Java

Friday, November 21, 2025 11:54 AM

Jframe class

Jtext

Javax -> functionalities beyond JDK -> namespace -> javax.swing ,
javax.servlet

We are saying spring pls manage and create an instance of this class - @Component

@Component -> Hey Spring, pls make a instance of this class and manage it

How will Spring find these components -> @ComponentScan -> Now Spring found the components we annotated -> Now, Spring will register them as beans in the ApplicationContext.

Dependencies are **injected automatically**

```
@Component

public class Engine {
 public String start() {
 return "Engine started!";
 }
```

Here, Engine is registered as a Bean

Now we will do Constructor Injection

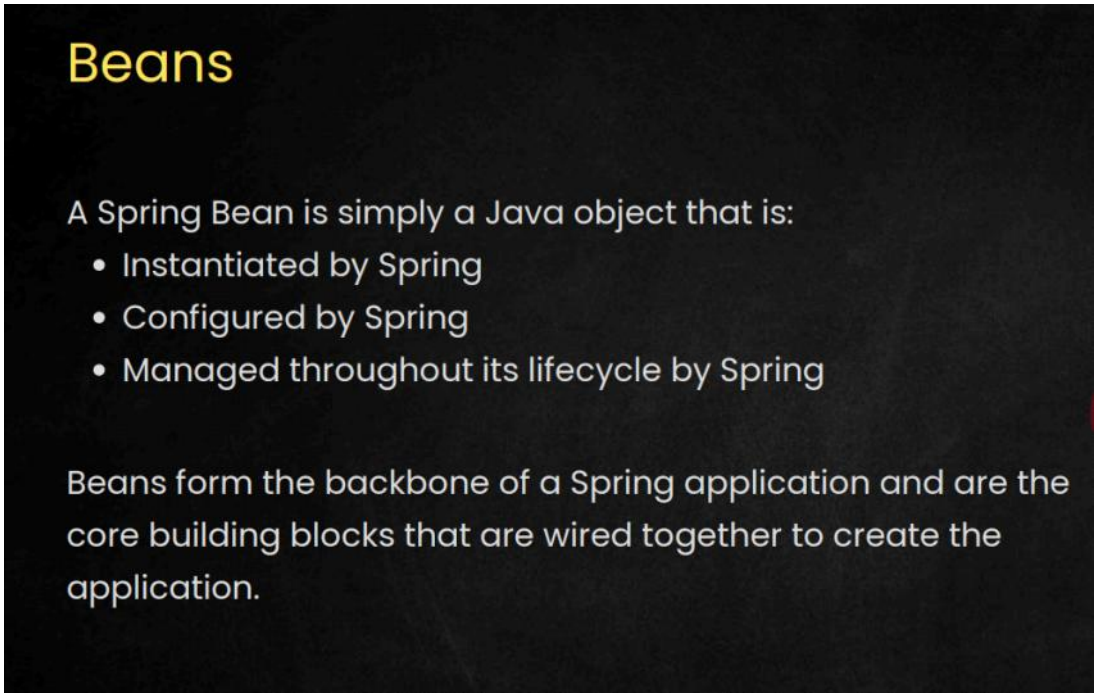
Constructor injection: Spring sees the constructor needs an Engine and injects the Engine bean it already created.
A service with constructor injection: CarService

```
@Service

public class CarService {
private final Engine engine;
        public CarService(Engine engine) {
        this.engine = engine;
        }

        public String drive() {
        return engine.start() + " Car is driving…";
        }

}
```

Object

```
class OrderService {
    private PaymentService paymentService = new PaymentService(); // tightly coupled
}
```

Apring web dependency for now on spring initialisr



What is IoC?

- **Inversion of Control** means that instead of your code controlling object creation and dependency management, the framework (Spring) takes over that responsibility.
- This is achieved through **Dependency Injection (DI)** — objects declare their dependencies, and Spring injects them at runtime.

BeanFactory vs ApplicationContext

- **BeanFactory**:
  - The simplest container in Spring.
  - Provides basic DI functionality.
  - Lazily initializes beans (creates them only when requested).
- **ApplicationContext**:
  - A superset of BeanFactory.
  - Adds enterprise-level features like:
    - **Internationalization (i18n)**
    - **Event propagation**
    - **Bean lifecycle management**
    - **Automatic BeanPostProcessor registration**
  - Eagerly initializes singleton beans by default.

Why ApplicationContext is central?

- It acts as the **IoC container** that:
  - Loads bean definitions from configuration (XML, annotations, or Java config).
  - Manages the lifecycle of beans.

- Resolves dependencies automatically.

Common Implementations of ApplicationContext

- ClassPathXmlApplicationContext – loads context from XML in classpath.
- AnnotationConfigApplicationContext – loads context from Java-based configuration.
- WebApplicationContext – specialized for web applications.

IoC means **your code does not create and manage dependencies directly**.

Instead, the **framework (Spring)** controls object creation and wiring. This is usually implemented via **Dependency Injection (DI)**.

Instead of doing:

Java
Engine engine = new Engine();
Car car = new Car(engine);
Show more lines
We let **Spring inject the dependency**:

XML
<!-- beans.xml -->
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans.xsd">

<bean id="engine" class="Engine"/>
<bean id="car" class="Car">
<constructor-arg ref="engine"/>
beans>
Show more lines

☑

Absolutely! In Spring, you can create and manage beans in two primary ways:

1. **Using @Component and stereotype annotations** (automatically discovered via component scanning)
2. **Using @Bean methods inside a @Configuration class** (explicitly declared, great for fine-grained control or third-party classes)

Below are lucid explanations with runnable-style code samples for both.

1) Creating Beans with @Component (and Stereotype Annotations)

Spring will **auto-detect** classes annotated with @Component (or its specializations) during **component scanning** and register them as beans in the ApplicationContext.

Common Annotations

- @Component → generic Spring-managed bean
- @Service → business/service layer semantics
- @Repository → persistence/DAO semantics (adds exception translation)
- @Controller → MVC web controller (returns views)
- @RestController → REST controller (@Controller + @ResponseBody)
  All of these are beans; the stereotypes add intent and extra behaviors (e.g., @Repository enables @Repository exception translation if @EnableTransactionManagement / persistence exception translation is configured).

