



# Introduction to Hibernate and JPA

Architecture. Domain Model. Bootstrapping. Configuration. Mapping metadata

# About me



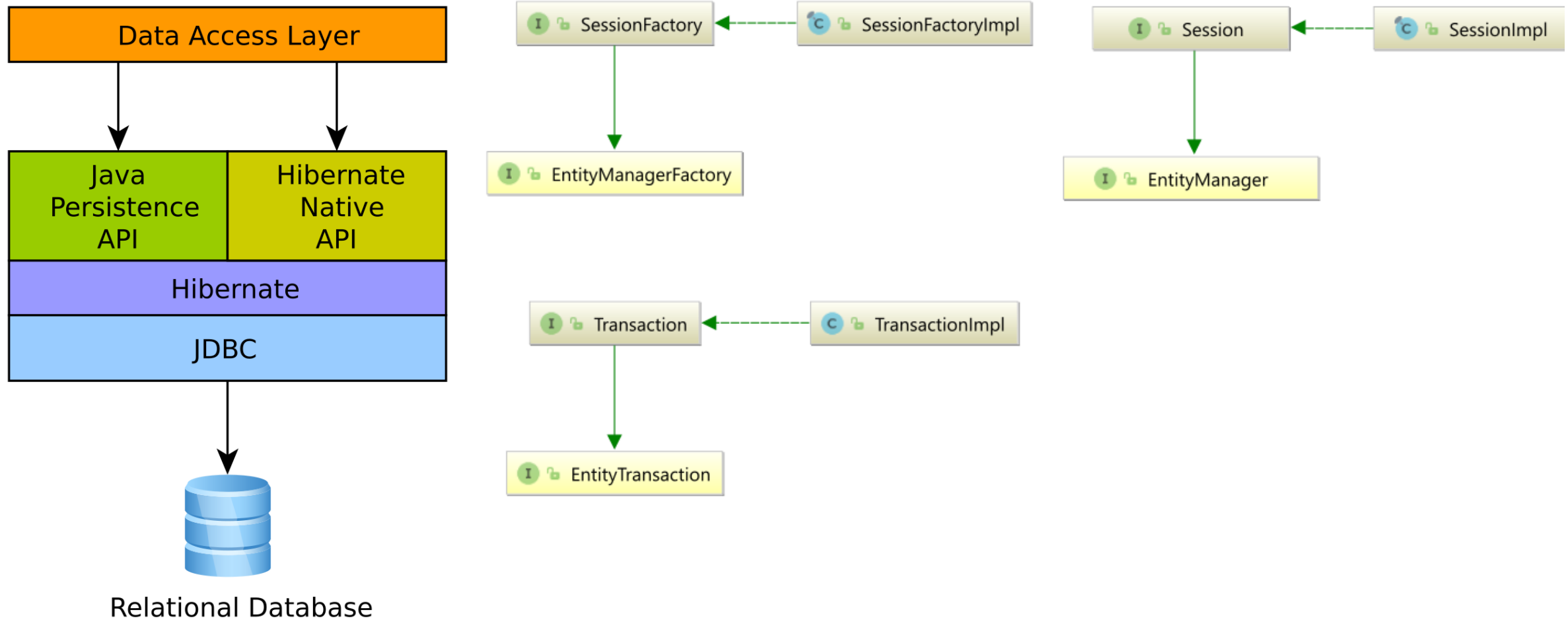
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# Where to Find The Code and Materials?

<https://github.com/iproduct/course-hibernate>

# Hibernate Architecture



## Hibernate Architecture - II

- **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.
- 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.

## Hibernate Architecture - III

- **Session (`org.hibernate.Session`)** - a single-threaded, short-lived object conceptually modeling a "Unit of Work" (PoEAA). In JPA nomenclature, the Session is 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`).

# Domain Model

- 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](#)).
- We usually prefer the [JPA mappings](#) where possible.
- For Hibernate mapping features not supported by JPA we will prefer [Hibernate extension annotations](#).

# Mapping Types

- **Hibernate** understands both the **Java** and **JDBC** representations of application data.
- **Hibernate type** – provides the ability to read/write this data from/to the database. It is an implementation of the **org.hibernate.type.Type** interface. Also describes various **behavioral aspects** of the **Java type** such as **how to check for equality**, **how to clone values**, etc.
- **Hibernate type** is **neither a Java type nor a SQL data type**. It provides information about mapping a Java type to an SQL type as well as **how to persist and fetch a given Java type to and from a relational database**.
- 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 the context.



# Hibernate Native Bootstrapping

- There are two types of ServiceRegistry and they are hierarchical:
- **BootstrapServiceRegistry**, which has no parent and holds these three required services:
  - ClassLoaderService: allows Hibernate to interact with the ClassLoader of the various runtime environments
  - IntegratorService: controls the discovery and management of the Integrator service allowing third-party applications to integrate with Hibernate
  - StrategySelector: resolves implementations of various strategy contracts
- **StandardServiceRegistry**

# Building BootstrapServiceRegistry

```
BootstrapServiceRegistry bootstrapServiceRegistry =  
    new BootstrapServiceRegistryBuilder()  
        .applyClassLoader()  
        .applyIntegrator()  
        .applyStrategySelector()  
        .build();
```

# Building StandardServiceRegistry

```
BootstrapServiceRegistry bootstrapServiceRegistry =  
    new BootstrapServiceRegistryBuilder().build();  
  
StandardServiceRegistryBuilder standardServiceRegistryBuilder =  
    new StandardServiceRegistryBuilder(bootstrapServiceRegistry);  
  
StandardServiceRegistry standardServiceRegistry = standardServiceRegistryBuilder  
    .configure()  
    .build();
```

# Building Metadata

```
MetadataSources metadataSources =  
    new MetadataSources(standardServiceRegistry);  
metadataSources.addPackage( ... );  
metadataSources.addAnnotatedClass( ... );  
metadataSources.addResource( ... )  
Metadata metadata = metadataSources.buildMetadata();
```

# Building and Using SessionFactory and Session

*// Get SessionFactory*

```
SessionFactory sessionFactory = metadata.getSessionFactoryBuilder().build();
```

*// Get Session*

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

*// Persist entity*

```
Contact contact = new Contact(1,  
    new Name("Ivan", "Dimitrov", "Petrov"),  
    "From work", new URL("http://ivan.petrov.me/"), true);  
session.beginTransaction();  
session.persist(contact);  
session.getTransaction().commit();  
session.close();  
sessionFactory.close();
```

# WEB-INF/applicationContext.xml -I

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:context="http://www.springframework.org/schema/context"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xmlns:tx="http://www.springframework.org/schema/tx"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
                           http://www.springframework.org/schema/beans/spring-beans.xsd
                           http://www.springframework.org/schema/context
                           http://www.springframework.org/schema/context/spring-context.xsd
                           http://www.springframework.org/schema/tx
                           http://www.springframework.org/schema/tx/spring-tx.xsd
                           http://www.springframework.org/schema/aop
                           http://www.springframework.org/schema/aop/spring-aop.xsd">

    <context:property-placeholder location="classpath:jdbc.properties" />

    <context:component-scan base-package="org.iproduct.spring.webmvc.dao,
        org.iproduct.spring.webmvc.service"/>

    <context:annotation-config />
```

# WEB-INF/applicationContext.xml -II

```
<bean id="dataSource" class="org.apache.commons.dbcp2.BasicDataSource"
      destroy-method="close">
  <property name="driverClassName" value="${jdbc.driverClassName}" />
  <property name="url" value="${jdbc.url}" />
  <property name="username" value="${jdbc.username}" />
  <property name="password" value="${jdbc.password}" />
</bean>

<bean id="sessionFactory"
      class="org.springframework.orm.hibernate5.LocalSessionFactoryBean">
  <property name="dataSource" ref="dataSource"/>
  <property name="mappingResources">
    <list><value>article.hbm.xml</value></list>
  </property>
  <property name="hibernateProperties">
    <value>
      hibernate.dialect=org.hibernate.dialect.HSQLDialect
      hibernate.hbm2ddl.auto=update
    </value>
  </property>
</bean>
```

# WEB-INF/applicationContext.xml III

