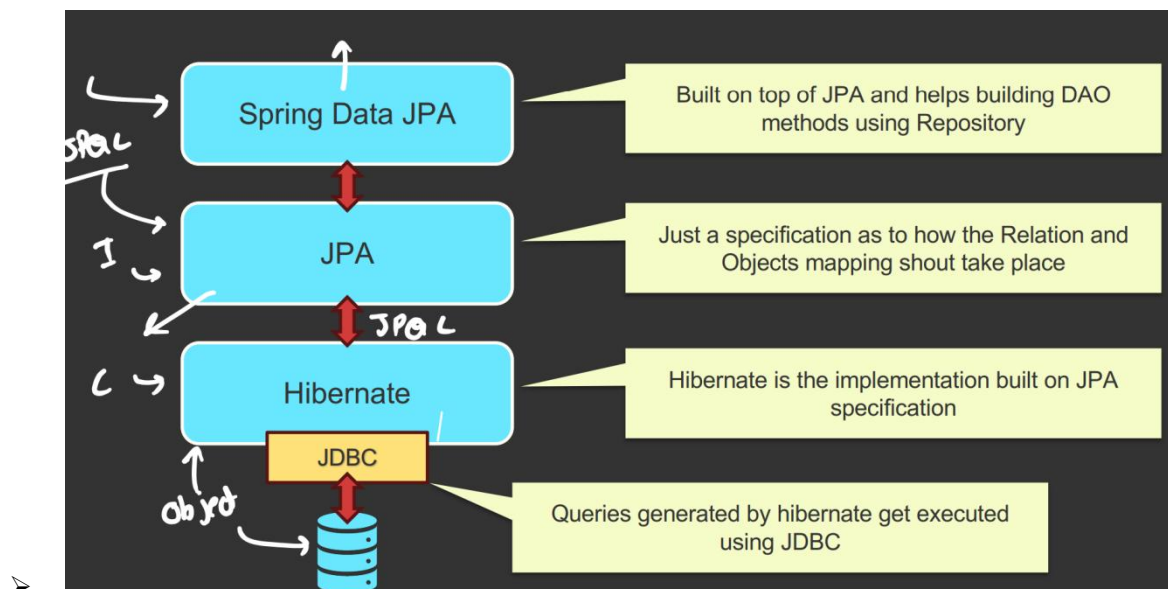
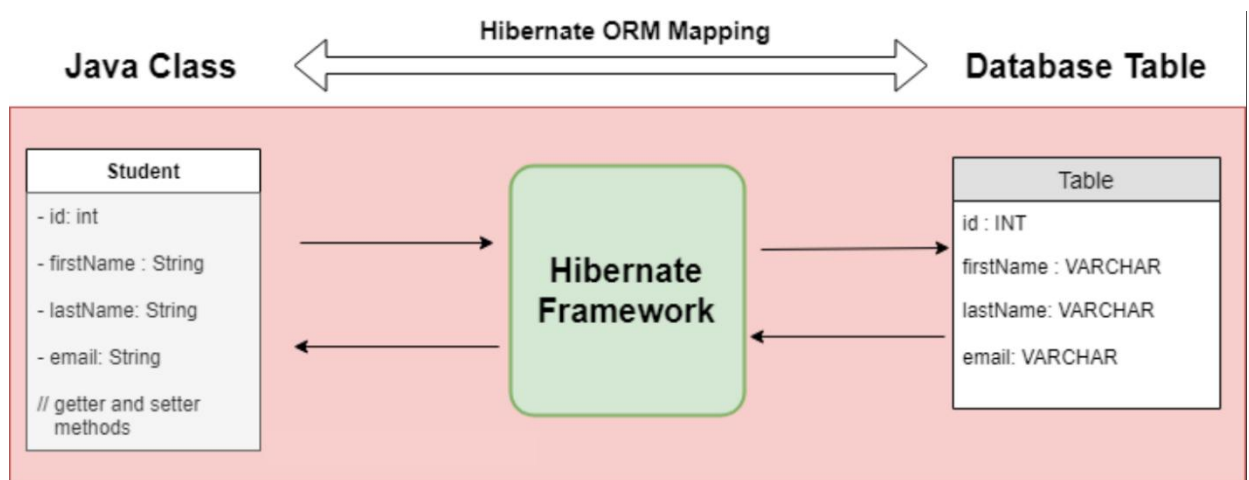


# Hibernate ORM Mapping



- With the help of driver of particular database, we can connect JDBC to it.
  - ♣ Inside JDBC, we need to write SQL queries that will be supplied to Database.
- Then comes Hibernate, it is responsible for **Object-Relational-Mapping (ORM)**.
  - ♣ It'll convert the specific Java object to Database relational entities.
  - ♣ Hibernate is the implementation built on JPA specification.
- JPA is just a specification as to how the Relation and Objects mapping should take place.
- Then it comes Spring JPA.
  - ♣ It is built on top of JPA and helps building DAO (Data Object) methods using Repository.
- We can write on top of Spring Data JPA that is high-level data manipulation methods. Or also we can write JPQL on JPA level.

## The exact flow from Spring Data JPA to Database

- First Layer is **SPRING DATA JPA**
  - ♣ Built by Spring on top of **JPA**.
  - ♣ Contains:
    - **JpaRepository** interface (extended by *user-defined repository interfaces*).
    - **SimpleJpaRepository** class (contains *method bodies of JpaRepository*).
  - ♣ SimpleJpaRepository already has implementations of CRUD methods (defined inside EntityManager interface of JPA).
  - ♣ No method implementation injection at runtime.
  - ♣ Spring creates a proxy that forwards repository method calls to **SimpleJpaRepository**.
  - ♣ Dependencies like **EntityManager** are **injected** at runtime.
- 2<sup>nd</sup> Layer is **JPA**
  - ♣ Pure Java specification.
  - ♣ Defines annotations and interfaces like **EntityManager**.
  - ♣ **SimpleJpaRepository** calls methods of **EntityManager**.
  - ♣ JPA provides only contracts, **no implementations**.
- 3<sup>rd</sup> Layer is **JPA Provider** (**Hibernate** is mainly used)
  - ♣ **Hibernate** implements **EntityManager** interface.
  - ♣ Provides actual method definitions.
  - ♣ Generates SQL queries.
  - ♣ Passes SQL to JDBC.
- 4<sup>th</sup> Layer is **JDBC**
  - ♣ Java API for DB communication.
  - ♣ Executes SQL generated by Hibernate.
  - ♣ Sends SQL to database drivers.
- 5<sup>th</sup> Layer is **Database Driver**
  - ♣ Executes SQL on the database.
  - ♣ Performs actual DB operations.

➤ **Hibernate**

- ⌘ It is a powerful, high-performance Object-Relational-Mapping (ORM) framework that is widely used with Java.
- ⌘ It provides a framework for mapping an object-oriented domain model to a relational database.
- ⌘ It is one of the implementations of Java Persistence API (JPA) which is a standard specification for ORM in Java.

➤ **JPA**

- ⌘ It is a specification for ORM in Java.
- ⌘ It defines a set of interfaces and annotations for mapping Java objects to database tables and vice versa.
- ⌘ It itself is just a guideline, doesn't provide any implementations. Implementation is provided by JPA Provider framework like Hibernate.

