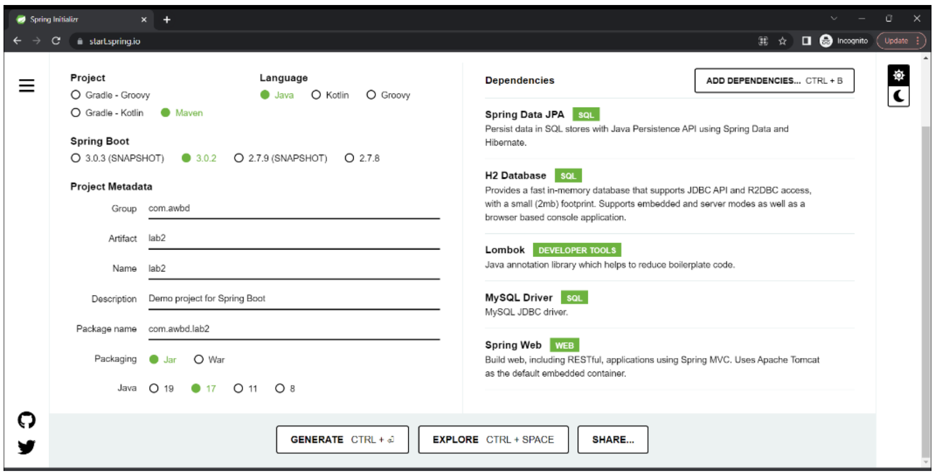
# Practice 2: JPA Java Persistence API, Hibernate, Part I

1. Use **Spring Initializr** to generate a Maven project with dependencies: Spring Data JPA, H2 Database, Lombok, MySQL Driver, Spring Web or open **LAB2_START** and skip to step **4.** Fill in project properties: Group id, Artifact Name etc.
[https://start.spring.io/](https://start.spring.io/)



Project: ○ Gradle - Groovy ○ Gradle - Kotlin [✓ Maven]
Language: [✓ Java] ○ Kotlin ○ Groovy
Spring Boot: ○ 3.0.3 (SNAPSHOT) [✓ 3.0.2] ○ 2.7.9 (SNAPSHOT) ○ 2.7.8

Project Metadata

| | |
|---|---|
| Group | com.awbd |
| Artifact | lab2 |
| Name | lab2 |
| Description | Demo project for Spring Boot |
| Package name | com.awbd.lab2 |
| Packaging | [✓ Jar] ○ War |
| Java | ○ 19 [✓ 17] ○ 11 ○ 8 |

Dependencies

**Spring Data JPA** SQL
Persist data in SQL stores with Java Persistence API using Spring Data and Hibernate.

**H2 Database** SQL
Provides a fast in-memory database that supports JDBC API and R2DBC access, with a small (2mb) footprint. Supports embedded and server modes as well as a browser based console application.