Minimal Example (Component Scanning)

Package structure

```
com.example.app
 ├─ config
 │   └─ AppConfig.java
 └─ domain
    ├─ Engine.java
    ├─ CarService.java
    ├─ CarRepository.java
    ├─ CarController.java
    └─ CarRestController.java
```

Config enabling component scan

```
// com/example/app/config/AppConfig.java
package com.example.app.config;
import org.springframework.context.annotation.ComponentScan;
import org.springframework.context.annotation.Configuration;
@Configuration
@ComponentScan(basePackages = "com.example.app") // scan this package tree
public class AppConfig { }
```

Generic component

```
// com/example/app/domain/Engine.java
package com.example.app.domain;
import org.springframework.stereotype.Component;
@Component
public class Engine {
   public String start() {
      return "Engine started!";
   }
}
```

Service layer

```
// com/example/app/domain/CarService.java
package com.example.app.domain;
import org.springframework.stereotype.Service;
@Service
public class CarService {
   private final Engine engine;
   // Prefer constructor injection (testable, immutable)
   public CarService(Engine engine) {
      this.engine = engine;
   }
   public String drive() {
      return engine.start() + " Car is driving...";
   }
}
```

Repository layer

```
// com/example/app/domain/CarRepository.java
package com.example.app.domain;
import org.springframework.stereotype.Repository;
@Repository
public class CarRepository {
    public String findById(Long id) {
        // pretend to hit DB
        return "Car#" + id;
    }
}
```

Spring MVC Controller (returns view names)

```
// com/example/app/domain/CarController.java
package com.example.app.domain;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
@Controller
public class CarController {
    private final CarService carService;
    public CarController(CarService carService) {
        this.carService = carService;
    }
    @GetMapping("/car/view")
    public String viewCar(Model model) {
        model.addAttribute("status", carService.drive());
        return "carView"; // resolves to a template (e.g., Thymeleaf)
    }
}
```

REST Controller (returns JSON/text directly)

```
// com/example/app/domain/CarRestController.java
package com.example.app.domain;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RestController;
@RestController
public class CarRestController {
    private final CarService carService;
    private final CarRepository carRepository;
    public CarRestController(CarService carService, CarRepository carRepository) {
        this.carService = carService;
        this.carRepository = carRepository;
    }
    @GetMapping("/api/car/drive")
    public String drive() {
        return carService.drive();
    }
```

Bootstrapping (non-Boot app for demo)

```
// Main.java
import com.example.app.config.AppConfig;
import com.example.app.domain.CarService;
import org.springframework.context.annotation.AnnotationConfigApplicationContext;
public class Main {
    public static void main(String[] args) {
        try (var ctx = new AnnotationConfigApplicationContext(AppConfig.class)) {
            CarService carService = ctx.getBean(CarService.class);
            System.out.println(carService.drive());
        }
    }
```

Notes & Best Practices

- **Constructor injection** is recommended; Spring 4.3+ auto-wires single constructors even without @Autowired.
- Use @Qualifier if there are multiple beans of the same type:
  public CarService(@Qualifier("sportEngine") Engine engine) { ... }
- Customize bean names:
  @Component("engineV1")
  public class Engine { ... }
- Control scope:
  @Service
  @Scope("prototype") // or "singleton" (default), "request", "session" in web contexts
  public class CarService { ... }

2) Creating Beans with @Bean in a @Configuration Class

Use this when:

- You need **precise control** over construction, initialization, or destruction
- You are wiring **third-party classes** (not annotated with Spring stereotypes)
- You want to **conditionally** define beans or choose profiles
- You need to **override** component-scanned beans

Example: Pure Java Config with @Bean

```
// com/example/app/config/AppConfig.java
package com.example.app.config;
import com.example.app.domain.Engine;
import com.example.app.domain.CarService;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
@Configuration
public class AppConfig {
   // Simple bean
   @Bean
   public Engine engine() {
      return new Engine();
   }
   // Bean method DI via parameters (Spring resolves by type)
   @Bean
   public CarService carService(Engine engine) {
      return new CarService(engine);
   }
}
```

Main

```
import com.example.app.config.AppConfig;
import com.example.app.domain.CarService;
import org.springframework.context.annotation.AnnotationConfigApplicationContext;
public class Main {
   public static void main(String[] args) {
      try (var ctx = new AnnotationConfigApplicationContext(AppConfig.class)) {
         CarService carService = ctx.getBean(CarService.class);
         System.out.println(carService.drive());
      }
   }
```

Using @Bean for Third-Party Classes

```
// Suppose this is a third-party DataSource class not annotated with Spring
import javax.sql.DataSource;
import org.apache.commons.dbcp2.BasicDataSource;
@Configuration
```

```
public class DataConfig {
    @Bean
    public DataSource dataSource() {
        var ds = new BasicDataSource();
        ds.setUrl("jdbc:h2:mem:testdb");
        ds.setUsername("sa");
        ds.setPassword("");
        ds.setInitialSize(2);
        return ds;
    }
```

Initialization / Destruction Hooks

```
@Configuration
public class LifecycleConfig {
    @Bean(initMethod = "init", destroyMethod = "shutdown")
    public CacheManager cacheManager() {
        return new CacheManager();
    }
}
// Hypothetical class
class CacheManager {
    public void init() { System.out.println("Cache initialized"); }
    public void shutdown() { System.out.println("Cache shutdown"); }
```

Choosing Primary / Qualifiers / Profiles

```
@Configuration
public class EnginesConfig {
    @Bean
    @Primary
    public Engine defaultEngine() { return new Engine(); }
    @Bean(name = "sportEngine")
    public Engine sportEngine() { return new Engine(); }
}
// Usage:
public class CarService {
    private final Engine engine;
    public CarService(@Qualifier("sportEngine") Engine engine) {
        this.engine = engine;
    }

@Configuration
@Profile("prod")
public class ProdConfig {
    @Bean
    public DataSource prodDataSource() { /* prod settings */ }
}
@Configuration
@Profile("dev")
public class DevConfig {
    @Bean
    public DataSource devDataSource() { /* dev settings */ }
}
```

Activate a profile via properties or programmatically:

```
var ctx = new AnnotationConfigApplicationContext();
ctx.getEnvironment().setActiveProfiles("dev");
ctx.register(DevConfig.class, ProdConfig.class);
```

When to Use Which?

- **@Component / Stereotypes**:\ Best for your **own application classes** (services, repositories, controllers). Cleaner, less boilerplate, and aligns with layered architecture semantics.

- **@Bean in @Configuration**:\ Best for **third-party objects**, **explicit construction** logic, **conditional beans**, **profiles**, or when you need **fine-grained control** over lifecycle and wiring. In real projects, you'll often combine both: component scan for your layers + @Bean methods for infra and third-party integrations.

If you'd like, I can share a small **Spring Boot** version of the same examples (with @SpringBootApplication) to show how Boot auto-config + component scanning works out of the box.

You're right—let me walk you through the code step by step and **explain what each piece is doing** and **why** you would use it. I'll keep it crisp and lucid.

1) Beans via @Component & Stereotypes

What is happening conceptually?

- When you annotate classes with @Component (or @Service, @Repository, @Controller, @RestController), you're telling Spring: **"Please create and manage an instance of this class."**
- Spring finds these classes using **component scanning** (enabled via @ComponentScan) and registers them as beans in the ApplicationContext.
- Dependencies are **injected automatically** (via constructor injection in our examples).

Code and Explanation

Configuration

```
@Configuration
@ComponentScan(basePackages = "com.example.app")
```

- @Configuration: Marks this class as a source of bean definitions.
- @ComponentScan(...): Tells Spring where to look for annotated components. Any @Component, @Service, etc., under com.example.app will be discovered and registered.

A generic component: Engine

```
@Component
public class Engine {
   public String start() {
      return "Engine started!";
   }
```

- @Component: Registers Engine as a bean.
- start(): A simple method to prove the bean works.

A service with constructor injection: CarService

```
@Service
public class CarService {
```

```
    private final Engine engine;
    public CarService(Engine engine) {
        this.engine = engine;
    }
    public String drive() {
        return engine.start() + " Car is driving...";
    }
```

- @Service: Same as @Component but semantically indicates **business logic** layer.
- **Constructor injection**: Spring sees the constructor needs an Engine and injects the Engine bean it already created.
- drive(): Uses the injected dependency.
  Why constructor injection?\ It makes the class immutable, easier to test, and ensures dependencies are available at creation time. Spring (4.3+) will autowire the only constructor without needing @Autowired.