### Common Hibernate Configurations

- **spring.jpa.hibernate.ddl-auto=update/create/validate/create-drop/none** (1)
  - ⌘ Update: we want to update the table when we update the entity
  - ⌘ Create: everytime we running the server, old table will be dropped and create a new.
  - ⌘ Validate: the table that we have and entity that we have are matching or not
  - ⌘ Create-drop: create table on running of server and drop that after stopping the server (not used in production)
- **spring.jpa.show-sql=true** (2)
  - ⌘ If we want to see all the queries being generated underneath
- **spring.jpa.properties.hibernate.format\_sql=true** (3)
  - ⌘ The queries coming from the previous command (2) should be displayed after properly beautifying not in a single line.
- **spring.jpa.properties.hibernate.dialect=org.hibernate.dialect.MySql5Dialect** (optional) (4)
  - ⌘ Defines the rule that hibernate will use to convert JPQL to queries.
  - ⌘ Database are having their own dialect.
  - ⌘ Its optional because it'll pick the proper dialect by itself.

- There are multiple annotations for **Entity** objects

```
public class Product {

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long id;

    // can't be nullable & max length = 23
    @Column(nullable = false, length = 20)
    private String sku;

    @Column(name = "title_x")
    private String title;

    private BigDecimal price;

    private Integer quantity;

    @CreationTimestamp
    private LocalDateTime createdAt;

    @UpdateTimestamp
    private LocalDateTime updatedAt;

}
```

^

- ^ **@Id**, **@GeneratedValue**, **@Column** (change name, nullable true or false, length if it's a string, etc etc), **@CreationTimestamp**, **@UpdateTimestamp** ...etc

- **@Table** annotation

```
@Table(
    name = "employees",
    catalog = "employee_catalog",
    schema = "hr",
    uniqueConstraints = {
        @UniqueConstraint(columnNames = {"email"})
    },
    indexes = {
        @Index(name = "idx_name", columnList = "name"),
        @Index(name = "idx_department", columnList = "department")
    }
)
```

^

- ^ There is something called **namespace** in database.

- **auth.user**, **sales.user**
- Here both have the same table name "user", but they do not conflict because they belong to different namespaces (auth, sales).

- ✦ In MySQL, the database acts as the namespace (mapped using **catalog** in **@Table**).
- ✦ In PostgreSQL and Oracle, the schema acts as the namespace (mapped using **schema** in **@Table**).
- ✦ So, schema and catalog both represent the same concept (**namespace**), and which one is used depends on the database.

```
UniqueConstraint[] uniqueConstraints() default {};
```

- ✦ UniqueConstraint is also an annotation :).

```
public @interface UniqueConstraint {
```

```
@Table(
    name = "product_table",
    uniqueConstraints = {
        // column "sku" should be unique
        @UniqueConstraint(name = "sku_unique", columnNames = {"sku"}),
        // columns "title" & "price" combination should be unique
        @UniqueConstraint(name = "title_price_unique", columnNames = {"title_x", "price"})
    },
```

- ✦ (**title\_x** because we have changed the column name to **title\_x**; previous image)
- ✦ Name is used to provide a specific name to the constraint. Otherwise it'll generate some random unique name for the constraint.
- ✦ **name** is useful during debugging.

```
Duplicate entry 'a@b.com' for key 'UK_3ks8d9'
```

(without name)

```
Duplicate entry 'a@b.com' for key 'uk_user_email'
```

(with name)

## indexes

- ✦ Here the **columnList** is a *String* not a *List*.
- ✦ You should give comma separated column names.

```
indexes = {
    @Index(name = "sku_index", columnList = "sku"),
    @Index(name = "title_price_index", columnList = "title, price")
}
```

➤ **NOTE: database** should already be present. It'll not create the database inside the server by itself.



## ➤ Indexing in database.

⌘ `@Index(name = "idx_user_email", columnList = "email")` (JPA)

⌘ `CREATE INDEX idx_user_email ON users(email);` (SQL)

⌘ An index is a *separate data structure* that stores indexed **column** values along with **row pointers**.

⌘ It is not a normal table; it is created and managed internally by the database..

⌘ `a@x.com → row 5`  
`b@y.com → row 12`

⌘ But this is not a normal table, it is created and managed by database itself.

⌘ **Read** queries are *faster*, but **create, update, delete** queries are *slower* as it needs to update the index table as well.

⌘

# Spring Data JPA

- It is a part of the larger Spring Data Family.
- It builds on top of JPA, providing a higher-level and more convenient abstraction for data access.
- Spring data JPA makes it easier to implement JPA-based repositories by providing boilerplate code, custom query methods, and various utilities to reduce the amount of code you need to write.





- **SimpleJpaRepository** *class* implements the *JpaRepository interface*. It contains implementation of all the methods of the JpaRepository and its parent interfaces.
- Key Features of Spring Data JPA
  - ⌘ Repository Abstraction:
    - ⌘ Provides a *Repository* interface with methods for common data access operations.
  - ⌘ Custom Query Methods:
    - ⌘ Allows defining custom query methods by simply declaring method names.
  - ⌘ Pagination & Sorting:
    - ⌘ Offers built-in support for pagination and sorting.
  - ⌘ Query Derivation:
    - ⌘ Automatically generates queries from method names.
- You'll have to just write the method name in the Repository and no need to implement. It'll be done automatically.

```
@Repository 2 usages
public interface ProductRepository extends JpaRepository<ProductEntity, Long> {

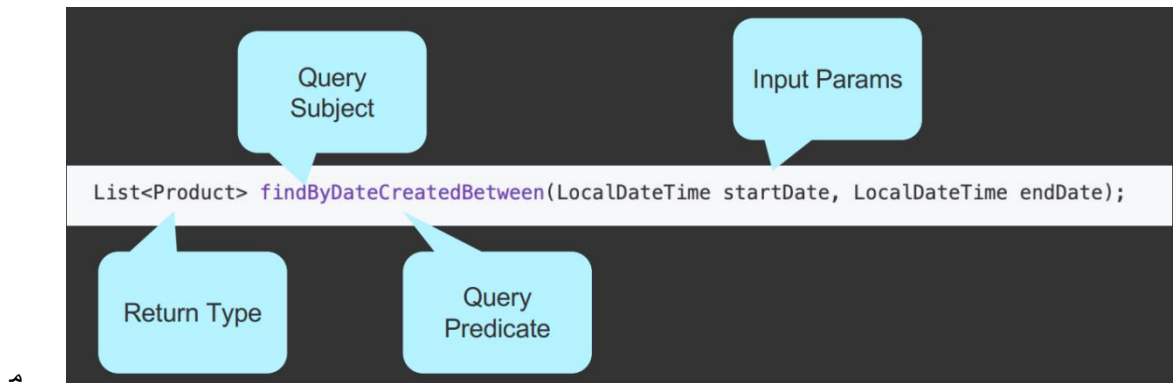
    List<ProductEntity> findByTitle(String title); 1 usage
```

- ⌘ Just like this just write the method.
- ⌘ NOTE: If you remember the column name is **title\_x** not **title**.

```
@Column(name = "title_x")
private String title;
```

- ⌘ **query generation takes place according to the Java object; not Database column; If you write findByTitleX then it'll not work;**

➤ Rules for Creating Query Methods



- ⌘ Return type will be mostly Entity, Optional<Entity> or List<Entity>
- ⌘ In the diagram, Query Subject is **findBy**, and Query Predicate is **DateCreatedBetween**.
- ⌘ The name of the query method must start with one of the following prefixes
  - ⌘ **find..By**, **read..By**, **query..By**, **get..By**
  - ⌘ Examples: **findByName**, **readByName**, **queryByName**, **getByName**
- ⌘ If we want to limit the number of returned query results, we can add the **First** or the **Top** keyword before the first by word.
  - ⌘ Examples: **findFirstByName**, **readFirst2ByName**, **findTop10ByName**
- ⌘ If we want to select unique results, we have to add the Distinct keyword before the first **By** word.
  - ⌘ Examples: **findDistinctByName** or **findNameDistinctBy** --- both are same
- ⌘ Combine property expression with **And** and **Or**
  - ⌘ Examples: **findByNameOrDescription**, **findByNameAndDescription**
- ⌘ For more, refer to the link: [query keyword reference](#)

➤ A few examples:

- ⌘ `List<ProductEntity> findByCreatedAtAfter(LocalDateTime after);`
  - ⌘ To get all the items that were created after a particular time.
- ⌘ **findByQuantityGreaterThanAndPriceLessThan**(int quantity, int price)
  - ⌘ The argument orders should be same as the query.