**Lombok** DEVELOPER TOOLS
Java annotation library which helps to reduce boilerplate code.

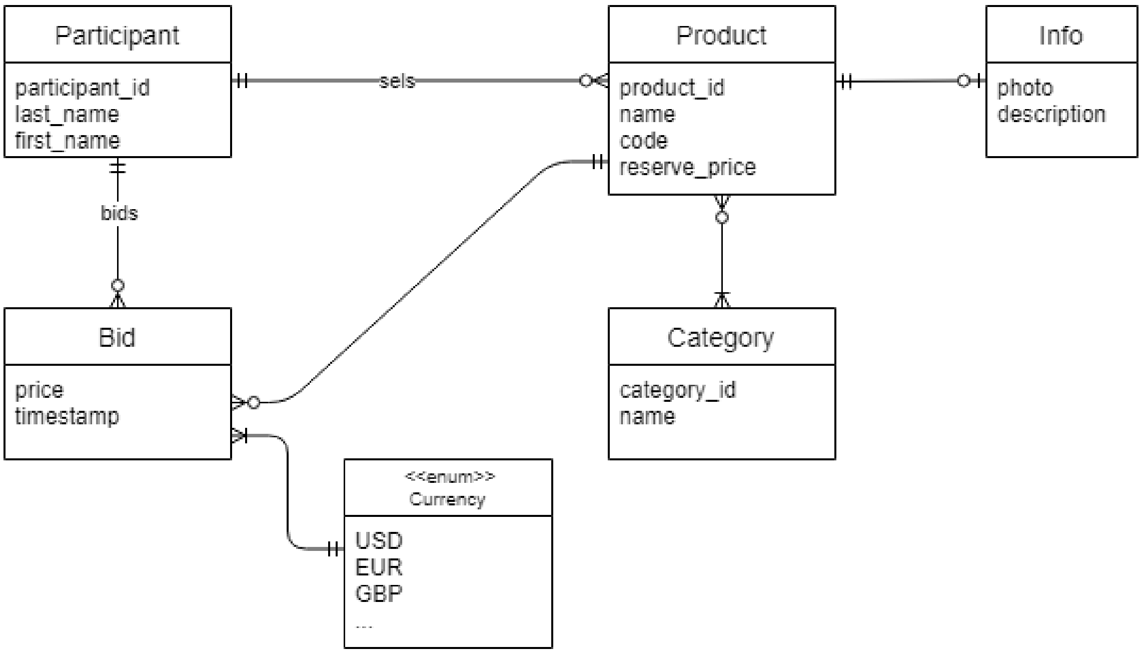
**MySQL Driver** SQL
MySQL JDBC driver.

**Spring Web** WEB
Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.

2. Open the project in IntelliJ IDE: File – New Project from Existing Sources. Check java.version in pom.xml file.

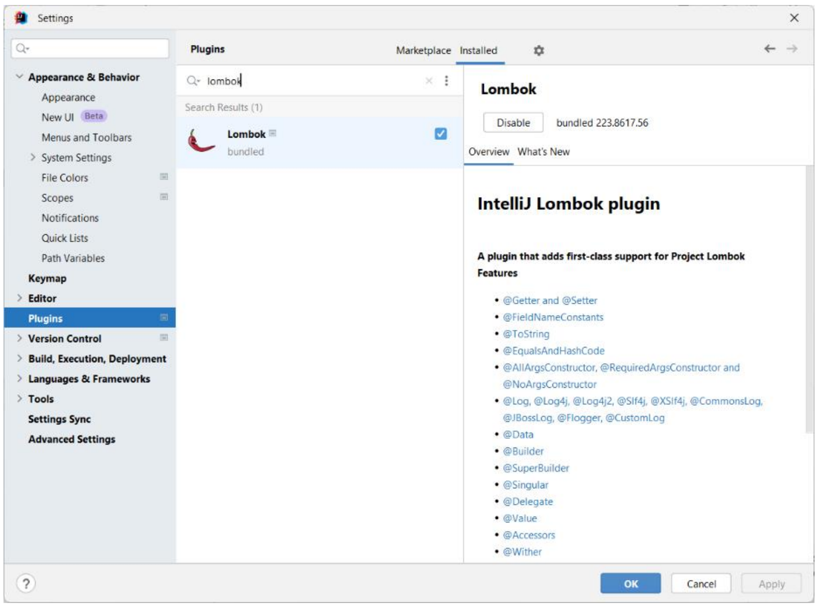
3. Add in src/main/java/com/awbd/lab2 a new package, **domain.**

Add enumeration awbd.com.lab2.domain.**Currency** and classes:
awbd.com.lab3.domain.**Participant**,  awbd.com.lab3.domain.**Product,** awbd.com.lab3.domain.**Info**
awbd.com.lab3.domain.**Category,** awbd.com.lab3.domain.**Info**



In the next steps we will use project Lombok to add **POJO** (plain old java object) basic methods (getters, setters, *toString, equals, hashCode* and constructors), then we will add **JPA** annotation and transform POJOs into entities, i.e. objects that maps tables from the database.

