is to assume that the absence of discriminator metadata means to follow the legacy behavior unless this setting is enabled.

With this setting enabled, Hibernate will interpret the absence of discriminator metadata as an indication to use the JPA-defined defaults for these absent annotations.

See Hibernate Jira issue [HHH-6911](https://hibernate.atlassian.net/browse/HHH-6911) for additional background info.

**hibernate.discriminator.ignore\_explicit\_for\_joined** (e.g. true or false (default value))

The legacy behavior of Hibernate is to not use discriminators for joined inheritance (Hibernate does not need the discriminator). However, some JPA providers do need the discriminator for handling joined inheritance so, in the interest of portability, this capability has been added to Hibernate too.

Existing applications rely (implicitly or explicitly) on Hibernate ignoring any DiscriminatorColumn declarations on joined inheritance hierarchies. This setting allows these applications to maintain the legacy behavior of DiscriminatorColumn annotations being ignored when paired with joined inheritance.

See Hibernate Jira issue [HHH-6911](https://hibernate.atlassian.net/browse/HHH-6911) for additional background info.

#### 23.5.5. Naming strategies

**hibernate.implicit\_naming\_strategy** (e.g. default (default value), jpa, legacy-jpa, legacy-hbm, component-path)

Used to specify the [ImplicitNamingStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategy.html) class to use. The following short names are defined for this setting:

default

Uses the [ImplicitNamingStrategyJpaCompliantImpl](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategyJpaCompliantImpl.html)

jpa

Uses the [ImplicitNamingStrategyJpaCompliantImpl](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategyJpaCompliantImpl.html)

legacy-jpa

Uses the [ImplicitNamingStrategyLegacyJpaImpl](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategyLegacyJpaImpl.html)

legacy-hbm

Uses the [ImplicitNamingStrategyLegacyHbmImpl](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategyLegacyHbmImpl.html)

component-path

Uses the [ImplicitNamingStrategyComponentPathImpl](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/ImplicitNamingStrategyComponentPathImpl.html)

If this property happens to be empty, the fallback is to use default strategy.

**hibernate.physical\_naming\_strategy** (e.g. org.hibernate.boot.model.naming.PhysicalNamingStrategyStandardImpl (default value))

Used to specify the [PhysicalNamingStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/naming/PhysicalNamingStrategy.html) class to use.

#### 23.5.6. Metadata scanning options

**hibernate.archive.scanner**

Pass an implementation of [Scanner](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/archive/scan/spi/Scanner.html). By default, [StandardScanner](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/archive/scan/internal/StandardScanner.html) is used.

Accepts either:

* an actual Scanner instance
* a reference to a Class that implements Scanner
* a fully qualified name of a Class that implements Scanner

**hibernate.archive.interpreter**

Pass [ArchiveDescriptorFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/archive/spi/ArchiveDescriptorFactory.html) to use in the scanning process.

Accepts either:

* an actual ArchiveDescriptorFactory instance
* a reference to a Class that implements ArchiveDescriptorFactory
* a fully qualified name of a Class that implements ArchiveDescriptorFactory

See information on [Scanner](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/archive/scan/spi/Scanner.html) about expected constructor forms.

**hibernate.archive.autodetection** (e.g. hbm,class (default value))

Identifies a comma-separate list of values indicating the mapping types we should auto-detect during scanning.

Allowable values include:

class

scan classes (e.g. .class) to extract entity mapping metadata

hbm

scan hbm mapping files (e.g. hbm.xml) to extract entity mapping metadata

By default both HBM, annotations, and JPA XML mappings are scanned.

When using JPA, to disable the automatic scanning of all entity classes, the exclude-unlisted-classespersistence.xml element must be set to true. Therefore, when setting exclude-unlisted-classes to true, only the classes that are explicitly declared in the persistence.xml configuration files are going to be taken into consideration.

**hibernate.mapping.precedence** (e.g. hbm,class (default value))

Used to specify the order in which metadata sources should be processed. Value is a delimited-list whose elements are defined by [MetadataSourceType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/cfg/MetadataSourceType.html).

Default is hbm,class", therefore hbm.xml files are processed first, followed by annotations (combined with orm.xmlmappings).

When using JPA, the XML mapping overrides a conflicting annotation mapping that targets the same entity attribute.

#### 23.5.7. JDBC-related options

**hibernate.use\_nationalized\_character\_data** (e.g. true or false (default value))

Enable nationalized character support on all string / clob based attribute ( string, char, clob, text etc ).

**hibernate.jdbc.lob.non\_contextual\_creation** (e.g. true or false (default value))

Should we not use contextual LOB creation (aka based on java.sql.Connection#createBlob() et al)? The default value for HANA, H2, and PostgreSQL is true.

**hibernate.jdbc.time\_zone** (e.g. A java.util.TimeZone, a java.time.ZoneId or a String representation of a ZoneId)

Unless specified, the JDBC Driver uses the default JVM time zone. If a different time zone is configured via this setting, the JDBC [PreparedStatement#setTimestamp](https://docs.oracle.com/javase/8/docs/api/java/sql/PreparedStatement.html#setTimestamp-int-java.sql.Timestamp-java.util.Calendar-) is going to use a Calendar instance according to the specified time zone.

**hibernate.dialect.oracle.prefer\_long\_raw** (e.g. true or false (default value))

This setting applies to Oracle Dialect only, and it specifies whether byte[] or Byte[] arrays should be mapped to the deprecated LONG RAW (when this configuration property value is true) or to a BLOB column type (when this configuration property value is false).

#### 23.5.8. Bean Validation options

**javax.persistence.validation.factory** (e.g. javax.validation.ValidationFactory implementation)

Specify the javax.validation.ValidationFactory implementation to use for Bean Validation.

**hibernate.check\_nullability** (e.g. true or false)

Enable nullability checking. Raises an exception if a property marked as not-null is null.

Default to false if Bean Validation is present in the classpath and Hibernate Annotations is used, true otherwise.

**hibernate.validator.apply\_to\_ddl** (e.g. true (default value) or false)

Bean Validation constraints will be applied in DDL if the automatic schema generation is enabled. In other words, the database schema will reflect the Bean Validation constraints.

To disable constraint propagation to DDL, set up hibernate.validator.apply\_to\_ddl to false in the configuration file. Such a need is very uncommon and not recommended.

#### 23.5.9. Misc options

**hibernate.create\_empty\_composites.enabled** (e.g. true or false (default value))

Enable instantiation of composite/embeddable objects when all of its attribute values are null. The default (and historical) behavior is that a null reference will be used to represent the composite when all of its attributes are null.

This is an experimental feature that has known issues. It should not be used in production until it is stabilized. See Hibernate Jira issue [HHH-11936](https://hibernate.atlassian.net/browse/HHH-11936) for details.

**hibernate.entity\_dirtiness\_strategy** (e.g. fully-qualified class name or an actual CustomEntityDirtinessStrategyinstance)

Setting to identify a org.hibernate.CustomEntityDirtinessStrategy to use.

**hibernate.default\_entity\_mode** (e.g. pojo (default value) or dynamic-map)

Default EntityMode for entity representation for all sessions opened from this SessionFactory, defaults to pojo.

### 23.6. Bytecode Enhancement Properties

**hibernate.enhancer.enableDirtyTracking** (e.g. true or false (default value))

Enable dirty tracking feature in runtime bytecode enhancement.

**hibernate.enhancer.enableLazyInitialization** (e.g. true or false (default value))

Enable lazy loading feature in runtime bytecode enhancement. This way, even basic types (e.g. @Basic(fetch = FetchType.LAZY)) can be fetched lazily.

**hibernate.enhancer.enableAssociationManagement** (e.g. true or false (default value))

Enable association management feature in runtime bytecode enhancement which automatically synchronizes a bidirectional association when only one side is changed.

**hibernate.bytecode.provider** (e.g. javassist (default value))

The [BytecodeProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/bytecode/spi/BytecodeProvider.html) built-in implementation flavor. Currently, only javassist is supported.

**hibernate.bytecode.use\_reflection\_optimizer** (e.g. true or false (default value))

Should we use reflection optimization? The reflection optimizer implements the [ReflectionOptimizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/bytecode/spi/ReflectionOptimizer.html) interface and improves entity instantiation and property getter/setter calls.

### 23.7. Query settings

**hibernate.query.plan\_cache\_max\_size** (e.g. 2048 (default value))

The maximum number of entries including: [HQLQueryPlan](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/query/spi/HQLQueryPlan.html), [FilterQueryPlan](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/query/spi/FilterQueryPlan.html), [NativeSQLQueryPlan](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/query/spi/NativeSQLQueryPlan.html).

Maintained by [QueryPlanCache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/query/spi/QueryPlanCache.html).

**hibernate.query.plan\_parameter\_metadata\_max\_size** (e.g. 128 (default value))

The maximum number of strong references associated with ParameterMetadata maintained by [QueryPlanCache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/query/spi/QueryPlanCache.html).

**hibernate.order\_by.default\_null\_ordering** (e.g. none, first or last)

Defines precedence of null values in ORDER BY clause. Defaults to none which varies between RDBMS implementation.

**hibernate.discriminator.force\_in\_select** (e.g. true or false (default value))

For entities which do not explicitly say, should we force discriminators into SQL selects?

**hibernate.query.substitutions** (e.g. true=1,false=0)

A comma-separated list of token substitutions to use when translating a Hibernate query to SQL.

**hibernate.query.factory\_class** (e.g. org.hibernate.hql.internal.ast.ASTQueryTranslatorFactory (default value) or org.hibernate.hql.internal.classic.ClassicQueryTranslatorFactory)

Chooses the HQL parser implementation.

**hibernate.query.jpaql\_strict\_compliance** (e.g. true or false (default value))

Map from tokens in Hibernate queries to SQL tokens, such as function or literal names.

Should we strictly adhere to JPA Query Language (JPQL) syntax, or more broadly support all of Hibernate’s superset (HQL)?

Setting this to true may cause valid HQL to throw an exception because it violates the JPQL subset.

**hibernate.query.startup\_check** (e.g. true (default value) or false)

Should named queries be checked during startup?

**hibernate.proc.param\_null\_passing** (e.g. true or false (default value))

Global setting for whether null parameter bindings should be passed to database procedure/function calls as part of [ProcedureCall](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/procedure/ProcedureCall.html) handling. Implicitly Hibernate will not pass the null, the intention being to allow any default argument values to be applied.

This defines a global setting, which can then be controlled per parameter via org.hibernate.procedure.ParameterRegistration#enablePassingNulls(boolean)

Values are true (pass the NULLs) or false (do not pass the NULLs).

**hibernate.jdbc.log.warnings** (e.g. true or false)

Enable fetching JDBC statement warning for logging. Default value is given by org.hibernate.dialect.Dialect#isJdbcLogWarningsEnabledByDefault().

**hibernate.session\_factory.statement\_inspector** (e.g. A fully-qualified class name, an instance, or a Class object reference)

Names a [StatementInspector](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/resource/jdbc/spi/StatementInspector.html) implementation to be applied to every Session created by the current SessionFactory.

Can reference a StatementInspector instance, StatementInspector implementation Class reference orStatementInspector implementation class name (fully-qualified class name).

**hibernate.query.validate\_parameters** (e.g. true (default value) or false)

This configuration property can be used to disable parameters validation performed by org.hibernate.query.Query#setParameter when the the Session is bootstrapped via JPAjavax.persistence.EntityManagerFactory

**hibernate.criteria.literal\_handling\_mode** (e.g. AUTO (default value), BIND or INLINE)

By default, Criteria queries uses bind parameters for any literal that is not a numeric value. However, to increase the likelihood of JDBC statement caching, you might want to use bind parameters for numeric values too.

The org.hibernate.query.criteria.LiteralHandlingMode#BIND mode will use bind variables for any literal value. The org.hibernate.query.criteria.LiteralHandlingMode#INLINE mode will inline literal values as-is.

To prevent SQL injection, never use org.hibernate.query.criteria.LiteralHandlingMode#INLINE with String variables. Always use constants with the org.hibernate.query.criteria.LiteralHandlingMode#INLINE mode.

Valid options are defined by the org.hibernate.query.criteria.LiteralHandlingMode enum. The default value is org.hibernate.query.criteria.LiteralHandlingMode#AUTO.

#### 23.7.1. Multi-table bulk HQL operations

**hibernate.hql.bulk\_id\_strategy** (e.g. A fully-qualified class name, an instance, or a Class object reference)

Provide a custom [org.hibernate.hql.spi.id.MultiTableBulkIdStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/hql/spi/id/MultiTableBulkIdStrategy.html) implementation for handling multi-table bulk HQL operations.

**hibernate.hql.bulk\_id\_strategy.global\_temporary.drop\_tables** (e.g. true or false (default value))

For databases that don’t support local tables, but just global ones, this configuration property allows you to DROP the global tables used for multi-table bulk HQL operations when the SessionFactory or the EntityManagerFactory is closed.

**hibernate.hql.bulk\_id\_strategy.persistent.drop\_tables** (e.g. true or false (default value))

This configuration property is used by the [PersistentTableBulkIdStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/hql/spi/id/persistent/PersistentTableBulkIdStrategy.html), that mimics temporary tables for databases which do not support temporary tables. It follows a pattern similar to the ANSI SQL definition of global temporary table using a "session id" column to segment rows from the various sessions.

This configuration property allows you to DROP the tables used for multi-table bulk HQL operations when the SessionFactory or the EntityManagerFactory is closed.

**hibernate.hql.bulk\_id\_strategy.persistent.schema** (e.g. Database schema name. By default, the hibernate.default\_schema is used.)

This configuration property is used by the [PersistentTableBulkIdStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/hql/spi/id/persistent/PersistentTableBulkIdStrategy.html), that mimics temporary tables for databases which do not support temporary tables. It follows a pattern similar to the ANSI SQL definition of global temporary table using a "session id" column to segment rows from the various sessions.

This configuration property defines the database schema used for storing the temporary tables used for bulk HQL operations.

**hibernate.hql.bulk\_id\_strategy.persistent.catalog** (e.g. Database catalog name. By default, the hibernate.default\_catalog is used.)

This configuration property is used by the [PersistentTableBulkIdStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/hql/spi/id/persistent/PersistentTableBulkIdStrategy.html), that mimics temporary tables for databases which do not support temporary tables. It follows a pattern similar to the ANSI SQL definition of global temporary table using a "session id" column to segment rows from the various sessions.

This configuration property defines the database catalog used for storing the temporary tables used for bulk HQL operations.

**hibernate.legacy\_limit\_handler** (e.g. true or false (default value))

Setting which indicates whether or not to use org.hibernate.dialect.pagination.LimitHandler implementations that sacrifices performance optimizations to allow legacy 4.x limit behavior.

Legacy 4.x behavior favored performing pagination in-memory by avoiding the use of the offset value, which is overall poor performance. In 5.x, the limit handler behavior favors performance, thus, if the dialect doesn’t support offsets, an exception is thrown instead.

**hibernate.query.conventional\_java\_constants** (e.g. true (default value) or false)

Setting which indicates whether or not Java constant follow the [Java Naming conventions](https://docs.oracle.com/javase/tutorial/java/nutsandbolts/variables.html).

Default is true. Existing applications may want to disable this (set it false) if non-conventional Java constants are used. However, there is a significant performance overhead for using non-conventional Java constants since Hibernate cannot determine if aliases should be treated as Java constants or not.

Check out [HHH-4959](https://hibernate.atlassian.net/browse/HHH-4959) for more details.

### 23.8. Batching properties

**hibernate.jdbc.batch\_size** (e.g. 5)

Maximum JDBC batch size. A nonzero value enables batch updates.

**hibernate.order\_inserts** (e.g. true or false (default value))

Forces Hibernate to order SQL inserts by the primary key value of the items being inserted. This preserves batching when using cascading.

**hibernate.order\_updates** (e.g. true or false (default value))

Forces Hibernate to order SQL updates by the primary key value of the items being updated. This preserves batching when using cascading and reduces the likelihood of transaction deadlocks in highly-concurrent systems.

**hibernate.jdbc.batch\_versioned\_data** (e.g. true(default value) or false)

Should versioned entities be included in batching?