```
<bean id="transactionManager"
      class="org.springframework.orm.hibernate5.HibernateTransactionManager">
    <property name="sessionFactory" ref="sessionFactory"/>
</bean>

<tx:annotation-driven/>

</beans>
```



# Hibernate Mapping: article.hbm.xml

```
<hibernate-mapping>
  <class name="org.iproduct.spring.webmvc.model.Article" table="ARTICLES">

    <meta attribute="class-description">
      This class contains the articles details.
    </meta>

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

    <property name="title" column="title" type="string"/>
    <property name="content" column="content" type="string"/>
    <property name="createdDate" column="created_date" type="timestamp"/>
    <property name="pictureUrl" column="picture_url" type="string"/>

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

# Java Persistence API (JPA)

- **JPA four main parts:**

- ☐ Java Persistence API
- ☐ JPA Query Language
- ☐ Java Persistence Criteria API
- ☐ Object to Relational Mapping (ORM) metadata

- **JPA Entity Classes**

- ☐ persistent fields
- ☐ persistent properties

- **@Entity** annotation

# Advantages of Spring ORM

- ❖ Easier testing
- ❖ Common data access exceptions
- ❖ General resource management
- ❖ Integrated transaction management

# Persistent Units

- Persistent Unit description in **persistence.xml** file:
  - description
  - provider
  - jta-data-source
  - non-jta-data-source
  - mapping-file
  - jar-file
  - class
  - exclude-unlisted-classes
  - properties

# Persistent Unit Example 1

```
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.0"
xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
  <persistence-unit name="CustomerDBPU" transaction-type="JTA">
    <jta-data-source>jdbc/sample</jta-data-source>
    <class>customerdb.Customer</class>
    <class>customerdb.DiscountCode</class>
    <properties/>
  </persistence-unit>
</persistence>
```

# Persistent Unit Example 2

```
<persistence version="1.0" xmlns="http://java.sun.com/xml/ns/persistence"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_1_0.xsd">
  <persistence-unit name="invoicingPU" transaction-type="RESOURCE_LOCAL">
    <provider>oracle.toplink.essentials.PersistenceProvider</provider>
    <class>myinvoice.dbentities.Product</class>
    <class>myinvoice.dbentities.Invoice</class>
    <properties>
      <property name="javax.persistence.jdbc.user" value="root"/>
      <property name="javax.persistence.jdbc.password" value="root"/>
      <property name="javax.persistence.jdbc.url"
        value="jdbc:mysql://localhost:3306/invoicing"/>
      <property name="javax.persistence.jdbc.driver" value="com.mysql.jdbc.Driver"/>
    </properties>
  </persistence-unit>
</persistence>
```

# JPA Setup in Spring

```
<beans>
  <bean id="myEmf" class="org.springframework.orm.jpa.LocalEntityManagerFactoryBean">
    <property name="persistenceUnitName" value="myPersistenceUnit"/>
  </bean>
</beans>
```

---

```
<beans>
  <jee:jndi-lookup id="myEmf" jndi-name="persistence/myPersistenceUnit"/>
</beans>
```

---

```
<beans>
  <bean id="myEmf" class="org.springframework.orm.jpa.LocalContainerEntityManagerFactoryBean">
    <property name="dataSource" ref="someDataSource"/>
    <property name="loadTimeWeaver">
      <bean class="org.springframework.instrument.classloading.InstrumentationLoadTimeWeaver"/>
    </property>
  </bean>
</beans>
```

# Mapping Example

@Entity(name = "Contact")

@Data

```
public class Contact {
```

@Id

```
private Integer id;
```

@Embedded

```
private Name name;
```

```
private String notes;
```

```
private URL website;
```

```
private boolean starred;
```

```
public Name getName() {
```

```
    return name;
```

```
}
```

```
}
```

@Embeddable

@Data

```
public class Name {
```

```
private String firstName;
```

```
private String middleName;
```

```
private String lastName;
```

```
}
```

Code First

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)

)

DB Schema First





# Value and Entity Types

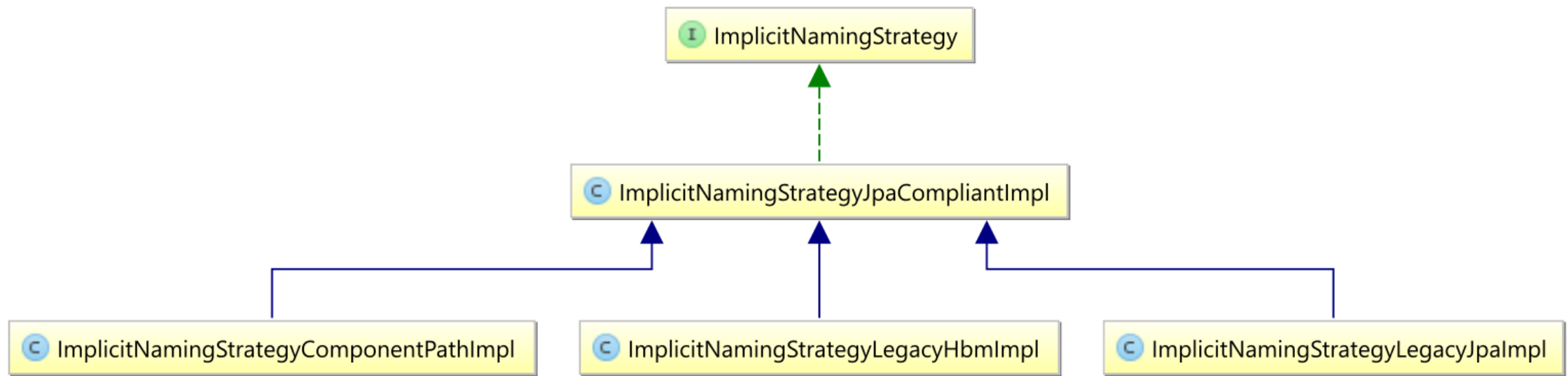
- **Value types** - a value type is a piece of data that does **not define its own lifecycle**. It is, in effect, owned by an entity, which defines its lifecycle -> **persistent attributes**.
  - Basic types – e.g. in mapping the Contact table, all attributes except for name would be basic types.
  - Embeddable types - the name attribute is an example of an embeddable type, which is discussed in details in Embeddable types
  - Collection types - although not featured in the aforementioned example, collection types are also a distinct category among value types. Collection types are
- **Entity types** - by nature of their **unique identifier**, entities exist independently and define their **own lifecycle**, whereas values do not. Entities are **domain model classes** which correlate to rows in a database table, using a unique identifier.

# 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:

1. 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 (e.g., using @Column or @Table) or it can be implicitly determined by Hibernate through an ImplicitNamingStrategy contract.
2. Second is the resolving of this logical name to a physical name which is defined by the PhysicalNamingStrategy contract.

# Naming Strategies



# Implicit Naming Strategies

- Hibernate defines multiple [ImplicitNamingStrategy](#) implementations out-of-the-box. Applications are also free to plug in custom implementations.
- Applications can specify the implementation using the [hibernate.implicit\\_naming\\_strategy](#) configuration setting which accepts:
  - **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** – [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 – e.g.
- By calling [org.hibernate.boot.MetadataBuilder#applyImplicitNamingStrategy](#)

# Physical Naming Strategies

- 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`

# Basic Types

- Basic value types usually map a single database column, to a single, non-aggregated Java type
- Internally Hibernate uses a registry of basic types when it needs to resolve a specific `org.hibernate.type.Type`:

[https://docs.jboss.org/hibernate/orm/5.6/userguide/html\\_single/Hibernate\\_User\\_Guide.html#basic-provided](https://docs.jboss.org/hibernate/orm/5.6/userguide/html_single/Hibernate_User_Guide.html#basic-provided)

- The `@Basic` annotation - defines 2 attributes:
  - `optional` - boolean (defaults to true) - whether this attribute allows nulls.
  - `fetch` - FetchType (defaults to EAGER) - whether should be fetched eagerly or lazily. Hibernate ignores this setting for basic types unless you are using bytecode enhancement.