Repository

```
@Repository
public class CarRepository {
    public String findById(Long id) {
        return "Car#" + id;
    }
```

- @Repository: Marks persistence/DAO components. It can enable **exception translation** (converting low-level persistence exceptions into Spring's DataAccessException).

MVC Controller

```
@Controller
public class CarController {
    private final CarService carService;
    public CarController(CarService carService) {
        this.carService = carService;
    }
    @GetMapping("/car/view")
    public String viewCar(Model model) {
        model.addAttribute("status", carService.drive());
        return "carView";
    }
}
```

- @Controller: A web controller that returns **view names** (e.g., Thymeleaf templates).
- @GetMapping("/car/view"): Maps HTTP GET /car/view to this method.
- Model: Adds attributes to be used in the rendered view.
- return "carView";: The name of the template to render.

REST Controller

```
@RestController
public class CarRestController {
    private final CarService carService;
    private final CarRepository carRepository;
    public CarRestController(CarService carService, CarRepository carRepository) {
        this.carService = carService;
        this.carRepository = carRepository;
    }
    @GetMapping("/api/car/drive")
    public String drive() {
        return carService.drive();
    }
}
```

- @RestController: Equivalent to @Controller + @ResponseBody. **Returns the response directly** (JSON/text) rather than rendering a view.
- Perfect for APIs returning data for clients.

Bootstrapping (non-Boot)

```
try (var ctx = new AnnotationConfigApplicationContext(AppConfig.class)) {
```

```
    CarService carService = ctx.getBean(CarService.class);
    System.out.println(carService.drive());
}
```

- Creates an ApplicationContext using your configuration.
- Retrieves the CarService bean from the container.
- Calls drive() to see the wiring in action.
- Try-with-resources ensures the context is closed properly (calls destroy methods).

2) Beans via @Bean in a @Configuration Class

What is happening conceptually?

- You explicitly define bean creation **in Java methods** inside a @Configuration class.
- Useful for **third-party classes** or when you need **fine-grained control** (e.g., init/destroy methods, conditional beans, profiles).

Code and Explanation

Explicit bean definitions

```
@Configuration
public class AppConfig {
    @Bean
    public Engine engine() {
        return new Engine();
    }
    @Bean
    public CarService carService(Engine engine) {
        return new CarService(engine);
    }
}
```

- @Bean: Registers the returned object as a bean.
- carService(Engine engine): Spring resolves the parameter by type from the container and injects the engine() bean.
- This approach gives **complete control** over construction logic (you can pass custom parameters, conditionals, etc.).

Third-party class example (DataSource)

```
@Configuration
public class DataConfig {
    @Bean
    public DataSource dataSource() {
        var ds = new BasicDataSource();
        ds.setUrl("jdbc:h2:mem:testdb");
        ds.setUsername("sa");
        ds.setPassword("");
        ds.setInitialSize(2);
        return ds;
    }
}
```

- This is perfect when the class (e.g., BasicDataSource) is **not annotated** with Spring stereotypes and you still want it managed by the container.
- You configure properties in code before returning the bean.

Lifecycle hooks

```
@Configuration
public class LifecycleConfig {
    @Bean(initMethod = "init", destroyMethod = "shutdown")
    public CacheManager cacheManager() {
        return new CacheManager();
    }
}
class CacheManager {
    public void init() { System.out.println("Cache initialized"); }
```

```
    public void shutdown() { System.out.println("Cache shutdown"); }
```

- initMethod runs **after** the bean is constructed and dependencies injected.
- destroyMethod runs **when the context is closing** (e.g., graceful shutdown).
- Great for resources like caches, thread pools, or connections.

Choosing which bean to inject (@Primary, @Qualifier)

```
@Configuration
public class EnginesConfig {
    @Bean
    @Primary
    public Engine defaultEngine() { return new Engine(); }
    @Bean(name = "sportEngine")
    public Engine sportEngine() { return new Engine(); }
}
```

- @Primary: If there are multiple beans of the same type, **this one wins by default**.
- @Bean(name = "sportEngine"): Gives a specific name for use with @Qualifier("sportEngine") in injection points.

Environment-specific beans with @Profile

```
@Configuration
@Profile("prod")
public class ProdConfig {
    @Bean
    public DataSource prodDataSource() { /* prod settings */ }
}
@Configuration
@Profile("dev")
public class DevConfig {
    @Bean
    public DataSource devDataSource() { / dev settings */ }
}
```

- @Profile: Only registers these beans when the **profile** is active (e.g., "dev" vs "prod").
- Activate programmatically:
  ```
  var ctx = new AnnotationConfigApplicationContext();
  ctx.getEnvironment().setActiveProfiles("dev");
  ctx.register(DevConfig.class, ProdConfig.class);
  ```

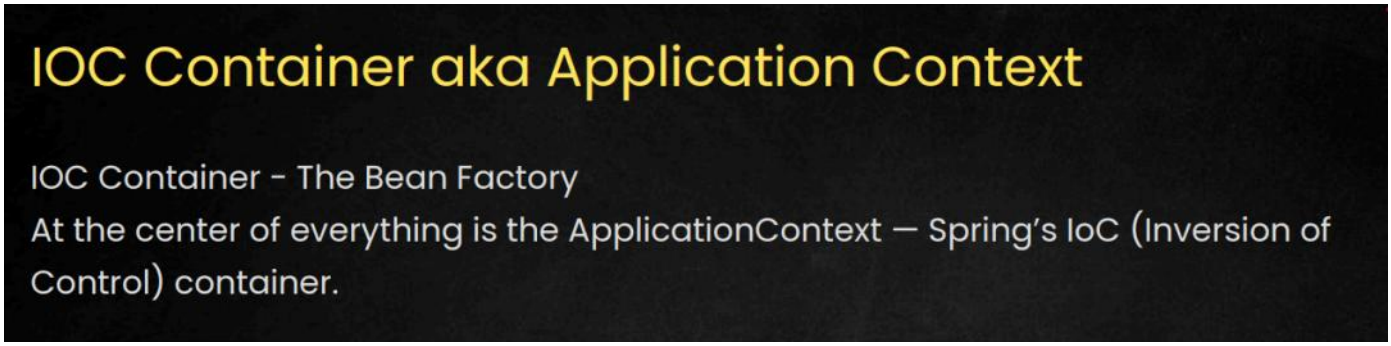
When to Use Which (Summary)