➤ Writing JPQL query directly

```
@Query("select e from ProductEntity e where e.title=?1 and e.price=?2") 1 usage  
Optional<ProductEntity> findByTitleAndPrice(String title, BigDecimal price);
```

^ @Query annotation is used to write the JPQL query.

^ ?1 , ?2 , ?3 etc are used to get the argument from the method. In the above image

⤵ ?1 means title

⤵ ?2 means price

^ Instead of ?1 ?2 you can also write :title and :price

```
@Query("select e from ProductEntity e where e.title=:title and e.price=:price")  
Optional<ProductEntity> findByTitleAndPrice(String title, BigDecimal price);
```

^ **NOTE:** JPQL should be written according to Java object (inside Entity), not according to Database table/column name.

⤵ In database the table name is **product\_table** as I have mentioned inside the @Table annotation, but the entity name is **ProductEntity**, so we need to pass **ProductEntity** in the JPQL.

⤵ Also, in the database the column name is **title\_x** as I have mentioned **title\_x** in the annotation @Column, but the field name is **title** inside **ProductEntity** class. So we need to pass **title** in the JPQL query.

⤵ And also, we are not writing **select \*** just like SQL, rather we are writing **select e**. here **select \*** will not work.

## Sorting & Pagination

- **OrderBy** is used to *Sort*.

```
List<ProductEntity> findByOrderByPrice();
```

^

- ^ Instead of **findAll**, here we need to write **findBy**.

- ^ It'll get all the rows and sort them according to the *price*. **OrderByPrice**.

```
List<ProductEntity> findByOrderByPriceDesc();
```

^

- ^ It'll also do the same, but it'll sort in *reverse order*.

- ^ **Asc** is for ascending, **Desc** is for descending order.

- But it is not proper; because if we want to *sort by some column*, then for each column we need to write one method each. For example *findByOrderByPrice*, *findByOrderByTitle*, *findByOrderById* ...etc

- ^ For this we can use **Sort** class.

```
List<ProductEntity> findBy(Sort sort);
```

^

- ^ Here we need to get the argument of type **Sort**.

```
@GetMapping no usages
public List<ProductEntity> getAllProducts(@RequestParam(defaultValue = "id") String sortBy) {
    return productRepository.findBy(Sort.by(sortBy));
}
```

^

- ^ We can call that method like this. Passing one **Sort** object.

- ^ Now, the API call should be made confirming according to which column it has to be sorted and its done.

- ^ `localhost:8080/products?sortBy=price` like this

```
return productRepository.findBy(Sort.by(...properties: sortBy, "price"));
```

^

- ^ If the **sortBy** column is same, then it'll further sort according to "price". like this we can give multiple properties.

```
return productRepository
    .findBy(Sort.by(Sort.Direction.DESC, ...properties: sortBy, "price"));
```

^

- ^ You can give the direction like this as well.

```
return productRepository
    .findBy(Sort.by(Sort.Order.asc(sortBy), Sort.Order.desc(property: "id")));
```

^

- ^ If you want different direction i.e. ASC, DESC for different columns then use like this.

```

Pageable  (interface) --> input
  |
  v
PageRequest (class)    --> implementation of Pageable

-----

Page<T>    (interface) --> output
  |
  v
PageImpl<T> (class)    --> implementation of Page

```



- ⌘ **Pageable** interface represents: **page size, page number, sorting info**
- ⌘ **PageRequest** is used to create **Pageable** object.
- ⌘ The query after being run returns **Page** object.
  - ⌘ Typically we never create object of **Page**.

➤ **Pageable** is the interface; **PageRequest** is the class which inherit **Pageable** (not direct parent, but ancestor).

- ⌘ We need to create one **Pageable** object to do the pagination.
- ⌘ **PageRequest** is used to create the object (as of course it is the class; and **Pageable** type of variable can keep **PageRequest** type of object; because **Pageable** is the ancestor of **PageRequest**)
- ⌘ The query methods can return **Page** type of object (if you write return type as **List** then of course it'll return **List** instead of **Page**)

```

int pageNumber = 2;
int pageSize = 10;
Pageable pageable = PageRequest
    .of(pageNumber, pageSize, Sort.by(Sort.Order.desc( property: "price")));

Page<ProductEntity> page = productRepository.findAll(pageable);
return page.getContent();

```



- ⌘ **findAll** method is already there.
- ⌘ `Page<T> findAll(Pageable pageable);`
- ⌘ It returns an object of type **Page**.
- ⌘ **getContent()** method is used to extract the **List of Entity** from the **Page**.

## ➤ NOTE

- The return type of the query doesn't only depends upon **Pageable** parameter. It depends on the return type of the method.

```
List<ProductEntity> findBySkuContaining(String sku, Pageable page);
```

- I wrote this method, and the return type is **List<ProductEntity>** so here **List** will be returned.

```
int pageNumber = 2;
int pageSize = 10;
Pageable pageable = PageRequest
    .of(pageNumber, pageSize);
return productRepository.findBySkuContaining(sku: "SKU", pageable);
```

- But if I write **Page<ProductEntity>** in that query then it'd have return **Page** type of object.

```
Page<ProductEntity> findBySkuContaining(String sku, Pageable page);
```

```
return productRepository.findBySkuContaining(sku: "SKU", pageable).getContent();
```

- Now I need to use **getContent()** method to get the **List** out of the **Page** object.
- By default, no query method supports **sorting** or **pagination**. You need to pass **Sort** type of parameter to sort and **Pageable** type of parameter to make pagination.

