Spring Boot

UA.DETI.IES

Main topics

- Spring Boot
  - Dependencies, auto-configuration and runtime

- Spring MVC Architecture
- Spring WebFlux Architecture

- Java Persistence
- Spring Data
- Spring Data JPA
- Spring Data <*others*>

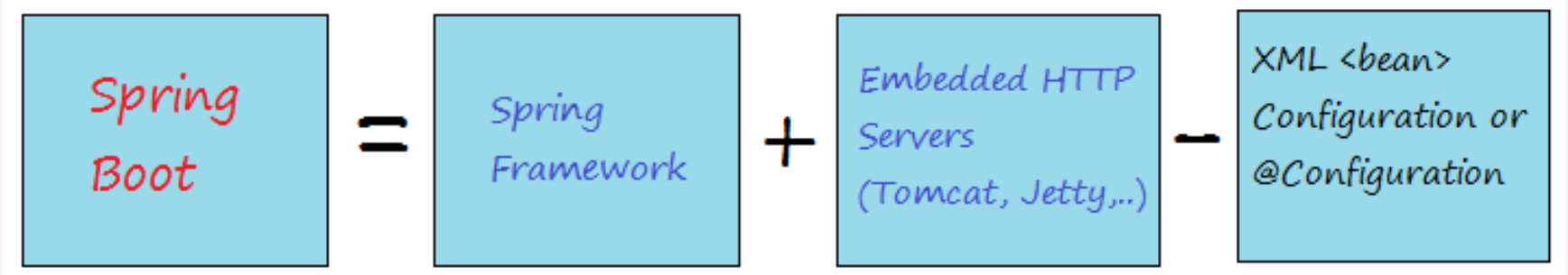
What is Spring?

- Simply put, the Spring framework provides comprehensive **infrastructure support for developing Java applications**.
- It is packed with some nice features like Dependency Injection and out of the box modules like:
  - Spring JDBC
  - Spring MVC
  - Spring Security
  - Spring AOP
  - Spring ORM
  - Spring Test
- These modules **can reduce the development time** of an application.
  - For example, in the early days of Java web development, we needed to write a lot of code to insert a record into a data source.
  - But by using the JDBCTemplate of the Spring JDBC module we can reduce it to a few lines of code with only a few configurations.

https://www.baeldung.com/spring-vs-spring-boot

What is Spring Boot?

- Extension of the Spring framework
  - that eliminated (even more) the boilerplate configurations required for setting up a Spring application.
  - It takes an opinionated view of the Spring platform, for a faster and more efficient development eco-system.
- Some features:
  - Opinionated 'starter' dependencies to simplify build and application configuration
  - Embedded server to avoid complexity
  - Automatic config for Spring functionality



Spring Boot Main Goals

- **Reducing development time**
  - as also Unit Test and Integration Test time
  - to ease the development of production ready web applications very easily compared to existing Spring Framework, which really takes more time.
- Avoiding completely XML Configuration
- Providing **simple Annotation** (based on Spring' ones)
- Avoiding writing lots of import statements
- **Opinionated development** approach
  - To provide some defaults to quick start

  new projects within no time

Spring Boot Main Components

- **Spring Initilizr** - Web Interface to quick start the development of Spring Boot Applications.
- **Starters** - combine a group of common or related dependencies into single dependency
  - allow to add jars in the classpath
- **AutoConfigurator** - reduce the Spring Configuration
  - attempts to automatically configure the Spring application based on the jar dependencies
- **CLI** - run and test Spring Boot applications from command prompt
  - groovy
- **Actuator** – provides EndPoints and Metrics
  - E.g., http://localhost:8080/actuator/health
    - {"status":"UP"}

Spring Initializr https://start.spring.io

spring initializr

Project
- ○ Gradle - Groovy
- ○ Gradle - Kotlin
- ● Maven

Language
- ● Java
- ○ Kotlin
- ○ Groovy

Spring Boot
- ○ 3.2.0 (SNAPSHOT)
- ○ 3.2.0 (RC2)
- ○ 3.1.6 (SNAPSHOT)
- ● 3.1.5
- ○ 3.0.13 (SNAPSHOT)
- ○ 3.0.12
- ○ 2.7.18 (SNAPSHOT)
- ○ 2.7.17

Project Metadata

Group	com.example
Artifact	demo
Name	demo
Description	Demo project for Spring Boot
Package name	com.example.demo
Packaging	● Jar ○ War

Dependencies ADD DEPENDENCIES... ⌘ + B

No dependency selected

GENERATE ⌘ + ↵ | EXPLORE CTRL + SPACE | SHARE...

Spring Initializr

demo.zip

- .gitignore
- .mvn
- HELP.md
- mvnw
- mvnw.cmd
- pom.xml
- src

DOWNLOAD COPY

```xml
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 https://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>3.1.5</version>
    <relativePath/> <!-- lookup parent from repository -->
  </parent>
  <groupId>com.example</groupId>
  <artifactI
  <version>0
  <name>demo
  <descriptio
  <propertie
    <java.ve
  </propertie
  <dependenc
    <depende
      <group
      <artif
    </depende
```

- .gitignore
- .mvn
- HELP.md
- mvnw
- mvnw.cmd
- pom.xml
- src
  - main
    - java
      - com
        - example
          - demo
            - DemoApplication.java

```java
package com.example.demo;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class DemoApplication {

  public static void main(String[] args) {
    SpringApplication.run(DemoApplication.class, args);
  }

}
```

Spring Boot main application

```
@SpringBootApplication
public class PayrollApplication {

    public static void main(String... args) {
        ApplicationContext ctx =
          SpringApplication.run(PayrollApplication.class, args);
    }
}
```