# Explicite Basic Types

```
@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;
}
```

# Basic Types

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[https://docs.jboss.org/hibernate/orm/5.6/userguide/html\\_single/Hibernate\\_User\\_Guide.html#basic-provided](https://docs.jboss.org/hibernate/orm/5.6/userguide/html_single/Hibernate_User_Guide.html#basic-provided)

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# Embeddable Types

@Embeddable

```
public class Publisher {
```

```
    private String name;
```

@Embedded

```
    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 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
```

```
}
```

# Embeddable Types - II

```
@Entity(name = "Book")
public class Book {

    @Id
    @GeneratedValue
    private Long id;

    private String title;

    private String author;

    @Embedded
    private Publisher2 publisher;

    public Publisher2 getPublisher() {
        return publisher;
    }
}
```

```
@Embeddable
@Data
class Publisher2 {

    @Column(name = "publisher_name")
    private String name;

    @Column(name = "publisher_country")
    private String country;
}
```

# Embeddable Types – Attribute Overrides

```
@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 class Book2 {
    @Id
    @GeneratedValue
    private Long id;

    private String title;

    private String author;

    @Embedded
    private Publisher2 ebookPublisher;

    @Embedded
    private Publisher2 paperBackPublisher;

    public Publisher2 getPaperBackPublisher() {
        return paperBackPublisher;
    }

    public Publisher2 getEbookPublisher() {
        return ebookPublisher;
    }
}
```

# @Target Mapping

@Embeddable

```
class GPS implements Coordinates {  
    private double latitude;  
    private double longitude;  
  
    public 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;  
    }  
}
```

```
interface Coordinates {  
    double x();  
    double y();  
}
```

@Entity(name = "City")

```
public class City {  
  
    @Id  
    @GeneratedValue  
    private Long id;  
  
    private String name;  
  
    @Embedded  
    @Target( GPS.class )  
    private Coordinates coordinates;  
}
```

# @Parent Mapping

@Embeddable

@Data

```
public class GPS {
```

```
    private double latitude;
```

```
    private double longitude;
```

@Parent

```
    private City city;
```

```
}
```

```
entityManager -> {
```

```
    City cluj = new City(); cluj.setName( "Cluj" );
```

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

```
    entityManager.persist( cluj );
```

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

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

```
}
```

@Entity(name = "City")

@Data

```
public class City {
```

@Id

@GeneratedValue

```
    private Long id;
```

```
    private String name;
```

@Embedded

@Target( GPS.class )

```
    private GPS coordinates;
```

```
}
```

# @Entity and @Table Mappings

```
@Entity(name = "Book")
```

```
@Table( catalog = "public", schema = "store", name = "book" )
```

```
public static class Book {
```

```
    @Id
```

```
    private Long id;
```

```
    private String title;
```

```
    private String author;
```

```
    ...
```

```
}
```



```
create table public.book (
```

```
    id bigint not null,
```

```
    author varchar(255),
```

```
    title varchar(255),
```

```
    primary key (id)
```

```
) engine=InnoDB
```

# Identifiers

- **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.
- **EVER-INCREASING** - fragmentation problem - because UUIDs are random, they have no natural ordering so cannot be used for clustering. This is why SQL Server has implemented a newsequentialid() function that is suitable for use in clustered indexes, and UUID PKs.

# Entity Objects Identity – equals() and hashCode()

```
Book book1 = new Book();  
book1.setTitle("High-Performance Java Persistence");
```

```
Book book2 = new Book();  
book2.setTitle("Java Persistence with Hibernate");
```

```
Library library = doInJPA(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));
```



# Entity Objects Identity – equals() and hashCode() - II

```
@Entity(name = "Library")
public class Library {
    @Id
    private Long id;
    private String name;
    @OneToMany(cascade = CascadeType.ALL)
    @JoinColumn(name = "book_id")
    private Set<Book> books = new HashSet<>();
}
```

```
@Entity(name = "Book")
public class Book {
    @Id
    @GeneratedValue
    private Long id;
    private String title;
    private String author;
    @NaturalId
    private String isbn;
```

```
@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 );
}
```

# Entity Objects Identity – equals() and hashCode() - II

```
@Entity(name = "Library")
public class Library {
    @Id
    private Long id;
    private String name;
    @OneToMany(cascade = CascadeType.ALL)
    @JoinColumn(name = "book_id")
    private Set<Book> books = new HashSet<>();
}
```

```
@Entity(name = "Book")
public class Book {
    @Id
    @GeneratedValue
    private Long id;
    private String title;
    private String author;
    @NaturalId
    private String isbn;
```

```
@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 );
}
```

# Object-Relational Mapping (ORM)

- Package: javax.persistence
- Simple keys - `@Id` annotation
- Composite keys
  - `Primary Key Class` – requirements and structure
  - Annotations – `@EmbeddedId`, `@IdClass`
- Relations between entity objects –
  - uni- and bi-directional,
  - 1:1, 1:many, many:1 many:many

# Main JPA Annotations

- @PersistenceUnit,
- @PersistenceContext
- @Entity
- @Id
- @OneToOne
- @OneToMany
- @ManyToMany
- @DiscriminatorColumn
- @Column
- @JoinTable
- @JoinColumn
- @Embeddable
- @Embedded

# Entity Embeddables

- **@Embeddable** – annotates class that is a value type (not Entity), but can be embedded into one or more Entities
- **@Embedded** – embeds Embeddable class into Entity class
- Embedding can be hierarchical on multiple levels
- Annotations: **@AttributeOverride**, **@AttributeOverrides**, **@AssociationOverride**, **@AssociationOverrides**

# Collection Type Persistent Fields

- Field or properties should be of **Collection** or **Map** type (usually generic):
  - `java.util.Collection`
  - `java.util.Set`
  - `java.util.List`
  - `java.util.Map`
- **@ElementCollection**
- **@CollectionTable** – name of additional table
- **@Embeddable, @Column**
- **@AttributeOverride, @AttributeOverrides**

# JPA Entities: @ManyToMany

```
@Entity
public class Book {
    @Id @GeneratedValue
    private int id;

    @NotNull
    private String title;

    @ManyToOne
    @JoinColumn(name = "PUBLISHER_ID",
                referencedColumnName = "id")
    private Publisher publisher;

    @Column(name = "PUBLISHED_DATE") @PastOrPresent
    @DateTimeFormat(iso = DateTimeFormat.ISO.DATE)
    private LocalDate publishedDate;

    @Pattern(regexp = "\\d{10}|\\d{13}")
    private String isbn;

    @NotNull @Min(0)
    private double price;

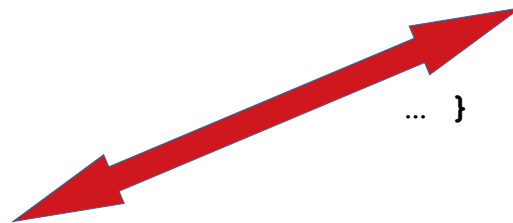
    @ManyToMany(fetch = FetchType.EAGER)
    @JoinTable(name="BOOK_AUTHOR", joinColumns=
        @JoinColumn(name="BOOK_ID",referencedColumnName="ID"),
              inverseJoinColumns=
        @JoinColumn(name="AUTHOR_ID",referencedColumnName="ID"))
    private List<Author> authors = new ArrayList<>();
}
```

```
@Entity
public class Author {
    @Id @GeneratedValue
    private int id;

    @NotNull
    @Length(min=2, max=60)
    @Column(name = "first_name")
    private String firstName;

    @NotNull
    @Length(min=2, max=60)
    @Column(name = "last_name")
    private String lastName;

    @ManyToMany(mappedBy = "authors",
                fetch = FetchType.EAGER)
    List<Book> books = new ArrayList<>();
}
```



# 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-than-1 increment size.
- 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 - custom algorithm for generating pools of values based on a single value from a table or sequence.
- Applications can also implement and use their own optimizer strategies, as defined by the [org.hibernate.id.enhanced.Optimizer](#) contract.