## ➤

- If you return **Page<ProductEntity>** instead of **List<ProductEntity>** then you'll get some **metadata** along with the **contents**.

```
{
  ▶ "content": [ ... ], // 10 items
  "empty": false,
  "first": false,
  "last": false,
  "number": 2,
  "numberOfElements": 10,
  ▶ "pageable": { ... }, // 6 items
  "size": 10,
  ▼ "sort": {
    "empty": true,
    "sorted": false,
    "unsorted": true
  },
  "totalElements": 60,
  "totalPages": 6
}
```

- (like this)

## Projection in Spring Data JPA

- A projection is a mechanism that allows you to define what data should be exposed to the caller, independent of how much data is fetched from the database.
- Returning full data can still be a projection if you are controlling what the caller can access.
- **Method-1 (DTO Interface)**

⌘ We are giving DTO directly to the repository; but as DTO interface is a view only model; so it doesn't hamper the design pattern.

```
public interface IPatientInfo {  
    Long getId(); no usages  
    String getName(); no usages  
    String getEmail(); no usages  
}
```

⌘

⌘ But there is no variables here so modification is not possible.

```
@Query("select p.id as id, p.name as name, p.email as email from Patient p")  
List<IPatientInfo> getAllPatientsInfo();
```

⌘

```
List<IPatientInfo> patientList = patientRepository.getAllPatientsInfo();  
  
for(IPatientInfo p: patientList) System.out.println(p);
```

⌘

```
{id=1, name=Aarav Sharma, email=aarav.sharma@example.com}  
{name=Diya Patel, id=2, email=diya.patel@example.com}  
{id=3, name=Dishant Verma, email=dishant.verma@example.com}  
{name=Neha Iyer, email=neha.iyer@example.com, id=4}  
{name=Kabir Singh, email=kabir.singh@example.com, id=5}
```

⌘

⌘ It'll work.

⌘ In the above query i.e. "select p.id as id, p.name as name, p.email as email from Patient p" the aliases are important i.e. id, name, email,

⌘ id will be mapped to getId

⌘ name will be mapped to getName ..etc



➤ **NOTE**

- ⌘ In case of **interface DTO**, it doesn't have any field. So **Spring Data** will not be able to create an object of this interface and return.

- ⌘ So, it creates one proxy class that implements the DTO interface.
- ⌘ Now DTO's getter methods will be forwarded to Entity's getter methods with the help of that Proxy.
- ⌘ Means the data you are getting is from the Entity itself.

```
@Query("select p from Patient p") 1 usage
List<IPatientInfo> getAllPatientsInfo();

List<IPatientInfo> patientList = patientRepository.getAllPatientsInfo();

for(IPatientInfo p: patientList) System.out.println(p);
```

- ⌘ When you execute this, You will see **entity-like output** because **toString()** is delegated to the entity. And it is basically **entity.toString()** .

\* For each object, **toString()** call was delegated to **toString()** of entity

⌘ Printed output ≠ actual object type

⌘ Actual object = proxy

```
Patient(id=1, name=Aarav Sharma, birthDate=1990-05-10, email=aarav.sharma@example.com, gender=MALE, bloodGroup=O_POSITIVE, createdAt=null)
```

- ⌘ In case of **class DTO** (lets assume only getters are there; no setters).
- ⌘ In this case, Spring/Hibernate doesn't need to create one proxy class because it can directly create one object of type **DTO class** because it's not an interface.
- ⌘ So, in case of **class DTO** (even if setters are not there), the object of type **DTO class** will be returned; No proxy class is required here.



- This is my **DTO Interface** (for reference of next explanations)

```
public interface IPatientInfo {  
    Long getId(); no usages  
    String getName(); no usages  
    String getEmail(); no usages  
}
```

- 2 Types of projections are there:

- ⌘ **Entity-backed Projection**
- ⌘ **Tuple-backed Projection**

- **Entity-Backed Projection**

```
List<IPatientInfo> findAll();  
  
@Query("select p from Patient p")  
List<IPatientInfo> findAll();
```

- ⌘ Both are same, if you don't give the query then it'll by default write that query only (which is being mentioned in the image)
- ⌘ So, here it is fetching the full **entity objects** which is of type **Entity**.
- ⌘ Flow will be like:
  - ⌘ **Hibernate** fetches **Patient Entity** object from the database (As full **entity** has to be fetched according to the query)
  - ⌘ **Spring** creates a **proxy** that implements the **DTO Interface** (IPatientInfo in our case)
  - ⌘ **Proxy** holds a reference to the **InvocationHandler**.
  - ⌘ The **InvocationHandler** holds a reference of the **Entity**.
  - ⌘ Now, whenever the method will be called from the DTO will be delegated to Entity. Proxy is responsible for this.
    - \* **dto.getName() ---- Proxy --- handler ----- entity.getName()**
- ⌘ Here no data is copied;
- ⌘ No aliases are needed;
- ⌘ The data directly comes from the **entity**.
- ⌘ If you are wondering how it is able to know about the **Entity**, then you can remember we were passing **Entity** and **Id** type in the generics of **JpaRepository**.

## ➤ Tuple-Backed Projection

```
@Query("""
select p.id as id, p.name as name, p.email as email
from Patient p
""")
List<IPatientInfo> findAll();
```

- ⌘ Here you need to give the query; and instead of fetching the whole **entity**, only select some specific columns that is being mentioned in the **DTO interface**.
- ⌘ In this case **aliases** are needed.
- ⌘ As here only some specific columns are being fetched from the table, so there is no need of keeping reference of **Entity**.
- ⌘ Flow:
  - ⌘ **Hibernate** does not create entities.
  - ⌘ Query returns selected column values.
  - ⌘ **Spring** keeps the **tuple/map** inside the **InvocationHandler**.
  - ⌘ **Spring** creates a **proxy** that implements **DTO Interface** (IPatientInfo in our case)
  - ⌘ **Proxy** holds a reference of **InvocationHandler** (just like previous case)
  - ⌘ Previously **InvocationHandler** was holding a reference of **Entity**, but in this case it is holding a reference of **Map/tuple**.
  - ⌘ When **getter** is called, **proxy** delegates that method call to **InvocationHandler**, which reads from **tuple/map** and returns the result.

```
Proxy (implements DTO interface)
|
v
InvocationHandler
|
v
Tuple / Map (query result)
```

## Some experiments:

### ➤ Experiment-1

- Interface DTO (id, name, email) (IPatientInfo)

```
public interface IPatientInfo {  
    Long getId(); no usages  
    String getName(); no usages  
    String getEmail(); no usages  
}
```

- PatientRepository (fetching the whole entities)

```
@Query("select p from Patient p") 2 usages  
List<IPatientInfo> getAllPatientsInfo();
```

- PatientController (returning the IPatientInfo type object)

```
@GetMapping no usages  
public List<IPatientInfo> getData() {  
    List<IPatientInfo> patientList = patientRepository.getAllPatientsInfo();  
    return patientList;  
}
```

- The response will be proper

```
[  
  {  
    "name": "Aarav Sharma",  
    "id": 1,  
    "email": "aarav.sharma@example.com"  
  },  
  {  
    "name": "Diya Patel",  
    "id": 2,  
    "email": "diya.patel@example.com"  
  },  
  {  
    "name": "Aarav Sharma",  
    "id": 1,  
    "email": "aarav.sharma@example.com"  
  }  
]
```

- Reason:

- IPatientInfo (Interface DTO) is having the getters for **name**, **id**, **email** which is delegated to **Patient** (Entity).
- From the **entity objects** the **getter** methods are being called and the result is properly being generated.

### ➤ Experiment-2

- Interface DTO (name, email) (IPatientInfo)

```
public interface IPatientInfo {
    String getName(); no usages
    String getEmail(); no usages
}
```

- ⌘ PatientRepository (fetching the **id** of the entities)

```
@Query("select p.id as id from Patient p")
List<IPatientInfo> getAllPatientsInfo();
```

- ⌘ **alias** is being used for **id** (here **getId()** will be called; otherwise it'd be null without alias)

- ⌘ PatientController (returning the IPatientInfo type object)

```
@GetMapping no usages
public List<IPatientInfo> getData() {
    List<IPatientInfo> patientList = patientRepository.getAllPatientsInfo();
    return patientList;
}
```

- ⌘ Now **name** and **email** will be **null**

```
[
  {
    "name": null,
    "email": null
  },
  {
    "name": null,
    "email": null
  }
]
```

- ⌘ Reason:

- ⌘ IPatientInfo (Interface DTO) is having the getters for name, email.
- ⌘ But now **getName()** and **getEmail()** are not there because now we don't have **entity** objects; rather we have **map/tuple** which are containing only **id**. So, here only **getId()** will work.
- ⌘ But **IPatientInfo** contains **email**, **name** so it is null now.