Enable component-scanning and auto-configuration

Bootstrap the application

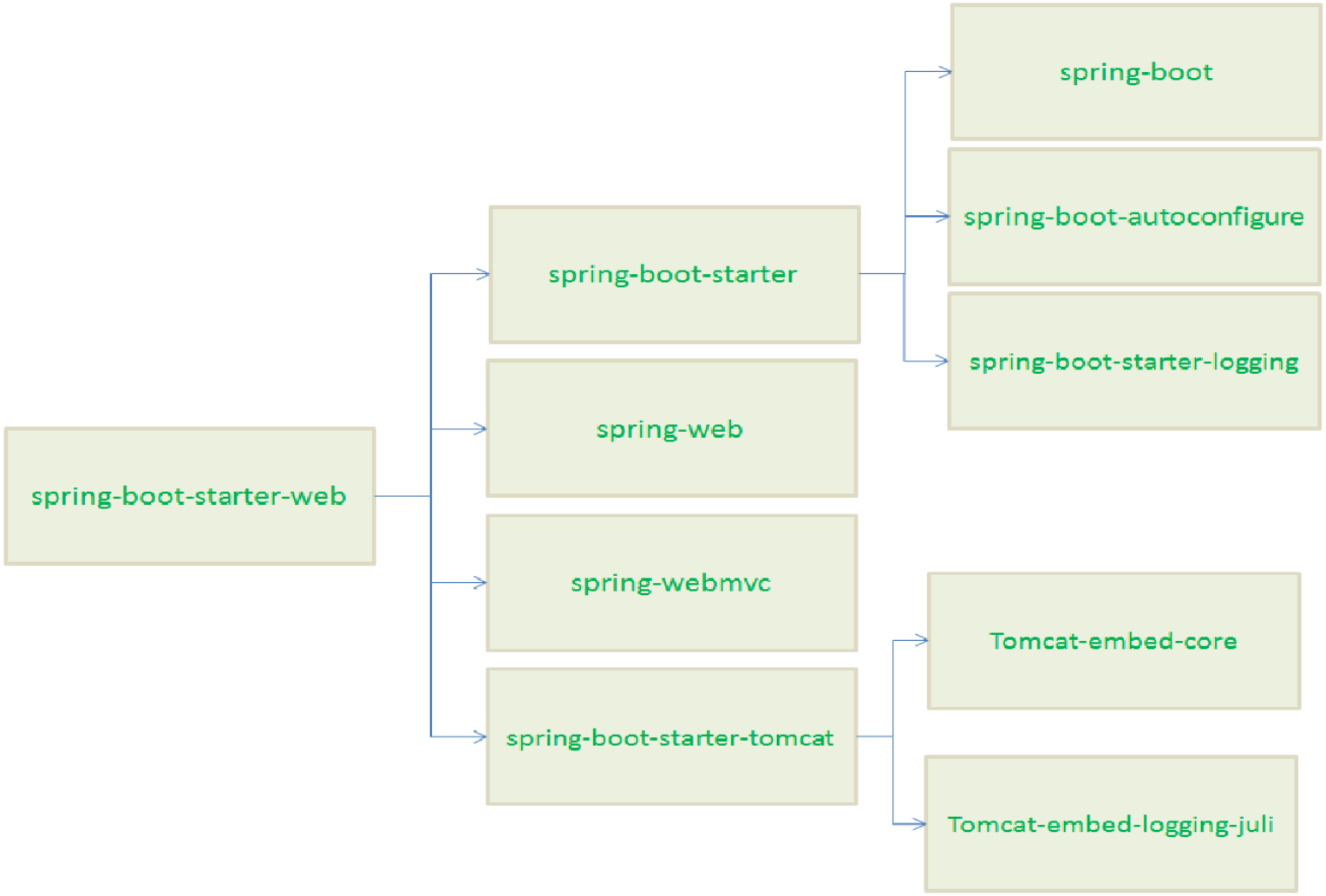
@SpringBootApplication

- Combines three other annotations:
  - **@Configuration**
    - Designates a class as a configuration class using Spring's Java-based configuration
  - **@ComponentScan**
    - Tells Spring Boot to scan the current package and its sub-packages in order to identify annotated classes (@Component, @Configuration, @Service, @Repository) and configure them as Spring beans
  - **@EnableAutoConfiguration**
    - It enables the "magic" of Spring Boot auto-configuration avoiding writing the pages of XML configuration that would be required otherwise

Starters

- A set of pre-defined dependency descriptors
  - They combine a **group of common or related dependencies** into single dependencies
  - They avoid having to copy-paste loads of dependencies.
- For instance, to develop a Spring WebApplication with Tomcat we need to add the following minimal jar dependencies in pom.xml file
  - Spring core Jar file(spring-core-xx.jar)
  - Spring Web Jar file(spring-web-xx.jar)
  - Spring Web MVC Jar file(spring-webmvc-xx.jar)
  - Servlet Jar file(servlet-xx.jar)
- Instead, we just add "spring-boot-starter-web".

Starters


spring-boot-starter-web
spring-boot-starter
spring-web
spring-webmvc
spring-boot-starter-tomcat
spring-boot
spring-boot-autoconfigure
spring-boot-starter-logging
Tomcat-embed-core
Tomcat-embed-logging-juli

Starters

- Let's pretend for a moment that Spring Boot starter dependencies don't exist.
  - What kind of dependencies would you add to your build without Spring Boot?
  - Which Spring dependencies do you need to support Spring MVC?
  - Do you remember the group and artifact IDs for Thymeleaf?
  - Which version of Spring Data JPA should you use?
  - Are all of these compatible?
- All official starters follow a similar naming pattern
  - *spring-boot-starter-**, where * is a particular type of application.

https://docs.spring.io/spring-boot/docs/current/reference/htmlsingle/#using-boot-starter

POM.xml – starter-parent

```
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
       https://maven.apache.org/xsd/maven-4.0.0.xsd">
   <modelVersion>4.0.0</modelVersion>
    <groupId>ies.spring</groupId>
    <artifactId>demo</artifactId>
   <version>0.0.1-SNAPSHOT</version>



   <parent>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-parent</artifactId>
      <version>2.4.0</version>
      <relativePath /> <!-- lookup parent from repository -->
   </parent>

    <!-- ... -->
```

default configurations for the application and a complete dependency tree to quickly build our Spring Boot project.

POM.xml – dependencies

```
   <dependencies>
      <dependency>
         <groupId>org.springframework.boot</groupId>
         <artifactId>spring-boot-starter-data-jpa</artifactId>
      </dependency>
      <dependency>
         <groupId>org.springframework.boot</groupId>
         <artifactId>spring-boot-starter-web</artifactId>
      </dependency>
      <dependency>
         <groupId>org.projectlombok</groupId>
         <artifactId>lombok</artifactId>
         <version>1.18.2</version>
         <scope>provided</scope>
      </dependency>

    ...
   </dependencies>
    <build>
        <plugins>
            <plugin>
                <groupId>org.springframework.boot</groupId>
                <artifactId>spring-boot-maven-plugin</artifactId>
            </plugin>
        </plugins>
    </build>
</project>
```

No version

github.com/spring-projects/spring-data-jpa/

main spring-data-jpa / pom.xml

schauder After release cleanups. ...

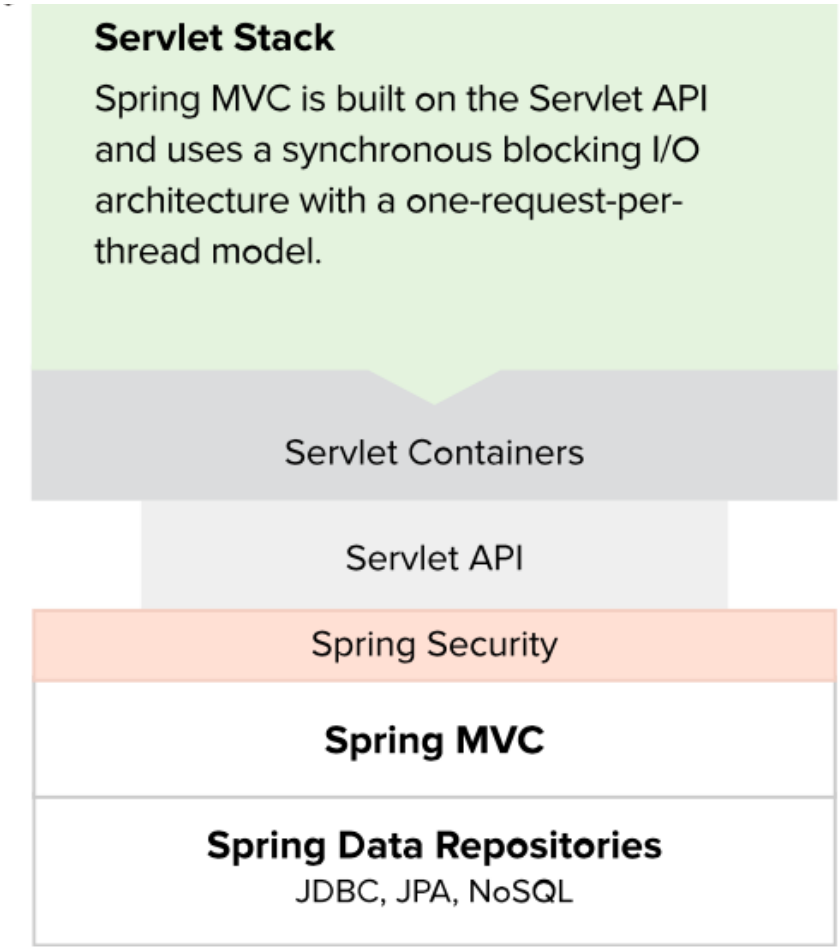
12 contributors

574 lines (516 sloc) | 14.8 KB

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi

        <modelVersion>4.0.0</modelVersion>

        <groupId>org.springframework.data</groupId>
        <artifactId>spring-data-jpa</artifactId>
        <version>2.7.0-SNAPSHOT</version>