# ORM Cascade Updates

- Entities that have a dependency relationship can be managed declaratively by JPA using **CascadeType**:

- **ALL** – всички операции са каскадни

- **DETACH** – каскадно отстраняване

- **MERGE** – каскадно сливане

- **PERSIST** – каскадно персистиране

- **REFRESH** – каскадно обновяване

- **REMOVE** – каскадно премахване

**@OneToMany(cascade=REMOVE, mappedBy="customer")**

**public Set<Order> getOrders() { return orders; }**

# ArticlesDaoHibernate Class - I

```
@Repository
@Transactional
public class ArticleDaoHibernate implements ArticleDao {

    private SessionFactory sessionFactory;

    @Autowired
    public void setSessionFactory(SessionFactory sessionFactory) {
        this.sessionFactory = sessionFactory;
    }

    @Override
    public Collection<Article> findAll() {
        return this.sessionFactory.getCurrentSession()
            .createQuery("select article from Article article",
Article.class)
            .list();
    }

    @Override
    public Article find(long id) {
        return this.sessionFactory.getCurrentSession()
            .byId(Article.class).load(id);
    }
}
```

Source: <https://docs.spring.io/spring-framework/docs/>

# JPA Entity Annotations Example

- `@Entity`  

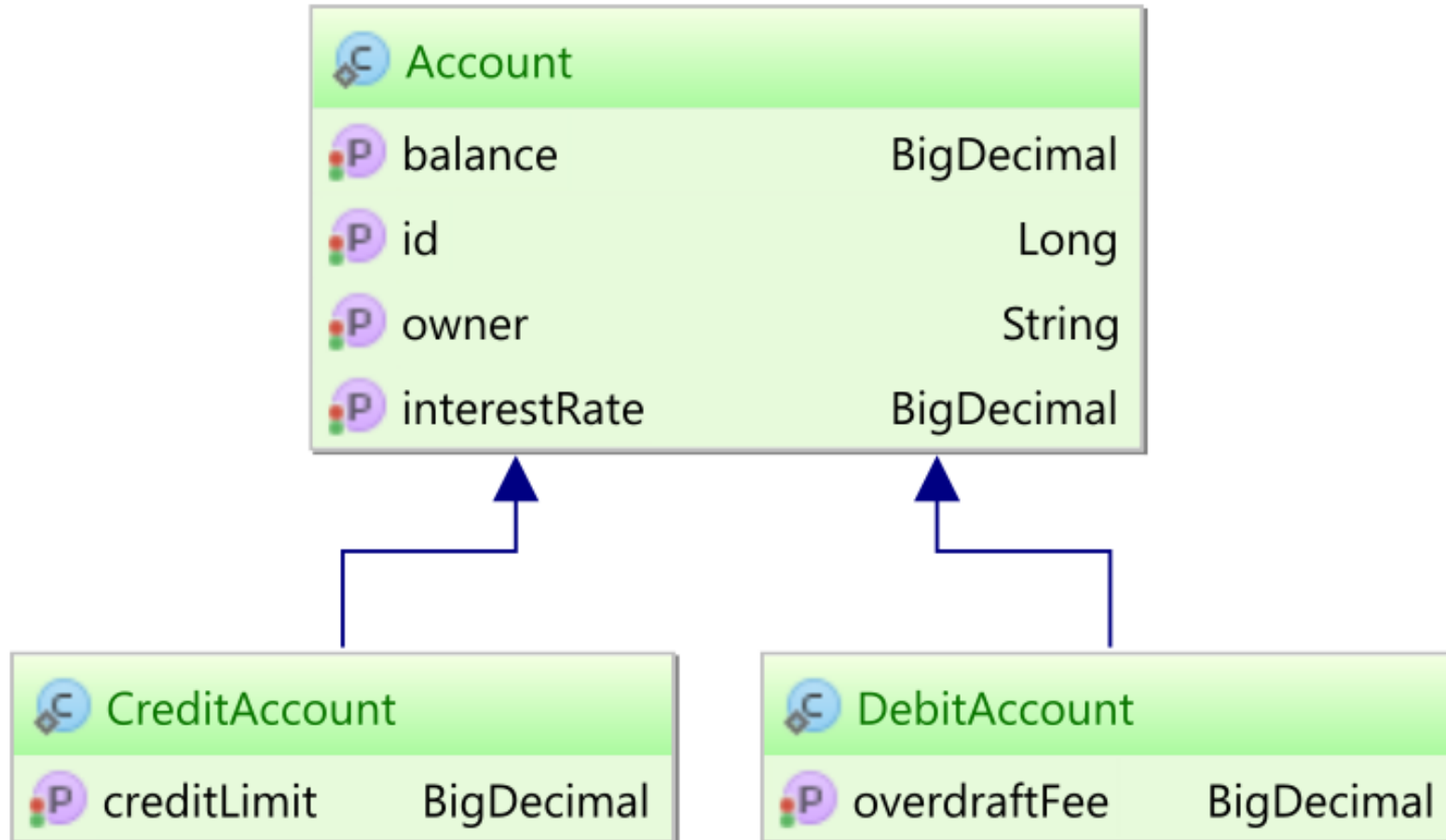
```
public class Article {  
    @Id  
    @GeneratedValue  
    private Long id;  
  
    @Length(min=3, max=80)  
    private String title;  
  
    @Length(min=3, max=2048)  
    private String content;  
  
    @NotNull  
    @ManyToOne  
    @JoinColumn(name="AUTHOR_ID", nullable=false)  
    private User author;  
  
    @Length(min=3, max=256)  
    private String pictureUrl;  
  
    @Temporal(TemporalType.TIMESTAMP)  
    private Date created = new Date();  
  
    @Temporal(TemporalType.TIMESTAMP)  
    private Date updated = new Date();  
}
```
- `@Entity`  

```
public class User implements UserDetails {  
    @Id  
    @GeneratedValue  
    private long id;  
  
    @NotNull  
    @Length(min = 3, max = 30)  
    private String username;  
    ...  
  
    @NotNull  
    private String roles = "ROLE_USER";  
  
    @OneToMany(mappedBy = "author",  
                cascade = CascadeType.ALL,  
                orphanRemoval=true)  
    Collection<Article> articles =  
        new ArrayList<>();  
  
    @Temporal(TemporalType.TIMESTAMP)  
    private Date created = new Date();  
  
    @Temporal(TemporalType.TIMESTAMP)  
    private Date updated = new Date();  
    ...  
}
```

