#30 and #31 JPA Native Query, Criteria API and Specification API

Saturday, 8 February 2025 12:21 PM

Native Query:

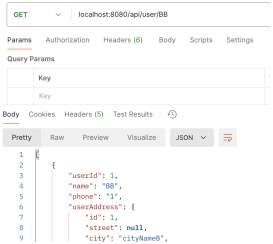
- Plain SQL queries.
- Directly interact with Database, thus if in future DB changes, code changes also required.
- No caching, lazy loading or entity life cycle management happens.

When to use over JPQL:

- More complex queries, including database specific features like JSONB, LATERAL JOIN
- Need to fetch non-entity results or joins table without any entity relationship.
- Query efficiency like Bulk operations.

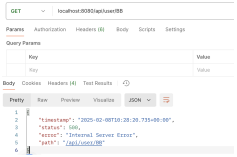
```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> {

    @Query(value = "SELECT * FROM user_details WHERE user_name = :userFirstName", nativeQuery = true)
    List<UserDetails> getUserDetailsByNameNativeQuery(@Param("userFirstName") String userName);

}
```

When all the fields (*) of the table are returned by Native Query, JPA internally does the mapping between DB column name and Entity fields.



But, when Native Query returned partial fields, then JPA don't map it to Entity by default.

```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> {

    @Query(value = "SELECT user_name, phone FROM user_details WHERE user_name = :userFirstName", nativeQuery = true)
    List<UserDetails> getUserDetailsByNameNativeQuery(@Param("userFirstName") String userName);

}
```




```
org.h2.jdbc.JdbcSQLSyntaxErrorException Create breakpoint : Column "user_id" not found [42122-224]
    at org.h2.message.DbException.getJdbcSQLException(DbException.java:514) ~[h2-2.2.224.jar:2.2.224]
    at org.h2.message.DbException.getJdbcSQLException(DbException.java:489) ~[h2-2.2.224.jar:2.2.224]
    at org.h2.message.DbException.get(DbException.java:223) ~[h2-2.2.224.jar:2.2.224]
    at org.h2.message.DbException.get(DbException.java:199) ~[h2-2.2.224.jar:2.2.224]
    at org.h2.jdbc.JdbcResultSet.getColumnIndex(JdbcResultSet.java:3518) ~[h2-2.2.224.jar:2.2.224]
    at org.h2.jdbc.JdbcResultSet.findColumn(JdbcResultSet.java:178) ~[h2-2.2.224.jar:2.2.224]
```

We need to manually tell JPA, how to do the mapping.

1st: Using **@SqlResultSetMapping and @NamedNativeQuery** Annotation

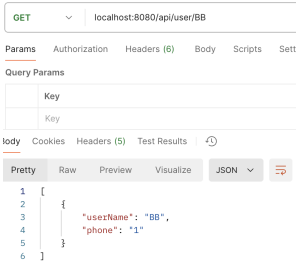
```
@Table(name = "user_details")
@Entity
@NamedNativeQuery(
        name = "UserDetails.getUserDetailsByName",
        query = "SELECT user_name, phone FROM user_details WHERE user_name = :userFirstName",
        resultSetMapping = "UserDTOMapping"
)
@SqlResultSetMapping(
        name = "UserDTOMapping",
        classes = @ConstructorResult(
```

```
public class UserDTO {

    String userName;
    String phone;

    public UserDTO(String userName, String phone) {
        this.userName = userName;
```

```
            targetClass = UserDTO.class,
            columns = {
                    @ColumnResult(name = "user_name", type = String.class),
                    @ColumnResult(name = "phone", type = String.class)}
        )
)
public class UserDetails {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long userId;

    @Column(name = "user_name")
    private String name;
    private String phone;

    @OneToOne(cascade = CascadeType.ALL)
    private UserAddress userAddress;

   //getters and setters
}
```

```
        this.phone = phone;
    }

    //getters and setters
}
```

```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> {

    @Query(name = "UserDetails.getUserDetailsByName", nativeQuery = true)
    List<UserDTO> getUserDetailsByNameNativeQuery(@Param("userFirstName") String userName);

}
```