- Interface DTOs are not flexible;

- ⌘ Only one type of response can be sent.
- ⌘ The object cannot be edited as it was coming from the Map(in case of few columns) or Entity(in case of whole entity). So, **Interface DTO are only view-only**.
- ⌘ So, class based DTO are used which can be modified, multiple types of responses are supported.

## ➤ Class DTO

- ⌘ If the DTO class is containing only one constructor, then the JPQL query can be written normally like Interface DTO.

```
@Getter 5 usages
public class CPatientInfo {
    private Long id;
    private String name;
    private String email;

    public CPatientInfo(Long id, String name, String email) {
        this.id = id;
        this.name = name;
        this.email = email;
    }
}
```

(class DTO)

```
@Query("select p.id as id, p.name as name, p.email as email from Patient p")
List<CPatientInfo> getAllPatientsInfoConcrete();
```

- ⌘ For this query, the response will be like the below:

```
[
  {
    "id": 1,
    "name": "Aarav Sharma",
    "email": "aarav.sharma@example.com"
  },
  {
    "id": 2,
    "name": "Diya Patel",
    "email": "diya.patel@example.com"
  }
]
```

(all fields are coming)

```
@Query("select p.id as id, p.name as name from Patient p")
List<CPatientInfo> getAllPatientsInfoConcrete();
```

- ⌘ It'll give "Internal Server Error" because the constructor is accepting 3 arguments but we are giving only one.

⌘ **NOTE:** In the JPQL query, the fields should be in same order as defined in the constructor; otherwise wrong fields will be passed in the constructor.

```
@Query("select p.id as id, p.email as email, p.name as name from Patient p")
List<CPatientInfo> getAllPatientsInfoConcrete();
```

```
{
  "id": 1,
  "name": "aarav.sharma@example.com",
  "email": "Aarav Sharma"
},
```

(it'll give wrong response like this)

⌘ If the type of fields are different then it'll give error instead of giving response.

- So, till now we were having only single constructor, but in case of multiple constructor we need to pass the **DTO class reference** in the JPQL query instead of writing like this normally.

```
public CPatientInfo(Long id, String name, String email) {
    this.id = id;
    this.name = name;
    this.email = email;
}

public CPatientInfo(Long id, String name) { no usages
    this.id = id;
    this.name = name;
}
```

⌘ So now I have 2 constructors.

```
@Query("select " + 1 usage ⌘ Anuj Kumar Sharma
        "new com.codingshuttle.springboot0To100.hospitalManagementSystem.dto.CPatientInfo(p.id, p.name, p.email)" +
        " from Patient p")
List<CPatientInfo> getAllPatientsInfoConcrete();
```

⌘ Like this you need to write.

⌘ new keyword is must to create object.

⌘ No aliases are required here.

```
[
  {
    "id": 1,
    "name": "Aarav Sharma",
    "email": "aarav.sharma@example.com"
  },
  ...
]
```

(response)

```
@Query("select " + 1 usage ⌘ Anuj Kumar Sharma
        "new com.codingshuttle.springboot0To100.hospitalManagementSystem.dto.CPatientInfo(p.id, p.name)" +
        " from Patient p")
List<CPatientInfo> getAllPatientsInfoConcrete();
```

⌘ Here I passed just 2 fields (id and name as per the 2<sup>nd</sup> constructor).

```
[
  {
    "id": 1,
    "name": "Aarav Sharma",
    "email": null
  },
  ...
]
```

⌘ Now if you see, all the fields are coming but having null values.

⌘ To avoid that @JsonInclude(JsonInclude.Include.NON\_NULL) is used.

```
@Getter 5 usages
@JsonInclude(JsonInclude.Include.NON_NULL)
public class CPatientInfo {
```

Now I added this here.

```
[
  {
    "id": 1,
    "name": "Aarav Sharma"
  },
```

Now if you see, only the non-null fields are being displayed.

### ➤ Aggregate JPQL queries

**NOTE:** Aggregate functions can have **aliases** but those aliases should not be used for **order by** and **group by**.

```
select p.bloodGroup as bloodGroup, count(p) as countPeople
from Patient p
group by p.bloodGroup
order by count(p) desc
```

You can see here, I have given alias for **count(p)** which is **countPeople** but that alias name is not given on the side of **order by**.

I have mentioned **count(p)** on the side of **order by**.

Also, you cannot give **\*** just like SQL query. Here you need to give the object name (**p**)

Instead of field name, **p.fieldName** should be given in **camelCase** (in db it'll be in **snake\_case**)

This is only valid for JPQL queries.

```
@Getter 5 usages
public class CPatientInfoAgg {
    private final BloodGroupType bloodGroupType;
    private final Long count;

    public CPatientInfoAgg(BloodGroupType bloodGroupType, Long count) {
        this.bloodGroupType = bloodGroupType;
        this.count = count;
    }
}
```

This is my **DTO** class for that aggregation query.



```
@Query("select p.bloodGroup as bloodGroup, count(p) " + 1 usage
      "from Patient p " +
      "group by p.bloodGroup " +
      "order by count(p) desc")
List<CPatientInfoAgg> getAllPatientsInfoConcreteAggregate();
```

☞ It'll give the proper response.

```
{
  "bloodGroupType": "A_POSITIVE",
  "count": 12
},
{
  "bloodGroupType": "O_POSITIVE",
  "count": 12
},
{
  "bloodGroupType": "AB_POSITIVE",
  "count": 6
}
```

```
@Query("select " + 1 usage new *
      "new com.codingshuttle.springboot0To100.hospitalManagementSystem.dto.CPatientInfoAgg(p.bloodGroup, count(p))"
      "from Patient p " +
      "group by p.bloodGroup " +
      "order by count(p) desc")
List<CPatientInfoAgg> getAllPatientsInfoConcreteAggregate();
```

☞ It is preferable to use **class reference** to write the JPQL queries.

➤ **@Params** is used to bind a *parameter name* to a *particular JPQL value*.

```
@Transactional no usages new *
@Modifying
@Query("update Patient p set p.name = :name where p.id = :id")
int updatePatientNameWithId(@Param("name") String patientName, @Param("id") Long patientId);
```

☞ Here I am executing one **update** query.

☞ You can see the parameter names are **patientName** and **patientId** but I have bound those with **name** and **id** respectively using **@Params** annotation.

☞ And also I am using **:name** and **:id** in the JPQL query.

➤ **@Modifying** is required in case of **modification** of database.

☞ By default **Spring** thinks that the query is of **select** type. So, it expects some **data to be returned** from the database.

☞ Hence, it'll read those data and give response.