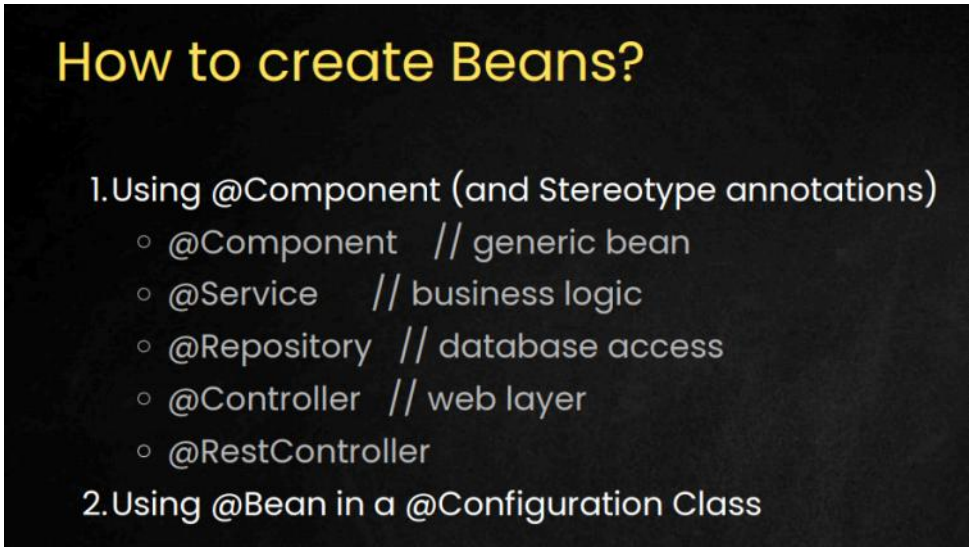
- **@Component / Stereotypes**:\ Best for your **own application classes** (services, repos, controllers). Clean and automatic via scanning.
- **@Bean in @Configuration**:\ Best for **third-party objects**, complex construction, lifecycle control, conditional registration, or environment-specific configs.
  In real-world apps, you **combine both**: use component scanning for your layers and @Bean methods for infrastructure.

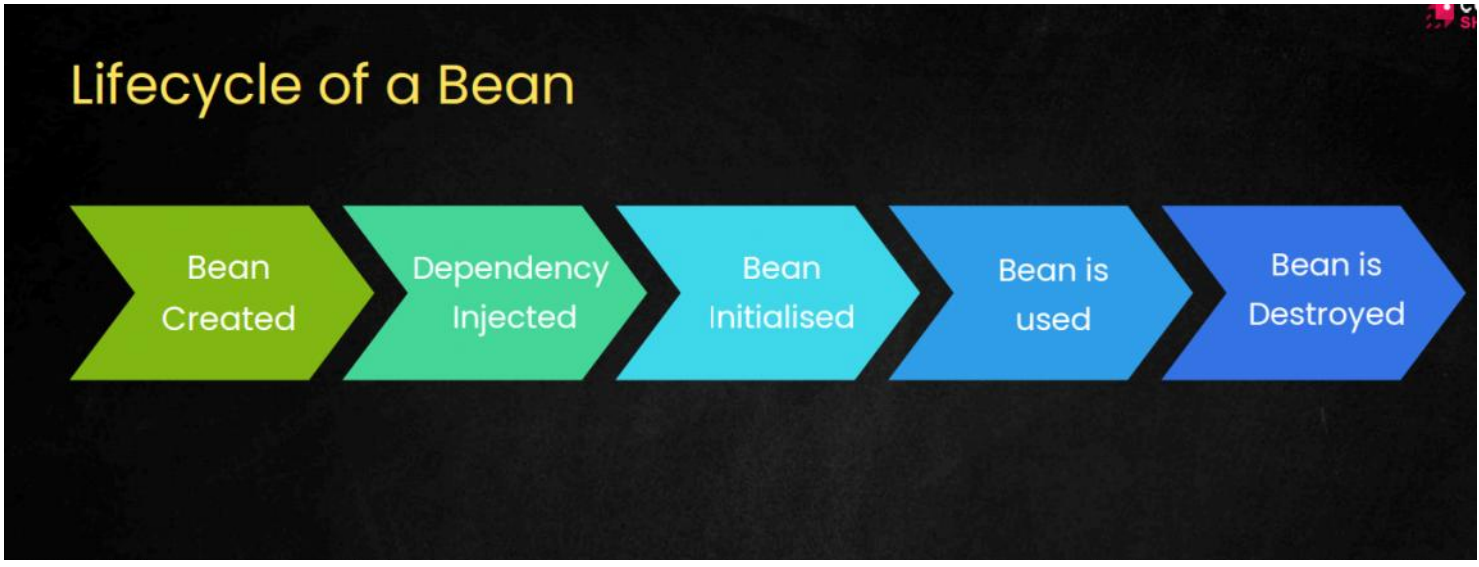
Quick Visual Mental Model

- **Component Scanning**: "Find all annotated classes in these packages and create beans automatically."
- **@Bean methods**: "Create exactly these beans, with this construction logic."

If you want, I can convert these examples into a **Spring Boot** project structure and show how @SpringBootApplication automatically enables component scanning and simplifies bootstrapping. Or we can add **@Autowired, scopes, and qualifiers** examples inside controllers/services to see different DI flavors. What would you like next?







The image is explaining the **lifecycle of a Bean** in the context of **Spring Framework** (or similar dependency injection frameworks in Java).
Here's what each stage means:

1. **Bean Created**
   - The container (like Spring IoC container) creates an instance of the bean class.
2. **Dependency Injected**
   - The container injects all required dependencies into the bean (using constructor injection, setter injection, etc.).
3. **Bean Initialized**
   - Any initialization logic runs here (e.g., methods annotated with @PostConstruct or custom init methods).
4. **Bean is Used**

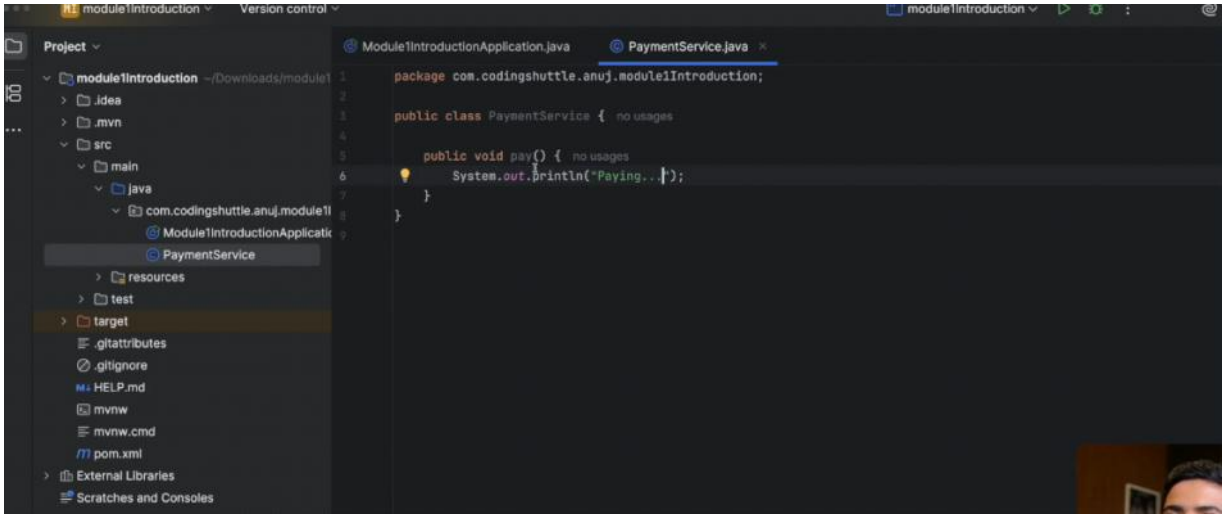
- The bean is now ready for use by the application. It serves its purpose during the application lifecycle.