        <name>Spring Data JPA</name>
        <description>Spring Data module for JPA repositories.</description>
        <url>https://projects.spring.io/spring-data-jpa</url>

        <parent>
                <groupId>org.springframework.data.build</groupId>
                <artifactId>spring-data-parent</artifactId>
                <version>2.7.0-SNAPSHOT</version>
        </parent>
```

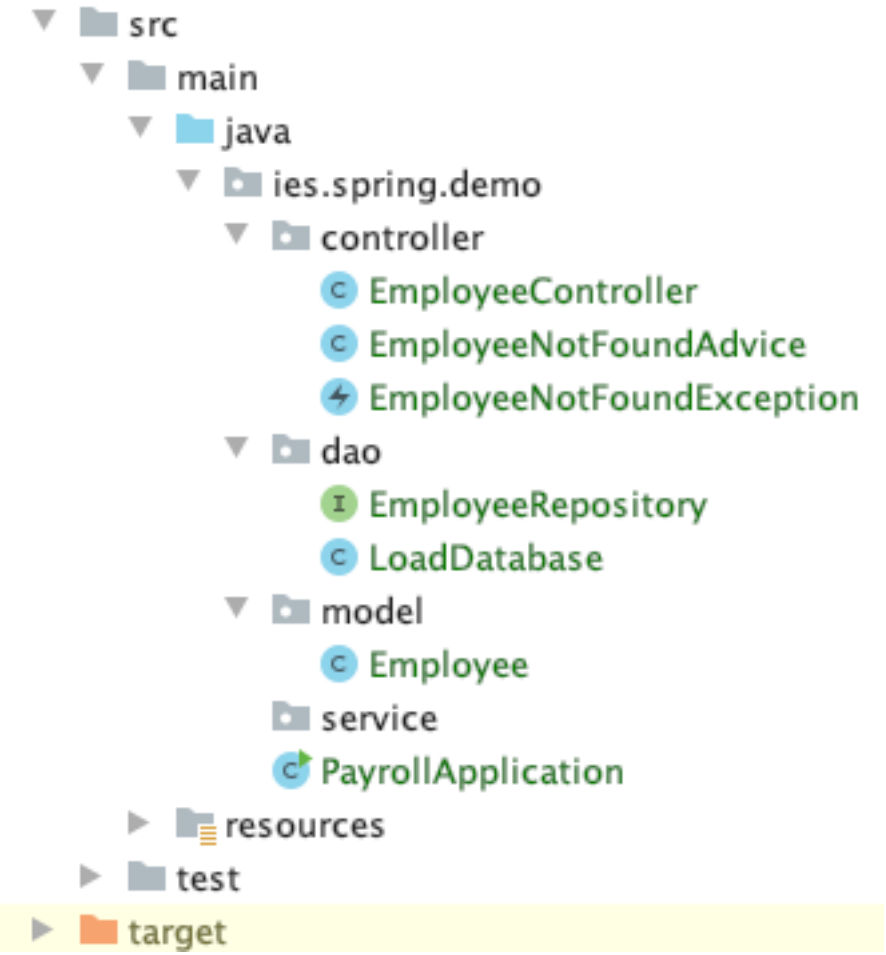
The Spring Web MVC

- Spring MVC allows creating special **@Controller** or **@RestController** beans to handle incoming HTTP requests.
- Methods in the controller are mapped to HTTP by using **@RequestMapping** annotations.



The Spring Web MVC

- Project structure - example



model.Employee.java

```
@Entity
@Table(name = "employees")
public class Employee {

    private @Id @GeneratedValue Long id;
    private String firstName;
    private String lastName;
    private String email;

    public Employee() {
    }

    public Employee(String firstName, String lastName, String email) {
        this.firstName = firstName;
        this.lastName = lastName;
        this.email = email;
    }
// ...
```

@Entity denotes this is an entity object for the table name employees

The field id is the Primary Key and, hence, marked as **@Id**.

The field id is also marked with **@GeneratedValue**, which denotes that this is an Auto-Increment column.

dao.EmployeeRepository

```
@Repository
public interface EmployeeRepository
     extends JpaRepository<Employee, Long> {
        public List<Employee> findByEmail(String email);
   // ... other methods
}
```

Where is this methods implemented?

- The ***JpaRepository*** interface has two parameters:
  - the domain type that the repository will work with, and the type of its ID property (primary key).
- ***EmployeeRepository*** inherits methods for performing common persistence operations.
  - In addition, we may add other methods.

- The interface will be implemented automatically by Spring Boot at runtime when the application is started.

Derived Query Methods

- Derived method names have two main parts separated by the first *By* keyword:
  - The first part – like *find* – is the introducer and the rest – like *ByName* – is the criteria.

```
public List<Employee> findByLastName(String lastname);
   // or equivalents:
public List<Employee> findByLastNameIs(String lastname);
public List<Employee> findByLastNameEquals(String lastname);
```

- Spring Data JPA supports ***find***, ***read***, ***query***, ***count*** and ***get***.
  - we could have done *queryByName* and Spring Data would behave the same.
- We can also use *Distinct*, *First*, or *Top* to remove duplicates or limit our result set:

```
public List<Employee> findTop3ByFirstName(String firstname);
```

Query methods: some examples

- findByLastnameAndFirstname
- findByLastnameOrFirstname
- findByStartDateBetween
- findByAgeLessThan
- findByStartDateAfter
- findByStartDateBefore
- findByAgeIsNull
- findByFirstnameLike
- findByFirstnameStartingWith
- findByAgeOrderByLastnameDesc
- findByAgeIn(Collection<Age> ages)
- findByFirstnameIgnoreCase

Controller.EmployeeController

```
@RestController
@RequestMapping("/api/v1")
public class EmployeeController {
    @Autowired
    private EmployeeRepository employeeRepository;

    @GetMapping("/employees")
    public List<Employee> getAllEmployees(
            @RequestParam(required = false) String email,
            @RequestParam(required = false) String lastname) {
        if (email != null)
            return employeeRepository.findByEmail(email);
        else if (lastname != null)
            return employeeRepository.findByLastName(lastname);
        else
            return employeeRepository.findAll();
    }
   // ...
```

Controller.EmployeeController

```
// ...

 @GetMapping("/employees/{id}")
 public ResponseEntity<Employee>
     getEmployeeById(@PathVariable(value = "id") Long employeeId)
         throws ResourceNotFoundException {
     Employee employee = employeeRepository.findById(employeeId)
         .orElseThrow(() -> new ResourceNotFoundException("Employee not
found for this id :: " + employeeId));
     return ResponseEntity.ok().body(employee);
 }

@PostMapping("/employees")
public Employee createEmployee(@Valid @RequestBody Employee employee) {
     return employeeRepository.save(employee);
}

// ...
```

AutoConfigurator with H2

- To complete this configuration scenario, we may use an embedded H2 database
- In POM.xml

```
  // ...
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-data-jpa</artifactId>
</dependency>
<dependency>
    <groupId>com.h2database</groupId>
    <artifactId>h2</artifactId>
    <scope>runtime</scope>
</dependency>
```

- In application.properties file:

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

AutoConfigurator with MySQL

- Using MySQL

```
create database demo
create user someuser ..
grant all on demo.* to someuser;
```

- In POM.xml

```
// ...
   <dependency>
         <groupId>mysql</groupId>
         <artifactId>mysql-connector-java</artifactId>
         <scope>runtime</scope>
   </dependency>
// ...
```

- In application.properties file

```
spring.datasource.url=jdbc:mysql://localhost:3306/demo
spring.datasource.username=demo
spring.datasource.password=password
spring.jpa.hibernate.use-new-id-generator-mappings=false
spring.jpa.hibernate.ddl-auto = update
server.port=9000
```

Running the application

- One of the biggest advantages of packaging an application as a jar and using an embedded HTTP server is that we can run it as:

```
~ java -jar target/demo-0.0.1-SNAPSHOT.jar
```

  - **or :**

```
~ ./mvnw clean spring-boot:run
...