Set this property to true if your JDBC driver returns correct row counts from executeBatch(). This option is usually safe, but is disabled by default. If enabled, Hibernate uses batched DML for automatically versioned data.

**hibernate.batch\_fetch\_style** (e.g. LEGACY(default value))

Names the [BatchFetchStyle](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/loader/BatchFetchStyle.html) to use.

Can specify either the [BatchFetchStyle](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/loader/BatchFetchStyle.html) name (insensitively), or a [BatchFetchStyle](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/loader/BatchFetchStyle.html) instance. LEGACY} is the default value.

**hibernate.jdbc.batch.builder** (e.g. The fully qualified name of an [BatchBuilder](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/batch/spi/BatchBuilder.html) implementation class type or an actual object instance)

Names the [BatchBuilder](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/batch/spi/BatchBuilder.html) implementation to use.

#### 23.8.1. Fetching properties

**hibernate.max\_fetch\_depth** (e.g. A value between 0 and 3)

Sets a maximum depth for the outer join fetch tree for single-ended associations. A single-ended association is a one-to-one or many-to-one assocation. A value of 0 disables default outer join fetching.

**hibernate.default\_batch\_fetch\_size** (e.g. 4,8, or 16)

Default size for Hibernate Batch fetching of associations (lazily fetched associations can be fetched in batches to prevent N+1 query problems).

**hibernate.jdbc.fetch\_size** (e.g. 0 or an integer)

A non-zero value determines the JDBC fetch size, by calling Statement.setFetchSize().

**hibernate.jdbc.use\_scrollable\_resultset** (e.g. true or false)

Enables Hibernate to use JDBC2 scrollable resultsets. This property is only relevant for user-supplied JDBC connections. Otherwise, Hibernate uses connection metadata.

**hibernate.jdbc.use\_streams\_for\_binary** (e.g. true or false (default value))

Use streams when writing or reading binary or serializable types to or from JDBC. This is a system-level property.

**hibernate.jdbc.use\_get\_generated\_keys** (e.g. true or false)

Allows Hibernate to use JDBC3 PreparedStatement.getGeneratedKeys() to retrieve natively-generated keys after insert. You need the JDBC3+ driver and JRE1.4+. Disable this property if your driver has problems with the Hibernate identifier generators. By default, it tries to detect the driver capabilities from connection metadata.

**hibernate.jdbc.wrap\_result\_sets** (e.g. true or false (default value))

Enable wrapping of JDBC result sets in order to speed up column name lookups for broken JDBC drivers.

**hibernate.enable\_lazy\_load\_no\_trans** (e.g. true or false (default value))

Initialize Lazy Proxies or Collections outside a given Transactional Persistence Context.

Although enabling this configuration can make LazyInitializationException go away, it’s better to use a fetch plan that guarantees that all properties are properly initialised before the Session is closed.

In reality, you shouldn’t probably enable this setting anyway.

### 23.9. Statement logging and statistics

#### 23.9.1. SQL statement logging

**hibernate.show\_sql** (e.g. true or false (default value))

Write all SQL statements to the console. This is an alternative to setting the log category org.hibernate.SQL to debug.

**hibernate.format\_sql** (e.g. true or false (default value))

Pretty-print the SQL in the log and console.

**hibernate.use\_sql\_comments** (e.g. true or false (default value))

If true, Hibernate generates comments inside the SQL, for easier debugging.

#### 23.9.2. Statistics settings

**hibernate.generate\_statistics** (e.g. true or false)

Causes Hibernate to collect statistics for performance tuning.

**hibernate.stats.factory** (e.g. the fully qualified name of an [StatisticsFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/stat/spi/StatisticsFactory.html) implementation or an actual instance)

The StatisticsFactory allow you to customize how the Hibernate Statistics are being collected.

**hibernate.session.events.log** (e.g. true or false)

A setting to control whether the org.hibernate.engine.internal.StatisticalLoggingSessionEventListener is enabled on all Sessions (unless explicitly disabled for a given Session).

The default value of this setting is determined by the value for hibernate.generate\_statistics, meaning that if statistics are enabled, then logging of Session metrics is enabled by default too.

### 23.10. Cache Properties

**hibernate.cache.region.factory\_class** (e.g. org.hibernate.cache.infinispan.InfinispanRegionFactory)

The fully-qualified name of the RegionFactory implementation class.

**hibernate.cache.default\_cache\_concurrency\_strategy**

Setting used to give the name of the default [CacheConcurrencyStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CacheConcurrencyStrategy.html) to use when either @javax.persistence.Cacheable or @org.hibernate.annotations.Cache. @org.hibernate.annotations.Cacheis used to override the global setting.

**hibernate.cache.use\_minimal\_puts** (e.g. true (default value) or false)

Optimizes second-level cache operation to minimize writes, at the cost of more frequent reads. This is most useful for clustered caches and is enabled by default for clustered cache implementations.

**hibernate.cache.use\_query\_cache** (e.g. true or false (default value))

Enables the query cache. You still need to set individual queries to be cachable.

**hibernate.cache.use\_second\_level\_cache** (e.g. true (default value) or false)

Enable/disable the second level cache, which is enabled by default, although the default RegionFactor is NoCachingRegionFactory (meaning there is no actual caching implementation).

**hibernate.cache.query\_cache\_factory** (e.g. Fully-qualified classname)

A custom [QueryCacheFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/cache/spi/QueryCacheFactory.html) interface. The default is the built-in StandardQueryCacheFactory.

**hibernate.cache.region\_prefix** (e.g. A string)

A prefix for second-level cache region names.

**hibernate.cache.use\_structured\_entries** (e.g. true or false (default value))

Forces Hibernate to store data in the second-level cache in a more human-readable format.

**hibernate.cache.auto\_evict\_collection\_cache** (e.g. true or false (default: false))

Enables the automatic eviction of a bi-directional association’s collection cache when an element in the ManyToOnecollection is added/updated/removed without properly managing the change on the OneToMany side.

**hibernate.cache.use\_reference\_entries** (e.g. true or false)

Optimizes second-level cache operation to store immutable entities (aka "reference") which do not have associations into cache directly, this case, lots of disasseble and deep copy operations can be avoid. Default value of this property is false.

**hibernate.ejb.classcache** (e.g. hibernate.ejb.classcache.org.hibernate.ejb.test.Item = read-write)

Sets the associated entity class cache concurrency strategy for the designated region. Caching configuration should follow the following pattern hibernate.ejb.classcache.<fully.qualified.Classname> usage[, region] where usage is the cache strategy used and region the cache region name.

**hibernate.ejb.collectioncache** (e.g. hibernate.ejb.collectioncache.org.hibernate.ejb.test.Item.distributors= read-write, RegionName)

Sets the associated collection cache concurrency strategy for the designated region. Caching configuration should follow the following pattern hibernate.ejb.collectioncache.<fully.qualified.Classname>.<role> usage[, region] where usage is the cache strategy used and region the cache region name

### 23.11. Infinispan properties

**hibernate.cache.infinispan.cfg** (e.g. org/hibernate/cache/infinispan/builder/infinispan-configs.xml)

Classpath or filesystem resource containing the Infinispan configuration settings.

**hibernate.cache.infinispan.statistics**

Property name that controls whether Infinispan statistics are enabled. The property value is expected to be a boolean true or false, and it overrides statistic configuration in base Infinispan configuration, if provided.

**hibernate.cache.infinispan.use\_synchronization**

Deprecated setting because Infinispan is designed to always register a Synchronization for TRANSACTIONAL caches.

**hibernate.cache.infinispan.cachemanager** (e.g. There is no default value, the user must specify the property.)

Specifies the JNDI name under which the EmbeddedCacheManager is bound.

### 23.12. Transactions properties

**hibernate.transaction.jta.platform** (e.g. JBossAS, BitronixJtaPlatform)

Names the [JtaPlatform](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/transaction/jta/platform/spi/JtaPlatform.html) implementation to use for integrating with JTA systems. Can reference either a [JtaPlatform](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/transaction/jta/platform/spi/JtaPlatform.html)instance or the name of the [JtaPlatform](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/transaction/jta/platform/spi/JtaPlatform.html) implementation class

**hibernate.jta.prefer\_user\_transaction** (e.g. true or false (default value))

Should we prefer using the org.hibernate.engine.transaction.jta.platform.spi.JtaPlatform#retrieveUserTransaction over using org.hibernate.engine.transaction.jta.platform.spi.JtaPlatform#retrieveTransactionManager

**hibernate.transaction.jta.platform\_resolver**

Names the [JtaPlatformResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/transaction/jta/platform/spi/JtaPlatformResolver.html) implementation to use.

**hibernate.jta.cacheTransactionManager** (e.g. true (default value) or false)

A configuration value key used to indicate that it is safe to cache.

**hibernate.jta.cacheUserTransaction** (e.g. true or false (default value))

A configuration value key used to indicate that it is safe to cache.

**hibernate.transaction.flush\_before\_completion** (e.g. true or false (default value))

Causes the session be flushed during the before completion phase of the transaction. If possible, use built-in and automatic session context management instead.

**hibernate.transaction.auto\_close\_session** (e.g. true or false (default value))

Causes the session to be closed during the after completion phase of the transaction. If possible, use built-in and automatic session context management instead.

**hibernate.transaction.coordinator\_class**

Names the implementation of [TransactionCoordinatorBuilder](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/resource/transaction/spi/TransactionCoordinatorBuilder.html) to use for creating [TransactionCoordinator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/resource/transaction/spi/TransactionCoordinator.html)instances.

Can be a`TransactionCoordinatorBuilder` instance, TransactionCoordinatorBuilder implementation Classreference, a TransactionCoordinatorBuilder implementation class name (fully-qualified name) or a short name.

The following short names are defined for this setting:

jdbc

Manages transactions via calls to java.sql.Connection (default for non-JPA applications)

jta

Manages transactions via JTA. See [Java EE bootstrapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-jpa-compliant)

If a JPA application does not provide a setting for hibernate.transaction.coordinator\_class, Hibernate will automatically build the proper transaction coordinator based on the transaction type for the persistence unit.

If a non-JPA application does not provide a setting for hibernate.transaction.coordinator\_class, Hibernate will use jdbc as the default. This default will cause problems if the application actually uses JTA-based transactions. A non-JPA application that uses JTA-based transactions should explicitly set hibernate.transaction.coordinator\_class=jta or provide a custom [TransactionCoordinatorBuilder](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/resource/transaction/TransactionCoordinatorBuilder.html) that builds a [TransactionCoordinator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/resource/transaction/TransactionCoordinator.html) that properly coordinates with JTA-based transactions.

**hibernate.jta.track\_by\_thread** (e.g. true (default value) or false)

A transaction can be rolled back by another thread ("tracking by thread") and not the original application. Examples of this include a JTA transaction timeout handled by a background reaper thread.

The ability to handle this situation requires checking the Thread ID every time Session is called, so enabling this can certainly have a performance impact.

**hibernate.transaction.factory\_class**

This is a legacy setting that’s been deprecated and you should use the hibernate.transaction.jta.platform instead.

### 23.13. Multi-tenancy settings

**hibernate.multiTenancy** (e.g. NONE (default value), SCHEMA, DATABASE, and DISCRIMINATOR (not implemented yet))

The multi-tenancy strategy in use.

**hibernate.multi\_tenant\_connection\_provider** (e.g. true or false (default value))

Names a [MultiTenantConnectionProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/connections/spi/MultiTenantConnectionProvider.html) implementation to use. As MultiTenantConnectionProvider is also a service, can be configured directly through the [StandardServiceRegistryBuilder](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/registry/StandardServiceRegistryBuilder.html).

**hibernate.tenant\_identifier\_resolver**

Names a [CurrentTenantIdentifierResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/context/spi/CurrentTenantIdentifierResolver.html) implementation to resolve the resolve the current tenant identifier so that calling SessionFactory#openSession() would get a Session that’s connected to the right tenant.

Can be a CurrentTenantIdentifierResolver instance, CurrentTenantIdentifierResolver implementation Class object reference or a CurrentTenantIdentifierResolver implementation class name.

**hibernate.multi\_tenant.datasource.identifier\_for\_any** (e.g. true or false (default value))

When the hibernate.connection.datasource property value is resolved to a javax.naming.Context object, this configuration property defines the JNDI name used to locate the DataSource used for fetching the initial Connectionwhich is used to access to the database metadata of the underlying database(s) (in situations where we do not have a tenant id, like startup processing).

### 23.14. Automatic schema generation

**hibernate.hbm2ddl.auto** (e.g. none (default value), create-only, drop, create, create-drop, validate, and update)

Setting to perform SchemaManagementTool actions automatically as part of the SessionFactory lifecycle. Valid options are defined by the externalHbm2ddlName value of the [Action](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/Action.html) enum:

none

No action will be performed.

create-only

Database creation will be generated.

drop

Database dropping will be generated.

create

Database dropping will be generated followed by database creation.

create-drop

Drop the schema and recreate it on SessionFactory startup. Additionally, drop the schema on SessionFactory shutdown.

validate

Validate the database schema

update

Update the database schema

**javax.persistence.schema-generation.database.action** (e.g. none (default value), create-only, drop, create, create-drop, validate, and update)

Setting to perform SchemaManagementTool actions automatically as part of the SessionFactory lifecycle. Valid options are defined by the externalJpaName value of the [Action](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/Action.html) enum:

none

No action will be performed.

create

Database creation will be generated.

drop

Database dropping will be generated.

drop-and-create

Database dropping will be generated followed by database creation.

**javax.persistence.schema-generation.scripts.action** (e.g. none (default value), create-only, drop, create, create-drop, validate, and update)

Setting to perform SchemaManagementTool actions writing the commands into a DDL script file. Valid options are defined by the externalJpaName value of the [Action](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/Action.html) enum:

none

No action will be performed.

create

Database creation will be generated.

drop

Database dropping will be generated.

drop-and-create

Database dropping will be generated followed by database creation.

**javax.persistence.schema-generation-connection**

Allows passing a specific java.sql.Connection instance to be used by SchemaManagementTool

**javax.persistence.database-product-name**

Specifies the name of the database provider in cases where a Connection to the underlying database is not available (aka, mainly in generating scripts). In such cases, a value for this setting must be specified.

The value of this setting is expected to match the value returned by java.sql.DatabaseMetaData#getDatabaseProductName() for the target database.

Additionally, specifying javax.persistence.database-major-version and/or javax.persistence.database-minor-version may be required to understand exactly how to generate the required schema commands.

**javax.persistence.database-major-version**

Specifies the major version of the underlying database, as would be returned by java.sql.DatabaseMetaData#getDatabaseMajorVersion for the target database.

This value is used to help more precisely determine how to perform schema generation tasks for the underlying database in cases where javax.persistence.database-product-name does not provide enough distinction.

**javax.persistence.database-minor-version**

Specifies the minor version of the underlying database, as would be returned by java.sql.DatabaseMetaData#getDatabaseMinorVersion for the target database.

This value is used to help more precisely determine how to perform schema generation tasks for the underlying database in cases where javax.persistence.database-product-name and javax.persistence.database-major-version does not provide enough distinction.

**javax.persistence.schema-generation.create-source**

Specifies whether schema generation commands for schema creation are to be determine based on object/relational mapping metadata, DDL scripts, or a combination of the two. See [SourceType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/SourceType.html) for valid set of values.

If no value is specified, a default is assumed as follows:

* if source scripts are specified (per javax.persistence.schema-generation.create-script-source), then scripts is assumed
* otherwise, metadata is assumed

**javax.persistence.schema-generation.drop-source**

Specifies whether schema generation commands for schema dropping are to be determine based on object/relational mapping metadata, DDL scripts, or a combination of the two. See [SourceType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/SourceType.html) for valid set of values.

If no value is specified, a default is assumed as follows:

* if source scripts are specified (per javax.persistence.schema-generation.create-script-source), then scripts is assumed
* otherwise, metadata is assumed

**javax.persistence.schema-generation.create-script-source**

Specifies the create script file as either a java.io.Reader configured for reading of the DDL script file or a string designating a file java.net.URL for the DDL script.

Hibernate historically also accepted hibernate.hbm2ddl.import\_files for a similar purpose, but javax.persistence.schema-generation.create-script-source should be preferred over hibernate.hbm2ddl.import\_files.