2nd: With Manual mapping

```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> {
```

```
    List<Object[]> getUserDetailsByNameNativeQuery(@Param("userFirstName") String userName);

}
```

```
public List<UserDTO> getUserDetailsByNameNativeQuery(String name) {
    List<Object[]> results = userDetailsRepository.getUserDetailsByNameNativeQuery(name);
    return results.stream() Stream<Object[]>
            .map(obj -> new UserDTO((String) obj[0], (String) obj[1])) Stream<UserDTO>
            .collect(Collectors.toList());
}
```

Dynamic Native Query:

```
@Service
public class UserDetailsService {

    @PersistenceContext
    private EntityManager entityManager;

    public List<UserDTO> getUserDetailsByNameNativeQuery(String userName) {
        StringBuilder queryBuilder = new StringBuilder("SELECT ud.user_name AS user_name, ud.phone AS phone, ua.city AS city ");
        queryBuilder.append("FROM user_details ud ");
        queryBuilder.append("JOIN user_address ua ON ud.user_address_id = ua.id ");
        queryBuilder.append("WHERE 1=1 ");

        List<Object> parameters = new ArrayList<>();

        // Dynamically add conditions
        if (userName != null && !userName.isEmpty()) {
            queryBuilder.append("AND ud.user_name = ? ");
            parameters.add(userName);
        }

        // Create the native query
        Query nativeQuery = entityManager.createNativeQuery(queryBuilder.toString());

        // Set the parameters for the query
        for (int i = 0; i < parameters.size(); i++) {
            nativeQuery.setParameter( position: i + 1, parameters.get(i));
        }

        // Execute and get results
        List<Object[]> result = nativeQuery.getResultList();

        // Map the result to UserDTO
        return UserDTO.mapResultToDTO(result);

    }
}
```

SELECT ud.user_name AS user_name, ud.phone AS phone, ua.city AS city FROM user_details ud JOIN user_address ua ON ud.user_address_id = ua.id WHERE 1=1 AND ud.user_name = ?

Pagination and Sorting in Native

SQL:

1st way:

```
public List<UserDTO> getUserDetailsByNameNativeQuery(String userName) {
    StringBuilder queryBuilder = new StringBuilder("SELECT ud.user_name AS user_name, ud.phone AS phone, ua.city AS city ");
    queryBuilder.append("FROM user_details ud ");
    queryBuilder.append("JOIN user_address ua ON ud.user_address_id = ua.id ");
    queryBuilder.append("WHERE 1=1 ");

    List<Object> parameters = new ArrayList<>();

    // Dynamically add conditions
    if (userName != null && !userName.isEmpty()) {
        queryBuilder.append("AND ud.user_name = ? ");
        parameters.add(userName);
    }

    //sorting
    queryBuilder.append("ORDER BY ").append("ud.user_name").append(" DESC");

    //pagination
    int size = 5;
    int page = 0;
    queryBuilder.append(" LIMIT ? OFFSET ? ");
    parameters.add(size);
    parameters.add(page * size);

    // Create the native query
    Query nativeQuery = entityManager.createNativeQuery(queryBuilder.toString());

    // Set the parameters for the query
    for (int i = 0; i < parameters.size(); i++) {
        nativeQuery.setParameter( position: i + 1, parameters.get(i));
    }

    // Execute and get results
    List<Object[]> result = nativeQuery.getResultList();

    // Map the result to UserDTO
    return UserDTO.mapResultToDTO(result);
}
```

2nd way:

```
public List<UserDetails> getUserDetailsByNameNativeQuery(String name) {

    Pageable pageableObj = PageRequest.of( pageNumber: 0, pageSize: 5, Sort.by( ...properties: "phone").descending());
    return userDetailsRepository.getUserDetailsByNameNativeQuery(name, pageableObj);

}
```

```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> {

    @Query(value = "SELECT * FROM user_details ud WHERE ud.user_name = :userName",
            nativeQuery = true)
    List<UserDetails> getUserDetailsByNameNativeQuery(@Param("userName") String userName, Pageable pageable);

}
```

```
Hibernate:
    SELECT
        *
```