4. Check that IntelliJ Lombok plugin is installed, from File-Settings, Plugins.



Lombok
bundled

Lombok

bundled 223.8617.56

IntelliJ Lombok plugin

A plugin that adds first-class support for Project Lombok
Features

- @Getter and @Setter
- @FieldNameConstants
- @ToString
- @EqualsAndHashCode
- @AllArgsConstructor, @RequiredArgsConstructor and @NoArgsConstructor
- @Log, @Log4j, @Log4j2, @Slf4j, @XSlf4j, @CommonsLog, @JBossLog, @Flogger, @CustomLog
- @Data
- @Builder
- @SuperBuilder
- @Singular
- @Delegate
- @Value
- @Accessors
- @Wither

5. Annotate all classes with *Lombok.Data*

```
package com.awbd.lab3.domain;

import lombok.Data;

@Data
public class Category {

    private Long Id;
    private String name;

}
```

6. Try Refactor – Delombok to see the equivalent Java Code:

```
package com.awbd.lab3.domain;

public class Category {

    private Long Id;
    private String name;

    public Category() {}

    public Long getId() {...}
    public String getName() {...}
    public void setId(Long Id) {...}
    public void setName(String name) {...}
    public boolean equals(final Object o) {...}
    protected boolean canEqual(final Object other) {...}
    public int hashCode() {...}
    public String toString() {...}
}
```

Info

**Lombok "Spicing up your Java"**

Lombok is a tool that uses annotations for code generation. [1]

It may be plugged in into editors (IntelliJ, Ecplipse, NEtbeans etc.) and automatically inject code that is immediately available.

One of its major benefits is that it's reduces boilerplate code (code that is repeated many times in the application).

**Lombok annotations**

**@Getter** and **@Setter** generates getters and setters for a field.
If the class already contains a getter method for the field annotated with @Getter, the annotation is ignored.

**@ToString**(callSuper=true,exclude="someExcludedFields")
generates toString method, some fields may be excluded from the output, also the output return by the method toString of a superclass may be included.

**@EqualsAndHashCode**(callSuper=true,exclude={"someExcludedFileds})
Generates equals and hashCode methods. By default all non-static, non-transient fields are considered.

**@Data** is the same as using @EqualsAndHashCode, @Getter, @Setter, @ToString. It also adds a constructor taking as arguments all @NonNull and final fields.

**@NoArgsConstructor** generates a constructor with no arguments.

**@RequiredArgsConstructor** adds a constructor for each @NonNull or not initialized final field.

**@Builder** implements builder pattern. If class Participant is annotated @Builder we may use
Participant.builder().lastName("Adam").firstName("John").build();

**@Log**
Creates private static final java.util.logging.Logger log =
java.util.logging.Logger.getLogger(LogExample.class.getName());

**@Slf4j**
Creates private static final org.slf4j.Logger log = org.slf4j.LoggerFactory.getLogger(LogExample.class);

Maven dependency:

```
<dependency>
   <groupId>org.projectlombok</groupId>
   <artifactId>lombok</artifactId>
   <optional>true</optional>
</dependency>
```

7. Enable H2 database console and configure the data source in the **application.properties** file:

```
spring.h2.console.enabled=true
spring.datasource.url=jdbc:h2:mem:testdb
spring.datasource.driverClassName=org.h2.Driver
spring.datasource.username=sa
spring.datasource.password=
spring.jpa.database-platform=org.hibernate.dialect.H2Dialect
```

Info **H2** in-memory RDBMS (relational database management system) [3], can be embedded in Java Applications. It supports standard SQL and JDBC API.

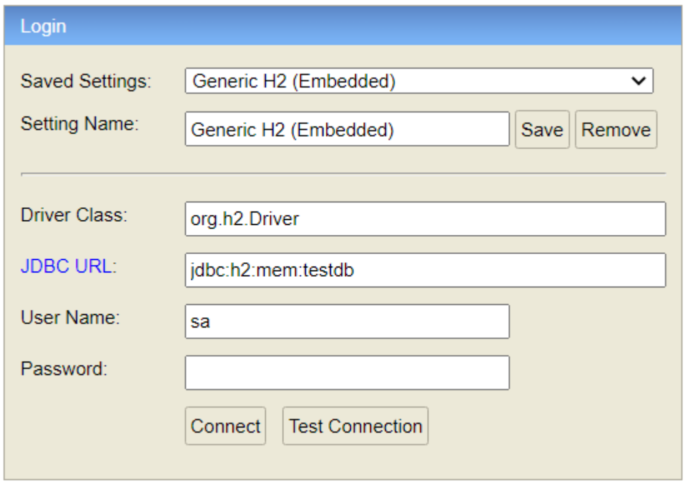
In-memory databases rely on main memory for data storage, in contrast to databases that store data on disk or SSDs, hence in-memory databases are faster than traditional RDBMS obtaining minimal response time by eliminating the need to access disks.