**javax.persistence.schema-generation.drop-script-source**

Specifies the drop script file as either a java.io.Reader configured for reading of the DDL script file or a string designating a file java.net.URL for the DDL script.

**javax.persistence.schema-generation.scripts.create-target**

For cases where the javax.persistence.schema-generation.scripts.action value indicates that schema creation commands should be written to DDL script file, javax.persistence.schema-generation.scripts.create-targetspecifies either a java.io.Writer configured for output of the DDL script or a string specifying the file URL for the DDL script.

**javax.persistence.schema-generation.scripts.drop-target**

For cases where the javax.persistence.schema-generation.scripts.action value indicates that schema dropping commands should be written to DDL script file, javax.persistence.schema-generation.scripts.drop-targetspecifies either a java.io.Writer configured for output of the DDL script or a string specifying the file URL for the DDL script.

**javax.persistence.hibernate.hbm2ddl.import\_files** (e.g. import.sql (default value))

Comma-separated names of the optional files containing SQL DML statements executed during the SessionFactorycreation. File order matters, the statements of a give file are executed before the statements of the following one.

These statements are only executed if the schema is created, meaning that hibernate.hbm2ddl.auto is set to create, create-drop, or update. javax.persistence.schema-generation.create-script-source / javax.persistence.schema-generation.drop-script-source should be preferred.

**javax.persistence.sql-load-script-source**

JPA variant of hibernate.hbm2ddl.import\_files. Specifies a java.io.Reader configured for reading of the SQL load script or a string designating the file java.net.URL for the SQL load script. A "SQL load script" is a script that performs some database initialization (INSERT, etc).

**hibernate.hbm2ddl.import\_files\_sql\_extractor**

Reference to the [ImportSqlCommandExtractor](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/hbm2ddl/ImportSqlCommandExtractor.html) implementation class to use for parsing source/import files as defined by javax.persistence.schema-generation.create-script-source, javax.persistence.schema-generation.drop-script-source or hibernate.hbm2ddl.import\_files.

Reference may refer to an instance, a Class implementing ImportSqlCommandExtractor of the fully-qualified name of the ImportSqlCommandExtractor implementation. If the fully-qualified name is given, the implementation must provide a no-arg constructor.

The default value is [SingleLineSqlCommandExtractor](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/hbm2ddl/SingleLineSqlCommandExtractor.html).

**hibernate.hbm2dll.create\_namespaces** (e.g. true or false (default value))

Specifies whether to automatically create also the database schema/catalog.

**javax.persistence.create-database-schemas** (e.g. true or false (default value))

The JPA variant of hibernate.hbm2dll.create\_namespaces. Specifies whether the persistence provider is to create the database schema(s) in addition to creating database objects (tables, sequences, constraints, etc). The value of this boolean property should be set to true if the persistence provider is to create schemas in the database or to generate DDL that contains "CREATE SCHEMA" commands.

If this property is not supplied (or is explicitly false), the provider should not attempt to create database schemas.

**hibernate.hbm2ddl.schema\_filter\_provider**

Used to specify the [SchemaFilterProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaFilterProvider.html) to be used by create, drop, migrate, and validate operations on the database schema. SchemaFilterProvider provides filters that can be used to limit the scope of these operations to specific namespaces, tables and sequences. All objects are included by default.

**hibernate.hbm2ddl.jdbc\_metadata\_extraction\_strategy** (e.g. grouped (default value) or individually)

Setting to choose the strategy used to access the JDBC Metadata. Valid options are defined by the strategy value of the [JdbcMetadaAccessStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/JdbcMetadaAccessStrategy.html) enum:

grouped

[SchemaMigrator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaMigrator.html) and [SchemaValidator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaValidator.html) execute a single java.sql.DatabaseMetaData#getTables(String, String, String, String[]) call to retrieve all the database table in order to determine if all the javax.persistence.Entity have a corresponding mapped database tables.This strategy may require hibernate.default\_schema and/or hibernate.default\_catalog to be provided.

individually

[SchemaMigrator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaMigrator.html) and [SchemaValidator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaValidator.html) execute one java.sql.DatabaseMetaData#getTables(String, String, String, String[]) call for each javax.persistence.Entity in order to determine if a corresponding database table exists.

**hibernate.hbm2ddl.delimiter** (e.g. ;)

Identifies the delimiter to use to separate schema management statements in script outputs.

**hibernate.schema\_management\_tool** (e.g. A schema name)

Used to specify the [SchemaManagementTool](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/spi/SchemaManagementTool.html) to use for performing schema management. The default is to use [HibernateSchemaManagementTool](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/schema/internal/HibernateSchemaManagementTool.html)

**hibernate.synonyms** (e.g. true or false (default value))

If enabled, allows schema update and validation to support synonyms. Due to the possibility that this would return duplicate tables (especially in Oracle), this is disabled by default.

**hibernate.hbm2dll.extra\_physical\_table\_types** (e.g. BASE TABLE)

Identifies a comma-separated list of values to specify extra table types, other than the default TABLE value, to recognize as defining a physical table by schema update, creation and validation.

**hibernate.schema\_update.unique\_constraint\_strategy** (e.g. DROP\_RECREATE\_QUIETLY, RECREATE\_QUIETLY, SKIP)

Unique columns and unique keys both use unique constraints in most dialects. SchemaUpdate needs to create these constraints, but DBs support for finding existing constraints is extremely inconsistent. Further, non-explicitly-named unique constraints use randomly generated characters.

Therefore, the [UniqueConstraintSchemaUpdateStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tool/hbm2ddl/UniqueConstraintSchemaUpdateStrategy.html) offers the following options:

DROP\_RECREATE\_QUIETLY

Default option. Attempt to drop, then (re-)create each unique constraint. Ignore any exceptions being thrown.

RECREATE\_QUIETLY

Attempts to (re-)create unique constraints, ignoring exceptions thrown if the constraint already existed

SKIP

Does not attempt to create unique constraints on a schema update.

**hibernate.hbm2ddl.charset\_name** (e.g. Charset.defaultCharset())

Defines the charset (encoding) used for all input/output schema generation resources. By default, Hibernate uses the default charset given by Charset.defaultCharset(). This configuration property allows you to override the default JVM setting so that you can specify which encoding is used when reading and writing schema generation resources (e.g. File, URL).

**hibernate.hbm2ddl.halt\_on\_error** (e.g. true or false (default value))

Whether the schema migration tool should halt on error, therefore terminating the bootstrap process. By default, the EntityManagerFactory or SessionFactory are created even if the schema migration throws exceptions. To prevent this default behavior, set this property value to true.

### 23.15. Exception handling

**hibernate.jdbc.sql\_exception\_converter** (e.g. Fully-qualified name of class implementing SQLExceptionConverter)

The [SQLExceptionConverter](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/exception/spi/SQLExceptionConverter.html) to use for converting SQLExceptions to Hibernate’s JDBCException hierarchy. The default is to use the configured [Dialect](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/dialect/Dialect.html)'s preferred SQLExceptionConverter.

### 23.16. Session events

**hibernate.session.events.auto**

Fully qualified class name implementing the SessionEventListener interface.

**hibernate.session\_factory.interceptor or**hibernate.ejb.interceptor (e.g. org.hibernate.EmptyInterceptor(default value))

Names a [Interceptor](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/Interceptor) implementation to be applied to every Session created by the current org.hibernate.SessionFactory

Can reference:

* Interceptor instance
* Interceptor implementation Class object reference
* Interceptor implementation class name

**hibernate.ejb.interceptor.session\_scoped** (e.g. fully-qualified class name or class reference)

An optional Hibernate interceptor.

The interceptor instance is specific to a given Session instance (and hence is not thread-safe) has to implement org.hibernate.Interceptor and have a no-arg constructor.

This property can not be combined with hibernate.ejb.interceptor.

**hibernate.ejb.session\_factory\_observer** (e.g. fully-qualified class name or class reference)

Specifies a SessionFactoryObserver to be applied to the SessionFactory. The class must have a no-arg constructor.

**hibernate.ejb.event** (e.g. hibernate.ejb.event.pre-load = com.acme.SecurityListener,com.acme.AuditListener)

Event listener list for a given event type. The list of event listeners is a comma separated fully qualified class name list.

### 23.17. JMX settings

**hibernate.jmx.enabled** (e.g. true or false (default value))

Enable JMX.

**hibernate.jmx.usePlatformServer** (e.g. true or false (default value))

Uses the platform MBeanServer as returned by ManagementFactory#getPlatformMBeanServer().

**hibernate.jmx.agentId**

The agent identifier of the associated MBeanServer.

**hibernate.jmx.defaultDomain**

The domain name of the associated MBeanServer.

**hibernate.jmx.sessionFactoryName**

The SessionFactory name appended to the object name the Manageable Bean is registered with. If null, the hibernate.session\_factory\_name configuration value is used.

**org.hibernate.core**

The default object domain appended to the object name the Manageable Bean is registered with.

### 23.18. JACC settings

**hibernate.jacc.enabled** (e.g. true or false (default value))

Is JACC enabled?

**hibernate.jacc** (e.g. hibernate.jacc.allowed.org.jboss.ejb3.test.jacc.AllEntity)

The property name defines the role (e.g. allowed) and the entity class name (e.g. org.jboss.ejb3.test.jacc.AllEntity), while the property value defines the authorized actions (e.g. insert,update,read).

**hibernate.jacc\_context\_id**

A String identifying the policy context whose PolicyConfiguration interface is to be returned. The value passed to this parameter must not be null.

### 23.19. ClassLoaders properties

**hibernate.classLoaders**

Used to define a java.util.Collection<ClassLoader> or the ClassLoader instance Hibernate should use for class-loading and resource-lookups.

**hibernate.classLoader.application**

Names the ClassLoader used to load user application classes.

**hibernate.classLoader.resources**

Names the ClassLoader Hibernate should use to perform resource loading.

**hibernate.classLoader.hibernate**

Names the ClassLoader responsible for loading Hibernate classes. By default this is the ClassLoader that loaded this class.

**hibernate.classLoader.environment**

Names the ClassLoader used when Hibernate is unable to locates classes on the hibernate.classLoader.application or hibernate.classLoader.hibernate.

### 23.20. Bootstrap properties

**hibernate.integrator\_provider** (e.g. The fully qualified name of an [IntegratorProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/jpa/boot/spi/IntegratorProvider.html))

Used to define a list of [Integrator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/integrator/spi/Integrator.html) which are used during bootstrap process to integrate various services.

**hibernate.strategy\_registration\_provider** (e.g. The fully qualified name of an [StrategyRegistrationProviderList](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/jpa/boot/spi/StrategyRegistrationProviderList.html))

Used to define a list of [StrategyRegistrationProvider](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/registry/selector/StrategyRegistrationProvider.html) which are used during bootstrap process to provide registrations of strategy selector(s).

**hibernate.type\_contributors** (e.g. The fully qualified name of an [TypeContributorList](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/jpa/boot/spi/TypeContributorList.html))

Used to define a list of [TypeContributor](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/boot/model/TypeContributor.html) which are used during bootstrap process to contribute types.

**hibernate.persister.resolver** (e.g. The fully qualified name of a [PersisterClassResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/spi/PersisterClassResolver.html) or a PersisterClassResolver instance)

Used to define an implementation of the PersisterClassResolver interface which can be used to customize how an entity or a collection is being persisted.

**hibernate.persister.factory** (e.g. The fully qualified name of a [PersisterFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/spi/PersisterFactory.html) or a PersisterFactoryinstance)

Like a PersisterClassResolver, the PersisterFactory can be used to customize how an entity or a collection are being persisted.

**hibernate.service.allow\_crawling** (e.g. true (default value) or false)

Crawl all available service bindings for an alternate registration of a given Hibernate Service.

### 23.21. Miscellaneous properties

**hibernate.dialect\_resolvers**

Names any additional [DialectResolver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/dialect/spi/DialectResolver.html) implementations to register with the standard [DialectFactory](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/engine/jdbc/dialect/spi/DialectFactory.html)

**hibernate.session\_factory\_name** (e.g. A JNDI name)

Setting used to name the Hibernate SessionFactory. Naming the SessionFactory allows for it to be properly serialized across JVMs as long as the same name is used on each JVM.

If hibernate.session\_factory\_name\_is\_jndi is set to true, this is also the name under which the SessionFactory is bound into JNDI on startup and from which it can be obtained from JNDI.

**hibernate.session\_factory\_name\_is\_jndi** (e.g. true (default value) or false)

Does the value defined by hibernate.session\_factory\_name represent a JNDI namespace into which the org.hibernate.SessionFactory should be bound and made accessible?

Defaults to true for backwards compatibility. Set this to false if naming a SessionFactory is needed for serialization purposes, but no writable JNDI context exists in the runtime environment or if the user simply does not want JNDI to be used.

**hibernate.ejb.entitymanager\_factory\_name** (e.g. By default, the persistence unit name is used, otherwise a randomly generated UUID)

Internally, Hibernate keeps track of all EntityManagerFactory instances using the EntityManagerFactoryRegistry. The name is used as a key to identify a given EntityManagerFactory reference.

**hibernate.ejb.cfgfile** (e.g. hibernate.cfg.xml (default value))

XML configuration file to use to configure Hibernate.

**hibernate.ejb.discard\_pc\_on\_close** (e.g. true or false (default value))

If true, the persistence context will be discarded (think clear() when the method is called. Otherwise, the persistence context will stay alive till the transaction completion: all objects will remain managed, and any change will be synchronized with the database (default to false, ie wait for transaction completion).

**hibernate.ejb.metamodel.population** (e.g. enabled or disabled, or ignoreUnsupported (default value))

Setting that indicates whether to build the JPA types.

Accepts three values:

enabled

Do the build

disabled

Do not do the build

ignoreUnsupported

Do the build, but ignore any non-JPA features that would otherwise result in a failure (e.g. @Any annotation).

**hibernate.jpa.static\_metamodel.population** (e.g. enabled or disabled, or skipUnsupported (default value))

Setting that controls whether we seek out JPA static metamodel classes and populate them.

Accepts three values:

enabled

Do the population

disabled

Do not do the population

skipUnsupported

Do the population, but ignore any non-JPA features that would otherwise result in the population failing (e.g. @Anyannotation).

**hibernate.delay\_cdi\_access** (e.g. true or false (default value))

Defines delayed access to CDI BeanManager. Starting in 5.1 the preferred means for CDI bootstrapping is through [ExtendedBeanManager](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/jpa/event/spi/jpa/ExtendedBeanManager.html).

**hibernate.allow\_update\_outside\_transaction** (e.g. true or false (default value))

Setting that allows to perform update operations outside of a transaction boundary.

Accepts two values:

true

allows to flush an update out of a transaction

false

does not allow

**hibernate.collection\_join\_subquery** (e.g. true (default value) or false)

Setting which indicates whether or not the new JOINS over collection tables should be rewritten to subqueries.

**hibernate.allow\_refresh\_detached\_entity** (e.g. true (default value when using Hibernate native bootstrapping) or false (default value when using JPA bootstrapping))

Setting that allows to call javax.persistence.EntityManager#refresh(entity) or Session#refresh(entity) on a detached instance even when the org.hibernate.Session is obtained from a JPA javax.persistence.EntityManager.

**hibernate.event.merge.entity\_copy\_observer** (e.g. disallow (default value), allow, log (testing purpose only) or fully-qualified class name)

Setting that specifies how Hibernate will respond when multiple representations of the same persistent entity ("entity copy") is detected while merging.

The possible values are:

disallow (the default)

throws IllegalStateException if an entity copy is detected

allow

performs the merge operation on each entity copy that is detected

log

(provided for testing only) performs the merge operation on each entity copy that is detected and logs information about the entity copies. This setting requires DEBUG logging be enabled for [EntityCopyAllowedLoggedObserver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/event/internal/EntityCopyAllowedLoggedObserver.html).

In addition, the application may customize the behavior by providing an implementation of [EntityCopyObserver](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/event/spi/EntityCopyObserver.html)and setting hibernate.event.merge.entity\_copy\_observer to the class name. When this property is set to allowor log, Hibernate will merge each entity copy detected while cascading the merge operation. In the process of merging each entity copy, Hibernate will cascade the merge operation from each entity copy to its associations with cascade=CascadeType.MERGE or CascadeType.ALL. The entity state resulting from merging an entity copy will be overwritten when another entity copy is merged.