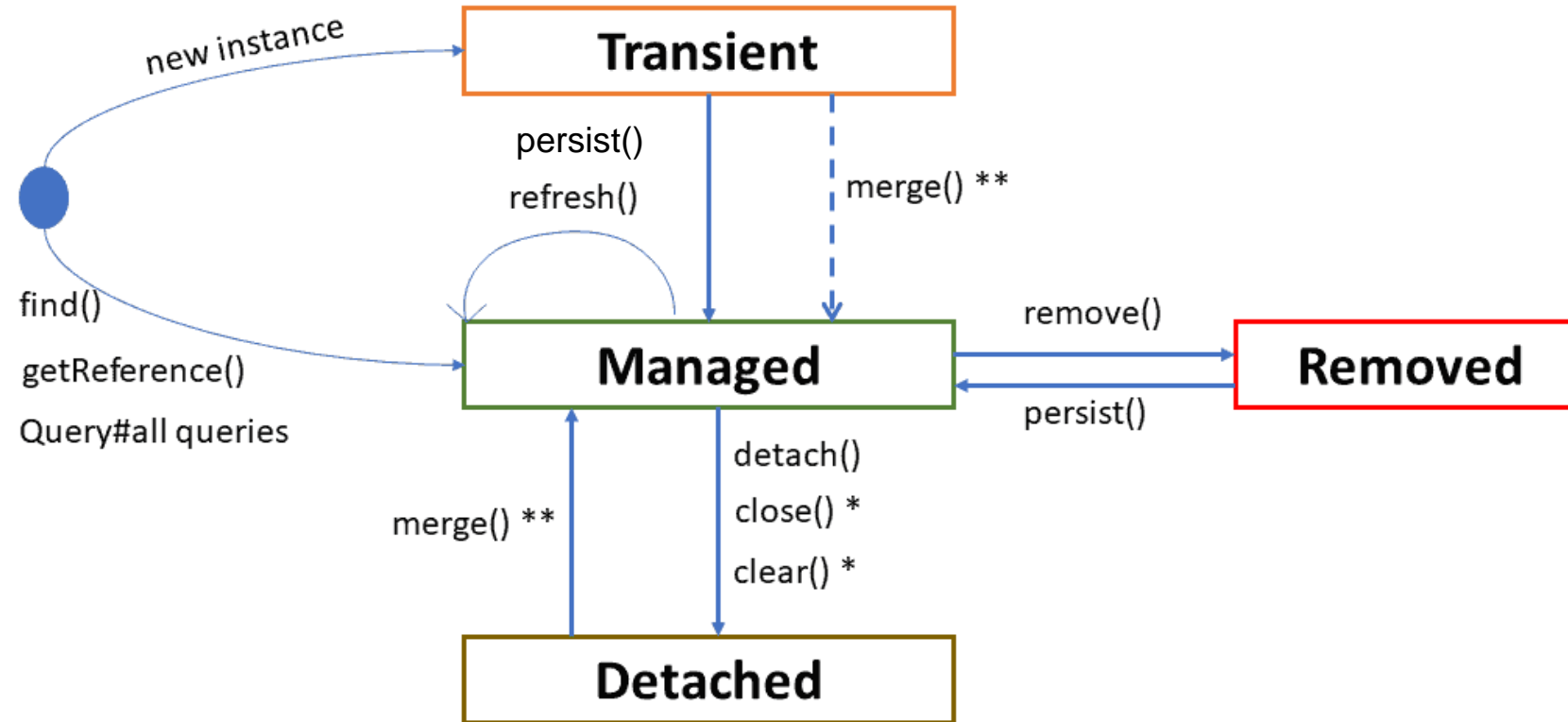
# Entity Inheritance

- Entity / Abstract entity
- Mapped superclass
- Non-entity superclass
- Entity -> DB tables mapping strategies
  - SingleTable per Class Hierarchy
  - TheTable per Concrete Class
  - The Joined Subclass Strategy