Maven dependency:

```
<dependency>
   <groupId>com.h2database</groupId>
   <artifactId>h2</artifactId>
   <scope>runtime</scope>
</dependency>
```

If H2 console is enabled, by setting the property spring.h2.console.enabled = true, we may access the url:
http://localhost:8080/h2-console

If property spring.datasource.url=jdbc:h2:mem:testdb is set, a database named testdb will be embeded in the application, notice also the properties to set up dirver and credentials.


Login

Saved Settings: Generic H2 (Embedded)
Setting Name: Generic H2 (Embedded)
Driver Class: org.h2.Driver
JDBC URL: jdbc:h2:mem:testdb
User Name: sa
Password:

8. Run the application and test the H2 console.
http://localhost:8080/h2-console

If no classes are annotated with entity, there will be no tables the database, we only have *information INFORMATION_SCHEMA* tabels and *USERS* .

9. Annotate all classes with *@Entity*. Also annotate key attributes with *@Id* and *@GeneratedValue*. Re-run the application and check that tables CATEGORY, PRODUCT, PARTICIPANT and INFO are created in the H2 database.

```
import jakarta.persistence.Entity;
import jakarta.persistence.GeneratedValue;
import jakarta.persistence.GenerationType;
import jakarta.persistence.Id;
import lombok.Data;


@Data
@Entity
public class Category {

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

}
```

Info

**@Entity**
**JPA Entities** are POJOs representing data that can be persisted to the database. Each entity represents a table stored in a database. Every instance of a class annotated with @Entity represents a row in the table.

**@Id**
All entities must have a primary key. The filed annotated with @Id represents the primary key.
For each primary key it is mandatory to define a generation strategy. There are four possible generation strategies and also one may define a custom strategy [4]:

| | |
|---|---|
| **GenerationType.AUTO** | Spring chooses strategy. |
| **GenerationType.IDENTITY** | auto-incremented value. |
| **GenerationType.SEQUENCE** | uses a sequence if sequences are supported by the database (for example for Oracle database). |
| **GenerationType.TABLE** | uses a table to store generated values. |

For the last two generation strategies one must also specify a generator (sequence or table):

@GeneratedValue(strategy = GenerationType.TABLE, **generator** = "table-generator")
@TableGenerator(**name** = "table-generator", …
)

For more info about **@Column**, **@Table**, **@Transient** annotations see [5].

10. Rename the file application.properties, **application-h2.properties.** Create in src\main\resources two more properties files
**application-mysql.properties**.

```
spring.datasource.url=jdbc:mysql://localhost:3306/awbd
spring.datasource.username=awbd
spring.datasource.password=awbd
spring.sql.init.platform=mysql
spring.jpa.hibernate.ddl-auto=create
```

**application.properties**

```
spring.profiles.active=mysql
spring.jpa.show-sql=true
```

11. Re-run the application. All sql commands are showed in the application log because *spring.jpa.show-sql* is set *true*. The active profile is mysql. The file application-**mysql**.properties will be used to set the datasource properties. We will connect to a mysql database, awbd, running on localhost, with user awbd.
Notice that any changes you make to the tables will be lost if we restart the application. The database is recreated any time the application restart. To change this behavior set the following property in **application-mysql.properties**:

```
...
spring.jpa.hibernate.ddl-auto=validate
```

Info **Database initialization**

**spring.jpa.hibernate.ddl-auto** [6]

**none**

**create**
tables are dropped and recreated, a table is created for each class annotated @Entity

**create-drop**
schema is dropped and recreated, a table is created for each class annotated @Entity, used for tests. This is the default value for embedded databases.