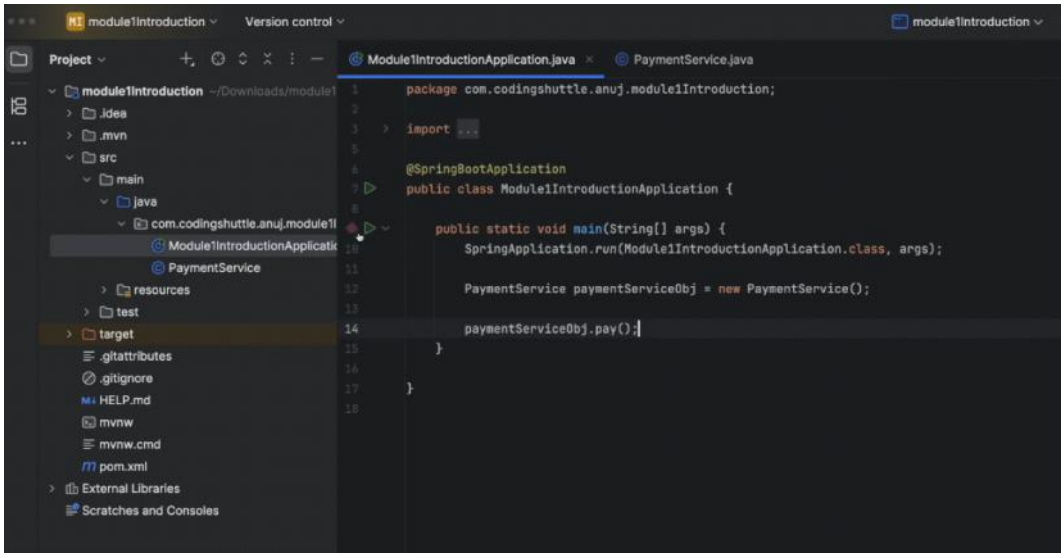
5. **Bean is Destroyed**
   - When the application context is closed, the bean is cleaned up (e.g., methods annotated with @PreDestroy or custom destroy methods).

This lifecycle is fundamental in **Spring's Inversion of Control (IoC)** and **Dependency Injection (DI)** concepts.

Would you like me to **draw a detailed diagram showing how this lifecycle works in Spring with annotations and interfaces**? Or should I **explain the role of each phase with code examples**?

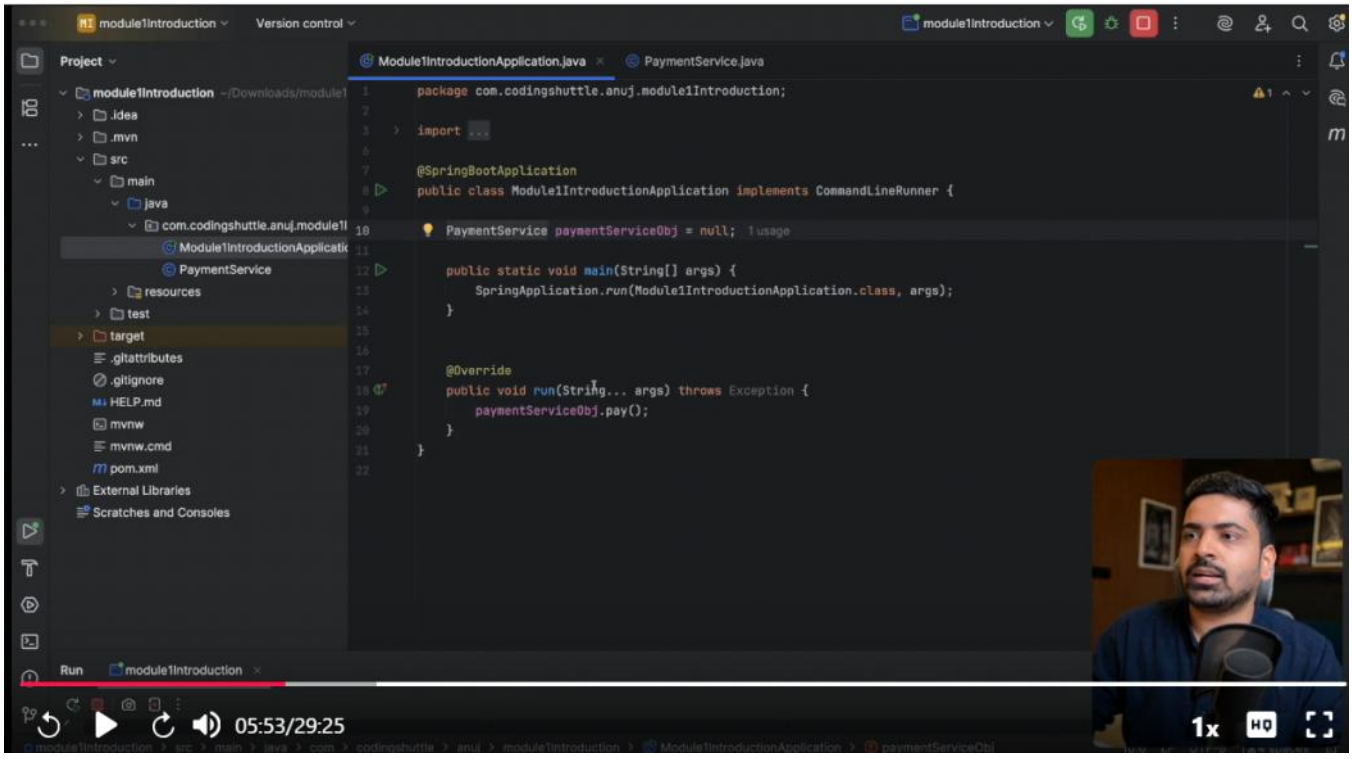
@Configuration -> within this file we gonna make a lotta beans