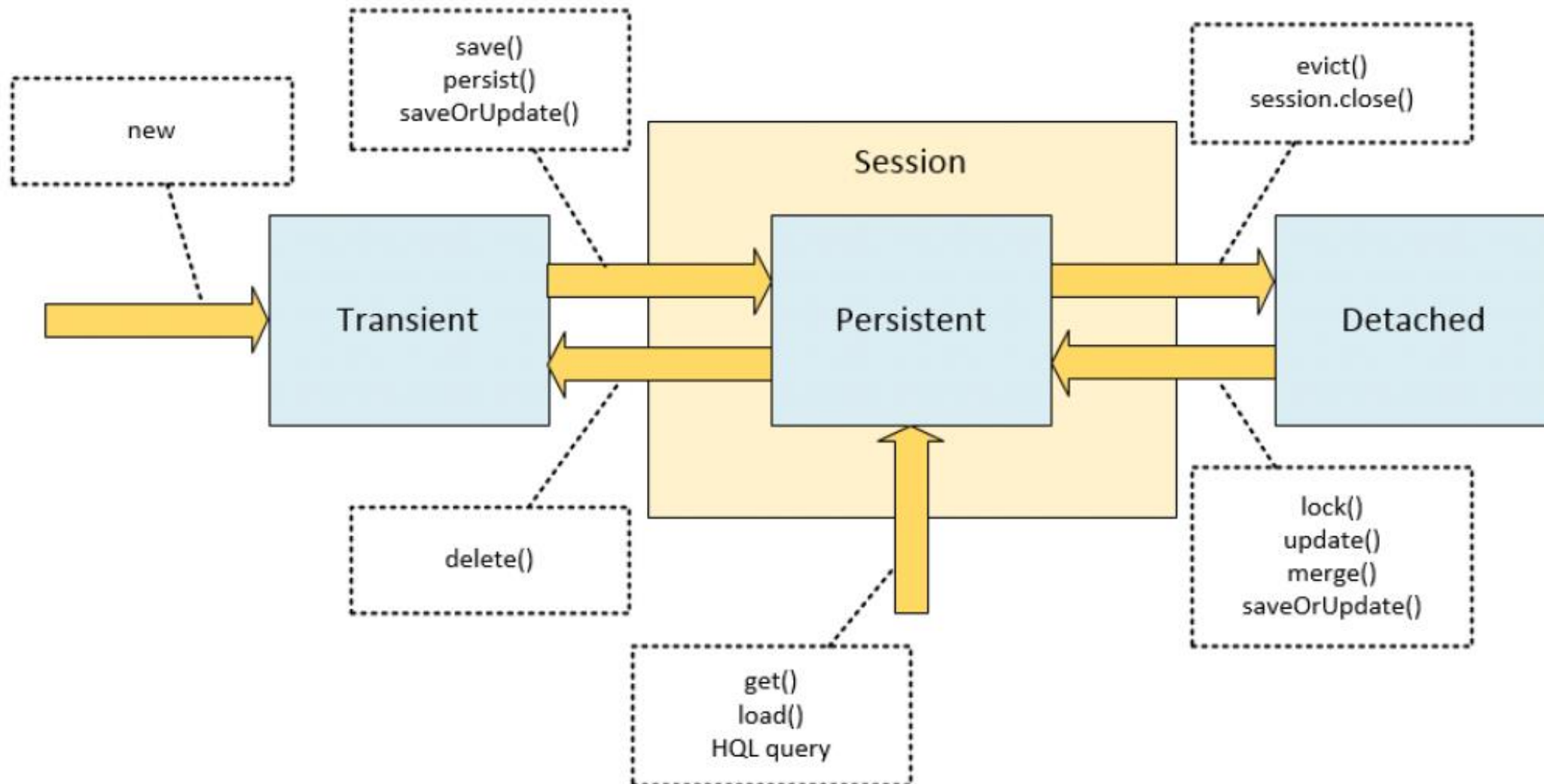
# Entity Inheritance



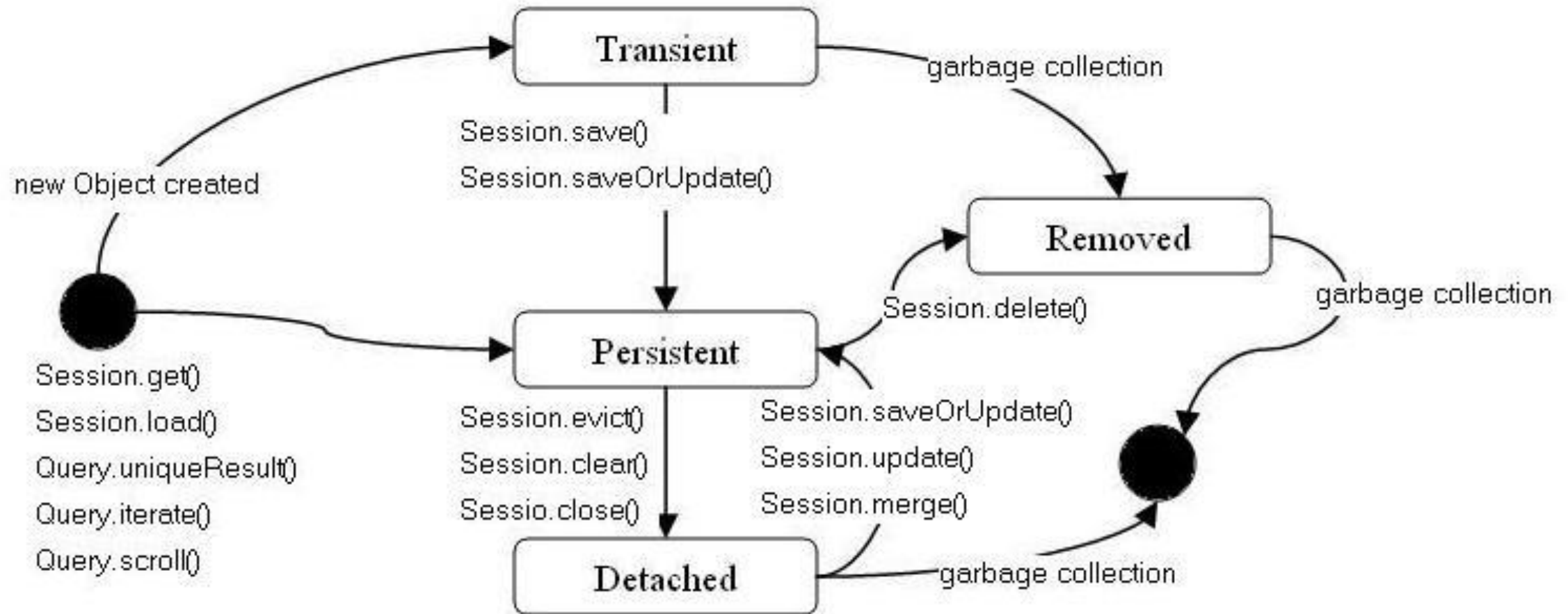
# JPA Entity Lifecycle



# Hibernate Entity Lifecycle



# Hibernate Entity Lifecycle





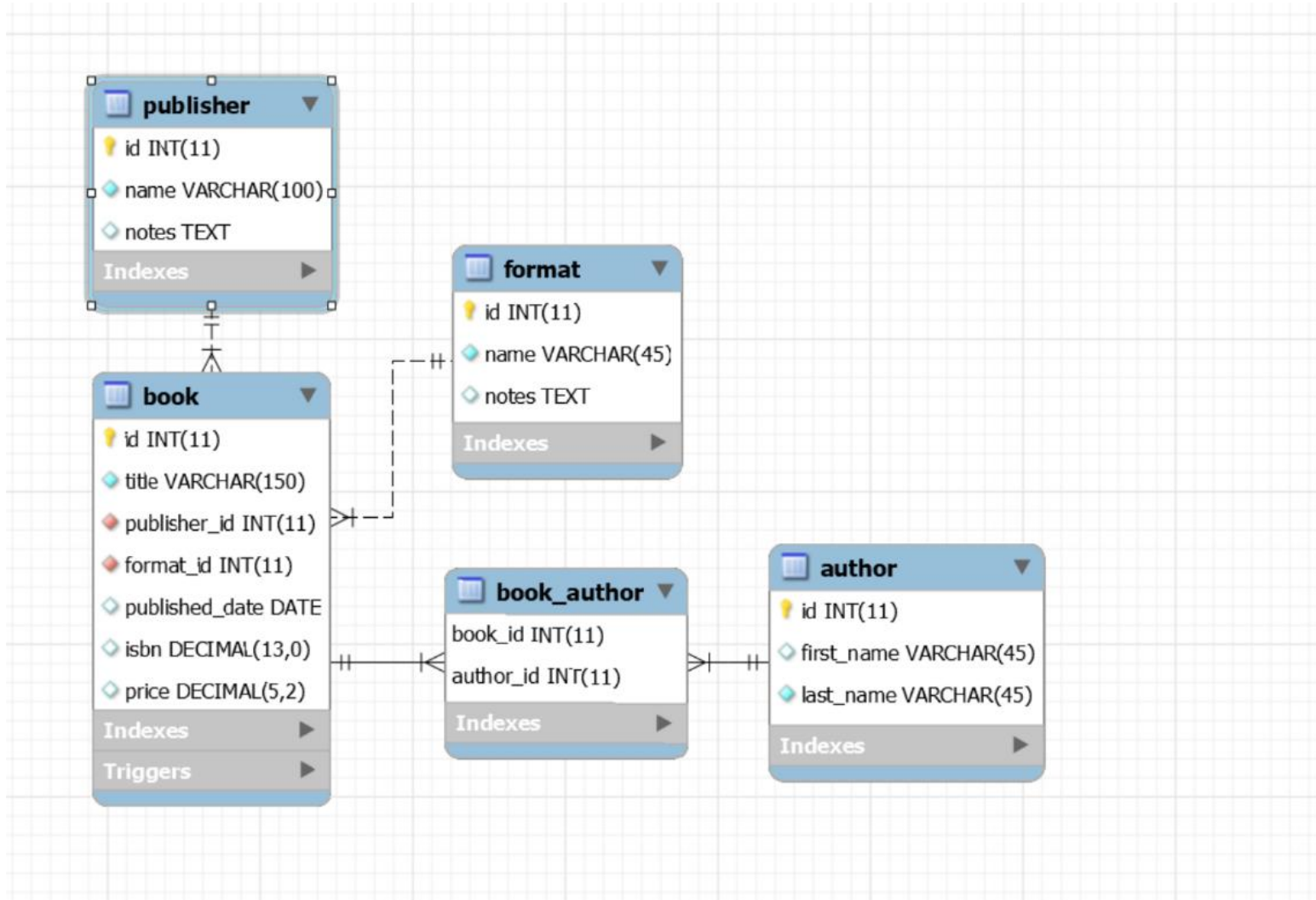
# ArticlesDaoHibernate Class - II

```
@Override
public Article create(Article article) {
    this.sessionFactory.getCurrentSession()
        .persist(article);
    return article;
}

@Override
public Article update(Article article) {
    Article toBeDeleted = find(article.getId());
    if (toBeDeleted == null) {
        throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    return (Article) this.sessionFactory.getCurrentSession()
        .merge(article);
}

@Override
public Article remove(long articleId) {
    Article toBeDeleted = find(articleId);
    if (toBeDeleted == null) {
        throw new EntityNotExistException("Article "+article.getId()+" not exist.");
    }
    this.sessionFactory.getCurrentSession()
        .delete(toBeDeleted);
    return toBeDeleted;
}}
```

# JPA Entities: ER Diagram



# Second Level Caching

- If an instance is already present in the first-level cache, it is returned from there
- If an instance is not found in the first-level cache, and the corresponding instance state is cached in the second-level cache, then the data is fetched from there and an instance is assembled and returned
- Otherwise, the necessary data are loaded from the database and an instance is assembled and returned

# Enabling Second Level Caching

`hibernate.cache.use_second_level_cache=true`

`hibernate.cache.region.factory_class=jcache`

`hibernate.cache.use_second_level_cache: true`

`hibernate.cache.default_cache_concurrency_strategy: read-write`

`hibernate.cache.use_query_cache: true`

# Cache Concurrency Strategy

- **READ\_ONLY** - used only for entities that never change (exception is thrown if an attempt to update such an entity is made). It is very simple and performant. Very suitable for some static reference data that don't change
- **NONSTRICT\_READ\_WRITE**: cache is updated after a transaction that changed the affected data has been committed. Thus, strong consistency is not guaranteed and there is a small time window in which stale data may be obtained from cache. This kind of strategy is suitable for use cases that can tolerate eventual consistency
- **READ\_WRITE**: this strategy guarantees strong consistency which it achieves by using 'soft' locks: When a cached entity is updated, a soft lock is stored in the cache for that entity as well, which is released after the transaction is committed. All concurrent transactions that access soft-locked entries will fetch the corresponding data directly from database
- **TRANSACTIONAL**: cache changes are done in distributed XA transactions. A change in a cached entity is either committed or rolled back in both database and cache in the same XA transaction

# Cache Modes

- **GET** - the session may read items from the cache, but will not add items, except to invalidate items when updates occur.
- **IGNORE** - the session will never interact with the cache, except to invalidate cache items when updates occur.
- **NORMAL** - the session may read items from the cache, and add items to the cache.
- **PUT** - the session will never read items from the cache, but will add items to the cache as it reads them from the database.
- **REFRESH** - the session will never read items from the cache, but will add items to the cache as it reads them from the database.