For more details, check out the [Merge gotchas](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc-merge-gotchas) section.

### 23.22. Envers properties

**hibernate.envers.autoRegisterListeners** (e.g. true (default value) or false)

When set to false, the Envers entity listeners are no longer auto-registered, so you need to register them manually during the bootstrap process.

**hibernate.integration.envers.enabled** (e.g. true (default value) or false)

Enable or disable the Hibernate Envers Service integration.

**hibernate.listeners.envers.autoRegister**

Legacy setting. Use hibernate.envers.autoRegisterListeners or hibernate.integration.envers.enabledinstead.

### 23.23. Spatial properties

**hibernate.integration.spatial.enabled** (e.g. true (default value) or false)

Enable or disable the Hibernate Spatial Service integration.

**hibernate.spatial.connection\_finder** (e.g. org.geolatte.geom.codec.db.oracle.DefaultConnectionFinder)

Define the fully-qualified name of class implementing the org.geolatte.geom.codec.db.oracle.ConnectionFinderinterface.

### 23.24. Internal properties

The following configuration properties are used internally, and you shouldn’t probably have to configured them in your application.

**hibernate.enable\_specj\_proprietary\_syntax** (e.g. true or false (default value))

Enable or disable the SpecJ proprietary mapping syntax which differs from JPA specification. Used during performance testing only.

**hibernate.temp.use\_jdbc\_metadata\_defaults** (e.g. true (default value) or false)

This setting is used to control whether we should consult the JDBC metadata to determine certain Settings default values when the database may not be available (mainly in tools usage).

**hibernate.connection\_provider.injection\_data** (e.g. java.util.Map)

Connection provider settings to be injected in the currently configured connection provider.

**hibernate.jandex\_index** (e.g. org.jboss.jandex.Index)

Names a Jandex org.jboss.jandex.Index instance to use.

## 24. Mapping annotations

### 24.1. JPA annotations

#### 24.1.1. @Access

The [@Access](http://docs.oracle.com/javaee/7/api/javax/persistence/Access.html) annotation is used to specify the access type of the associated entity class, mapped superclass, or embeddable class, or entity attribute.

See the [Access type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#access) section for more info.

#### 24.1.2. @AssociationOverride

The [@AssociationOverride](http://docs.oracle.com/javaee/7/api/javax/persistence/AssociationOverride.html) annotation is used to override an association mapping (e.g. @ManyToOne, @OneToOne, @OneToMany, @ManyToMany) inherited from a mapped superclass or an embeddable.

See the [Overriding Embeddable types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddable-override) section for more info.

#### 24.1.3. @AssociationOverrides

The [@AssociationOverrides](http://docs.oracle.com/javaee/7/api/javax/persistence/AssociationOverrides.html) is used to group several [@AssociationOverride](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-associationoverride) annotations.

#### 24.1.4. @AttributeOverride

The [@AttributeOverride](http://docs.oracle.com/javaee/7/api/javax/persistence/AttributeOverride.html) annotation is used to override an attribute mapping inherited from a mapped superclass or an embeddable.

See the [Overriding Embeddable types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddable-override) section for more info.

#### 24.1.5. @AttributeOverrides

The [@AttributeOverrides](http://docs.oracle.com/javaee/7/api/javax/persistence/AttributeOverrides.html) is used to group several [@AttributeOverride](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-attributeoverride) annotations.

#### 24.1.6. @Basic

The [@Basic](http://docs.oracle.com/javaee/7/api/javax/persistence/Basic.html) annotation is used to map a basic attribute type to a database column.

See the [Basic types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic) chapter for more info.

#### 24.1.7. @Cacheable

The [@Cacheable](http://docs.oracle.com/javaee/7/api/javax/persistence/Cacheable.html) annotation is used to specify whether an entity should be stored in the second-level cache.

If the persistence.xml shared-cache-mode XML attribute is set to ENABLE\_SELECTIVE, then only the entities annotated with the @Cacheable are going to be stored in the second-level cache.

If shared-cache-mode XML attribute value is DISABLE\_SELECTIVE, then the entities marked with the @Cacheableannotation are not going to be stored in the second-level cache, while all the other entities are stored in the cache.

See the [Caching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching) chapter for more info.

#### 24.1.8. @CollectionTable

The [@CollectionTable](http://docs.oracle.com/javaee/7/api/javax/persistence/CollectionTable.html) annotation is used to specify the database table that stores the values of a basic or an embeddable type collection.

See the [Collections of embeddable types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddable-collections) section for more info.

#### 24.1.9. @Column

The [@Column](http://docs.oracle.com/javaee/7/api/javax/persistence/Column.html) annotation is used to specify the mapping between a basic entity attribute and the database table column.

See the [@Column annotation](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-column-annotation) section for more info.

#### 24.1.10. @ColumnResult

The [@ColumnResult](http://docs.oracle.com/javaee/7/api/javax/persistence/ColumnResult.html) annotation is used in conjunction with the [@SqlResultSetMapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-sqlresultsetmapping) or [@ConstructorResult](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-constructorresult)annotations to map a SQL column for a given SELECT query.

See the [Entity associations with named native queries](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-composite-key-entity-associations_named-query-example) section for more info.

#### 24.1.11. @ConstructorResult

The [@ConstructorResult](http://docs.oracle.com/javaee/7/api/javax/persistence/ConstructorResult.html) annotation is used in conjunction with the [@SqlResultSetMapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-sqlresultsetmapping) annotations to map columns of a given SELECT query to a certain object constructor.

See the [Multiple scalar values NamedNativeQuery with ConstructorResult](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-multiple-scalar-values-dto-NamedNativeQuery-example) section for more info.

#### 24.1.12. @Convert

The [@Convert](http://docs.oracle.com/javaee/7/api/javax/persistence/Convert.html) annotation is used to specify the [AttributeConverter](http://docs.oracle.com/javaee/7/api/javax/persistence/AttributeConverter.html) implementation used to convert the current annotated basic attribute.

If the AttributeConverter uses [autoApply](http://docs.oracle.com/javaee/7/api/javax/persistence/Converter.html#autoApply--), then all entity attributes with the same target type are going to be converted automatically.

See the [AttributeConverter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-enums-attribute-converter) section for more info.

#### 24.1.13. @Converter

The [@Converter](http://docs.oracle.com/javaee/7/api/javax/persistence/Converter.html) annotation is used to specify that the current annotate [AttributeConverter](http://docs.oracle.com/javaee/7/api/javax/persistence/AttributeConverter.html) implementation can be used as a JPA basic attribute converter.

If the [autoApply](http://docs.oracle.com/javaee/7/api/javax/persistence/Converter.html#autoApply--) attribute is set to true, then the JPA provider will automatically convert all basic attributes with the same Java type as defined by the current converter.

See the [AttributeConverter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-enums-attribute-converter) section for more info.

#### 24.1.14. @Converts

The [@Converts](http://docs.oracle.com/javaee/7/api/javax/persistence/Converts.html) annotation is used to group multiple [@Convert](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-convert) annotations.

See the [AttributeConverter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-enums-attribute-converter) section for more info.

#### 24.1.15. @DiscriminatorColumn

The [@DiscriminatorColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/DiscriminatorColumn.html) annotation is used to specify the discriminator column name and the [discriminator type](http://docs.oracle.com/javaee/7/api/javax/persistence/DiscriminatorColumn.html#discriminatorType--) for the SINGLE\_TABLE and JOINED Inheritance strategies.

See the [Discriminator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-discriminator) section for more info.

#### 24.1.16. @DiscriminatorValue

The [@DiscriminatorValue](http://docs.oracle.com/javaee/7/api/javax/persistence/DiscriminatorValue.html) annotation is used to specify what value of the discriminator column is used for mapping the current annotated entity.

See the [Discriminator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-discriminator) section for more info.

#### 24.1.17. @ElementCollection

The [@ElementCollection](http://docs.oracle.com/javaee/7/api/javax/persistence/ElementCollection.html) annotation is used to specify a collection of a basic or embeddable types.

See the [Collections](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections) section for more info.

#### 24.1.18. @Embeddable

The [@Embeddable](http://docs.oracle.com/javaee/7/api/javax/persistence/Embeddable.html) annotation is used to specify embeddable types. Like basic types, embeddable types do not have any identity, being managed by their owning entity.

See the [Embeddables](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddables) section for more info.

#### 24.1.19. @Embedded

The [@Embedded](http://docs.oracle.com/javaee/7/api/javax/persistence/Embedded.html) annotation is used to specify that a given entity attribute represents an embeddable type.

See the [Embeddables](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#embeddables) section for more info.

#### 24.1.20. @EmbeddedId

The [@EmbeddedId](http://docs.oracle.com/javaee/7/api/javax/persistence/EmbeddedId.html) annotation is used to specify the entity identifier is an embeddable type.

See the [Composite identifiers with @EmbeddedId](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite-aggregated) section for more info.

#### 24.1.21. @Entity

The [@Entity](http://docs.oracle.com/javaee/7/api/javax/persistence/Entity.html) annotation is used to specify that the currently annotate class represents an entity type. Unlike basic and embeddable types, entity types have an identity and their state is managed by the underlying Persistence Context.

See the [Entity](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity) section for more info.

#### 24.1.22. @EntityListeners

The [@EntityListeners](http://docs.oracle.com/javaee/7/api/javax/persistence/EntityListeners.html) annotation is used to specify an array of callback listener classes that are used by the current annotated entity.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.23. @EntityResult

The [@EntityResult](http://docs.oracle.com/javaee/7/api/javax/persistence/EntityResult.html) annotation is used with the [@SqlResultSetMapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-sqlresultsetmapping) annotation to map the selected columns to an entity.

See the [Entity associations with named native queries](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-composite-key-entity-associations_named-query-example) section for more info.

#### 24.1.24. @Enumerated

The [@Enumerated](http://docs.oracle.com/javaee/7/api/javax/persistence/Enumerated.html) annotation is used to specify that an entity attribute represents an enumerated type.

See the [@Enumerated basic type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-enums-Enumerated) section for more info.

#### 24.1.25. @ExcludeDefaultListeners

The [@ExcludeDefaultListeners](http://docs.oracle.com/javaee/7/api/javax/persistence/ExcludeDefaultListeners.html) annotation is used to specify that the current annotated entity skips the invocation of any default listener.

See the [Exclude default entity listeners](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-exclude-default-listener) section for more info.

#### 24.1.26. @ExcludeSuperclassListeners

The [@ExcludeSuperclassListeners](http://docs.oracle.com/javaee/7/api/javax/persistence/ExcludeSuperclassListeners.html) annotation is used to specify that the current annotated entity skips the invocation of listeners declared by its superclass.

See the [Exclude default entity listeners](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-exclude-default-listener) section for more info.

#### 24.1.27. @FieldResult

The [@FieldResult](http://docs.oracle.com/javaee/7/api/javax/persistence/FieldResult.html) annotation is used with the [@EntityResult](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-entityresult) annotation to map the selected columns to the fields of some specific entity.

See the [Entity associations with named native queries](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-composite-key-entity-associations_named-query-example) section for more info.

#### 24.1.28. @ForeignKey

The [@ForeignKey](http://docs.oracle.com/javaee/7/api/javax/persistence/ForeignKey.html) annotation is used to specify the associated foreign key of a [@JoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-joincolumn) mapping. The @ForeignKeyannotation is only used if the automated schema generation tool is enabled, in which case, it allows you to customize the underlying foreign key definition.

See the [@ManyToOne with @ForeignKey](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-one-example) section for more info.

#### 24.1.29. @GeneratedValue

The [@GeneratedValue](http://docs.oracle.com/javaee/7/api/javax/persistence/GeneratedValue.html) annotation specifies that the entity identifier value is automatically generated using an identity column, a database sequence, or a table generator. Hibernate supports the @GeneratedValue mapping even for UUIDidentifiers.

See the [Automatically-generated identifiers](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-simple-generated) section for more info.

#### 24.1.30. @Id

The [@Id](http://docs.oracle.com/javaee/7/api/javax/persistence/Id.html) annotation specifies the entity identifier. An entity must always have an identifier attribute which is used when loading the entity in a given Persistence Context.

See the [Identifiers](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers) section for more info.

#### 24.1.31. @IdClass

The [@IdClass](http://docs.oracle.com/javaee/7/api/javax/persistence/IdClass.html) annotation is used if the current entity defined a composite identifier. A separate class encapsulates all the identifier attributes, which are mirrored by the current entity mapping.

See the [Composite identifiers with @IdClass](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-composite-nonaggregated) section for more info.

#### 24.1.32. @Index

The [@Index](http://docs.oracle.com/javaee/7/api/javax/persistence/Index.html) annotation is used by the automated schema generation tool to create a database index.

See the [Columns index](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#schema-generation-columns-index) chapter for more info.

#### 24.1.33. @Inheritance

The [@Inheritance](http://docs.oracle.com/javaee/7/api/javax/persistence/Inheritance.html) annotation is used to specify the inheritance strategy of a given entity class hierarchy.

See the [Inheritance](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance) section for more info.

#### 24.1.34. @JoinColumn

The [@JoinColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/JoinColumn.html) annotation is used to specify the FOREIGN KEY column used when joining an entity association or an embeddable collection.

See the [@ManyToOne with @JoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-one-example) section for more info.

#### 24.1.35. @JoinColumns

The [@JoinColumns](http://docs.oracle.com/javaee/7/api/javax/persistence/JoinColumns.html) annotation is used to group multiple [@JoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-joincolumn) annotations, which are used when mapping entity association or an embeddable collection using a composite identifier

#### 24.1.36. @JoinTable

The [@JoinTable](http://docs.oracle.com/javaee/7/api/javax/persistence/JoinTable.html) annotation is used to specify the link table between two other database tables.

See the [@JoinTable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-unidirectional-example) section for more info.

#### 24.1.37. @Lob

The [@Lob](http://docs.oracle.com/javaee/7/api/javax/persistence/Lob.html) annotation is used to specify that the current annotated entity attribute represents a large object type.

See the [BLOB mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-blob-example) section for more info.

#### 24.1.38. @ManyToMany

The [@ManyToMany](http://docs.oracle.com/javaee/7/api/javax/persistence/ManyToMany.html) annotation is used to specify a many-to-many database relationship.

See the [@ManyToMany mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-many) section for more info.

#### 24.1.39. @ManyToOne

The [@ManyToOne](http://docs.oracle.com/javaee/7/api/javax/persistence/ManyToOne.html) annotation is used to specify a many-to-one database relationship.

See the [@ManyToOne mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-one) section for more info.

#### 24.1.40. @MapKey

The [@MapKey](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKey.html) annotation is used to specify the key of a java.util.Map association for which the key type is either the primary key or an attribute of the entity which represents the value of the map.

See the [@MapKey mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-unidirectional-example) section for more info.

#### 24.1.41. @MapKeyClass

The [@MapKeyClass](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyClass.html) annotation is used to specify the type of the map key of a java.util.Map associations.

See the [@MapKeyClass mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-key-class) section for more info.

#### 24.1.42. @MapKeyColumn

The [@MapKeyColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyColumn.html) annotation is used to specify the database column which stores the key of a java.util.Mapassociation for which the map key is a basic type.

See the [@MapKeyType mapping section](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-custom-key-type-mapping-example) section for an example of @MapKeyColumn annotation usage.

#### 24.1.43. @MapKeyEnumerated

The [@MapKeyEnumerated](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyEnumerated.html) annotation is used to specify that the key of java.util.Map association is a Java Enum.

See the [@MapKeyEnumerated mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-bidirectional-example) section for more info.

#### 24.1.44. @MapKeyJoinColumn

The [@MapKeyJoinColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyJoinColumn.html) annotation is used to specify that the key of java.util.Map association is an entity association. The map key column is a FOREIGN KEY in a link table that also joins the Map owner’s table with the table where the Map value resides.

See the [@MapKeyJoinColumn mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-value-type-entity-key-example) section for more info.

#### 24.1.45. @MapKeyJoinColumns

The [@MapKeyJoinColumns](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyJoinColumns.html) annotation is used to group several [@MapKeyJoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-mapkeyjoincolumn) mappings when the java.util.Map association key uses a composite identifier.