SELECT * FROM USER_DETAILS;

USER_ID	PHONE	USER_NAME
1	1	RR

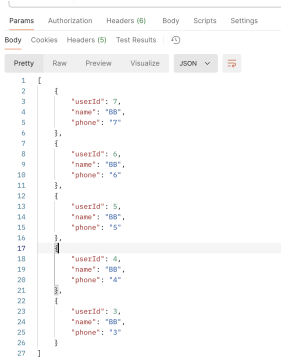
localhost:8080/api/user/RR

GET localhost:8080/api/user/RR

```
    FROM
        user_details ud
    WHERE
        ud.user_name = ?
    order by
        ud.phone desc
    fetch
        first ? rows only
```

2	2	BB
3	3	BB
4	4	BB
5	5	BB
6	6	BB
7	7	BB

(7 rows, 3 ms)

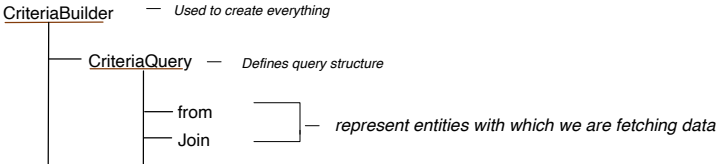


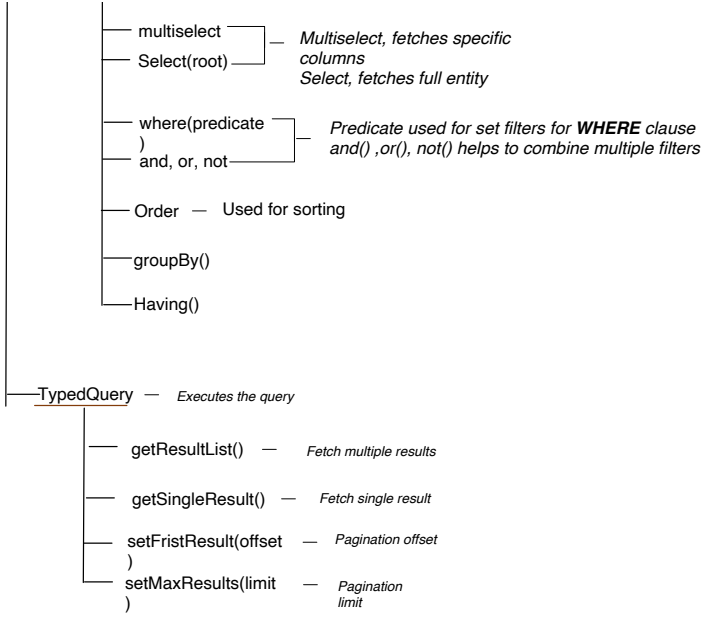
Criteria API:

Native SQL queries support dynamic query building, but they are database-dependent and don't leverage JPA abstraction.

That's why **JPA Criteria API** exists, it allows you to build dynamic, type-safe queries without writing raw SQL.

Lets understand the Hierarchy





Controller class:

```java
@GetMapping("/user/{phone}")
public List<UserDetails> getUserDetailsByPhoneCriteriaAPI(@PathVariable Long phone) {
    return userDetailsService.getUserDetailsByPhoneCriteriaAPI(phone);
}
```

Service class:

```java
@Service
public class UserDetailsService {
```

```
    @Autowired
    UserDetailsRepository userDetailsRepository;

    @PersistenceContext
    private EntityManager entityManager;

    public UserDetails saveUser(UserDetails user) {
        return userDetailsRepository.save(user);
    }

    public List<UserDetails> getUserDetailsByPhoneCriteriaAPI(Long phoneNo) {

        CriteriaBuilder cb = entityManager.getCriteriaBuilder();

        CriteriaQuery<UserDetails> crQuery = cb.createQuery(UserDetails.class); //what my each row would look like, so in this case each row would be UserDetails

        Root<UserDetails> user = crQuery.from(UserDetails.class); // from clause

        crQuery.select(user); //select *

        Predicate predicate = cb.equal(user.get("phone"), phoneNo); // where clause
        crQuery.where(predicate);

        TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
        List<UserDetails> output = query.getResultList();

        return output;
    }
}
```