# Using Query Cache JPA & Hibernate

- ```
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();
```
- ```
List<Person> persons = session.createQuery(  
    "select p " +  
    "from Person p " +  
    "where p.name = :name")  
    .setParameter( "name", "John Doe")  
    .setCacheable(true)  
    .list();
```

# 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" )  
    .setHint( "javax.persistence.cache.storeMode", CacheStoreMode.REFRESH )  
    .getResultList();
```



# Caching query in custom region using Hibernate

- ```
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` or `CacheMode.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 behavior is particularly useful in cases when the underlying data may have been updated via a separate process and is a far more efficient alternative to the bulk eviction of the region via `SessionFactory` eviction which looks as follows:

```
session.getSessionFactory().getCache().evictQueryRegion( "query.cache.person" );
```

# Cache modes relationships

| <b>Hibernate</b>  | <b>JPA</b>                                          | <b>Description</b>                                                              |
|-------------------|-----------------------------------------------------|---------------------------------------------------------------------------------|
| CacheMode.NORMAL  | CacheStoreMode.USE and CacheRetrieveMode.USE        | Default. Reads/writes data from/into the 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 the cache                                     |

# Using custom cache modes for queries

- ```
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();
```
- ```
List<Person> persons = session.createQuery(  
    "select p from Person p" )  
    .setCacheable( true )  
    .setCacheMode( CacheMode.REFRESH )  
    .list();
```

# Query Cache Best Practice

- As is case with collections, only ids of entities returned as a result of a cacheable query are cached, so it is strongly recommended that second-level cache is enabled for such entities.
- There is one cache entry per each combination of query parameter values (bind variables) for each query, so queries for which you expect lots of different combinations of parameter values are not good candidates for caching.
- Queries that involve entity classes for which there are frequent changes in the database are not good candidates for caching either, because they will be invalidated whenever there is a change related to any of the entity classed participating in the query, regardless whether the changed instances are cached as part of the query result or not.

# Query Cache Best Practice

- By default, all query cache results are stored in [org.hibernate.cache.internal.StandardQueryCache](#) region. As with entity/collection caching, you can customize cache parameters for this region to define eviction and expiration policies according to your needs. For each query you can also specify a custom region name in order to provide different settings for different queries.
- For all tables that are queried as part of cacheable queries, Hibernate keeps last update timestamps in a separate region named [org.hibernate.cache.spi.UpdateTimestampsCache](#). Being aware of this region is very important if you use query caching, because Hibernate uses it to verify that cached query results are not stale. The entries in this cache must not be evicted/expired as long as there are cached query results for the corresponding tables in query results regions. It is best to turn off automatic eviction and expiration for this cache region, as it does not consume lots of memory anyway.

# Itering Entities and Associations

Hibernate offers two options if you want to filter entities or entity associations:

- static (e.g. `@Where` and `@WhereJoinTable`) - which are defined at mapping time and cannot change at runtime.
- dynamic (e.g. `@Filter` and `@FilterJoinTable`) - which are applied and configured at runtime.

# JPA Query Language Syntax

- **Select Statements** - **SELECT**, **FROM**, **WHERE**, **GROUP BY**, **HAVING**, and **ORDER BY**.
- The **SELECT** clause defines the types of the objects or values returned by the query.
- The **FROM** clause defines the scope of the query by declaring one or more identification variables, which can be referenced in the **SELECT** and **WHERE** clauses. An identification variable represents one of the following elements:
  - The abstract schema name of an entity
  - An element of a collection relationship
  - An element of a single-valued relationship
  - A member of a collection that is the multiple side of a one-to-many relationship
- The **WHERE** clause is a conditional expression that restricts the objects or values retrieved by the query. Although the clause is optional, most queries have a **WHERE** clause.
- The **GROUP BY** clause groups query results according to a set of properties.
- The **HAVING** clause is used with the **GROUP BY** clause to further restrict the query results according to a conditional expression.
- The **ORDER BY** clause sorts the objects or values returned by the query into a specified order.

# JPA Query Language Syntax

**Update and delete statements** provide bulk operations over sets of entities. These statements have the following syntax:

- `update_statement :: = update_clause [where_clause]`
- `delete_statement :: = delete_clause [where_clause]`
- The update and delete clauses determine the type of the entities to be updated or deleted. The WHERE clause may be used to restrict the scope of the update or delete operation.



# Java Persistence Query Language

- Object-oriented database queries
- Navigation
- Abstract schema
- Path expression
- State field
- Relationship field

# Java Persistence Query Language

- SELECT
- FROM
- WHERE
- GROUP BY
- HAVING
- ORDER BY
- UPDATE
- DELETE
- AS, IN
- LIKE
- EXISTS, ANY, ALL
- NEW

# 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);
```

# Hibernate Flush Modes

## 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.

# JPA defines some standard hints - I

[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.

[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.EAGER depending on the attribute's definition in metadata. For details, see the EntityGraph discussions in 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](#).

# JPA defines some standard hints - II

[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`.

# JPA retrieving result set

In terms of execution, JPA Query offers 3 different methods for retrieving a result set:

`Query#getResultList()` - executes the select query and returns back the list of results.

`Query#getResultStream()` - executes the select query and returns back a Stream over the results.

`Query#getSingleResult()` - executes the select query and returns a single result. If there were more than one result an exception is thrown.

# Basic Hibernate Query usage

- `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)");`



# Hibernate query scrolling

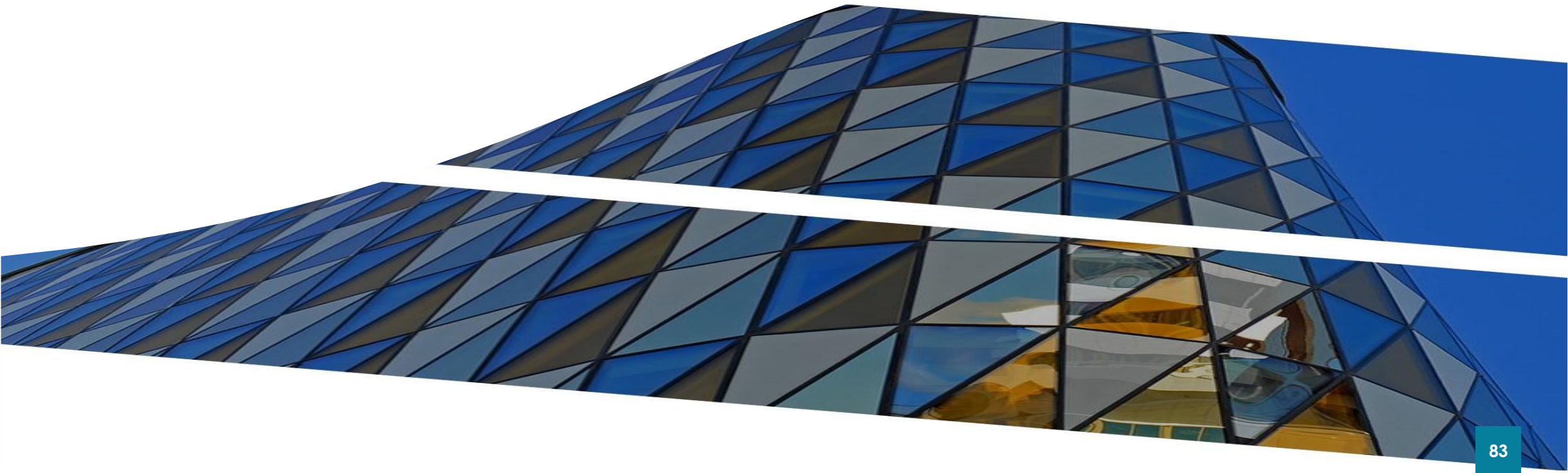
```
try ( ScrollableResults scrollableResults = session.createQuery(
    "select p " +
    "from Person p " +
    "where p.name like :name" )
    .setParameter( "name", "J%" )
    .scroll()
) {
    while(scrollableResults.next()) {
        Person person = (Person) scrollableResults.get()[0];
        process(person);
    }
}
```

# Hibernate query streaming