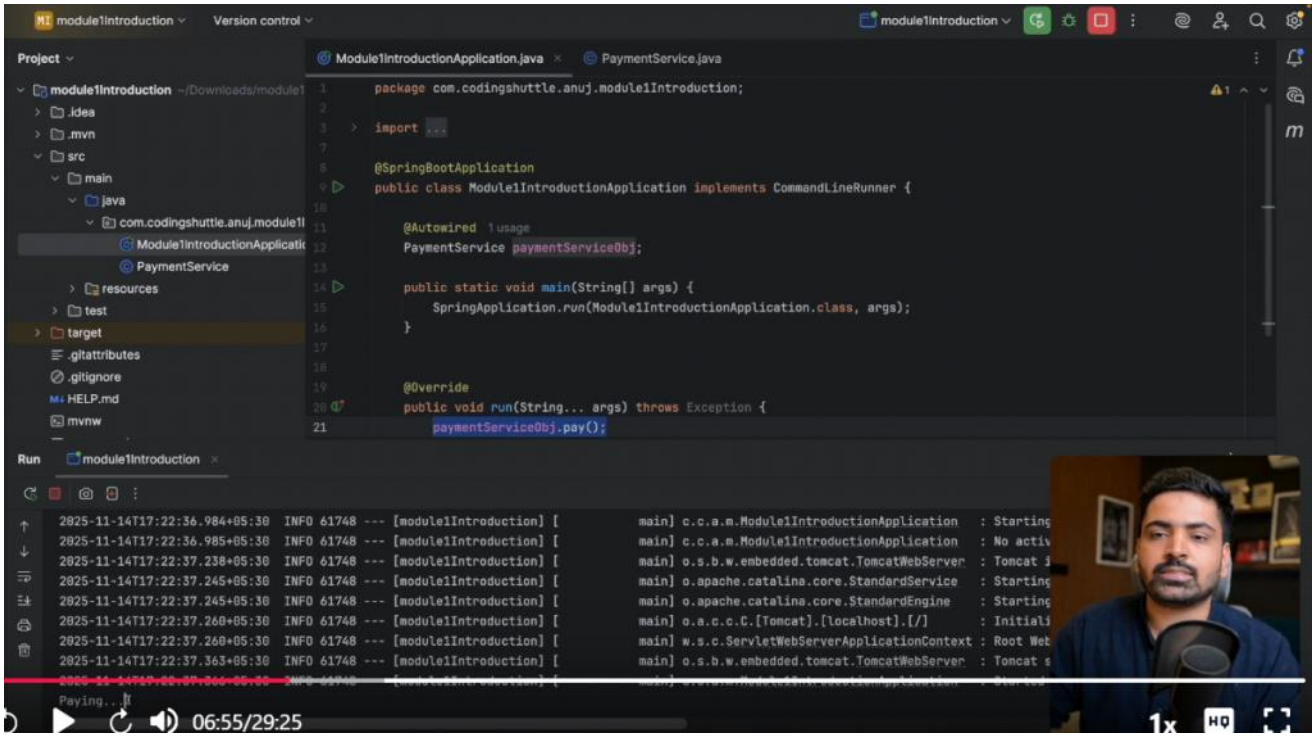


Output: Paying...

Now we are just trying to get into some Spring magic

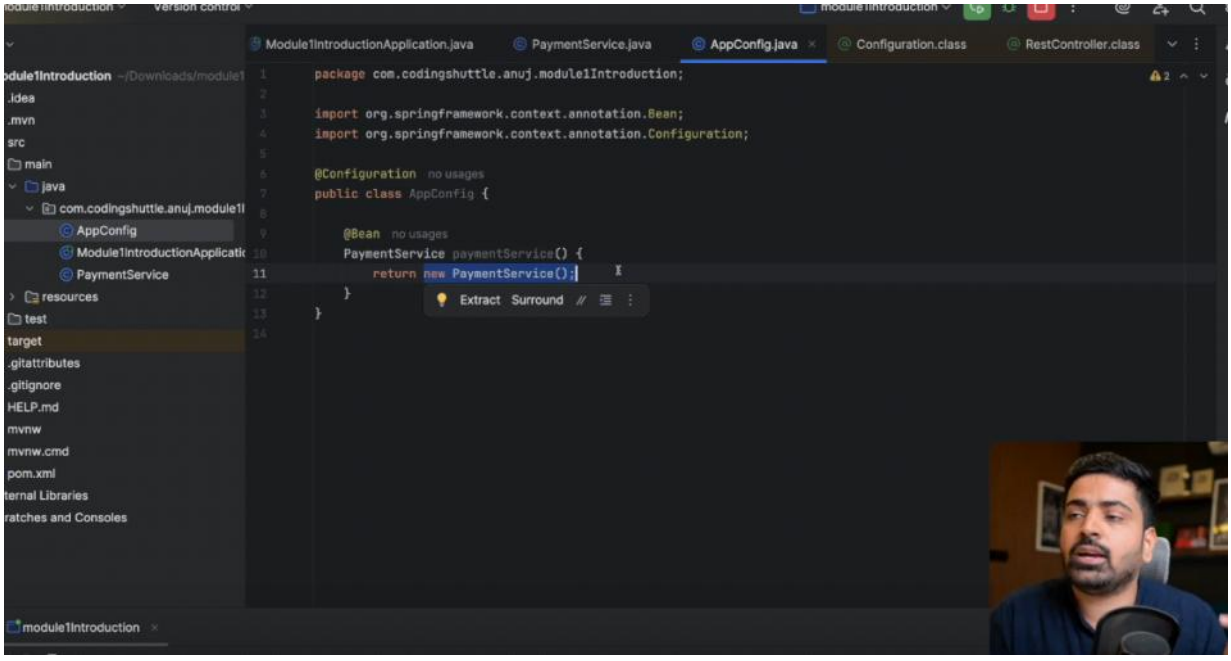


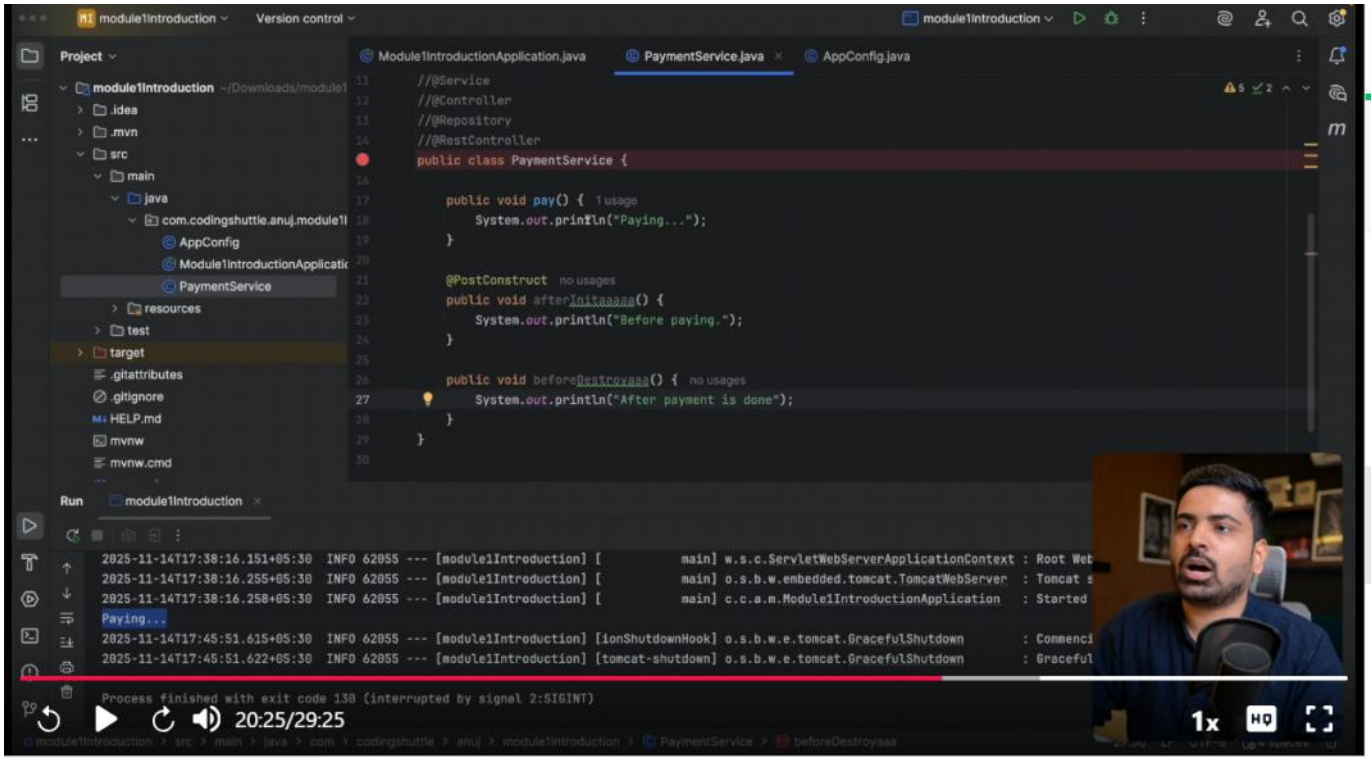
After using @Autowired ,



Spring IOC container will manage the objects

Now, we can create @Beans instead of @Component as in PaymentService class earlier.