**validate**
application starts if all tables corresponding to entities exists, along with the column correspond to entities fields

**update**
Hibernates updates schema if tables differ from entities specifications.

Scripts **import.sql** (Hibernate option) or [ **schema.sql** and **data.sql** (Spring Boot option)] may be used to create (LDD) and initialize (LMD) the database.

12. Add a category in table *awbd.category*, in mysql database. Modify `spring.jpa.hibernate.ddl-auto=validate`
restart the application and check awbd.category rows. Check also with
`spring.jpa.hibernate.ddl-auto=create`

```
insert into awbd.category values(1, 'paintings');

SELECT * FROM awbd.category;
```

13. Add in src\main\resources a file **import.sql**. This DML script is executed when the active profile is H2, and may be used to add test data in the schema when **spring.jpa.hibernate.dll-auto = create|create-drop** is used. [6]

```
insert into category(name) values('paintings');
insert into category(name) values('sculptures');
insert into category(name) values('books');
```

14. Re-run the application with VM option -Dspring.profiles.active=H2. In IntelliJ create two run configurations (one for MySql profile and one for H2 profile).
Check in H2 console that table category contains three rows.

**-Dspring.profiles.active=H2**

15. Add in src\main\resources a file **data-mysql.sql**. This DML script is executed when the active profile is mysql, if spring.datasource.initialization-mode is set always.

**application-mysql.properties**:

```
spring.jpa.hibernate.ddl-auto=validate

spring.sql.init.mode = always
```

**data-mysql.sql**:

```
delete from category;
insert into category(name) values('paintings');
insert into category(name) values('sculptures');
insert into category(name) values('books');
```

In the next steps we will create the relations between entities.

Info **Relationships between entities** [7]:

**@OneToOne** In a RDBMS, a one-to-one relationship links two tables based on a **FK** column. The child table Foreign Key references the Primary Key from the parent table row.
Each row in the child table is linked to exactly one row in the parent table, in other words, each instance of the child @Entity is linked to exactly one instance of the parent @Entity.

OneToOne relationships can be either **unidirectional or bidirectional**.
For instance, unidirectional relationship *product* – *info* means that the entity *product* will provide access to entity *info*, and we will be able to get info about the product (photo, description etc.) if we know the product, but info entity we will not provide access to the associated product.

In the associated tables in the RDBMS we will add info_id column in table *product* but we will not add product_id column in table *info*.

**@OneToMany** one entity is associated with one or more entities stored in a collection of type List, Set, Map, SortedSet, SortedMap etc. The foreign key is added in the table corresponding to “many”.

**@ManyToOne** is the opposite relationship of @OneToMany.

**@JoinColum** defines the foreign key. In @Entity *Bid* we have:

```
@ManyToOne
@JoinColumn(name="participant_id")
private Participant participant;
```

The attribute **mappedBy** defines the corresponding field in the opposite relationship. (@ManyToOne relationship) in @Entity *Participant* we have:

```
@OneToMany(mappedBy = "participant")
private List<Bid> bids;
```

Info **@ManyToMany** in RDBMS is defined by an association table. For instance, the relationship product-category is defined by the table product_category with columns: product_id, category_id.

**@JoinTable** defines the association table. In @Entity *Category* we have:

```
@JoinTable(name = "product_category",
joinColumns = @JoinColumn(name = "category_id", referencedColumnName = "id"),
inverseJoinColumns = @JoinColumn(name = "product_id",
referencedColumnName = "id"))
private List<Product> products;
```

The attribute **mappedBy** defines the corresponding field in the opposite (@ManyToMany relationship) in @Entity Product we have:

```
@ManyToMany(mappedBy = "products")
private List<Category> categories;
```

16. Add @OnoToOne relationship between product and info entities:

In Product entity add filed:

```
@OneToOne
private Info info;
```

In Info entity add field:

```
@OneToOne
private Product product;
```

Change spring.jpa.hibernate.ddl-auto property in application-mysql.properties and re-run the application. Check that column **product_id** and **info_id** are added in tables **info** and **product**:

```
spring.jpa.hibernate.ddl-auto=update
```

17. Add @OneToMany and @ManyToOne relationships between entities **Participant** and **Product**.

In Participant entity add:

```
@OneToMany(mappedBy = "seller")
private List<Product> products;
```

In Product entity add:

```
@ManyToOne
private Participant seller;
```

Re-run the application. Check that column **seller_id** is added in table **product,** in MySql database.