#### 24.1.46. @MapKeyTemporal

The [@MapKeyTemporal](http://docs.oracle.com/javaee/7/api/javax/persistence/MapKeyTemporal.html) annotation is used to specify that the key of java.util.Map association is a [@TemporalType](http://docs.oracle.com/javaee/7/api/javax/persistence/TemporalType.html) (e.g. DATE, TIME, TIMESTAMP).

See the [@MapKeyTemporal mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-unidirectional-example) section for more info.

#### 24.1.47. @MappedSuperclass

The [@MappedSuperclass](http://docs.oracle.com/javaee/7/api/javax/persistence/MappedSuperclass.html) annotation is used to specify that the current annotated type attributes are inherited by any subclass entity.

See the [@MappedSuperclass](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-mapped-superclass) section for more info.

#### 24.1.48. @MapsId

The [@MapsId](http://docs.oracle.com/javaee/7/api/javax/persistence/MapsId.html) annotation is used to specify that the entity identifier is mapped by the current annotated @ManyToOne or @OneToOne association.

See the [@MapsId mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-derived-mapsid) section for more info.

#### 24.1.49. @NamedAttributeNode

The [@NamedAttributeNode](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedAttributeNode.html) annotation is used to specify each individual attribute node that needs to be fetched by an Entity Graph.

See the [Fetch graph](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-dynamic-fetching-entity-graph-example) section for more info.

#### 24.1.50. @NamedEntityGraph

The [@NamedEntityGraph](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedEntityGraph.html) annotation is used to specify an Entity Graph that can be used by an entity query to override the default fetch plan.

See the [Fetch graph](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-dynamic-fetching-entity-graph-example) section for more info.

#### 24.1.51. @NamedEntityGraphs

The [@NamedEntityGraphs](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedEntityGraphs.html) annotation is used to group multiple [@NamedEntityGraph](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namedentitygraph) annotations.

#### 24.1.52. @NamedNativeQueries

The [@NamedNativeQueries](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedNativeQueries.html) annotation is used to group multiple [@NamedNativeQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namednativequery) annotations.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.1.53. @NamedNativeQuery

The [@NamedNativeQuery](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedNativeQuery.html) annotation is used to specify a native SQL query that can be retrieved later by its name.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.1.54. @NamedQueries

The [@NamedQueries](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedQueries.html) annotation is used to group multiple [@NamedQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namedquery) annotations.

#### 24.1.55. @NamedQuery

The [@NamedQuery](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedQuery.html) annotation is used to specify a JPQL query that can be retrieved later by its name.

See the [@NamedQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#jpql-api-named-query-example) section for more info.

#### 24.1.56. @NamedStoredProcedureQueries

The [@NamedStoredProcedureQueries](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedStoredProcedureQueries.html) annotation is used to group multiple [@NamedStoredProcedureQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namedstoredprocedurequery) annotations.

#### 24.1.57. @NamedStoredProcedureQuery

The [@NamedStoredProcedureQuery](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedStoredProcedureQuery.html) annotation is used to specify a stored procedure query that can be retrieved later by its name.

See the [Using named queries to call stored procedures](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-sp-named-query) section for more info.

#### 24.1.58. @NamedSubgraph

The [@NamedSubgraph](http://docs.oracle.com/javaee/7/api/javax/persistence/NamedSubgraph.html) annotation used to specify a subgraph in an Entity Graph.

See the [Fetch subgraph](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-dynamic-fetching-entity-subgraph) section for more info.

#### 24.1.59. @OneToMany

The [@OneToMany](http://docs.oracle.com/javaee/7/api/javax/persistence/OneToMany.html) annotation is used to specify a one-to-many database relationship.

See the [@OneToMany mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-one-to-many) section for more info.

#### 24.1.60. @OneToOne

The [@OneToOne](http://docs.oracle.com/javaee/7/api/javax/persistence/OneToOne.html) annotation is used to specify a one-to-one database relationship.

See the [@OneToOne mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-one-to-one) section for more info.

#### 24.1.61. @OrderBy

The [@OrderBy](http://docs.oracle.com/javaee/7/api/javax/persistence/OrderBy.html) annotation is used to specify the entity attributes used for sorting when fetching the current annotated collection.

See the [@OrderBy mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-ordered-list) section for more info.

#### 24.1.62. @OrderColumn

The [@OrderColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/OrderColumn.html) annotation is used to specify that the current annotation collection order should be materialized in the database.

See the [@OrderColumn mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-ordered-list-order-column-example) section for more info.

#### 24.1.63. @PersistenceContext

The [@PersistenceContext](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceContext.html) annotation is used to specify the EntityManager that needs to be injected as a dependency.

See the [@PersistenceContext mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-jpa-compliant-PersistenceContext-example) section for more info.

#### 24.1.64. @PersistenceContexts

The [@PersistenceContexts](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceContexts.html) annotation is used to group multiple [@PersistenceContext](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-persistencecontext) annotations.

#### 24.1.65. @PersistenceProperty

The [@PersistenceProperty](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceProperty.html) annotation is used by the [@PersistenceContext](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-persistencecontext) annotation to declare JPA provider properties that are passed to the underlying container when the EntityManager instance is created.

See the [@PersistenceProperty mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-jpa-compliant-PersistenceContext-configurable-example) section for more info.

#### 24.1.66. @PersistenceUnit

The [@PersistenceUnit](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceUnit.html) annotation is used to specify the EntityManagerFactory that needs to be injected as a dependency.

See the [@PersistenceUnit mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-jpa-compliant-PersistenceUnit-example) section for more info.

#### 24.1.67. @PersistenceUnits

The [@PersistenceUnits](http://docs.oracle.com/javaee/7/api/javax/persistence/PersistenceUnits.html) annotation is used to group multiple [@PersistenceUnit](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-persistenceunit) annotations.

#### 24.1.68. @PostLoad

The [@PostLoad](http://docs.oracle.com/javaee/7/api/javax/persistence/PostLoad.html) annotation is used to specify a callback method that fires after an entity is loaded.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.69. @PostPersist

The [@PostPersist](http://docs.oracle.com/javaee/7/api/javax/persistence/PostPersist.html) annotation is used to specify a callback method that fires after an entity is persisted.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.70. @PostRemove

The [@PostRemove](http://docs.oracle.com/javaee/7/api/javax/persistence/PostRemove.html) annotation is used to specify a callback method that fires after an entity is removed.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.71. @PostUpdate

The [@PostUpdate](http://docs.oracle.com/javaee/7/api/javax/persistence/PostUpdate.html) annotation is used to specify a callback method that fires after an entity is updated.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.72. @PrePersist

The [@PrePersist](http://docs.oracle.com/javaee/7/api/javax/persistence/PrePersist.html) annotation is used to specify a callback method that fires before an entity is persisted.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.73. @PreRemove

The [@PreRemove](http://docs.oracle.com/javaee/7/api/javax/persistence/PreRemove.html) annotation is used to specify a callback method that fires before an entity is removed.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.74. @PreUpdate

The [@PreUpdate](http://docs.oracle.com/javaee/7/api/javax/persistence/PreUpdate.html) annotation is used to specify a callback method that fires before an entity is updated.

See the [JPA callbacks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.75. @PrimaryKeyJoinColumn

The [@PrimaryKeyJoinColumn](http://docs.oracle.com/javaee/7/api/javax/persistence/PrimaryKeyJoinColumn.html) annotation is used to specify that the primary key column of the current annotated entity is also a foreign key to some other entity (e.g. a base class table in a JOINED inheritance strategy, the primary table in a secondary table mapping, or the parent table in a @OneToOne relationship).

See the [@PrimaryKeyJoinColumn mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-derived-primarykeyjoincolumn) section for more info.

#### 24.1.76. @PrimaryKeyJoinColumns

The [@PrimaryKeyJoinColumns](http://docs.oracle.com/javaee/7/api/javax/persistence/PrimaryKeyJoinColumns.html) annotation is used to group multiple [@PrimaryKeyJoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-primarykeyjoincolumn) annotations.

#### 24.1.77. @QueryHint

The [@QueryHint](http://docs.oracle.com/javaee/7/api/javax/persistence/QueryHint.html) annotation is used to specify a JPA provider hint used by a @NamedQuery or a @NamedNativeQueryannotation.

See the [@QueryHint](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#jpa-read-only-entities-native-example) section for more info.

#### 24.1.78. @SecondaryTable

The [@SecondaryTable](http://docs.oracle.com/javaee/7/api/javax/persistence/SecondaryTable.html) annotation is used to specify a secondary table for the current annotated entity.

See the [@SecondaryTable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-secondary-table-example) section for more info.

#### 24.1.79. @SecondaryTables

The [@SecondaryTables](http://docs.oracle.com/javaee/7/api/javax/persistence/SecondaryTables.html) annotation is used to group multiple [@SecondaryTable](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-secondarytable) annotations.

#### 24.1.80. @SequenceGenerator

The [@SequenceGenerator](http://docs.oracle.com/javaee/7/api/javax/persistence/SequenceGenerator.html) annotation is used to specify the database sequence used by the identifier generator of the current annotated entity.

See the [@SequenceGenerator mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-sequence-configured) section for more info.

#### 24.1.81. @SqlResultSetMapping

The [@SqlResultSetMapping](http://docs.oracle.com/javaee/7/api/javax/persistence/SqlResultSetMapping.html) annotation is used to specify the ResultSet mapping of a native SQL query or stored procedure.

See the [SqlResultSetMapping mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-composite-key-entity-associations_named-query-example) section for more info.

#### 24.1.82. @SqlResultSetMappings

The [@SqlResultSetMappings](http://docs.oracle.com/javaee/7/api/javax/persistence/SqlResultSetMappings.html) annotation is group multiple [@SqlResultSetMapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-sqlresultsetmapping) annotations.

#### 24.1.83. @StoredProcedureParameter

The [@StoredProcedureParameter](http://docs.oracle.com/javaee/7/api/javax/persistence/StoredProcedureParameter.html) annotation is used to specify a parameter of a [@NamedStoredProcedureQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namedstoredprocedurequery).

See the [Using named queries to call stored procedures](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-sp-named-query) section for more info.

#### 24.1.84. @Table

The [@Table](http://docs.oracle.com/javaee/7/api/javax/persistence/Table.html) annotation is used to specify the primary table of the current annotated entity.

See the [@Table mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-secondary-table-example) section for more info.

#### 24.1.85. @TableGenerator

The [@TableGenerator](http://docs.oracle.com/javaee/7/api/javax/persistence/TableGenerator.html) annotation is used to specify the database table used by the identity generator of the current annotated entity.

See the [@TableGenerator mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-table-configured-mapping-example) section for more info.

#### 24.1.86. @Temporal

The [@Temporal](http://docs.oracle.com/javaee/7/api/javax/persistence/Temporal.html) annotation is used to specify the TemporalType of the current annotated java.util.Date or java.util.Calendar entity attribute.

See the [Basic temporal types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-datetime) chapter for more info.

#### 24.1.87. @Transient

The [@Transient](http://docs.oracle.com/javaee/7/api/javax/persistence/Transient.html) annotation is used to specify that a given entity attribute should not be persisted.

See the [@Transient mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#events-jpa-callbacks-example) section for more info.

#### 24.1.88. @UniqueConstraint

The [@UniqueConstraint](http://docs.oracle.com/javaee/7/api/javax/persistence/UniqueConstraint.html) annotation is used to specify a unique constraint to be included by the automated schema generator for the primary or secondary table associated with the current annotated entity.

See the [Columns unique constraint](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#schema-generation-columns-unique-constraint) chapter for more info.

#### 24.1.89. @Version

The [@Version](http://docs.oracle.com/javaee/7/api/javax/persistence/Version.html) annotation is used to specify the version attribute used for optimistic locking.

See the [Optimistic locking mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking-optimistic) section for more info.

### 24.2. Hibernate annotations

#### 24.2.1. ~~@AccessType~~

The [~~@AccessType~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/AccessType.html) annotation is deprecated. You should use either the JPA [@Access](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-access) or the Hibernate native [@AttributeAccessor](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-attributeaccessor) annotation.

#### 24.2.2. @Any

The [@Any](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Any.html) annotation is used to define the **any-to-one** association which can point to one one of several entity types.

See the [@Any mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-any) section for more info.

#### 24.2.3. @AnyMetaDef

The [@AnyMetaDef](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/AnyMetaDef.html) annotation is used to provide metadata about an @Any or @ManyToAny mapping.

See the [@Any mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-any) section for more info.

#### 24.2.4. @AnyMetaDefs

The [@AnyMetaDefs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/AnyMetaDefs.html) annotation is used to group multiple [@AnyMetaDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-anymetadef) annotations.

#### 24.2.5. @AttributeAccessor

The [@AttributeAccessor](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/AttributeAccessor.html) annotation is used to specify a custom [PropertyAccessStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/property/access/spi/PropertyAccessStrategy.html).

Should only be used to name a custom PropertyAccessStrategy. For property/field access type, the JPA [@Access](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-access)annotation should be preferred.

However, if this annotation is used with either value="property" or value="field", it will act just as the corresponding usage of the JPA [@Access](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-access) annotation.

#### 24.2.6. @BatchSize

The [@BatchSize](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/BatchSize.html) annotation is used to specify the size for batch loading the entries of a lazy collection.

See the [Batch fetching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-batch) section for more info.

#### 24.2.7. @Cache

The [@Cache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Cache.html) annotation is used to specify the [CacheConcurrencyStrategy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CacheConcurrencyStrategy.html) of a root entity or a collection.

See the [Caching](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#caching) chapter for more info.

#### 24.2.8. @Cascade

The [@Cascade](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Cascade.html) annotation is used to apply the Hibernate specific [CascadeType](http://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CascadeType.html) strategies (e.g. CascadeType.LOCK, CascadeType.SAVE\_UPDATE, CascadeType.REPLICATE) on a given association.

For JPA cascading, prefer using the [javax.persistence.CascadeType](http://docs.oracle.com/javaee/7/api/javax/persistence/CascadeType.html) instead.

When combining both JPA and Hibernate CascadeType strategies, Hibernate will merge both sets of cascades.

See the [Cascading](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc-cascade) chapter for more info.

#### 24.2.9. @Check

The [@Check](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Check.html) annotation is used to specify an arbitrary SQL CHECK constraint which can be defined at the class level.

See the [Database-level checks](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#schema-generation-database-checks) chapter for more info.

#### 24.2.10. @CollectionId

The [@CollectionId](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CollectionId.html) annotation is used to specify an identifier column for an idbag collection.

You might want to use the JPA [@OrderColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-ordercolumn) instead.

#### 24.2.11. @CollectionType

The [@CollectionType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CollectionType.html) annotation is used to specify a custom collection type.

The collection can also name a [@Type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-type), which defines the Hibernate Type of the collection elements.

See the [Custom collection types](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-custom) chapter for more info.

#### 24.2.12. @ColumnDefault

The [@ColumnDefault](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ColumnDefault.html) annotation is used to specify the DEFAULT DDL value to apply when using the automated schema generator.

The same behavior can be achieved using the definition attribute of the JPA [@Column](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-column) annotation.

See the [Default value for database column](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#schema-generation-column-default-value) chapter for more info.

#### 24.2.13. @Columns

The [@Columns](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Columns.html) annotation is used to group multiple JPA [@Column](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-column) annotations.

See the [@Columns mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-read-and-write-composite-type-example) section for more info.

#### 24.2.14. @ColumnTransformer

The [@ColumnTransformer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ColumnTransformer.html) annotation is used to customize how a given column value is read from or write into the database.

See the [@ColumnTransformer mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-read-and-write-example) section for more info.

#### 24.2.15. @ColumnTransformers

The [@ColumnTransformers](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ColumnTransformers.html) annotation iis used to group multiple [@ColumnTransformer](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-columntransformer) annotations.

#### 24.2.16. @CreationTimestamp

The [@CreationTimestamp](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/CreationTimestamp.html) annotation is used to specify that the current annotated temporal type must be initialized with the current JVM timestamp value.

See the [@CreationTimestamp mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated-CreationTimestamp) section for more info.