Got it, Arka. Let's use **your exact code** and explain **what @Bean does**, **how it differs from @Component**, and **why you see new in the @Bean method but not with @Component**—step by step and super lucid.

Your code (annotated)

```
@Component
public class PaymentService {
    public void pay() {
        System.out.println("Paying...");
    }
}
// Bootstraps the Spring context
public static void main(String[] args) {
    SpringApplication.run(Module1IntroductionApplication.class, args);
}
@Configuration
public class AppConfig {
    @Bean
    @Scope("request")
    public PaymentService paymentService() {
        // more logic
        return new PaymentService(); // <-- you wrote "new" here
    }
```

You are defining **two ways** to register PaymentService as a Spring bean:

1. @Component on the class
2. @Bean method inside @Configuration

Both produce a bean, but **they do it differently**. Here's how.

How @Component works (with your class)

- @Component means: **"Spring, during component scanning, detect this class and create a bean from it."**
- Spring finds PaymentService when the app starts (thanks to @SpringBootApplication enabling component scan).
- Spring creates an instance **without you writing new**. It does this internally using reflection:
  - It calls the class's constructor (default no-args constructor here).
  - It registers that instance in the Application Context.
- **Default scope** is singleton (one instance for the whole app), unless you add @Scope on the class.

Why no new in your code?\ Because **you're not the factory** here—**Spring is**. You just annotate the class; Spring takes care of constructing the object.

How @Bean works (with your AppConfig)

- @Bean means: **"Spring, call this method and register its return value as a bean."**
- Spring loads AppConfig (because it's @Configuration).
- Spring **invokes the paymentService() method** and **whatever object you return becomes the bean**.
- In your method, you wrote:
  return new PaymentService();
  That's **you** explicitly constructing the object (i.e., **you are the factory** here).
- You also set @Scope("request"), which tells Spring: "create a fresh instance **per HTTP request** (via a proxy)." This only works in a web context.

Why do you use new here?\ Because **@Bean is a factory method**—you are telling Spring exactly **how to build** the object, so you write new (or call builders, set properties, etc.).

Short, crisp contrast (using your example)

Aspect	@Component on PaymentService	@Bean in AppConfig.paymentService()
Who constructs the object?	**Spring** (via component scan & reflection)	**You**, inside the method
Where defined?	On the class itself	Inside a configuration class
Bean name (default)	paymentService (from class name)	paymentService (from method name)
Scope	Singleton by default (unless you put @Scope on class)	You set it per method (here: request)
Use cases	Simple, your own classes	Custom construction, variants, third-party classes, special scopes

Important: Your code has two beans of the same type/name

Since both @Component and @Bean produce a bean named paymentService by default:

- Spring Boot (modern versions) will **fail** with a bean definition collision (or injection ambiguity) unless you:
  - Give **different names**:
    @Component("paymentServiceComponent")
    public class PaymentService { ... }
    @Bean(name = "paymentServiceRequestScoped")
    @Scope("request")
    public PaymentService paymentService() { return new PaymentService(); }
  - Or **remove one** of the definitions (recommended).
  - Or use @Primary on the one you want injected by default.

One more subtlety: @Scope("request") needs a web context

- If you run only main() without a web server/controller, a **request-scoped** bean won't be meaningful.
- In a Spring Boot web app, @Scope("request") works by injecting a **proxy** that gives a fresh PaymentService instance on each HTTP request.

If you just want to print "Paying..." on startup, don't use request scope; use singleton and call it via a runner:

```
@SpringBootApplication
public class Module1IntroductionApplication {
   public static void main(String[] args) {
      SpringApplication.run(Module1IntroductionApplication.class, args);
   }
   @Bean
   public CommandLineRunner runner(PaymentService paymentService) {
      return args -> paymentService.pay(); // prints "Paying..."
   }
```

And choose **one** registration:

Option A: via @Component

```
@Component
public class PaymentService {
   public void pay() { System.out.println("Paying..."); }
}
```

Option B: via @Bean

```
@Configuration
public class AppConfig {
   @Bean
   public PaymentService paymentService() {
      return new PaymentService(); // we construct it here
   }
```

The core answer to your "why"

- **In @Component, you don't write new** because you are **declaring** that the class is a Spring-managed component, and Spring's **component scanner** creates it for you.
- **In @Bean, you do write new** because you are **defining a factory method** that returns the object; **you control** how it's constructed. Spring simply **registers the return value** as the bean.

Think of it like:

- @Component → "**Spring, find this class and make the bean yourself.**"
- @Bean → "**Spring, here's a method; I'll build the object and hand it to you. Use it as a bean.**"

If you tell me whether your app is web or CLI, I'll refactor your exact snippet to the cleanest working version (no collisions, correct scope) and show where "Paying..." will print.

Perfect, Arka! Here are **two minimal, runnable examples** that achieve the **same thing**—register PaymentService as a Spring bean and call pay()—using:

1. **@Component** (component scanning)
2. **@Bean** (explicit configuration)

Both examples print Paying... on application startup via a CommandLineRunner.

◇ Example A — Using @Component

What you do: Annotate the class; let Spring discover and create it.

```
// DemoApplication.java
import org.springframework.boot.CommandLineRunner;
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);
   }
   // Runs after the context starts; injects PaymentService and calls pay()
   @Bean
   public CommandLineRunner runner(PaymentService paymentService) {
      return args -> paymentService.pay();
   }
}

// PaymentService.java
import org.springframework.stereotype.Component;
@Component  // <-- Spring will discover and instantiate this bean
public class PaymentService {
   public void pay() {
      System.out.println("Paying...");
   }
}
```

How it works:

- @SpringBootApplication enables component scanning.
- Spring finds @Component on PaymentService and **creates the bean** (you don't write new).
- CommandLineRunner is injected with PaymentService and calls pay().

◇ Example B — Using @Bean

What you do: Provide a factory method returning the object.

```
// DemoApplication.java
import org.springframework.boot.CommandLineRunner;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.Bean;
@SpringBootApplication
public class DemoApplication {
   public static void main(String[] args) {
      SpringApplication.run(DemoApplication.class, args);
   }
   // Runs after the context starts; injects PaymentService and calls pay()
   @Bean
   public CommandLineRunner runner(PaymentService paymentService) {
      return args -> paymentService.pay();
   }

// AppConfig.java
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
@Configuration
public class AppConfig {
   @Bean  // <-- You construct and return the bean here
   public PaymentService paymentService() {
      return new PaymentService(); // <-- "new" because you are the factory
   }
}

// PaymentService.java
```

```
// No annotations needed on the class in the @Bean approach
public class PaymentService {
    public void pay() {
        System.out.println("Paying...");
    }
}
```

How it works:

- Spring loads AppConfig because it's @Configuration.
- It calls the paymentService() method and **registers the returned object** as a bean.
- CommandLineRunner is injected with that bean and calls pay().