Entity class:

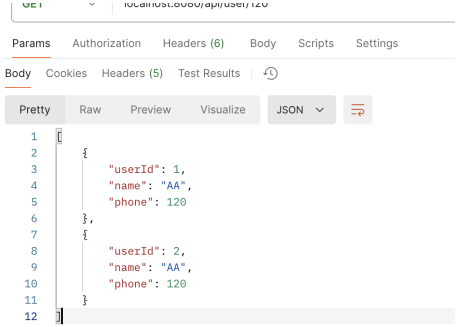
```
@Table(name = "user_details")
@Entity
public class UserDetails {
    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private Long userId;

    @Column(name = "user_name")
    private String name;
    private Long phone;

   //getters and setters
}
```

GET localhost:8080/api/user/120

SELECT * FROM USER_DETAILS;

PHONE	USER_ID	USER_NAME
120	1	AA
120	2	AA
110	3	AA

(3 rows, 3 ms)




```
Hibernate:
    select
        ud1_0.user_id,
        ud1_0.user_name,
        ud1_0.phone
    from
        user_details ud1_0
    where
        ud1_0.phone=?
```

Comparison operator:

Root<UserDetails>user=crQuery.from(UserDetails.class); //from clause

Method	Description	Equivalent SQL query
cb.equal(user.get("phone"),123);	Check for equality	Where phone = 123
cb.notEqual(user.get("phone"),123);	Check for in-equality	Where phone <> 123
cb.gt(user.get("phone"),123);	Greater than	Where phone > 123
cb.ge(user.get("phone"),123);	Greater than or equal	Where phone >= 123
cb.lt(user.get("phone"),123);	Less than	Where phone < 123
cb.le(user.get("phone"),123);	Less than or equal	Where phone <= 123

Logical operator:

Method	Description	Equivalent SQL query
cb.and(predicate1, predicate2);	Combining two conditions using and	Where conditiion1 AND condition2
cb.or(predicate1, predicate2);	Combining two conditions using or	Where conditiion1 OR condition2
cb.not(predicate1,);	Negate the condition	WHERE NOT conditiion1

```
Predicate predicate1 = cb.equal(user.get("phone"), phoneNo); // where clause
Predicate predicate2 = cb.notEqual(user.get("name"), y: "AA"); // where clause
Predicate finalPredicate = cb.and(predicate1, predicate2);

crQuery.where(finalPredicate);
```

Strings Operations:

Method	Description	Equivalent SQL query
cb.like(user.get("name"), "S%");	Name starts with J	Where name LIKE 'S%'
cb.notLike(user.get("name"), "S%");	Name do not start with J	Where name NOT LIKE 'S%'

Collection Operations:

Method	Description	Equivalent SQL query
cb.in(user.get("phone")).value(11).value(7);	Check if phone no is in the list	Where phone IN (11, 7)
cb.not(user.get("phone").in(11,7));	Check if phone no is not in the list	Where phone NOT IN (11, 7)

Select Multiple fields:

```
public List<UserDTO> getUserDetailsByPhoneCriteriaAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<Object[]> crQuery = cb.createQuery(Object[].class); //what my each row would look like

    Root<UserDetails> user = crQuery.from(UserDetails.class); // from clause

    crQuery.multiselect(user.get("name"), user.get("phone")); //select multiple fields

    Predicate predicate1 = cb.equal(user.get("phone"), phoneNo); // where clause
```

```
    crQuery.where(predicate1);

    TypedQuery<Object[]> query = entityManager.createQuery(crQuery);
    List<Object[]> results = query.getResultList();

    // Processing results
    List<UserDTO> output = new ArrayList<>();
    for (Object[] row : results) {

        String name = (String) row[0];
        Long phone = (Long) row[1];
        UserDTO result = new UserDTO(name, phone);
        output.add(result);
    }
    return output;
}
```