 .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.4.0)

2020-12-02 11:42:27.833  INFO 47912 --- [  restartedMain] n.g.s.s.Application                    :
Starting Application on pc.lan with PID 47912
2020-12-02 11:42:27.889  INFO 47912 --- [  restartedMain] n.g.s.s.Application                    :
No active profile set, falling back to default profiles: default
```

Examples

```
 ~ curl http://localhost:9000/api/v1/employees
[]
 ~ curl -i -H "Content-Type:application/json" -d '{"firstName": "Maria",
"lastName": "Curia", "email": "mcuria@ua.pt"}'
http://localhost:9000/api/v1/employees
HTTP/1.1 200
Content-Type: application/json
Transfer-Encoding: chunked
Date: Wed, 02 Dec 2020 12:19:21 GMT
{"id":1,"firstName":"Maria","lastName":"Curia","email":"mcuria@ua.pt"}%
 ~ curl http://localhost:9000/api/v1/employees
[{"id":1,"firstName":"Maria","lastName":"Curia","email":"mcuria@ua.pt"}]

 ~ curl http://localhost:9000/api/v1/employees/1
{"id":1,"firstName":"Maria","lastName":"Curia","email":"mcuria@ua.pt"}

~ curl http://localhost:9000/api/v1/employees/33
{"timestamp":"2020-12-02T12:29:18.253+0000","message":"Employee not found
for this id :: 20","details":"uri=/api/v1/employees/20"}
```

Examples

```
~ curl -v localhost:9000/api/v1/employees

*   Trying ::1...
* TCP_NODELAY set
* Connected to localhost (::1) port 9000 (#0)
> GET /api/v1/employees HTTP/1.1
> Host: localhost:9000
> User-Agent: curl/7.64.1
> Accept: */*
>
< HTTP/1.1 200
< Content-Type: application/json
< Transfer-Encoding: chunked
< Date: Wed, 02 Dec 2020 19:34:15 GMT
<
* Connection #0 to host localhost left intact
[{"id":1,"firstName":"Maria","lastName":"Curia","email":"mcuria@anyplace.pt"},{"id":2,"
firstName":"Alba","lastName":"Andrade","email":"alba@ua.pt"},{"id":3,"firstName":"Mario
","lastName":"Pinto","email":"mario@pt"},{"id":4,"firstName":"Batista","lastName":"Tati
ana","email":"batata@aveiro"},{"id":5,"firstName":"Jaime","lastName":"Louro","email":"j
louro@avr.pt"},{"id":6,"firstName":"Maria","lastName":"Luanda","email":"maria@pt"},{"id
":7,"firstName":"Lisa","lastName":"Mona","email":"lisa@pt"}]* Closing connection 0
```

Examples

localhost:9000/api/v1/employees

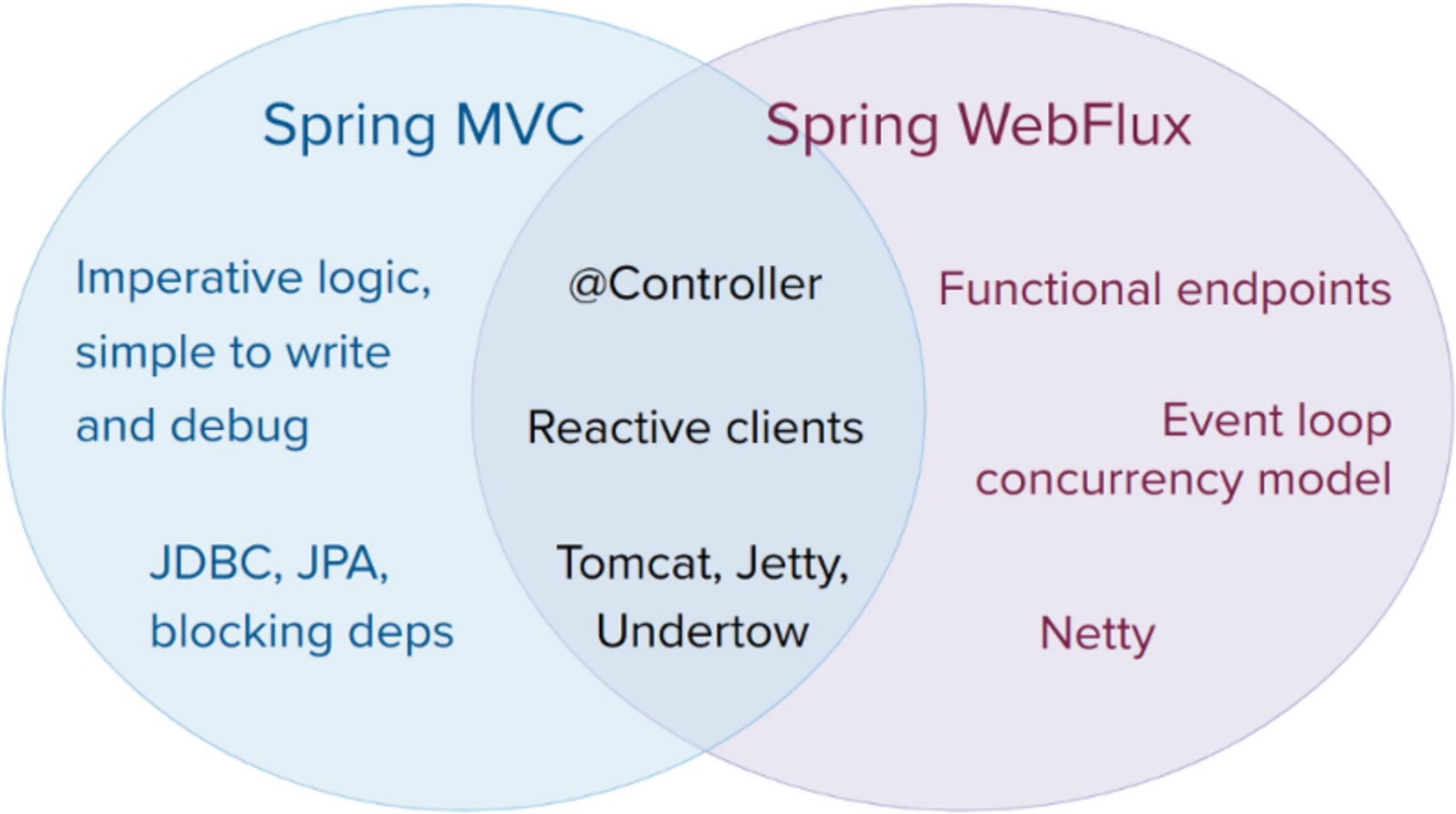
localhost:9000/api/v1/employees


```
[{"id":1,"firstName":"Maria","lastName":"Curia","email":"mcuria@anyplace.pt"},
{"id":2,"firstName":"Alba","lastName":"Andrade","email":"alba@ua.pt"},
{"id":3,"firstName":"Mario","lastName":"Pinto","email":"mario@pt"},
{"id":4,"firstName":"Batista","lastName":"Tatiana","email":"batata@aveiro"},
{"id":5,"firstName":"Jaime","lastName":"Louro","email":"jlouro@avr.pt"},
{"id":6,"firstName":"Maria","lastName":"Luanda","email":"maria@pt"},
{"id":7,"firstName":"Lisa","lastName":"Mona","email":"lisa@pt"}]
```

Spring WebFlux Framework

- A new **reactive** web framework (as a parallel version of Spring MVC)
  - Introduced in Spring Framework 5.0.
  - It is fully **asynchronous** and **non-blocking**, and implements the Reactive Streams specification (Reactor lib).
- Essentially, reactive streams is a specification for asynchronous stream processing.
  - In other words, a system where lots of events are being produced and consumed asynchronously.
- Spring WebFlux comes in two flavours: functional and annotation-based.
  - The annotation-based one is quite close to the Spring MVC model, as shown in the following example.

Spring WebFlux Framework



WebFlux – Annotations