#### 24.2.17. @DiscriminatorFormula

The [@DiscriminatorFormula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/DiscriminatorFormula.html) annotation is used to specify a Hibernate [@Formula](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-formula) to resolve the inheritance discriminator value.

See the [@DiscriminatorFormula](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-single-table-discriminator-formula-example) section for more info.

#### 24.2.18. @DiscriminatorOptions

The [@DiscriminatorOptions](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/DiscriminatorOptions.html) annotation is used to provide the force and insert Discriminator properties.

See the [Discriminator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-discriminator) section for more info.

#### 24.2.19. @DynamicInsert

The [@DynamicInsert](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/DynamicInsert.html) annotation is used to specify that the INSERT SQL statement should be generated whenever an entity is to be persisted.

By default, Hibernate uses a cached INSERT statement that sets all table columns. When the entity is annotated with the @DynamicInsert annotation, the PreparedStatement is going to include only the non-null columns.

See the [@CreationTimestamp mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated-CreationTimestamp) section for more info on how @DynamicInsert works.

#### 24.2.20. @DynamicUpdate

The [@DynamicUpdate](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/DynamicUpdate.html) annotation is used to specify that the UPDATE SQL statement should be generated whenever an entity is modified.

By default, Hibernate uses a cached UPDATE statement that sets all table columns. When the entity is annotated with the @DynamicUpdate annotation, the PreparedStatement is going to include only the columns whose values have been changed.

See the [@DynamicUpdate](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc-managed-state-dynamic-update) section for more info.

|  |  |
| --- | --- |
|  | For reattachment of detached entities, the dynamic update is not possible without having the [@SelectBeforeUpdate](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-selectbeforeupdate) annotation as well. |

#### 24.2.21. ~~@Entity~~

The [~~@Entity~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Entity.html) annotation is deprecated. Use the JPA [@Entity](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-entity) annotation instead.

#### 24.2.22. @Fetch

The [@Fetch](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Fetch.html) annotation is used to specify the Hibernate specific [FetchMode](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FetchMode.html) (e.g. JOIN, SELECT, SUBSELECT) used for the current annotated association:

See the [@Fetch mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-fetch-annotation) section for more info.

#### 24.2.23. @FetchProfile

The [@FetchProfile](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FetchProfile.html) annotation is used to specify a custom fetching profile, similar to a JPA Entity Graph.

See the [Fetch mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-dynamic-fetching-profile-example) section for more info.

#### 24.2.24. @FetchProfile.FetchOverride

The [@FetchProfile.FetchOverride](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FetchProfile.FetchOverride.html) annotation is used in conjunction with the [@FetchProfile](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-fetchprofile) annotation, and it’s used for overriding the fetching strategy of a particular entity association.

See the [Fetch profile](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-strategies-dynamic-fetching-profile-example) section for more info.

#### 24.2.25. @FetchProfiles

The [@FetchProfiles](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FetchProfiles.html) annotation is used to group multiple [@FetchProfile](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-fetchprofile) annotations.

#### 24.2.26. @Filter

The [@Filter](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Filter.html) annotation is used to add filters to an entity or the target entity of a collection.

See the [Filter mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-filter-example) section for more info.

#### 24.2.27. @FilterDef

The [@FilterDef](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FilterDef.html) annotation is used to specify a @Filter definition (name, default condition and parameter types, if any).

See the [Filter mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-filter-example) section for more info.

#### 24.2.28. @FilterDefs

The [@FilterDefs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FilterDefs.html) annotation is used to group multiple [@FilterDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-filterdef) annotations.

#### 24.2.29. @FilterJoinTable

The [@FilterJoinTable](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FilterJoinTable.html) annotation is used to add @Filter capabilities to a join table collection.

See the [FilterJoinTable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-filter-join-table) section for more info.

#### 24.2.30. @FilterJoinTables

The [@FilterJoinTables](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/FilterJoinTables.html) annotation is used to group multiple [@FilterJoinTable](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-filterjointable) annotations.

#### 24.2.31. @Filters

The [@Filters](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Filters.html) annotation is used to group multiple [@Filter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-filter) annotations.

#### 24.2.32. ~~@ForeignKey~~

The [~~@ForeignKey~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ForeignKey.html) annotation is deprecated. Use the JPA 2.1 [@ForeignKey](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-foreignkey) annotation instead.

#### 24.2.33. @Formula

The [@Formula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Formula.html) annotation is used to specify an SQL fragment that is executed in order to populate a given entity attribute.

See the [@Formula mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-formula-example) section for more info.

#### 24.2.34. @Generated

The [@Generated](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Generated.html) annotation is used to specify that the current annotated entity attribute is generated by the database.

See the [@Generated mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated-Generated) section for more info.

#### 24.2.35. @GeneratorType

The [@GeneratorType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GeneratorType.html) annotation is used to provide a [ValueGenerator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tuple/ValueGenerator.html) and a [GenerationTime](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenerationTime.html) for the current annotated generated attribute.

See the [@GeneratorType mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated-GeneratorType-example) section for more info.

#### 24.2.36. @GenericGenerator

The [@GenericGenerator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenericGenerator.html) annotation can be used to configure any Hibernate identifier generator.

See the [@GenericGenerator mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-generators-GenericGenerator) section for more info.

#### 24.2.37. @GenericGenerators

The [@GenericGenerators](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/GenericGenerators.html) annotation is used to group multiple [@GenericGenerator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-genericgenerator) annotations.

#### 24.2.38. @Immutable

The [@Immutable](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Immutable.html) annotation is used to specify that the annotated entity, attribute, or collection is immutable.

See the [@Immutable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-immutability) section for more info.

#### 24.2.39. ~~@Index~~

The [~~@Index~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Index.html) annotation is deprecated. Use the JPA [@Index](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-index) annotation instead.

#### 24.2.40. ~~@IndexColumn~~

The [~~@IndexColumn~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/IndexColumn.html) annotation is deprecated. Use the JPA [@OrderColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-ordercolumn) annotation instead.

#### 24.2.41. @JoinColumnOrFormula

The [@JoinColumnOrFormula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/JoinColumnOrFormula.html) annotation is used to specify that the entity association is resolved either through a FOREIGN KEY join (e.g. [@JoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-joincolumn)) or using the result of a given SQL formula (e.g. [@JoinFormula](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-joinformula)).

See the [@JoinColumnOrFormula mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-JoinColumnOrFormula) section for more info.

#### 24.2.42. @JoinColumnsOrFormulas

The [@JoinColumnsOrFormulas](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/JoinColumnsOrFormulas.html) annotation is used to group multiple [@JoinColumnOrFormula](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-joincolumnorformula) annotations.

#### 24.2.43. @JoinFormula

The [@JoinFormula](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/JoinFormula.html) annotation is used as a replacement for [@JoinColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-joincolumn) when the association does not have a dedicated FOREIGN KEY column.

See the [@JoinFormula mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-JoinFormula) section for more info.

#### 24.2.44. @LazyCollection

The [@LazyCollection](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyCollection.html) annotation is used to specify the lazy fetching behavior of a given collection. The possible values are given by the [LazyCollectionOption](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyCollectionOption.html) enumeration:

TRUE

Load it when the state is requested.

FALSE

Eagerly load it.

EXTRA

Prefer extra queries over full collection loading.

The TRUE and FALSE values are deprecated since you should be using the JPA [FetchType](http://docs.oracle.com/javaee/7/api/javax/persistence/FetchType.html) attribute of the [@ElementCollection](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-elementcollection), [@OneToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-onetomany), or [@ManyToMany](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-manytomany) collection.

The EXTRA value has no equivalent in the JPA specification, and it’s used to avoid loading the entire collection even when the collection is accessed for the first time. Each element is fetched individually using a secondary query.

See the [@LazyCollection mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#fetching-LazyCollection) section for more info.

#### 24.2.45. @LazyGroup

The [@LazyGroup](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyGroup.html) annotation is used to specify that an entity attribute should be fetched along with all the other attributes belonging to the same group.

To load entity attributes lazily, bytecode enhancement is needed. By default, all non-collection attributes are loaded in one group named "DEFAULT".

This annotation allows defining different groups of attributes to be initialized together when access one attribute in the group.

See the [@LazyGroup mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#BytecodeEnhancement-lazy-loading-example) section for more info.

#### 24.2.46. @LazyToOne

The [@LazyToOne](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyToOne.html) annotation is used to specify the laziness options, represented by [LazyToOneOption](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/LazyToOneOption.html), available for a @OneToOne or @ManyToOne association.

LazyToOneOption defines the following alternatives:

FALSE

Eagerly load the association. This one is not needed since the JPA FetchType.EAGER offers the same behavior.

NO\_PROXY

This option will fetch the association lazily while returning real entity object.

PROXY

This option will fetch the association lazily while returning a proxy instead.

See the [@LazyToOne mapping example](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-one-to-one-bidirectional-lazy) section for more info.

#### 24.2.47. @ListIndexBase

The [@ListIndexBase](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ListIndexBase.html) annotation is used to specify the start value for a list index, as stored in the database.

By default, List indexes are stored starting at zero. Generally used in conjunction with [@OrderColumn](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-ordercolumn).

See the [@ListIndexBase mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-customizing-ordered-list-ordinal) section for more info.

#### 24.2.48. @Loader

The [@Loader](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Loader.html) annotation is used to override the default SELECT query used for loading an entity loading.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.2.49. @ManyToAny

The [@ManyToAny](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ManyToAny.html) annotation is used to specify a many-to-one association when the target type is dynamically resolved.

See the [@ManyToAny mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-many-to-any) section for more info.

#### 24.2.50. @MapKeyType

The [@MapKeyType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/MapKeyType.html) annotation is used to specify the map key type.

See the [@MapKeyType mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-map-custom-key-type) section for more info.

#### 24.2.51. @MetaValue

The [@MetaValue](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/MetaValue.html) annotation is used by the [@AnyMetaDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-anymetadef) annotation to specify the association between a given discriminator value and an entity type.

See the [@Any mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-any) section for more info.

#### 24.2.52. @NamedNativeQueries

The [@NamedNativeQueries](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedNativeQueries.html) annotation is used to group multiple [@NamedNativeQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-namednativequery) annotations.

#### 24.2.53. @NamedNativeQuery

The [@NamedNativeQuery](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedNativeQuery.html) annotation extends the JPA [@NamedNativeQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namednativequery) with Hibernate specific features, like:

* flush mode for this particular query
* if the query should be cached, and which cache region should be used
* the selected entity CacheModeType strategy
* the JDBC Statement fetch size
* the JDBC Statement execution timeout
* if the query is a CallableStatement, targeting a stored procedure or a database function
* what SQL-level comment should be sent to the database
* if the query is read-only, hence it does not store the resulted entities into the currently running Persistence Context

See the [Hibernate @NamedNativeQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-multiple-scalar-values-dto-NamedNativeQuery-hibernate-example) section for more info.

#### 24.2.54. @NamedQueries

The [@NamedQueries](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedQueries.html) annotation is used to group multiple [@NamedQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-namedquery) annotations.

#### 24.2.55. @NamedQuery

The [@NamedQuery](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NamedQuery.html) annotation extends the JPA [@NamedQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-namedquery) with Hibernate specific features, like:

* flush mode for this particular query
* if the query should be cached, and which cache region should be used
* the selected entity CacheModeType strategy
* the JDBC Statement fetch size
* the JDBC Statement execution timeout
* if the query is a CallableStatement, targeting a stored procedure or a database function
* what SQL-level comment should be sent to the database
* if the query is read-only, hence it does not store the resulted entities into the currently running Persistence Context

See the [@NamedQuery](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#jpql-api-hibernate-named-query-example) section for more info.

#### 24.2.56. @Nationalized

The [@Nationalized](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Nationalized.html) annotation is used to specify that the current annotated attribute is a character type (e.g. String, Character, Clob) that is stored in a nationalized column type (NVARCHAR, NCHAR, NCLOB).

See the [@Nationalized mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-nationalized-example) section for more info.

#### 24.2.57. @NaturalId

The [@NaturalId](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NaturalId.html) annotation is used to specify that the current annotated attribute is part of the natural id of the entity.

See the [Natural Ids](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid) section for more info.

#### 24.2.58. @NaturalIdCache

The [@NaturalIdCache](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NaturalIdCache.html) annotation is used to specify that the natural id values associated with the annotated entity should be stored in the second-level cache.

See the [@NaturalIdCache mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#naturalid-caching) section for more info.

#### 24.2.59. @NotFound

The [@NotFound](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NotFound.html) annotation is used to specify the [NotFoundAction](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/NotFoundAction.html) strategy for when an element is not found in a given association.

The NotFoundAction defines with two possibilities:

EXCEPTION

An exception is thrown when an element is not found (default and recommended).

IGNORE

Ignore the element when not found in the database.

See the [@NotFound mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-not-found) section for more info.

#### 24.2.60. @OnDelete

The [@OnDelete](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OnDelete.html) annotation is used to specify the delete strategy employed by the current annotated collection, array or joined subclasses. This annotation is used by the automated schema generation tool to generated the appropriate FOREIGN KEY DDL cascade directive.

The two possible strategies are defined by the [OnDeleteAction](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OnDeleteAction.html) enumeration:

CASCADE

Use the database FOREIGN KEY cascade capabilities.

NO\_ACTION

Take no action.

See the [@OnDelete cascade](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#pc-cascade-on-delete) chapter for more info.

#### 24.2.61. @OptimisticLock

The [@OptimisticLock](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLock.html) annotation is used to specify if the current annotated attribute will trigger an entity version increment upon being modified.

See the [Excluding attributes](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking-optimistic-exclude-attribute) section for more info.

#### 24.2.62. @OptimisticLocking

The [@OptimisticLocking](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLocking.html) annotation is used to specify the current annotated an entity optimistic locking strategy.

The four possible strategies are defined by the [OptimisticLockType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OptimisticLockType.html) enumeration:

NONE

The implicit optimistic locking mechanism is disabled.

VERSION

The implicit optimistic locking mechanism is using a dedicated version column.

ALL

The implicit optimistic locking mechanism is using **all** attributes as part of an expanded WHERE clause restriction for the UPDATE and DELETE SQL statements.

DIRTY

The implicit optimistic locking mechanism is using the **dirty** attributes (the attributes that were modified) as part of an expanded WHERE clause restriction for the UPDATE and DELETE SQL statements.

See the [Versionless optimistic locking](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking-optimistic-versionless) section for more info.

#### 24.2.63. @OrderBy

The [@OrderBy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/OrderBy.html) annotation is used to specify a **SQL** ordering directive for sorting the current annotated collection.

It differs from the JPA [@OrderBy](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-jpa-orderby) annotation because the JPA annotation expects a JPQL order-by fragment, not an SQL directive.

See the [@OrderBy mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-customizing-ordered-by-sql-clause) section for more info.

#### 24.2.64. @ParamDef

The [@ParamDef](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ParamDef.html) annotation is used in conjunction with [@FilterDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-filterdef) so that the Hibernate Filter can be customized with runtime-provided parameter values.

See the [Filter mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-filter-example) section for more info.

#### 24.2.65. @Parameter

The [@Parameter](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Parameter.html) annotation is generic parameter (basically a key/value combination) tused to parametrize other annotations, like [@CollectionType](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-collectiontype), [@GenericGenerator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-genericgenerator), and [@Type](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-type), [@TypeDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-typedef).

#### 24.2.66. @Parent

The [@Parent](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Parent.html) annotation is used to specify that the current annotated embeddable attribute references back the owning entity.

See the [@Parent mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-Parent) section for more info.

#### 24.2.67. @Persister

The [@Persister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Persister.html) annotation is used to specify a custom entity or collection persister.

For entities, the custom persister must implement the [EntityPersister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/entity/EntityPersister.html) interface.

For collections, the custom persister must implement the [CollectionPersister](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/persister/collection/CollectionPersister.html) interface.

See the [@Persister mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-persister) section for more info.

#### 24.2.68. @Polymorphism

The [@Polymorphism](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Polymorphism.html) annotation is used to define the [PolymorphismType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/PolymorphismType.html) Hibernate will apply to entity hierarchies.

There are two possible PolymorphismType options:

EXPLICIT

The current annotated entity is retrieved only if explicitly asked.