Join

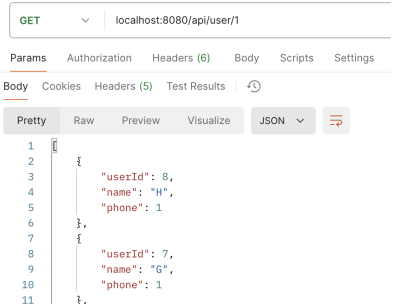
```
public List<UserDTO> getUserDetailsByPhoneCriteriaAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<Object[]> crQuery = cb.createQuery(Object[].class); //what my each row would look like

    Root<UserDetails> user = crQuery.from(UserDetails.class); // from clause

    Join<UserDetails, UserAddress> address =  user.join( attributeName: "userAddress", JoinType.INNER);

    crQuery.multiselect(user.get("name"), address.get("city")); //select all the files of both the table

    Predicate predicate1 = cb.equal(user.get("phone"), phoneNo); // where clause
    crQuery.where(predicate1);

    TypedQuery<Object[]> query = entityManager.createQuery(crQuery);
    List<Object[]> results = query.getResultList();

    // Processing results
    List<UserDTO> output = new ArrayList<>();
    for (Object[] row : results) {

        String name = (String) row[0];
        String city = (String) row[1];
        UserDTO result = new UserDTO(name, city);
        output.add(result);
    }
    return output;
}
```

Pagination and Sorting

```java
public List<UserDetails> getUserDetailsByPhoneCriteriaAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<UserDetails> crQuery = cb.createQuery(UserDetails.class); //what my each row would look like

    Root<UserDetails> user = crQuery.from(UserDetails.class); // from clause

    crQuery.select(user); //all columns of UserDetails table

    Predicate predicate1 = cb.equal(user.get("phone"), phoneNo); // where clause
    crQuery.where(predicate1);

    // Sorting
    crQuery.orderBy(cb.desc(user.get("name"))); // ORDER BY name DESC


    TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
    query.setFirstResult(0); //kind of page number or offset
    query.setMaxResults(5); // page size

    List<UserDetails> results = query.getResultList();
    return results;
}
```

SELECT * FROM USER_DETAILS;

PHONE	USER_ID	USER_NAME
1	1	A
1	2	B
1	3	C
1	4	D
1	5	E
1	6	F
1	7	G
1	8	H



```
    {
        "userId": 6,
        "name": "F",
        "phone": 1
    },
    {
        "userId": 5,
        "name": "E",
        "phone": 1
    },
    {
        "userId": 4,
        "name": "D",
        "phone": 1
    }
]
```


Specification API

1st problem it solves is: ***CODE DUPLICITY***

- In Criteria API its possible that, same filter (predicate) used at multiple methods and class, so there is always a challenge of Code Duplicity.

```
        crQuery.where(predicate);

        TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
        List<UserDetails> output = query.getResultList();

        return output;
    }
}
```

Through Specification API, we can solve this:

Specification Interface support following methods

Method	Description	Equivalent SQL query
toPredicate()	Abstract method, for which we need to provide implementation	Where clause
and()	specf1.and(spec2)	Where cond1 AND cond2
or()	specf1.or(spec2)	Where cond1 OR cond2
not()	Specification.not(spec1)	Where NOT condition1

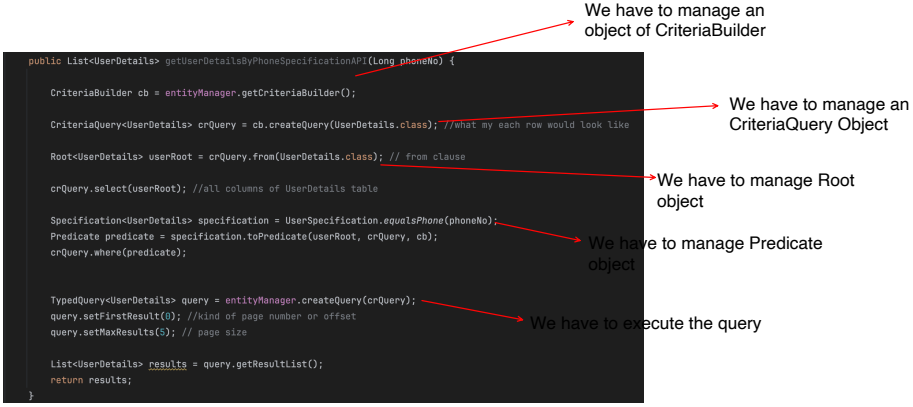
```
public class UserSpecification {

    public static Specification<UserDetails> equalsPhone(Long phoneNo) {

        return (root, query, cb) -> {
            return cb.equal(root.get("phone"), phoneNo);
        };
    }
}
```