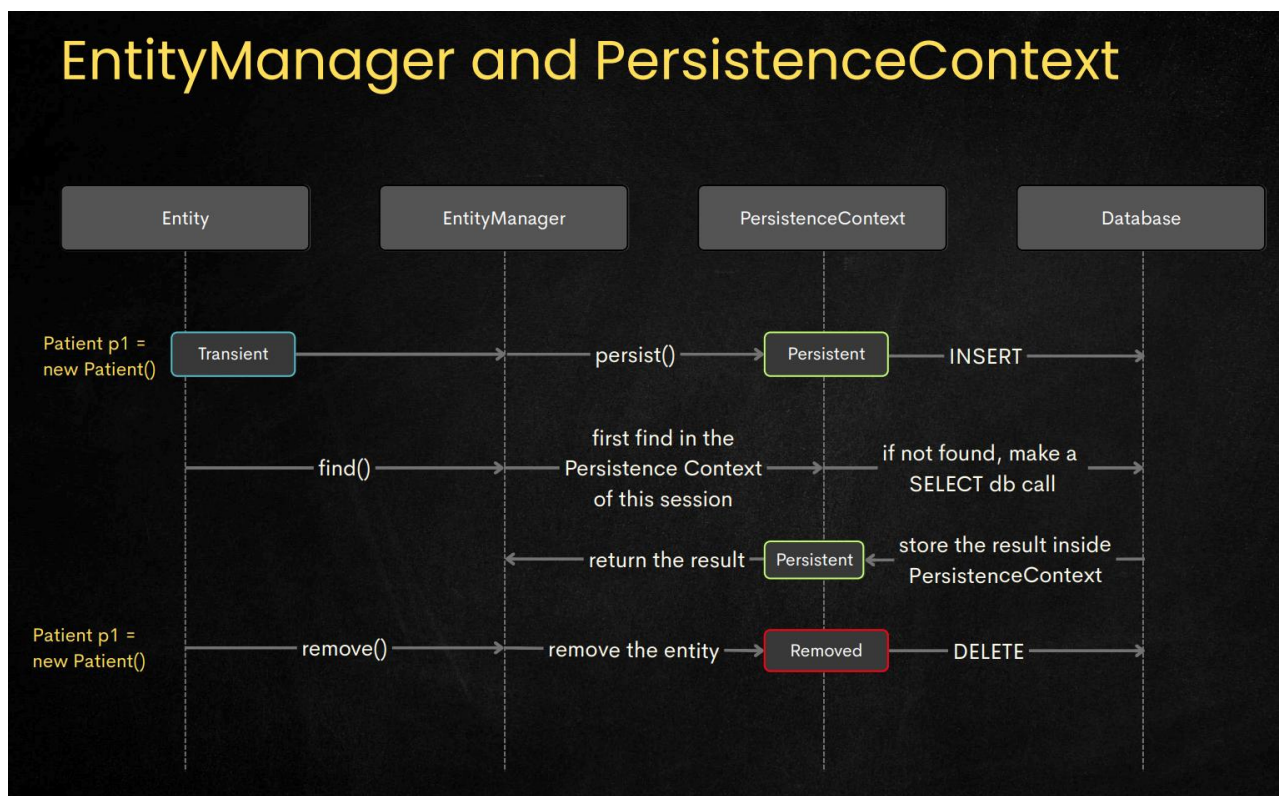
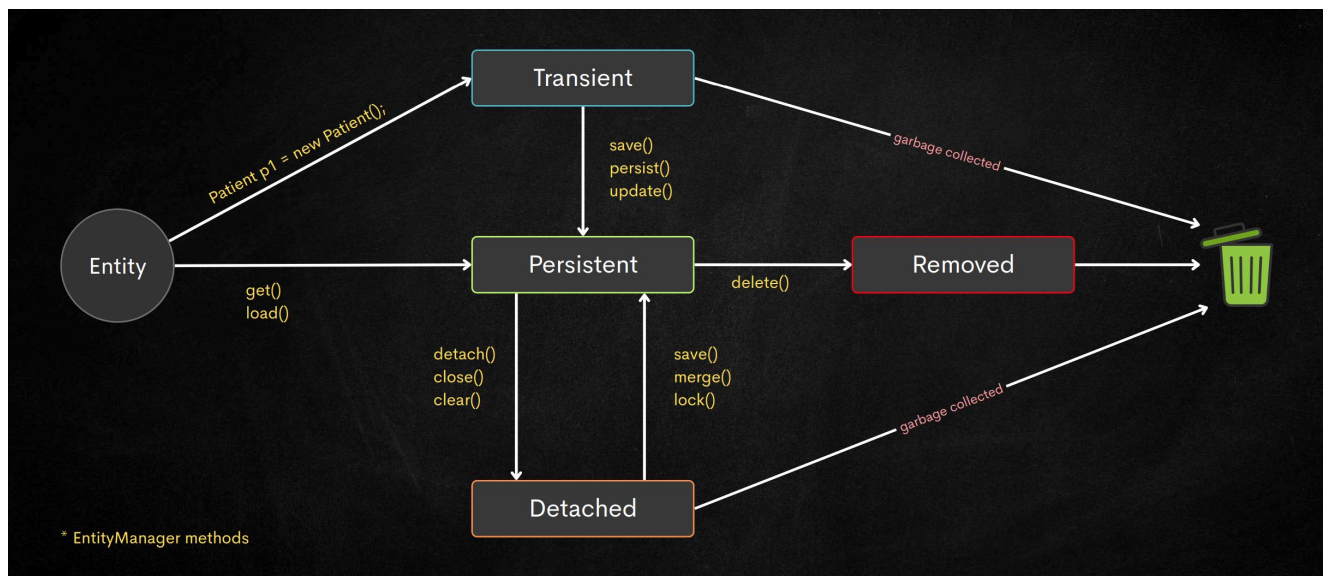
☞ But, in case of **create/update/delete** method, no data is returned; only one number of *rows affected* will be returned.

☞ So, **@Modifying** will tell spring that don't expect any data to be returned.



- ♣ **@Modifying** will always go with **@Transactional** because you are changing the database state. And it means its involving one **transaction**.

## Hibernate Entity Lifecycle, Entity Manager, Persistence Context



- **PatientEntity p = new PatientEntity();**
  - ⌘ This will take the state to **Transient**.
  - ⌘ This is only used for **creating new entry**.
  - ⌘ So, basically only **create** is related to **transient state**, **other operation (update, delete, read)** doesn't include **transient state** at all.
  - ⌘ In **transient state**, it is only a pure Java object; nothing more.
  - ⌘ **Transient state is not managed by EntityManager; because it is pure Java object.**

- Either you create one object just like above and call **repository.save(p)** or you are making the **get** call like **repository.findById(id)** to get the **entity**, it'll be remaining in the **Persistence Context** only.
  - ↪ **Persistence Context** is nothing but a **run-time** state that holds all the **changes** being made, or **data** being fetched till now to **reduce the number of database calls**.
  - ↪ For read, it'll check in the **Persistence Context**, if the entry is present then it'll directly return; otherwise **query the db, fetch the data, store the data in Persistence Context, return the data**.
  - ↪ Once all the **requests are being processed** (it may be update, or delete, or create; because **read happens directly only**), when the **transaction is coming to the end**, it **commits all the changes to the database at once**. Hence reducing the number of **db calls**.
  - ↪ **persist()** puts an object into the Persistence Context **WITHOUT** reading from DB
  - ↪ **find()** puts an object into the Persistence Context **BY** reading from DB (if needed)
- Simple thing: if the operation is of type **create, update, delete**, then it'll keep all the operations within it; and when the **transaction ends** it trigger those queries to **db**.
- If the **entity** is made **Detached** and left hanging there in the **Transactional method**; and after that method ends if the **reference of the entity** is destroyed; then the **entity will be garbage collected**.
- Same for **remove** and **transient(create)** as well;
- Means its normal Java concept; if the **variables** that were holding the reference of the **entity object** are destroyed; then the **entity object** will be garbage collected; it has nothing to do with the **transient** or **persistence** or **detach** state.
- **IMPORTANT: @Transactional** is required to make proper use of **Persistence Context**.  
If **@Transactional** is not mentioned, then there is no guarantee that each method will run in same **Persistence contexts**.
- **Some Points to Remember**
  - ↪ Repository object will be having **EntityManager's** methods.
  - ↪ **JpaRepository** will be implemented by **SimpleJpaRepository** class.
  - ↪ **SimpleJpaRepository** class will *call the methods* of **EntityManager**.
    - ⌘ (Hibernate implements the **EntityManager** interface)
  - ↪ So, we call the methods like
    - ⌘ **repository.save(entityObject)**
    - ⌘ So, under the hood it is called like
    - ⌘ **entityManagerObject.persist(entityObject)**