IMPLICIT

The current annotated entity is retrieved if any of its super entity are retrieved. This is the default option.

See the [@Polymorphism](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-inheritance-polymorphism) section for more info.

#### 24.2.69. @Proxy

The [@Proxy](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Proxy.html) annotation is used to specify a custom Proxy implementation for the current annotated entity.

See the [@Proxy mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-proxy) section for more info.

#### 24.2.70. @RowId

The [@RowId](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/RowId.html) annotation is used to specify the database column used as a ROWID pseudocolumn. For instance, Oracle defines the [ROWID pseudocolumn](https://docs.oracle.com/cd/B19306_01/server.102/b14200/pseudocolumns008.htm) which provides the address of every table row.

According to Oracle documentation, ROWID is the fastest way to access a single row from a table.

See the [@RowId mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#identifiers-rowid) section for more info.

#### 24.2.71. @SelectBeforeUpdate

The [@SelectBeforeUpdate](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SelectBeforeUpdate.html) annotation is used to specify that the current annotated entity state be selected from the database when determining whether to perform an update when the detached entity is reattached.

See the [OptimisticLockType.DIRTY mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking-optimistic-lock-type-dirty-example) section for more info on how @SelectBeforeUpdate works.

#### 24.2.72. ~~@Sort~~

The [~~@Sort~~](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Sort.html) annotation is deprecated. Use the Hibernate specific [@SortComparator](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-sortcomparator) or [@SortNatural](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-sortnatural) annotations instead.

#### 24.2.73. @SortComparator

The [@SortComparator](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SortComparator.html) annotation is used to specify a Comparator for sorting the Set/Map in-memory.

See the [@SortComparator mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-unidirectional-sorted-set-custom-comparator-example) section for more info.

#### 24.2.74. @SortNatural

The [@SortNatural](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SortNatural.html) annotation is used to specify that the Set/Map should be sorted using natural sorting.

See the [@SortNatural mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#collections-bidirectional-sorted-set-example) section for more info.

#### 24.2.75. @Source

The [@Source](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Source.html) annotation is used in conjunction with a @Version timestamp entity attribute indicating the [SourceType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SourceType.html)of the timestamp value.

The SourceType offers two options:

DB

Get the timestamp from the database.

VM

Get the timestamp from the current JVM.

See the [Database-generated version timestamp mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#locking-optimistic-version-timestamp-source-mapping-example) section for more info.

#### 24.2.76. @SQLDelete

The [@SQLDelete](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SQLDelete.html) annotation is used to specify a custom SQL DELETE statement for the current annotated entity or collection.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.2.77. @SQLDeleteAll

The [@SQLDeleteAll](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SQLDeleteAll.html) annotation is used to specify a custom SQL DELETE statement when removing all elements of the current annotated collection.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.2.78. @SqlFragmentAlias

The [@SqlFragmentAlias](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SqlFragmentAlias.html) annotation is used to specify an alias for a Hibernate [@Filter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-filter).

The alias (e.g. myAlias) can then be used in the @Filter condition clause using the {alias} (e.g. {myAlias}) placeholder.

See the [@SqlFragmentAlias mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-filter-sql-fragment-alias) section for more info.

#### 24.2.79. @SQLInsert

The [@SQLInsert](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SQLInsert.html) annotation is used to specify a custom SQL INSERT statement for the current annotated entity or collection.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.2.80. @SQLUpdate

The [@SQLUpdate](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/SQLUpdate.html) annotation is used to specify a custom SQL UPDATE statement for the current annotated entity or collection.

See the [Custom CRUD mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-example) section for more info.

#### 24.2.81. @Subselect

The [@Subselect](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Subselect.html) annotation is used to specify an immutable and read-only entity using a custom SQL SELECT statement.

See the [Mapping the entity to a SQL query](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-sql-query-mapping) section for more info.

#### 24.2.82. @Synchronize

The [@Synchronize](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Synchronize.html) annotation is usually used in conjunction with the [@Subselect](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-subselect) annotation to specify the list of database tables used by the @Subselect SQL query.

With this information in place, Hibernate will properly trigger an entity flush whenever a query targeting the @Subselect entity is to be executed while the Persistence Context has scheduled some insert/update/delete actions against the database tables used by the @Subselect SQL query.

Therefore, the @Synchronize annotation prevents the derived entity from returning stale data when executing entity queries against the @Subselect entity.

See the [Mapping the entity to a SQL query](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-sql-query-mapping) section for more info.

#### 24.2.83. @Table

The [@Table](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Table.html) annotation is used to specify additional information to a JPA [@Table](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-table) annotation, like custom INSERT, UPDATE or DELETE statements or a specific [FetchMode](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/FetchMode.html).

See the [@SecondaryTable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#sql-custom-crud-secondary-table-example) section for more info about Hibernate-specific @Table mapping.

#### 24.2.84. @Tables

The [@Tables](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Tables.html) annotation is used to group multiple [@Table](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-table) annotations.

#### 24.2.85. @Target

The [@Target](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Target.html) annotation is used to specify an explicit target implementation when the current annotated association is using an interface type.

See the [@Target mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-Target) section for more info.

#### 24.2.86. @Tuplizer

The [@Tuplizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Tuplizer.html) annotation is used to specify a custom tuplizer for the current annotated entity or embeddable.

For entities, the tupelizer must implement the [EntityTuplizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tuple/entity/EntityTuplizer.html) interface.

For embeddables, the tupelizer must implement the [ComponentTuplizer](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/tuple/component/ComponentTuplizer.html) interface.

See the [@Tuplizer mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#entity-tuplizer) section for more info.

#### 24.2.87. @Tuplizers

The [@Tuplizers](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Tuplizers.html) annotation is used to group multiple [@Tuplizer](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-tuplizer) annotations.

#### 24.2.88. @Type

The [@Type](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Type.html) annotation is used to specify the Hibernate [@Type](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/type/Type.html) used by the current annotated basic attribute.

See the [@Type mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-custom-type-BitSetType-mapping-example) section for more info.

#### 24.2.89. @TypeDef

The [@TypeDef](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/TypeDef.html) annotation is used to specify a [@Type](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/type/Type.html) definition which can later be reused for multiple basic attribute mappings.

See the [@TypeDef mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#basic-custom-type-BitSetTypeDef-mapping-example) section for more info.

#### 24.2.90. @TypeDefs

The [@TypeDefs](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/TypeDefs.html) annotation is used to group multiple [@TypeDef](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#annotations-hibernate-typedef) annotations.

#### 24.2.91. @UpdateTimestamp

The [@UpdateTimestamp](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/UpdateTimestamp.html) annotation is used to specify that the current annotated timestamp attribute should be updated with the current JVM timestamp whenever the owning entity gets modified.

* java.util.Date
* java.util.Calendar
* java.sql.Date
* java.sql.Time
* java.sql.Timestamp

See the [@UpdateTimestamp mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-generated-UpdateTimestamp) section for more info.

#### 24.2.92. @ValueGenerationType

The [@ValueGenerationType](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/ValueGenerationType.html) annotation is used to specify that the current annotation type should be used as a generator annotation type.

See the [@ValueGenerationType mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-database-generated-value-example) section for more info.

#### 24.2.93. @Where

The [@Where](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/Where.html) annotation is used to specify a custom SQL WHERE clause used when fetching an entity or a collection.

See the [@Where mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-where-example) section for more info.

#### 24.2.94. @WhereJoinTable

The [@WhereJoinTable](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/annotations/WhereJoinTable.html) annotation is used to specify a custom SQL WHERE clause used when fetching a join collection table.

See the [@WhereJoinTable mapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-where-join-table) section for more info.

## 25. Performance Tuning and Best Practices

Every enterprise system is unique. However, having a very efficient data access layer is a common requirement for many enterprise applications. Hibernate comes with a great variety of features that can help you tune the data access layer.

### 25.1. Schema management

Although Hibernate provides the update option for the hibernate.hbm2ddl.auto configuration property, this feature is not suitable for a production environment.

An automated schema migration tool (e.g. [Flyway](https://flywaydb.org/), [Liquibase](http://www.liquibase.org/)) allows you to use any database-specific DDL feature (e.g. Rules, Triggers, Partitioned Tables). Every migration should have an associated script, which is stored on the Version Control System, along with the application source code.

When the application is deployed on a production-like QA environment, and the deploy worked as expected, then pushing the deploy to a production environment should be straightforward since the latest schema migration was already tested.

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|  | You should always use an automatic schema migration tool and have all the migration scripts stored in the Version Control System. |

### 25.2. Logging

Whenever you’re using a framework that generates SQL statements on your behalf, you have to ensure that the generated statements are the ones that you intended in the first place.

There are several alternatives to logging statements. You can log statements by configuring the underlying logging framework. For Log4j, you can use the following appenders:

### log just the SQL

log4j.logger.org.hibernate.SQL=debug

### log JDBC bind parameters ###

log4j.logger.org.hibernate.type=trace

log4j.logger.org.hibernate.type.descriptor.sql=trace

However, there are some other alternatives like using datasource-proxy or p6spy. The advantage of using a JDBC Driveror DataSource Proxy is that you can go beyond simple SQL logging:

* statement execution time
* JDBC batching logging
* [database connection monitoring](https://github.com/vladmihalcea/flexy-pool)

Another advantage of using a DataSource proxy is that you can assert the number of executed statements at test time. This way, you can have the integration tests fail when a N+1 query issue is automatically detected.

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|  | While simple statement logging is fine, using [datasource-proxy](https://github.com/ttddyy/datasource-proxy) or [p6spy](https://github.com/p6spy/p6spy) is even better. |

### 25.3. JDBC batching

JDBC allows us to batch multiple SQL statements and to send them to the database server into a single request. This saves database roundtrips, and so it [reduces response time significantly](https://leanpub.com/high-performance-java-persistence/read#jdbc-batch-updates).

Not only INSERT and UPDATE statements, but even DELETE statements can be batched as well. For INSERT and UPDATEstatements, make sure that you have all the right configuration properties in place, like ordering inserts and updates and activating batching for versioned data. Check out this article for more details on this topic.

For DELETE statements, there is no option to order parent and child statements, so cascading can interfere with the JDBC batching process.

Unlike any other framework which doesn’t automate SQL statement generation, Hibernate makes it very easy to activate JDBC-level batching as indicated in the [Batching chapter](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#batch).

### 25.4. Mapping

Choosing the right mappings is very important for a high-performance data access layer. From the identifier generators to associations, there are many options to choose from, yet not all choices are equal from a performance perspective.

#### 25.4.1. Identifiers

When it comes to identifiers, you can either choose a natural id or a synthetic key.

For natural identifiers, the **assigned** identifier generator is the right choice.

For synthetic keys, the application developer can either choose a randomly generates fixed-size sequence (e.g. UUID) or a natural identifier. Natural identifiers are very practical, being more compact than their UUID counterparts, so there are multiple generators to choose from:

* IDENTITY
* SEQUENCE
* TABLE

Although the TABLE generator addresses the portability concern, in reality, it performs poorly because it requires emulating a database sequence using a separate transaction and row-level locks. For this reason, the choice is usually between IDENTITY and SEQUENCE.

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|  | If the underlying database supports sequences, you should always use them for your Hibernate entity identifiers.  Only if the relational database does not support sequences (e.g. MySQL 5.7), you should use the IDENTITYgenerators. However, you should keep in mind that the IDENTITY generators disables JDBC batching for INSERT statements. |

If you’re using the SEQUENCE generator, then you should be using the enhanced identifier generators that were enabled by default in Hibernate 5. The **pooled** and the **pooled-lo** optimizers are very useful to reduce the number of database roundtrips when writing multiple entities per database transaction.

#### 25.4.2. Associations

JPA offers four entity association types:

* @ManyToOne
* @OneToOne
* @OneToMany
* @ManyToMany

And an @ElementCollection for collections of embeddables.

Because object associations can be bidirectional, there are many possible combinations of associations. However, not every possible association type is efficient from a database perspective.

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|  | The closer the association mapping is to the underlying database relationship, the better it will perform.  On the other hand, the more exotic the association mapping, the better the chance of being inefficient. |

Therefore, the @ManyToOne and the @OneToOne child-side association are best to represent a FOREIGN KEY relationship.

The parent-side @OneToOne association requires bytecode enhancement so that the association can be loaded lazily. Otherwise, the parent-side is always fetched even if the association is marked with FetchType.LAZY.

For this reason, it’s best to map @OneToOne association using @MapsId so that the PRIMARY KEY is shared between the child and the parent entities. When using @MapsId, the parent-side becomes redundant since the child-entity can be easily fetched using the parent entity identifier.

For collections, the association can be either:

* unidirectional
* bidirectional

For unidirectional collections, Sets are the best choice because they generate the most efficient SQL statements. Unidirectional Lists are less efficient than a @ManyToOne association.

Bidirectional associations are usually a better choice because the @ManyToOne side controls the association.

Embeddable collections (`@ElementCollection) are unidirectional associations, hence Sets are the most efficient, followed by ordered Lists, whereas bags (unordered Lists) are the least efficient.

The @ManyToMany annotation is rarely a good choice because it treats both sides as unidirectional associations.

For this reason, it’s much better to map the link table as depicted in the [Bidirectional many-to-many with link entity lifecycle](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#associations-many-to-many-bidirectional-with-link-entity-lifecycle-example) section. Each FOREIGN KEY column will be mapped as a @ManyToOne association. On each parent-side, a bidirectional @OneToMany association is going to map to the aforementioned @ManyToOne relationship in the link entity.

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|  | Just because you have support for collections, it does not mean that you have to turn any one-to-many database relationship into a collection.  Sometimes, a @ManyToOne association is sufficient, and the collection can be simply replaced by an entity query which is easier to paginate or filter. |

### 25.5. Inheritance

JPA offers SINGLE\_TABLE, JOINED, and TABLE\_PER\_CLASS to deal with inheritance mapping, and each of these strategies has advantages and disadvantages.

* SINGLE\_TABLE performs the best in terms of executed SQL statements. However, you cannot use NOT NULLconstraints on the column-level. You can still use triggers and rules to enforce such constraints, but it’s not as straightforward.
* JOINED addresses the data integrity concerns because every subclass is associated with a different table. Polymorphic queries or `@OneToMany base class associations don’t perform very well with this strategy. However, polymorphic @ManyToOne` associations are fine, and they can provide a lot of value.
* TABLE\_PER\_CLASS should be avoided since it does not render efficient SQL statements.

### 25.6. Fetching

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|  | Fetching too much data is the number one performance issue for the vast majority of JPA applications. |

Hibernate supports both entity queries (JPQL/HQL and Criteria API) and native SQL statements. Entity queries are useful only if you need to modify the fetched entities, therefore benefiting from the automatic dirty checking mechanism.

For read-only transactions, you should fetch DTO projections because they allow you to select just as many columns as you need to fulfill a certain business use case. This has many benefits like reducing the load on the currently running Persistence Context because DTO projections don’t need to be managed.

#### 25.6.1. Fetching associations

Related to associations, there are two major fetch strategies:

* EAGER
* LAZY

EAGER fetching is almost always a bad choice.

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|  | Prior to JPA, Hibernate used to have all associations as LAZY by default. However, when JPA 1.0 specification emerged, it was thought that not all providers would use Proxies. Hence, the @ManyToOne and the @OneToOne associations are now EAGER by default.  The EAGER fetching strategy cannot be overwritten on a per query basis, so the association is always going to be retrieved even if you don’t need it. More, if you forget to JOIN FETCH an EAGER association in a JPQL query, Hibernate will initialize it with a secondary statement, which in turn can lead to N+1 query issues. |

So, EAGER fetching is to be avoided. For this reason, it’s better if all associations are marked as LAZY by default.

However, LAZY associations must be initialized prior to being accessed. Otherwise, a LazyInitializationException is thrown. There are good and bad ways to treat the LazyInitializationException.

The best way to deal with LazyInitializationException is to fetch all the required associations prior to closing the Persistence Context. The JOIN FETCH directive is good for @ManyToOne and OneToOne associations, and for at most one collection (e.g. @OneToMany or @ManyToMany). If you need to fetch multiple collections, to avoid a Cartesian Product, you should use secondary queries which are triggered either by navigating the LAZY association or by calling Hibernate#initialize(proxy) method.