18. Add @ManyToMany relationship Product-Category:

In entity Product add:

```
@ManyToMany(mappedBy = "products")
private List<Category> categories;
```

In entity Category add:

```
@ManyToMany
@JoinTable(name = "product_category",
joinColumns =@JoinColumn(name="category_id",referencedColumnName =
"id"),
inverseJoinColumns
=@JoinColumn(name="product_id",referencedColumnName="id"))
private List<Product> products;
```

Re-run the application and check the existence of table **product_catgory**, in MySql database.

19. Populate table product with one row and re-run:

**H2 profile import.sql:**

```
insert into category(name) values('paintings');
insert into category(name) values('sculptures');
insert into category(name) values('books');

insert into participant(id, last_name, first_name) values(1, 'Adam',
'George');

insert into product (id, name, code, reserve_price, restored, seller_id)
values (1, 'The Card Players', 'PCEZ', 250, 0, 1);

insert into product_category values(1,1);
```

**MySql profile data-mysql.sql**

```
delete from product_category;
delete from product;
delete from category;
delete from participant;

insert into category(id, name) values(1, 'paintings');
insert into category(id, name) values(2, 'sculptures');
insert into category(name) values('books');

insert into participant(id, last_name, first_name) values(1, 'Adam',
'George');

insert into product (id, name, code, reserve_price, restored, seller_id)
values (1, 'The Card Players', 'PCEZ', 250, 0, 1);

insert into product_category values(1,1);
```

20. Create a test class, **EntityManagerTest** in package src\test\java\com\awbd\lab2

```java
@DataJpaTest
@ActiveProfiles("h2")
public class EntityManagerTest {

    @Autowired
    private EntityManager entityManager;

    @Test
    public void findProduct() {

        Product productFound = entityManager.find(Product.class, 1L);

        assertEquals(productFound.getCode(), "PCEZ");
    }
}
```

Info **Spring Testing** [8]

**spring-boot-starter-test** imports useful modules and libraries for testing spring applications:
  **spring-boot-test** module, with core items
  **spring-boot-test-autoconfigure** module, providing support for auto-configuration

**Junit** [9]
  **AssertJ** library to write assertions for tests[10]
  **Mockito** mocking framework [11] etc.

Maven dependency **spring-boot-starter-test**

```xml
<dependency>
   <groupId>org.springframework.boot</groupId>
   <artifactId>spring-boot-starter-test</artifactId>
   <scope>test</scope>
</dependency>
```

**@RunWith(SpringRunner.class)**
  Runs test with SpringRunner so that Spring annotations will be interpreted with SpringTestContext Framework [12]. For a better understanding of runner see [13].

**@DataJpaTest** [14]
  @DataJpaTest can be used to test JPA applications. By default, it will configure an in-memory embedded database (replacing any explicit or usually auto-configured DataSource), scan for @Entity classes and configure Spring Data JPA repositories. Regular @Component beans will not be loaded into the ApplicationContext.

  By default, tests annotated with @DataJpaTest are transactional and rollback at the end of each test. @Rollback(false) overrides this setting.