- ♣ **persist** for *create*, **merge** for *update*, **delete** for *remove*.

```
public <S extends T> S save(S entity) {  
    Assert.notNull(entity, message: "Entity must not be null");  
    if (this.entityInformation.isNew(entity)) {  
        this.entityManager.persist(entity);  
        return entity;  
    } else {  
        return (S) this.entityManager.merge(entity);  
    }  
}
```

- ♣ It's the SimpleJpaRepository class's save method.
- ♣ If it is **isNew** then **persist** else **merge** for update.

## ➤ Garbage Collection

- ♣ Garbage Collection is **purely a Java concept**
- ♣ **objects are created inside heap**
- ♣ As variables are **created on stack** so after the execution of their respective scope, those variables will be destroyed.
- ♣ So, when all the **variables holding reference to an object** are **destroyed or cleared**, and there is **no variable present which is containing the reference of that object** so that **JVM can reach that object**, then the **object will be eligible for garbage collection.**
- ♣ JVM can not reach the object means: JVM is not able to find any variable(normal or static or anything) that contains the reference of the Object. So, the **reference of the object** is lost now. So In that case JVM send the Object for garbage collection.

## Relationship Owning side and Inverse Side

- In every bidirectional JPA relationship, exactly ONE side must be the owner. That owner is the side that contains the foreign key in the database.
- How to know which is OWNING and which is INVERSE?
  - ♣ Just find out where should the foreign key can be stored?
  - ♣ Normally the decision making will be like:
    - ♣ For 2 entities **entity-1** and **entity-2**
    - ♣ If **entity-1** can exist without **entity-2** then **entity-2** should contain the **foreign key** (i.e. **primary key of entity-1**); so **entity-1** is **inverse** and **entity-2** is **owning**.
      - \* One catch will be here; lets say 2 entities are there **user** and **profile**.
      - \* **user** can exist without **profile** but vice-versa is not true.
      - \* So, **profile** should contain the FK.
      - \* But, its upon **USER**'s decision that he'll create his profile or not so in this case **PROFILE** can be **null** as well.
      - \* So, in this case it is better to keep FK in **user** table instead of **profile**.
- **One-To-One** mapping in JPA
  - ♣ Lets say **USER** and **PASSPORT**.
  - ♣ **PASSPORT** is the *owning* and **USER** is the *inverse*.
  - ♣ **inverse side will contain mappedBy in JPA.**
  - ♣ **@OneToOne**
    - ♣ It'll tell Hibernate that I need one **foreign key** column in my table.
    - ♣ If you pass **mappedBy** then it'll think that "okay, my other half has already kept me; I don't need to keep that"
    - ♣ without **mappedBy** hibernate thinks this is the owner. If you don't write **mappedBy** in neither of 2 entities (**User** and **Passport**) then it'll create foreign key column in both.
    - ♣ **mappedBy** will contain the variable name **(of object; not database column)** which is created in the **owning side** as the value.

```
@Entity 1 usage new *
class Passport {
    @Id no usages
    private Long id;

    @OneToOne no usages
    @JoinColumn(name = "user_id")
    private User user;
}
```

Here owning type has variable name: **user**

```
@Entity 1 usage new *
class User {

    @Id no usages
    private Long id;

    @OneToOne(mappedBy = "user")
    private Passport passport;
}
```

So, **user** has to be given as the value of **mappedBy** in inverse.

#### ~ @JoinColumn

- it is just used to provide name of foreign key column; if you don't give this annotation then by default the column name will be like the below:
  - \* Let inverse table is **Person** and **id** field is **myPmId**
  - \* The column name would be: **person\_my\_pm\_id**. (if @Column doesn't contain any different column name; else that column name will be created)
- @JoinColumn("person\_id") it means nothing but "store the primary key of inverse table in my table as foreign key under the column having name **person\_id**"
- Means the **foreign key** column will be named as **person\_id**.
- In case of **person\_id** I can even right **@JoinColumn("lalala\_lululu")**

#### ➤ One-to-Many or Many-to-One mapping in JPA

~ **Many side will always be the owning type; hence foreign key will be there in the Many side only.**

~ **Many side:**

- @ManyToOne
- @JoinColumn (if you want a personalize column name)

~ **One side:**

- @OneToMany(mappedBy)

#### ➤ Many-to-Many mapping in JPA

- ~ This is slightly different than the previous mappings.
- ~ **Here No FK in either of tables.**
- ~ **Relationship will be stored in another table.**
- ~ **Any table can be owning and other will be inverse** (its completely up-to you)

```

Student
-----
id (PK)

Course
-----
id (PK)

student_course  ← join table
-----
student_id (FK → Student.id)
course_id  (FK → Course.id)

```

(Student, Course)

♣ I chose **Student** as the *owning* type.

```

@Entity
class Student {

    @Id
    private Long id;

    @ManyToMany
    @JoinTable(
        name = "student_course",
        joinColumns = @JoinColumn(name = "student_id"),
        inverseJoinColumns = @JoinColumn(name = "course_id")
    )
    private Set<Course> courses;
}

```

(owning)

♣ Here **@JoinTable** is used; inside which **@JoinColumn** is used.

\* Again, here also **@JoinColumn** is not mandatory.

```

@Entity
class Course {

    @Id
    private Long id;

    @ManyToMany(mappedBy = "courses")
    private Set<Student> students;
}

```

(inverse)

## Cascading

- It tells persistence provider (Hibernate) what operations to propagate from a **Parent entity to Child entity**.
- NOTE: **owning** and **inverse** are no way related to **parent entity** and **child entity** concept.
- The **orphanRemoval** and **cascade** are written in **Entity level**. If you call the method like **deleteById** it is *not guaranteed* that those **cascade** will be used.
- ⚡ You need to call the method **delete()** which take an **entity object** as the argument.

### ➤ **cascade vs orphanRemoval**

- ⚡ **cascade** means if some operation is being executed on **parent entity** (**create, update, delete**) then the same operation will be executed on **child entities**.
- ⚡ **orphanRemoval** means if the **reference is gone**, then delete the object that was being referenced (just like GC in Java)

```
// It is inside Insurance Entity
@OneToOne(mappedBy = "insurance", orphanRemoval = true)
Patient patient;
```

- ⚡ If I set **patient=null** for the **insurance entity object**, and if there is no **entity** that has reference of that **particular patient entity object**, then that entity will be deleted.
- ⚡ In simple terms, when an **entity becomes orphan** (no parents are there), then it'll be deleted.
- ⚡ Its independent of **owning/inverse** concept.
- ⚡ Simple analogy:
  - ⚡ **cascade** : if I am being punished, all my children will also be punished.
  - ⚡ **orphanRemoval** : I don't want my children now; if no one has made them their children then remove them.