```
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 );  
}
```

# JPA & Hibernate Locking



# DB Locking

- In a relational database, **locking** refers to actions taken to **prevent data from changing between the time it is read and the time it is used**.
- Your **locking strategy** can be either **optimistic** or **pessimistic**. Hibernate provides mechanisms for implementing both types in your applications.
- **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 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.

# Optimistic Locking

- 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**.
- 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

# @Version Based Optimistic Locking - I

```
@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
```

```
}
```

# @Version Based Optimistic Locking - II

```
@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
```

```
}
```

# @Version Based Optimistic Locking - III

```
@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
```

```
}
```



## @Version Optimistic Locking

- `@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. You can artificially increase the version number, using the `LockModeType.OPTIMISTIC_FORCE_INCREMENT` or `LockModeType.PESSIMISTIC_FORCE_INCREMENT`.
- 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 Optimistic Locking

- **Timestamp** - 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. E.g.:

**@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 **org.hibernate.annotations.SourceType.DB** or **VM**. Default is database.
- 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.

# Timestamp Optimistic Locking

```
@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;
}
```

# Timestamp Optimistic Locking

```
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 from Version Increment

```
@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++;
    }
}
```

# Excluding Attributes from Version Increment

```
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" );  
} );
```

# Excluding Attributes from Version Increment

-- 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

# Versionless optimistic locking

- 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` annotation which defines a single attribute of type `OptimisticLockType`:
- **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

```
@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;
}
```

- 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 `UPDATE` statement 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)` operation.

# LOCK MODES

| Lock Mode                   | Description                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OPTIMISTIC                  | Obtain an optimistic read lock for all entities with version attributes.                                                                                                                                                                                                                                                                        |
| OPTIMISTIC_FORCE_INCREMENT  | Obtain an optimistic read lock for all entities with version attributes, and increment the version attribute value.                                                                                                                                                                                                                             |
| PESSIMISTIC_READ            | Immediately obtain a long-term read lock on the data to prevent the data from being modified or deleted. Other transactions may read the data while the lock is maintained, but may not modify or delete the data.<br>The persistence provider is permitted to obtain a database write lock when a read lock was requested, but not vice versa. |
| PESSIMISTIC_WRITE           | Immediately obtain a long-term write lock on the data to prevent the data from being read, modified, or deleted.                                                                                                                                                                                                                                |
| PESSIMISTIC_FORCE_INCREMENT | Immediately obtain a long-term lock on the data to prevent the data from being modified or deleted, and increment the version attribute of versioned entities.                                                                                                                                                                                  |
| READ                        | A synonym for OPTIMISTIC. Use of LockModeType.OPTIMISTIC is to be preferred for new applications.                                                                                                                                                                                                                                               |
| WRITE                       | A synonym for OPTIMISTIC_FORCE_INCREMENT. Use of LockModeType.OPTIMISTIC_FORCE_INCREMENT is to be preferred for new applications.                                                                                                                                                                                                               |
| NONE                        | No additional locking will occur on the data in the database.                                                                                                                                                                                                                                                                                   |

# LockModeType -> 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 <a href="#">javax.persistence.lock.timeout</a> setting of 0  | UPGRADE_NOWAIT              | The lock acquisition request fails fast if the row is already locked.                                                                                                                                   |
| PESSIMISTIC_WRITE with a <a href="#">javax.persistence.lock.timeout</a> setting 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.    |

# Hibernate Specific Lock Options

- **NO\_WAIT** - indicates that the database should not wait at all to acquire the pessimistic lock.
- **NONE** - represents LockMode.NONE (timeout + scope do not apply).
- **READ** - represents LockMode.READ (timeout + scope do not apply).
- **SKIP\_LOCKED** - indicates that rows that are already locked should be skipped.
- **UPGRADE** - represents LockMode.UPGRADE (will wait forever for lock, and scope of false meaning only entity is locked).
- **WAIT\_FOREVER** - indicates that there is no timeout for the acquisition.

## Setting the Lock Mode

- Call the `EntityManager.lock` method, passing in one of the lock modes:

```
EntityManager em = ...;
```

```
Person person = ...;
```

```
em.lock(person, LockModeType.OPTIMISTIC);
```

- Call one of the `EntityManager.find` methods that take the lock mode as a parameter:

```
EntityManager em = ...;
```

```
String personPK = ...;
```

```
Person person = em.find(Person.class, personPK,  
    LockModeType.PESSIMISTIC_WRITE);
```

## Setting the Lock Mode

- Call one of the `EntityManager.refresh` methods that take the lock mode as a parameter:

```
EntityManager em = ...;
```

```
String personPK = ...;
```

```
Person person = em.find(Person.class, personPK);
```

```
...
```

```
em.refresh(person, LockModeType.OPTIMISTIC_FORCE_INCREMENT);
```

- Call the `Query.setLockMode` or `TypedQuery.setLockMode` method, passing the lock mode as the parameter:

```
Query q = em.createQuery(...);
```

```
q.setLockMode(LockModeType.PESSIMISTIC_FORCE_INCREMENT);
```

## Setting the Lock Mode

- Add a lockMode element to the @NamedQuery annotation:

```
@NamedQuery(name="lockPersonQuery",  
  query="SELECT p FROM Person p WHERE p.name LIKE :name",  
  lockMode=PESSIMISTIC_READ)
```

## JPA Locking Query Hints

- `javax.persistence.lock.timeout` - it gives the number of milliseconds a lock acquisition request will wait before throwing an exception. Not all JDBC database drivers support setting a timeout value for a locking request. If not supported, the Hibernate dialect ignores this query hint.
- `javax.persistence.lock.scope` - defines the scope 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`). According to the Hibernate 5.5.9 user guide, `javax.persistence.lock.scope` is **not yet supported** as specified by the JPA standard.



## Example Specifying javax.persistence.lock.timeout

```
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
```

# The Hibernate Native buildLockRequest API

```
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
```

## Follow-on-locking (DISTINCT, GROUP BY, UNION, views – Oracle)

```
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
```

## 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
```

## Disabling Follow-on-locking

```
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
```

# Locking Exceptions

- Pessimistic Locking Exceptions
  - **LockTimeoutException** – indicates that obtaining a lock or converting a shared to exclusive lock times out, and the result is a **statement-level rollback**
  - **PessimisticLockException** – indicates that obtaining a lock or converting a shared to exclusive lock fails, and the result is a **transaction-level rollback**
  - **PersistenceException** – indicates that a persistence problem occurred. PersistenceException and its subtypes (except LockTimeoutException, QueryTimeoutException, NoResultException, and NonUniqueResultException), results in a **transaction-level rollback**.
- Optimistic Locking Exceptions
  - **OptimisticLockException** – when persistence provider discovers optimistic locking conflicts between entity versions, results in a **transaction-level rollback**.
  - Usually (but not always) it contains a **reference to the conflicting entity**.
  - The recommended way of handling the exception is to try **reloading (refreshing) the entity** and **applying required changes again** in a **new transaction** (e.g. trying to call the domain service method again with same data until success).

# References

- [PoEAA] Martin Fowler. [Patterns of Enterprise Application Architecture](#). Addison-Wesley Professional. 2002.
- [JPwH] Christian Bauer & Gavin King. [Java Persistence with Hibernate, Second Edition](#). Manning. 2015.

# Thank's for Your Attention!



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