```
@RestController
@RequestMapping("/users")
public class MyRestController {

    @GetMapping("/{user}")
    public Mono<User> getUser(@PathVariable Long user) {
        // ...
    }

    @GetMapping("/{user}/customers")
    public Flux<Customer> getUserCustomers(@PathVariable Long user) {
        // ...
    }

    @DeleteMapping("/{user}")
    public Mono<User> deleteUser(@PathVariable Long user) {
        // ...
    }

}
```

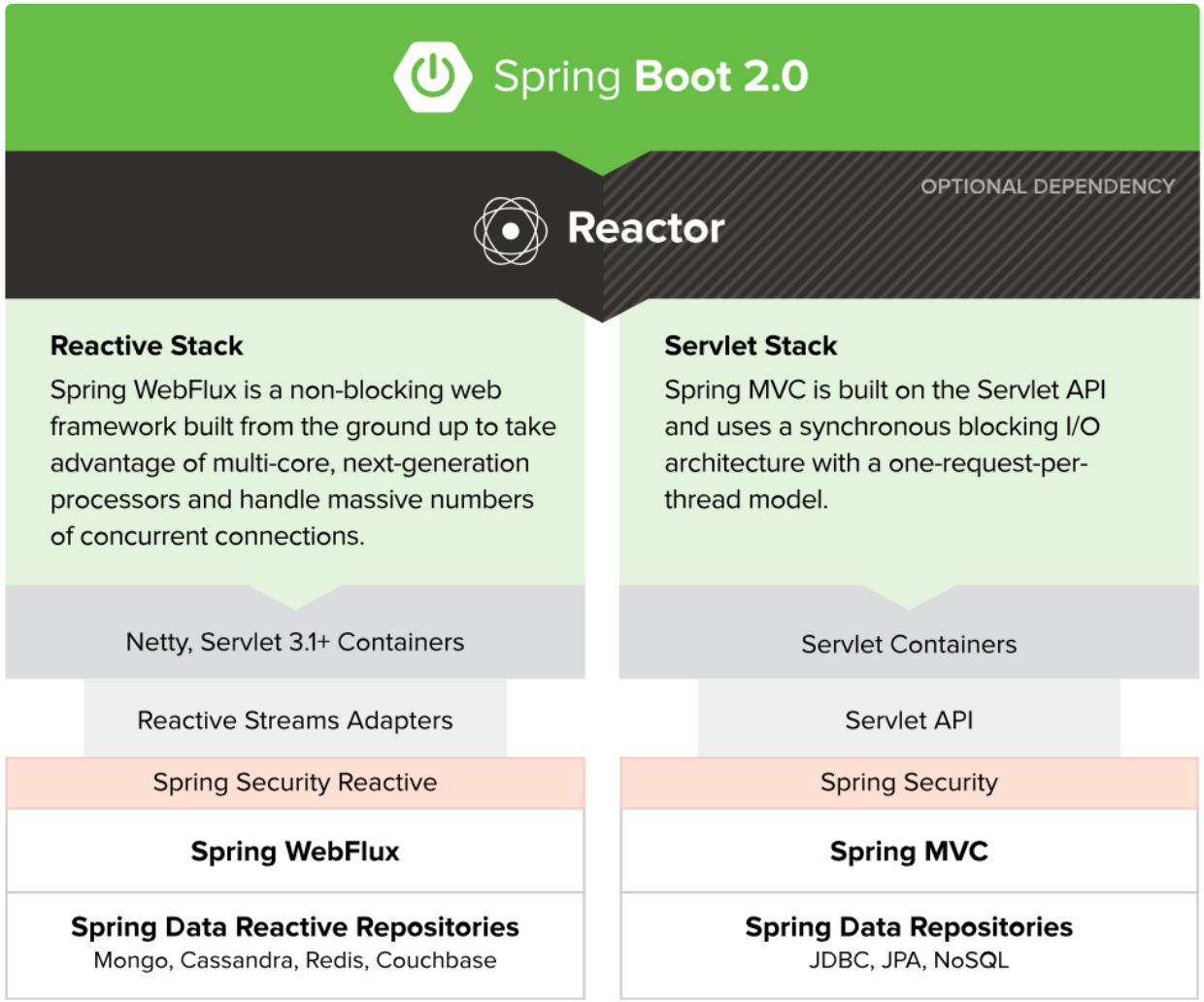
Mono<T> emits 0..1 elements

Flux<T> emits 0..n elements

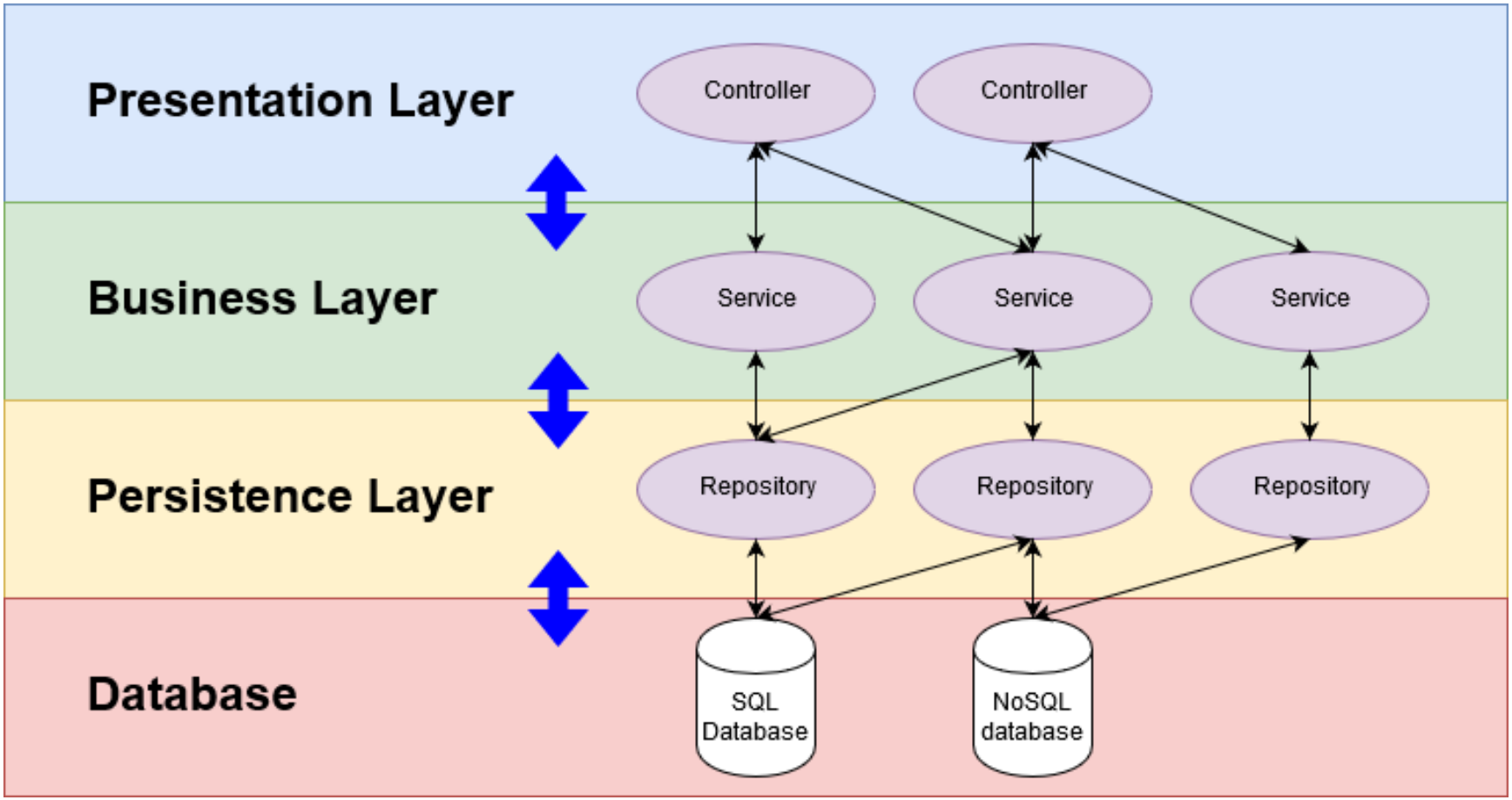
WebFlux – Functional variant