Service Class

```
public List<UserDetails> getUserDetailsByPhoneSpecificationAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<UserDetails> crQuery = cb.createQuery(UserDetails.class); //what my each row would look like

    Root<UserDetails> userRoot = crQuery.from(UserDetails.class); // from clause

    crQuery.select(userRoot); //all columns of UserDetails table

    Specification<UserDetails> specification = UserSpecification.equalsPhone(phoneNo);
    Predicate predicate = specification.toPredicate(userRoot, crQuery, cb);
    crQuery.where(predicate);


    TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
    query.setFirstResult(0); //kind of page number or offset
    query.setMaxResults(5); // page size

    List<UserDetails> results = query.getResultList();
    return results;
}
```

2nd problem it solves is: ***CODE BOILERPLATE***

Even though we have taken out the predicate logic / filtering logic out, still there are so many boiler code present here




```
public List<UserDetails> getUserDetailsByPhoneSpecificationAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<UserDetails> crQuery = cb.createQuery(UserDetails.class); //what my each row would look like

    Root<UserDetails> userRoot = crQuery.from(UserDetails.class); // from clause

    crQuery.select(userRoot); //all columns of UserDetails table

    Specification<UserDetails> specification = UserSpecification.equalsPhone(phoneNo);
    Predicate predicate = specification.toPredicate(userRoot, crQuery, cb);
    crQuery.where(predicate);


    TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
    query.setFirstResult(0); //kind of page number or offset
    query.setMaxResults(5); // page size

    List<UserDetails> results = query.getResultList();
    return results;
}
```

All, we need to tell JPA that:

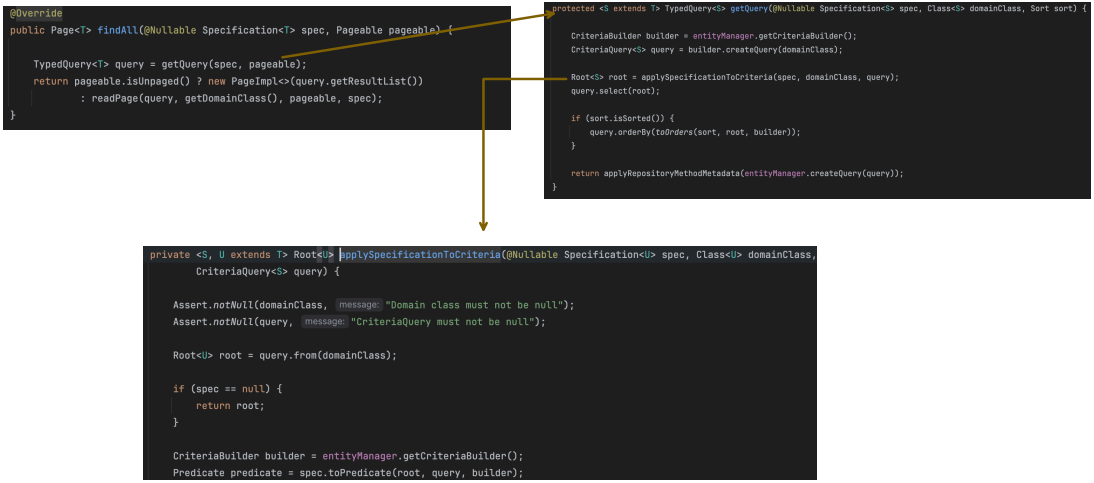
- From Which table we have to fetch the data, including joins
- What all columns
- Filtering in where clause

that's it, JPA should take care of everything like object creation, query building and execution.