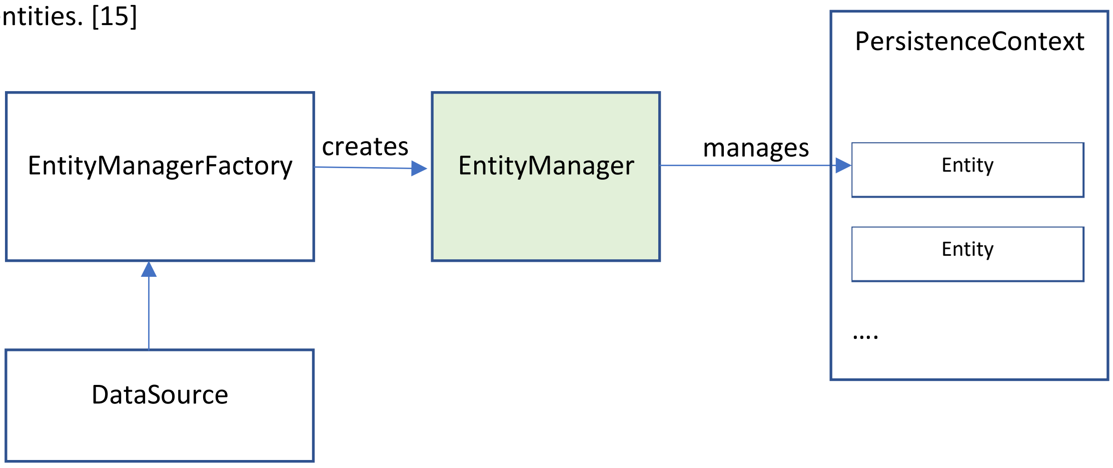
  The @AutoConfigureTestDatabase annotation can be used to override settings for default DataSource configuration.

Info

**Persistence Context**
A persistence context is a set of instances of entities. An *EntityManager* instance is associated with each persistence context. The entity instances and their lifecycle are managed by a particular entity manager.

**EntityManagerFactory**
An entity manager factory provides EntityManager instances connected to the same *datasource*.

**EntityManager**
An EntityManager instance is used to create and remove persistent entity instances and to query entities. [15]



21. Add filed currency in entity Product:

```java
@Enumerated(value = EnumType.ORDINAL)
private Currency currency;
```

22. Add a test *updateProduct* in class EntityManagerTest

```java
@Test
public void updateProduct() {

    Product productFound = entityManager.find(Product.class, 1L);
    productFound.setCurrency(Currency.EUR);

    entityManager.persist(productFound);

    productFound = entityManager.find(Product.class, 1L);
    assertEquals(Currency.EUR, productFound.getCurrency());

    entityManager.flush();

}
```

The column currency will be set 1, the order number of currency *EUR* in the enumeration, counting from 0.

23. Drop column currency and recreate the schema so that @Enumerated values will store string instead of integers.

```
alter table product drop column currency;
```

Change field currency in entity Product and add field currency in entity Bid:

```
@Enumerated(value = EnumType.STRING)
private Currency currency;
```

24. Create a test class similar to EntityManagerMySqlTest for the profile **mysql**

```
@DataJpaTest
@ActiveProfiles("mysql")
@AutoConfigureTestDatabase(replace =
AutoConfigureTestDatabase.Replace.NONE)
@Rollback(false)
public class EntityManagerMySqlTest
```

25. Create the Entity **Bid** with all attributes and relationships.

## B

[1] https://projectlombok.org/

[2] https://www.artima.com/lejava/articles/equality.html

[3] https://www.h2database.com/html/main.html

[4] https://www.baeldung.com/hibernate-identifiers

[5] https://www.baeldung.com/jpa-entities

[6] https://docs.spring.io/spring-boot/docs/1.1.0.M1/reference/html/howto-database-initialization.html

[7] https://www.baeldung.com/spring-data-rest-relationships

[8] https://docs.spring.io/spring-boot/docs/1.5.7.RELEASE/reference/html/boot-features-testing.html

[9] https://junit.org/junit5/docs/current/user-guide/

[10] https://joel-costigliola.github.io/assertj/

[11] https://site.mockito.org/

[12] https://docs.spring.io/spring-framework/docs/current/reference/html/testing.html#testcontext-framework

[13] https://www.logicbig.com/tutorials/unit-testing/junit/runner.html

[14] https://docs.spring.io/spring-boot/docs/current/api/org/springframework/boot/test/autoconfigure/orm/jpa/DataJpaTest.html

[15] https://www.baeldung.com/hibernate-entitymanager

[16] https://www.baeldung.com/jpa-persisting-enums-in-jpa