```
@Configuration(proxyBeanMethods = false)
public class RoutingConfiguration {
   @Bean
   public RouterFunction<ServerResponse> monoRouterFunction(UserHandler userHandler) {
     return route(GET("/{user}").and(accept(APPLICATION_JSON)), userHandler::getUser)
       .andRoute(GET("/{user}/customers")
             .and(accept(APPLICATION_JSON)), userHandler::getUserCustomers)
       .andRoute(DELETE("/{user}")
             .and(accept(APPLICATION_JSON)), userHandler::deleteUser);
    }
}

@Component
public class UserHandler {
    public Mono<ServerResponse> getUser(ServerRequest request) {
        // ...
    }
    public Mono<ServerResponse> getUserCustomers(ServerRequest request) {
        // ...
    }
    public Mono<ServerResponse> deleteUser(ServerRequest request) {
        // ...
    }
}
```

Spring MVC vs. WebFlux



Data Persistence



https://anchormen.nl/blog/big-data-services/spring-boot-tutorial/

Data Objects

- **DAO** (Data Access Object)
  - A structural pattern that isolate the application/business layer from the persistence layer using **an abstract API**.
    - It is not a spring module in a strict sense, but rather conventions that should dictate you to write DAO, and to write them well.
    - Example:

```
public interface Dao<T> {
    Optional<T> get(long id);
    List<T> getAll();
    void save(T t);
    void update(T t, String[] params);
    void delete(T t);
}
```

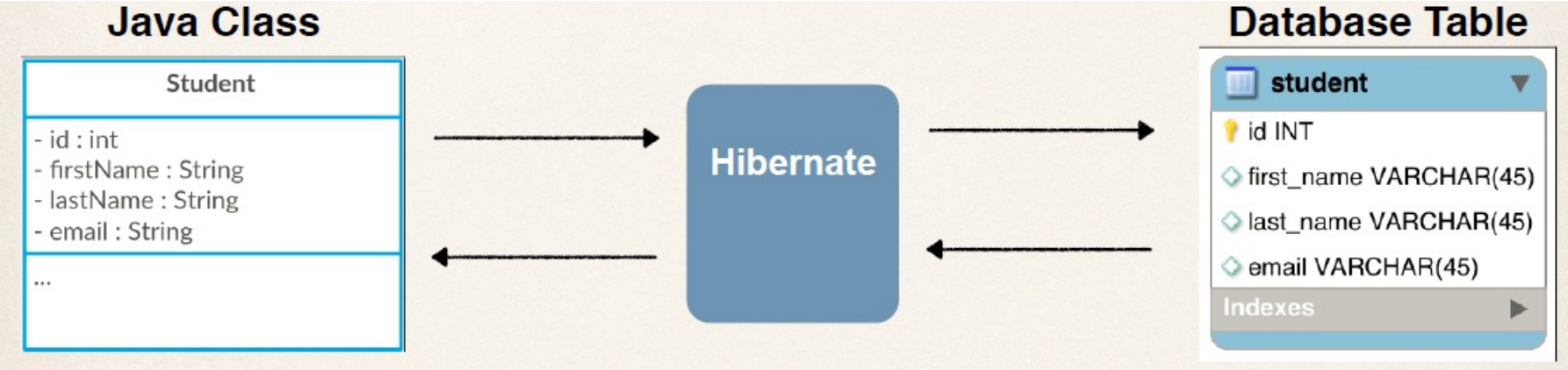
- **ORM** (Object-relational mapping)
  - The ORM package is related to the database access.
  - It provides **integration layers for popular object-relational mapping APIs** (e.g., JDO, Hibernate).

Java/Jakarta Persistence API (JPA)

- The Jakarta Persistence API (JPA) – formerly Java Persistence API – is the standard specification for mapping Java objects to a relational database
  - It includes specifications, the entity and association mappings, the entity lifecycle management, and JPA's query capabilities
  - Mapping Java objects to database tables and vice versa is called Object-relational mapping (ORM).
- The **Java Persistence API (JPA)** is one possible approach to ORM.
  - Via JPA the developer can **map, store, update and retrieve data** from relational databases to Java objects and vice versa.
- Popular implementations are Hibernate, EclipseLink and Apache OpenJPA.

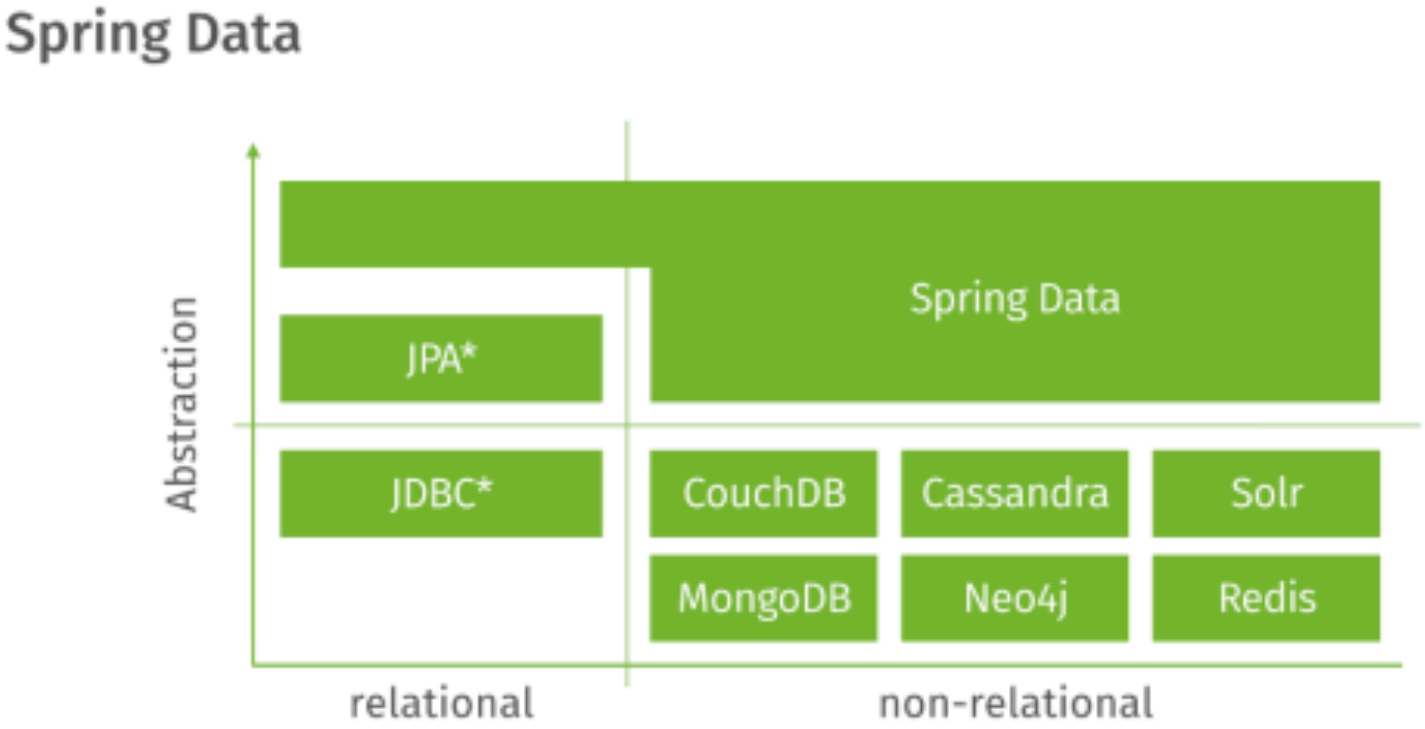
Hibernate

- Hibernate is a Java-based ORM tool