## ➤ NOTE

- ⌘ In case of **cascade** or **orphanRemoval**, even the **repository method** will not be able to manage the **transaction** properly.
- ⌘ So, its better to use **@Transactional** in the method when doing **CUD** (create, update, delete) operations.
- ⌘ If the parent function contains **@Transactional**, and the child function (being called in the parent function) is also having **@Transactional**, then also it won't give error. It is good practice to use **@Transactional**

```
@Service
public class PatientService {

    @Transactional
    public void outerMethod() {
        appointmentService.deleteAppointments();
    }
}

@Service
public class AppointmentService {

    @Transactional
    public void deleteAppointments() {
        // joins same transaction
    }
}
```

⌘

⌘ Its safe.



```

@Transactional 1 usage
public Insurance assignInsuranceToPatient(Insurance insurance, Long patientId) {
    // patient to insurance: one-to-one
    // insurance: owning, patient: inverse
    Patient patient = patientRepository.findById(patientId).orElseThrow();
    patient.setInsurance(insurance);

    // optional: if you want to use insurance object in this scope
    insurance.setPatient(patient);

    return insurance;
}

```

- Here this service method is assigning one **insurance** to the **patient**.
- **@Transactional** is required to make these whole queries run in a single **persistence context**.
- If you remember, without **@Transactional**, all the method may not run in same **persistence context**.

```

@Test
public void testAssignInsuranceToPatient() {
    Insurance insurance = Insurance.builder()
        .provider("HDFC Ergo0")
        .policyNumber("HDFC_2369")
        .validUntil(LocalDate.of(year: 2025, month: 3, dayOfMonth: 10))
        .build();
    var updatedInsurance = insuranceService.assignInsuranceToPatient(insurance, patientId: 1L);
    System.out.println(updatedInsurance);
}

```

- It is the test method; but it'll fail because we have not made the **patient** entity as **cascade** yet. So, even if the **patient** is created, it'll not create the **insurance**.

```

@OneToOne(
    cascade = CascadeType.ALL
)
@JoinColumn(name = "insurance_id")
Insurance insurance;

```

NOW IT WILL PASS

```

@OneToOne(
    cascade = { CascadeType.PERSIST, CascadeType.MERGE }
)
@JoinColumn(name = "insurance_id")
Insurance insurance;

```

- (or)

➤ There are 2 sides: **owning** & **inverse**.

- ⌘ As we know **owning** side will contain the foreign key.
- ⌘ So, if you try to delete the **inverse** entity then it'll not happen; because it is being referenced in another table (**owning** table)

⌘ **You cannot delete the inverse side of a relationship while the owning side still points to it.**

➤ Some points to be remembered:

- ⌘ **orphanRemoval** on *inverse* side is of no use;
  - ⌘ Because, **inverse** side doesn't have a solid *foreign key* column;
  - ⌘ If just keep one reference of the **owning** entity to fetch the data and store there;
- ⌘ **cascade** doesn't care about **owning/inverse**. It'll execute all the operation, that is being executed to the **parent** entity, to every **child** entities whose references are there in **current** entity.

➤ **orphanRemoval** example

```
@Transactional no usages new *
public Insurance updateInsuranceToPatient(Insurance insurance, Long patientId) {
    Patient patient = patientRepository.findById(patientId).orElseThrow();
    patient.setInsurance(insurance);

    return insurance;
}
```

- ⌘ Here I am **updating** the insurance.
- ⌘ So, **previous insurance object** became **orphan**, hence it'll be deleted.
- ⌘ **new insurance object** will be created, saved; then it'll be added to patient.

```
@Transactional no usages new *
public Insurance removeInsuranceToPatient(Insurance insurance, Long patientId) {
    Patient patient = patientRepository.findById(patientId).orElseThrow();
    patient.setInsurance(null);

    return insurance;
}
```

- ⌘ Same here as well; in stead of changing the insurance, here insurance is being removed;

➤ F

# Key Points About orphanRemoval

- When It Triggers:
  - For @OneToMany: When an entity is removed from the collection (e.g., List.remove(), clear(), or reassigning a new collection).
  - For @OneToOne: When the reference is set to null or replaced with a new entity.
- Automatic Deletion:
  - Orphaned entities are deleted automatically during the JPA flush or commit operation, without needing explicit calls to entity.remove()
- Difference from CascadeType.REMOVE:
  - CascadeType.REMOVE deletes child entities only when the parent is deleted.
  - orphanRemoval = true deletes child entities when they are no longer referenced by the parent, even if the parent remains in the database.
- Use Case:
  - Ideal for relationships where the child entity has no meaning without the parent (e.g., an Appointment without a Doctor or Patient, or an Insurance without a Patient).



## ➤ N+1 Query Optimization

- ↪ For **one to many** relations, the entity having **one-side** will be having a **List** of the entities of **many-side**.
- ↪ In this case, by default the fetching behaviour is **Lazy**.
- ↪ If you want to get all the things within the same object directly then you can use:
  - ↪ **fetch = FetchType.EAGER** (eager means it'll directly call **join query** and give you one object having all the objects of the referenced type(s))
- ↪ When you make this **FetchType.EAGER**, you can see there will be **N+1** queries; which is not optimized behaviour;

↪



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## Some Error Causes

### ➤ ERROR-1

- ⌘ Consider the following codes:

```
@Test
public void testAssignInsuranceToPatient() {
    Insurance insurance = insuranceRepository.findById(5L).orElseThrow();
    var updatedInsurance = insuranceService.assignInsuranceToPatient(insurance, patientId: 7L);
}
```

```
@Transactional 1 usage
public Insurance assignInsuranceToPatient(Insurance insurance, Long patientId) {
    // patient to insurance: one-to-one
    // insurance: owning, patient: inverse
    Patient patient = patientRepository.findById(patientId).orElseThrow();
    patient.setInsurance(insurance);

    // optional: if you want to use insurance object in this scope
    insurance.setPatient(patient);

    return insurance;
}
```

- ⌘ In this case you'll get an error like: “**detached entity passed to persist**”
- ⌘ In the first method i.e. *testAssignInsuranceToPatient*,
  - ⌘ you are using **findById** to get the insurance.
  - ⌘ So during this method call:
    - \* Spring opens a short lived EntityManager
    - \* Loads **Insurance**
    - \* Returns it
    - \* **Closes the EntityManager**
  - ⌘ Now, as the EntityManager is closed, so now **insurance** is in **detached** state now, not in **managed** (persistent context) state.
  - ⌘ Now you are sending this **detached** object to next method i.e. *assignInsuranceToPatient* which is passing this object to *setInsurance*.
  - ⌘ So, in here, *setInsurance* expects one **managed state** object; but its getting **detached state** object;
  - ⌘ Hence, it is giving that error.
- ⌘ Fix:
  - ⌘ write **@Transactional** in the **@Test** method; Now, both the method will run in same EntityManager till the transaction is completed.

If you are writing **@Transactional** in **@Test** method, then no need to write **@Transactional** in the *assignInsuranceToPatient* method. Only the **outer** method needs to have **@Transactional**.

4

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