JpaSpecificationExecutor

- Optional<T> findOne (Specification<T> spec);
- List<T> findAll (Specification<T> spec);
- Page<T> findAll (Specification<T> spec, Pageable pageable);
- Boolean exists (Specification<T> spec);

JpaSpecificationExecutor Framework code



```
@Override
public Page<T> findAll(@Nullable Specification<T> spec, Pageable pageable) {

    TypedQuery<T> query = getQuery(spec, pageable);
    return pageable.isUnpaged() ? new PageImpl<>(query.getResultList())
            : readPage(query, getDomainClass(), pageable, spec);
}
```

```
protected <S extends T> TypedQuery<S> getQuery(@Nullable Specification<S> spec, Class<S> domainClass, Sort sort) {

    CriteriaBuilder builder = entityManager.getCriteriaBuilder();
    CriteriaQuery<S> query = builder.createQuery(domainClass);

    Root<S> root = applySpecificationToCriteria(spec, domainClass, query);
    query.select(root);

    if (sort.isSorted()) {
        query.orderBy(toOrders(sort, root, builder));
    }

    return applyRepositoryMethodMetadata(entityManager.createQuery(query));
}
```

```
private <S, U extends T> Root<U> applySpecificationToCriteria(@Nullable Specification<U> spec, Class<U> domainClass,
        CriteriaQuery<S> query) {

    Assert.notNull(domainClass,  message: "Domain class must not be null");
    Assert.notNull(query,  message: "CriteriaQuery must not be null");

    Root<U> root = query.from(domainClass);

    if (spec == null) {
        return root;
    }

    CriteriaBuilder builder = entityManager.getCriteriaBuilder();
    Predicate predicate = spec.toPredicate(root, query, builder);
```

```
    if (predicate != null) {
        query.where(predicate);
    }

    return root;
}
```

```
public class UserSpecification {

    public static Specification<UserDetails> equalsPhone(Long phoneNo) {

        return (root, query, cb) -> {
            return cb.equal(root.get("phone"), phoneNo);
        };
    }

    public static Specification<UserDetails> likeName(String name) {

        return (root, query, cb) -> {
            return cb.like(root.get("name"), pattern: "%" + name + "%");
        };
    }

    public static Specification<UserDetails> joinAddress() {
        return (root, query, cb) -> {
            Join<UserDetails, UserAddress> address = root.join( attributeName: "userAddress", JoinType.INNER);
            return null;
        };
    }
}
```

```
@Repository
public interface UserDetailsRepository extends
        JpaRepository<UserDetails, Long> , JpaSpecificationExecutor<UserDetails> {

}
```

```
public List<UserDetails> getUserDetailsByPhoneSpecificationAPI() {

    Specification<UserDetails> result = Specification.where(UserSpecification.joinAddress())
            .and(UserSpecification.equalsPhone( phoneNo: 123l))
            .and(UserSpecification.likeName("AA"));

    return userDetailsRepository.findAll(result);
}
```

Compares to Criteria API,
Specification API is more clean and
has reusable code

```
public List<UserDetails> getUserDetailsByPhoneCriteriaAPI(Long phoneNo) {

    CriteriaBuilder cb = entityManager.getCriteriaBuilder();

    CriteriaQuery<UserDetails> crQuery = cb.createQuery(UserDetails.class); //what my each row would look like

    Root<UserDetails> user = crQuery.from(UserDetails.class); // from clause
    Join<UserDetails, UserAddress> address = user.join( attributeName: "userAddress", JoinType.INNER);
```

```
    crQuery.select(user); //all columns of UserDetails table

    Predicate predicate1 = cb.equal(user.get("phone"),  y: 123); // where clause
    Predicate predicate2 = cb.equal(user.get("name"),  y: "% AA %"); // where clause
    crQuery.where(cb.and(predicate1, predicate2));

    TypedQuery<UserDetails> query = entityManager.createQuery(crQuery);
    return query.getResultList();
}
```