  - provides a framework for mapping application domain objects to the relational database tables and vice versa
- Hibernate provides a reference implementation of the Java/Jakarta Persistence API



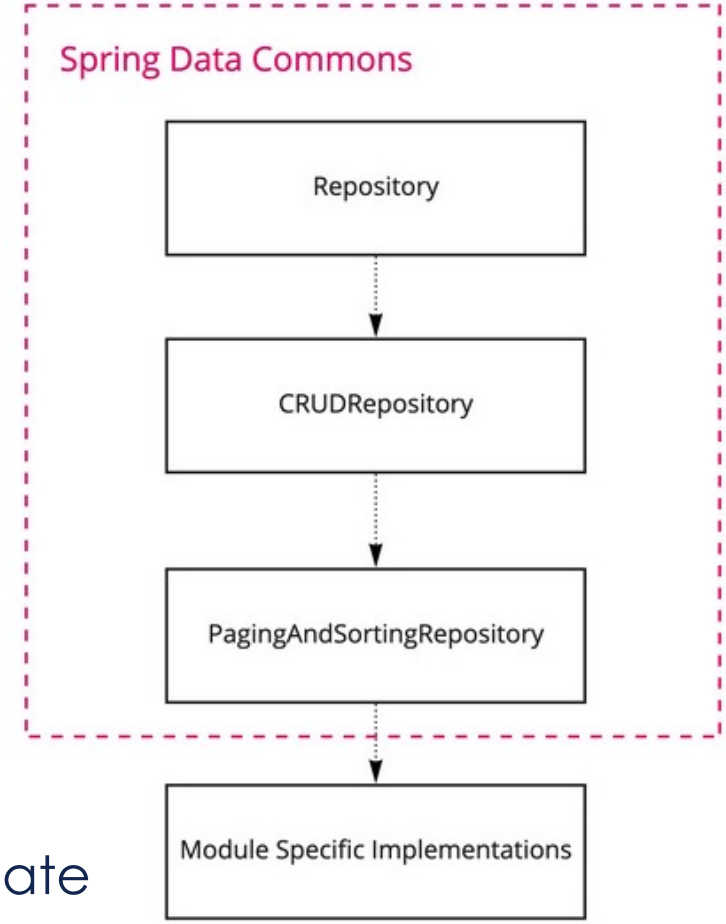
Spring Data Persistence

- An umbrella project having several sub-projects
  - Aiming to unify and ease the access to different kinds of persistence stores, from relational to NoSQL databases



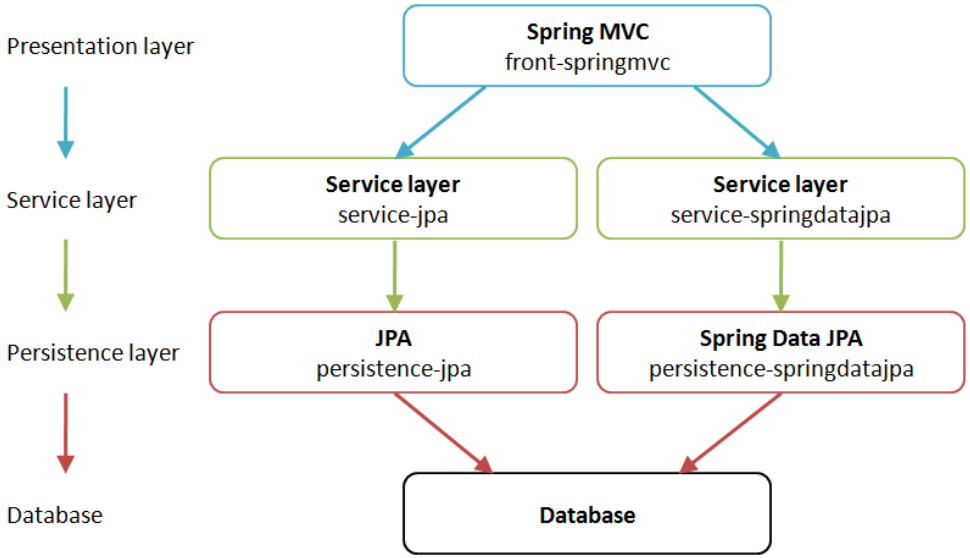
Spring Data

- Main interfaces
  - Repository, CRUDRepository, PagingAndSorting Repository
- Main annotations
  - @Repository
    - a specialization of @Component
  - @Id
  - @Param
  - @Transient
  - @Transactional
  - @CreatedBy, @LastModifiedBy,
  - @CreatedDate, @LastModifiedDate



Spring Data JPA

- An **abstraction** used to significantly reduce the amount of boilerplate code required to implement data access layers for various persistence stores.
- It adds its own features like a **no-code implementation of the repository pattern** and the **creation of database queries from method names**.
- It can also generate JPA queries on your behalf through method name conventions.



Spring Data JPA

- JPA repositories tie to a particular JPA entity

```
@Repository
public interface UserRepository extends JpaRepository<User, Long> {}
```

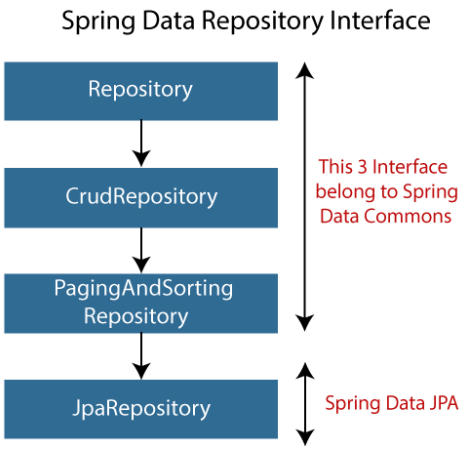
- Main annotations
  - @Query
    - With @Query, we can provide a JPQL implementation for a repository method:

```
@Query("SELECT COUNT(*) FROM Person p") long getPersonCount();
```

    - Also, we can use named parameters:

```
@Query("FROM Person p WHERE p.name = :name") Person
findByName(@Param("name") String name);
```

  - @Procedure
    - call stored procedures from repositories.
  - @Lock
  - @Modifying



Spring Data JPA with Hibernate

- Spring Boot configures Hibernate as the default JPA provider
  - To enable JPA in a Spring Boot application, we need the ***spring-boot-starter*** and ***spring-boot-starter-data-jpa*** dependencies

- Spring Boot can also auto-configure the ***dataSource*** bean, depending on the database we are using
  - For in-memory database (e.g. H2), Boot automatically configures the *dataSource*.
  - we only need to add the H2 dependency to the pom.xml file.

@Entity

- Entities in JPA are nothing but POJOs representing data that can be persisted to the database
  - Assuming we have:

```
public class Customer {
    private Long id;
    private String username;
    private String password;
    private String full_name;
    private Integer age;
    ...
}
```

  - We must ensure that the entity **has a no-arg constructor and a primary key**
  - Entity classes must not be declared final
- An entity represents a table stored in a database
  - Every instance of an entity represents a row in the table.

@Entity

```
@Entity(name="customer")
@Table(name = "CUSTOMERS", schema = "CHAINS") // namespace
public class Customer {
   @Id
   @GeneratedValue(strategy=GenerationType.AUTO)
   private Long id;

   private String username;
   @Column (nullable = false)
   private String password;
   @Column (name = "name", length=50, nullable = false)
   private String full_name;
   @Transient
   private Integer age;  // not persistent (or static, final, transient)
     ...
}
```

Embeddable Classes

- User-defined classes that function as value types
  - As with other non-entity types, instances of an embeddable class can only be stored in the database as embedded objects, i.e. as part of a containing entity object.
- A class is declared as embeddable by marking it with the Embeddable annotation:

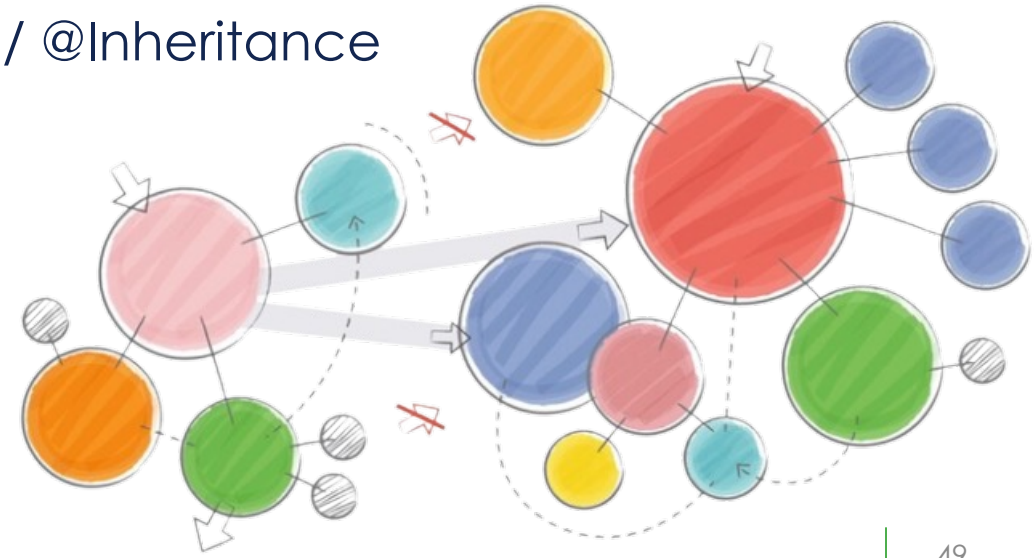
```
@Entity public class Company {
    @Id @GeneratedValue
    private Integer id;
    private String name;
    private String address;
    @Embedded
    private ContactPerson contactPerson;
    // ...
}
```

Embeddable Classes

```
@Entity public class Company {
    @Id @GeneratedValue
    private Integer id;
    private String name;
    private String address;
   @Embedded
   @AttributeOverrides({
   @AttributeOverride( name = "firstName", column = @Column(name =
"contact_first_name")),
   @AttributeOverride( name = "lastName", column = @Column(name =
"contact_last_name")),
   @AttributeOverride( name = "phone", column = @Column(name =
"contact_phone"))
   })
    private ContactPerson contactPerson;
    // ...

}
```

Relationships

- Every persistent field can be marked with one of the following annotations:
  - @OneToOne, @ManyToOne
    - for references of entity types
  - @OneToMany, @ManyToMany
    - for collections and maps of entity types
  - @MappedSuperClass / @Inheritance
    - for inherited types



@OneToMany / @ManyToOne

- The following entity classes demonstrate a bidirectional relationship:


```
@Entity
class Customer {
    ...
    @OneToMany (mappedBy = "customer")  // owned
    Set<Order> orders;
}

@Entity
class Order {
    ...
    @ManyToOne (optional = false)  // owning
    Customer customer;
    ...
}
```

Owned entity always maps to owning entity!

@ManyToMany


```
@Entity
class Product {
    @Id
    @GeneratedValue (strategy = GenerationType.SEQUENCE)
    @Column (name = "pid")
    long prod_id;

    @Column (nullable = false)
    float price;

    @ManyToMany (mappedBy = "products",  // owned
                 fetch = FetchType.EAGER)
    Set<Order> orders;
}

@Entity
class Order {
    ...
    @ManyToMany (fetch = FetchType.EAGER)  // owning
    @JoinTable (name = "OrderLines",
                joinColumns = @JoinColumn (name = "oid"),
                inverseJoinColumns = @JoinColumn (name = "pid"))
    Set<Product> products;
    ...
}
```

Spring Data JPA @Query

- We can use the @Query annotation to execute both JPQL and native SQL queries
  - SQL native – *over JDBC*

```
@Query( value = "SELECT * FROM USERS u WHERE u.status = 1",
        nativeQuery = true)
Collection<User> findAllActiveUsersNative();
```

  - JPQL (*JPA Query Language*) – *over Hibernate*

```
@Query("SELECT u FROM User u WHERE u.status = 1")
Collection<User> findAllActiveUsers();

@Query(value = "SELECT u FROM User u")
List<User> findAllUsers(Sort sort);

@Query(value = "SELECT u FROM User u ORDER BY id")
Page<User> findAllUsersWithPagination(Pageable pageable);
```

Sorting

Pagination

https://www.baeldung.com/spring-data-jpa-query

JPA with MongoDB

- Define the model (as previously)
  - e.g. Person

```
@Document(collection = "school")
public class Person {
  @Id
  private ObjectId id;
  private Integer ssn;
  @Indexed
  private String name;
}
```

- Adding Repository

```
@Repository
public interface PersonRepository
     extends MongoRepository<Person, String> {
        Person findByName(String name);
}
```

JPA with MongoDB

- Adding connection info in application.properties

```
spring.data.mongodb.host=[host]
spring.data.mongodb.port=[port]
spring.data.mongodb.authentication-database=[authentication_database]
spring.data.mongodb.username=[username]
spring.data.mongodb.password=[password]
spring.data.mongodb.database=some_database
```

- Create the REST Controller
- Querying

```
@Query("{'name : ?0'}")  //  in @Repository
Employee findByName(String name);

Query query = new Query();  // application
query.addCriteria(Criteria.where("age").lt(50).gt(20));
List<User> users = mongoTemplate.find(query,User.class);
```

Spring Data Mongo Annotations

- @Document
  - Mongo's equivalent of @Entity in JPA.
- @Field

```
@Document
class User {
    // ...
    @Field("email")
    String emailAddress;
    // ...
}
```

- @Query

```
@Query("{ 'name' : ?0 }")
List<User> findUsersByName(String name);
```

Spring Data - summary

- Spring Data consists of many independent projects
  - Spring Data Commons
  - Spring Data JPA
  - Spring Data KeyValue
  - Spring Data LDAP
  - Spring Data MongoDB
  - Spring Data Redis
  - Spring Data REST
  - Spring Data for Apache Cassandra
  - Spring Data for Apache Solr
  - Spring Data Couchbase (community module)
  - Spring Data Elasticsearch (community module)
  - Spring Data Neo4j (community module)

References

- https://spring.io/projects/spring-boot
- https://spring.io/projects/spring-data

- https://www.baeldung.com/spring-tutorial
- https://www.baeldung.com/persistence-with-spring-series

- https://www.edureka.co/blog/spring-tutorial/

- *... and many others*