### 25.7. Caching

Hibernate has two caching layers:

* the first-level cache (Persistence Context) which is a application-level repeatable reads.
* the second-level cache which, unlike application-level caches, it doesn’t store entity aggregates but normalized dehydrated entity entries.

The first-level cache is not a caching solution "per se", being more useful for ensuring READ COMMITTED isolation level.

While the first-level cache is short lived, being cleared when the underlying EntityManager is closed, the second-level cache is tied to an EntityManagerFactory. Some second-level caching providers offer support for clusters. Therefore, a node needs only to store a subset of the whole cached data.

Although the second-level cache can reduce transaction response time since entities are retrieved from the cache rather than from the database, there are other options to achieve the same goal, and you should consider these alternatives prior to jumping to a second-level cache layer:

* tuning the underlying database cache so that the working set fits into memory, therefore reducing Disk I/O traffic.
* optimizing database statements through JDBC batching, statement caching, indexing can reduce the average response time, therefore increasing throughput as well.
* database replication is also a very valuable option to increase read-only transaction throughput

After properly tuning the database, to further reduce the average response time and increase the system throughput, application-level caching becomes inevitable.

Topically, a key-value application-level cache like [Memcached](https://memcached.org/) or [Redis](http://redis.io/) is a common choice to store data aggregates. If you can duplicate all data in the key-value store, you have the option of taking down the database system for maintenance without completely loosing availability since read-only traffic can still be served from the cache.

One of the main challenges of using an application-level cache is ensuring data consistency across entity aggregates. That’s where the second-level cache comes to the rescue. Being tightly integrated with Hibernate, the second-level cache can provide better data consistency since entries are cached in a normalized fashion, just like in a relational database. Changing a parent entity only requires a single entry cache update, as opposed to cache entry invalidation cascading in key-value stores.

The second-level cache provides four cache concurrency strategies:

* READ\_ONLY
* NONSTRICT\_READ\_WRITE
* READ\_WRITE
* TRANSACTIONAL

READ\_WRITE is a very good default concurrency strategy since it provides strong consistency guarantees without compromising throughput. The TRANSACTIONAL concurrency strategy uses JTA. Hence, it’s more suitable when entities are frequently modified.

Both READ\_WRITE and TRANSACTIONAL use write-through caching, while NONSTRICT\_READ\_WRITE is a read-through caching strategy. For this reason, NONSTRICT\_READ\_WRITE is not very suitable if entities are changed frequently.

When using clustering, the second-level cache entries are spread across multiple nodes. When using [Infinispan distributed cache](http://blog.infinispan.org/2015/10/hibernate-second-level-cache.html), only READ\_WRITE and NONSTRICT\_READ\_WRITE are available for read-write caches. Bear in mind that NONSTRICT\_READ\_WRITE offers a weaker consistency guarantee since stale updates are possible.

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|  | For more about Hibernate Performance Tuning, check out the [High-Performance Hibernate](https://www.youtube.com/watch?v=BTdTEe9QL5k&t=1s)presentation from Devoxx France. |

## 26. Legacy Bootstrapping

The legacy way to bootstrap a SessionFactory is via the org.hibernate.cfg.Configuration object. Configurationrepresents, essentially, a single point for specifying all aspects of building the SessionFactory: everything from settings, to mappings, to strategies, etc. I like to think of Configuration as a big pot to which we add a bunch of stuff (mappings, settings, etc) and from which we eventually get a SessionFactory.

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|  | There are some significant draw backs to this approach which led to its deprecation and the development of the new approach, which is discussed in [Native Bootstrapping](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#bootstrap-native). Configuration is semi-deprecated but still available for use, in a limited form that eliminates these drawbacks. "Under the covers", Configuration uses the new bootstrapping code, so the things available there as also available here in terms of auto-discovery. |

You can obtain the Configuration by instantiating it directly. You then specify mapping metadata (XML mapping documents, annotated classes) that describe your applications object model and its mapping to a SQL database.

Configuration cfg = new Configuration()

// addResource does a classpath resource lookup

.addResource("Item.hbm.xml")

.addResource("Bid.hbm.xml")

// calls addResource using "/org/hibernate/auction/User.hbm.xml"

.addClass(`org.hibernate.auction.User.class`)

// parses Address class for mapping annotations

.addAnnotatedClass( Address.class )

// reads package-level (package-info.class) annotations in the named package

.addPackage( "org.hibernate.auction" )

.setProperty("hibernate.dialect", "org.hibernate.dialect.H2Dialect")

.setProperty("hibernate.connection.datasource", "java:comp/env/jdbc/test")

.setProperty("hibernate.order\_updates", "true");

There are other ways to specify Configuration information, including:

* Place a file named hibernate.properties in a root directory of the classpath
* Pass an instance of java.util.Properties to Configuration#setProperties
* Via a hibernate.cfg.xml file
* System properties using java -Dproperty=value

## 27. Migration

Mapping Configuration methods to the corresponding methods in the new APIs..

|  |  |
| --- | --- |
| Configuration#addFile | Configuration#addFile |
| Configuration#add(XmlDocument) | Configuration#add(XmlDocument) |
| Configuration#addXML | Configuration#addXML |
| Configuration#addCacheableFile | Configuration#addCacheableFile |
| Configuration#addURL | Configuration#addURL |
| Configuration#addInputStream | Configuration#addInputStream |
| Configuration#addResource | Configuration#addResource |
| Configuration#addClass | Configuration#addClass |
| Configuration#addAnnotatedClass | Configuration#addAnnotatedClass |
| Configuration#addPackage | Configuration#addPackage |
| Configuration#addJar | Configuration#addJar |
| Configuration#addDirectory | Configuration#addDirectory |
| Configuration#registerTypeContributor | Configuration#registerTypeContributor |
| Configuration#registerTypeOverride | Configuration#registerTypeOverride |
| Configuration#setProperty | Configuration#setProperty |
| Configuration#setProperties | Configuration#setProperties |
| Configuration#addProperties | Configuration#addProperties |
| Configuration#setNamingStrategy | Configuration#setNamingStrategy |
| Configuration#setImplicitNamingStrategy | Configuration#setImplicitNamingStrategy |
| Configuration#setPhysicalNamingStrategy | Configuration#setPhysicalNamingStrategy |
| Configuration#configure | Configuration#configure |
| Configuration#setInterceptor | Configuration#setInterceptor |
| Configuration#setEntityNotFoundDelegate | Configuration#setEntityNotFoundDelegate |
| Configuration#setSessionFactoryObserver | Configuration#setSessionFactoryObserver |
| Configuration#setCurrentTenantIdentifierResolver | Configuration#setCurrentTenantIdentifierResolver |

## 28. Legacy Domain Model

*Example 655. Declaring a version property in hbm.xml*

<!--

~ Hibernate, Relational Persistence for Idiomatic Java

~

~ License: GNU Lesser General Public License (LGPL), version 2.1 or later.

~ See the lgpl.txt file in the root directory or <http://www.gnu.org/licenses/lgpl-2.1.html>.

-->

<version

column="version\_column"

name="propertyName"

type="typename"

access="field|property|ClassName"

unsaved-value="null|negative|undefined"

generated="never|always"

insert="true|false"

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

/>

|  |  |
| --- | --- |
| column | The name of the column holding the version number. Optional, defaults to the property name. |
| name | The name of a property of the persistent class. |
| type | The type of the version number. Optional, defaults to integer. |
| access | Hibernate’s strategy for accessing the property value. Optional, defaults to property. |
| unsaved-value | Indicates that an instance is newly instantiated and thus unsaved. This distinguishes it from detached instances that were saved or loaded in a previous session. The default value, undefined, indicates that the identifier property value should be used. Optional. |
| generated | Indicates that the version property value is generated by the database. Optional, defaults to never. |
| insert | Whether or not to include the version column in SQL insert statements. Defaults to true, but you can set it to false if the database column is defined with a default value of 0. |

*Example 656. The timestamp element in hbm.xml*

<!--

~ Hibernate, Relational Persistence for Idiomatic Java

~

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~ See the lgpl.txt file in the root directory or <http://www.gnu.org/licenses/lgpl-2.1.html>.

-->

<timestamp

column="timestamp\_column"

name="propertyName"

access="field|property|ClassName"

unsaved-value="null|undefined"

source="vm|db"

generated="never|always"

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

/>

|  |  |
| --- | --- |
| column | The name of the column which holds the timestamp. Optional, defaults to the property name |
| name | The name of a JavaBeans style property of Java type Date or Timestamp of the persistent class. |
| access | The strategy Hibernate uses to access the property value. Optional, defaults to property. |
| unsaved-value | A version property which indicates than instance is newly instantiated, and unsaved. This distinguishes it from detached instances that were saved or loaded in a previous session. The default value of undefined indicates that Hibernate uses the identifier property value. |
| source | Whether Hibernate retrieves the timestamp from the database or the current JVM. Database-based timestamps incur an overhead because Hibernate needs to query the database each time to determine the incremental next value. However, database-derived timestamps are safer to use in a clustered environment. Not all database dialects are known to support the retrieval of the database’s current timestamp. Others may also be unsafe for locking because of lack of precision. |
| generated | Whether the timestamp property value is generated by the database. Optional, defaults to never. |

## 29. Legacy Hibernate Criteria Queries

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|  | This appendix covers the legacy Hibernate org.hibernate.Criteria API, which should be considered deprecated.  New development should focus on the JPA javax.persistence.criteria.CriteriaQuery API. Eventually, Hibernate-specific criteria features will be ported as extensions to the JPA javax.persistence.criteria.CriteriaQuery. For details on the JPA APIs, see [Criteria](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria). |

Hibernate features an intuitive, extensible criteria query API.

### 29.1. 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();

### 29.2. JPA vs Hibernate entity name

When using the [Session#createCriteria(String entityName) or StatelessSession#createCriteria(String entityName)](https://docs.jboss.org/hibernate/orm/5.2/javadocs/org/hibernate/SharedSessionContract.html#createCriteria-java.lang.String-), the **entityName** means the fully-qualified name of the underlying entity and not the name denoted by the name attribute of the JPA @Entity annotation.

Considering you have the following entity:

@Entity(name = "ApplicationEvent")

public static class Event {

@Id

private Long id;

private String name;

}

If you provide the JPA entity name to a legacy Criteria query:

List<Event> events =

entityManager.unwrap( Session.class )

.createCriteria( "ApplicationEvent" )

.list();

Hibernate is going to throw the following MappingException:

org.hibernate.MappingException: Unknown entity: ApplicationEvent

On the other hand, the Hibernate entity name (the fully qualified class name) works just fine:

List<Event> events =

entityManager.unwrap( Session.class )

.createCriteria( Event.class.getName() )

.list();

For more about this topic, check out the [HHH-2597](https://hibernate.atlassian.net/browse/HHH-2597) JIRA issue.

### 29.3. 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 Restrictions 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();

### 29.4. 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").nulls(NullPrecedence.LAST) )

.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();

### 29.5. 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 kittenscollection.

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");

}

Additionally, you may manipulate the result set using a left outer join:

List cats = session.createCriteria( Cat.class )

.createAlias("mate", "mt", Criteria.LEFT\_JOIN, Restrictions.like("mt.name", "good%") )

.addOrder(Order.asc("mt.age"))

.list();

This will return all of the `Cat`s with a mate whose name starts with "good" ordered by their mate’s age, and all cats who do not have a mate. This is useful when there is a need to order or limit in the database prior to returning complex/large result sets, and removes many instances where multiple queries would have to be performed and the results unioned by java in memory.

Without this feature, first all of the cats without a mate would need to be loaded in one query.

A second query would need to retrieve the cats with mates who’s name started with "good" sorted by the mates age.

Thirdly, in memory; the lists would need to be joined manually.

### 29.6. 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.

### 29.7. Components

To add a restriction against a property of an embedded component, the component property name should be prepended to the property name when creating the Restriction. The criteria object should be created on the owning entity, and cannot be created on the component itself. For example, suppose the Cat has a component property fullName with sub-properties firstName and lastName:

List cats = session.createCriteria(Cat.class)

.add(Restrictions.eq("fullName.lastName", "Cattington"))

.list();

Note: this does not apply when querying collections of components, for that see below [Collections](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-collections)

### 29.8. Collections

When using criteria against collections, there are two distinct cases. One is if the collection contains entities (eg. <one-to-many/> or <many-to-many/>) or components (<composite-element/> ), and the second is if the collection contains scalar values (<element/>). In the first case, the syntax is as given above in the section [Associations](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#criteria-associations) where we restrict the kittens collection. Essentially we create a Criteria object against the collection property and restrict the entity or component properties using that instance.

For querying a collection of basic values, we still create the Criteria object against the collection, but to reference the value, we use the special property "elements". For an indexed collection, we can also reference the index property using the special property "indices".

List cats = session.createCriteria(Cat.class)

.createCriteria("nickNames")

.add(Restrictions.eq("elements", "BadBoy"))

.list();

### 29.9. 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();

### 29.10. 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().as("catCountByColor") )

.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();

### 29.11. 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();

Example of multi-column restriction based on a subquery:

DetachedCriteria sizeQuery = DetachedCriteria.forClass( Man.class )

.setProjection( Projections.projectionList().add( Projections.property( "weight" ) )

.add( Projections.property( "height" ) ) )

.add( Restrictions.eq( "name", "John" ) );

session.createCriteria( Woman.class )

.add( Subqueries.propertiesEq( new String[] { "weight", "height" }, sizeQuery ) )

.list();

### 29.12. 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();

## 30. Legacy Hibernate Native Queries

### 30.1. Legacy Named SQL queries

Named SQL queries can also be defined during mapping and called in exactly the same way as a named HQL query. In this case, you do not need to call addEntity() anymore.

*Example 657. Named sql query using the <sql-query> mapping element*

<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>

*Example 658. Execution of a named query*

List people = session

.getNamedQuery( "persons" )

.setParameter( "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.

*Example 659. Named sql query with association*

<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:

*Example 660. Named query returning a scalar*

<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.

*Example 661. <resultset> mapping used to externalize mappinginformation*

<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.

*Example 662. Programmatically specifying the result mapping information*

List cats = session

.createSQLQuery( "select {cat.\*}, {kitten.\*} from cats cat, cats kitten where kitten.mother = cat.id" )

.setResultSetMapping("catAndKitten")

.list();

### 30.2. Legacy 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.

### 30.3. Legacy stored procedures for querying

Hibernate 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.

### 30.4. Legacy 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.doWork().

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.

### 30.5. Legacy custom SQL for create, update and delete

Hibernate can use custom SQL for create, update, and delete operations. The SQL can be overridden at the statement level or individual column level. This section describes statement overrides. For columns, see [Column transformers: read and write expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-read-and-write). The following example shows how to define custom SQL operations using annotations.

*Example 663. Custom CRUD XML*

<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>

|  |  |
| --- | --- |
|  | If you expect to call a store procedure, be sure to set the callable attribute to true, in annotations as well as in xml. |

To check that the execution happens correctly, Hibernate allows you to define one of those three strategies:

* none: no check is performed: the store procedure is expected to fail upon issues
* count: use of rowcount to check that the update is successful
* param: like COUNT but using an output parameter rather that the standard mechanism

To define the result check style, use the check parameter which is again available in annotations as well as in xml.

Last but not least, stored procedures are in most cases required to return the number of rows inserted, updated and deleted. Hibernate always registers the first statement parameter as a numeric output parameter for the CUD operations:

*Example 664. Stored procedures and their return value*

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;

### 30.6. Legacy custom SQL for loading

You can also declare your own SQL (or HQL) queries for entity loading. As with inserts, updates, and deletes, this can be done at the individual column level as described in For columns, see [Column transformers: read and write expressions](http://docs.jboss.org/hibernate/orm/5.2/userguide/html_single/Hibernate_User_Guide.html#mapping-column-read-and-write) or at the statement level. Here is an example of a statement level override:

<sql-query name = "person">

<return alias = "pers" class = "Person" lock-mod e= "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>

## 31. References

* [PoEAA] Martin Fowler. Patterns of Enterprise Application Architecture. Addison-Wesley Publishing Company. 2003.
* [JPwH] Christian Bauer & Gavin King. [Java Persistence with Hibernate](http://www.manning.com/bauer2). Manning Publications Co. 2007.

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