🧠 Key difference (in one line)

- @Component: **Spring constructs** the object (no new in your code).
- @Bean: **You construct** the object inside the method (you usually use new, or a factory).

⚠ Important

Don't keep **both** definitions for the same type (PaymentService) at the same time in one app, or you'll have bean conflicts. Choose **either** @Component **or** @Bean.

If you want, I can share a **Maven/Gradle skeleton** or a **REST endpoint version** (instead of CommandLineRunner) that calls pay() on GET /pay.

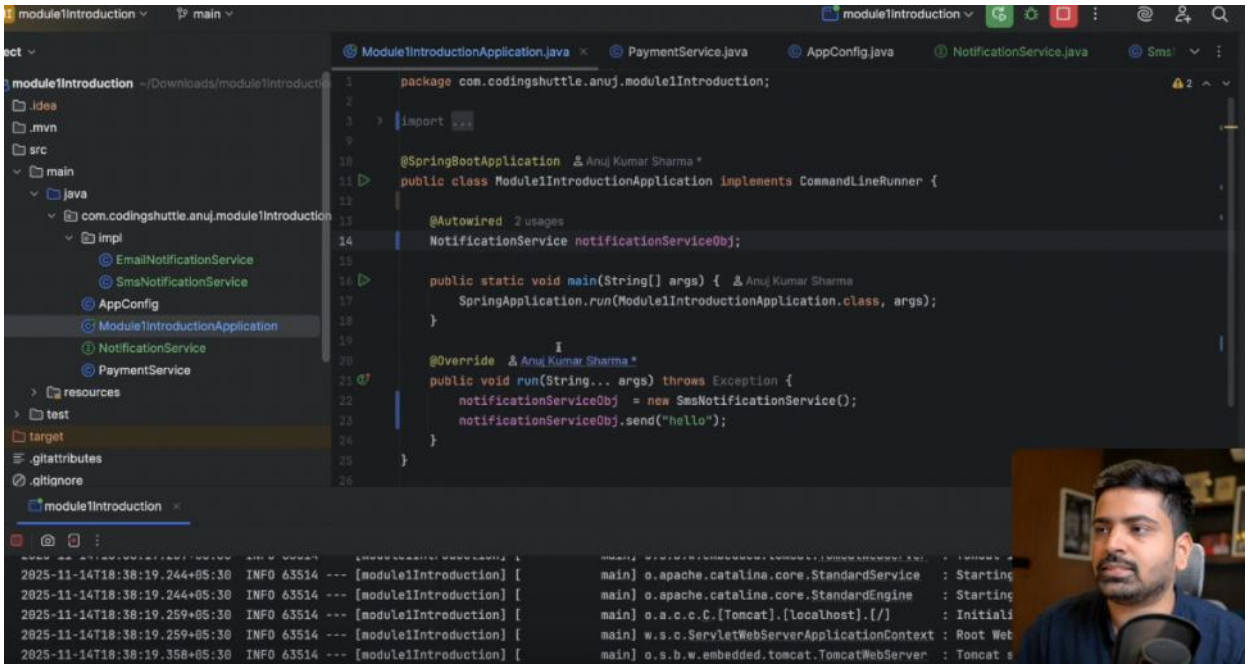
Dependency Injection

We have used NotificationServices interface example here to explain us the tightly coupled scenario. Because we created 2 classes - SmsNotification and EmailNotification which implements the interface, and their method overrides it.

But in the main method, we create

Here, to change implementation of NotificationServices to either email, or phone, we have to make changes in the object creation of interface line. So the Main Class is tightly coupled with the NotificationService we use.

So, for loose coupling we have to create a Bean. But we can't create bean of interface, because we can't create object of an interface. SO give component annotation in email or smsService classes, and give @Autowired annotation in main class where we define NotificationService interface object (dependency injection, But field dependency is happening here and not recommended, Constructor dependency is more preferred than this, will be discussed later)

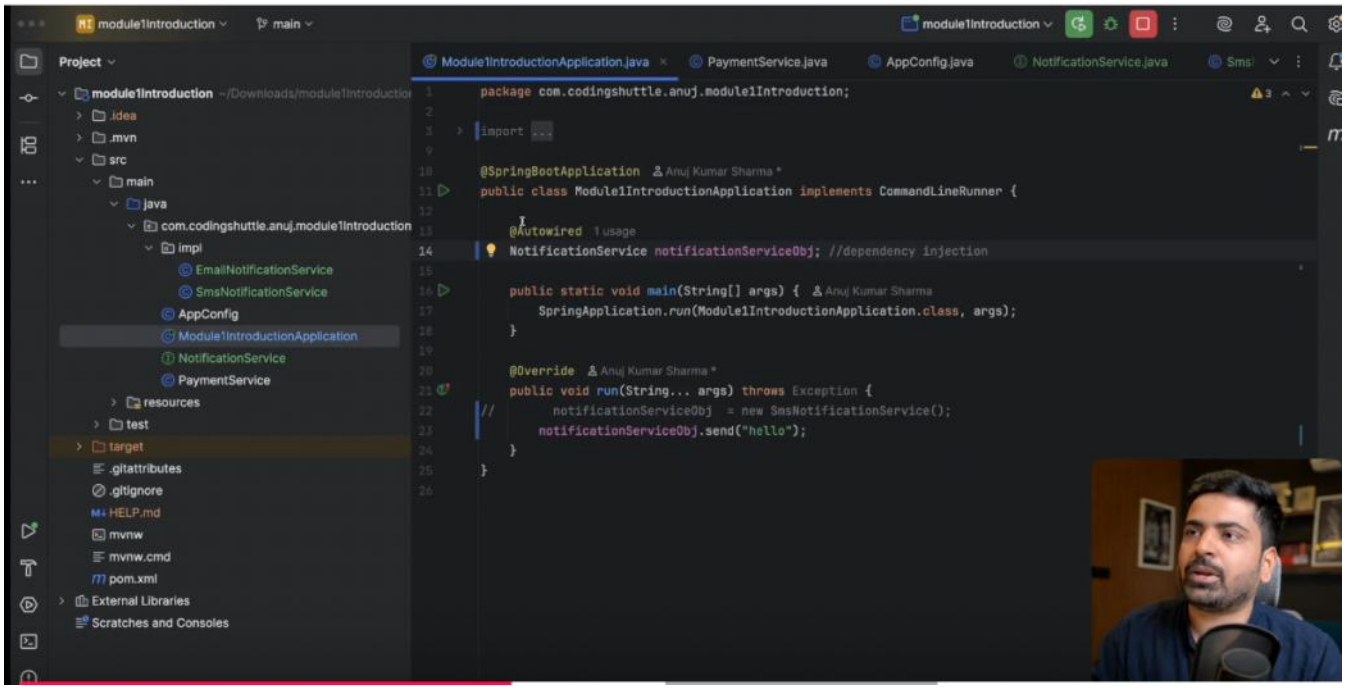


If u give component in both classes - email and sms - ambiguity

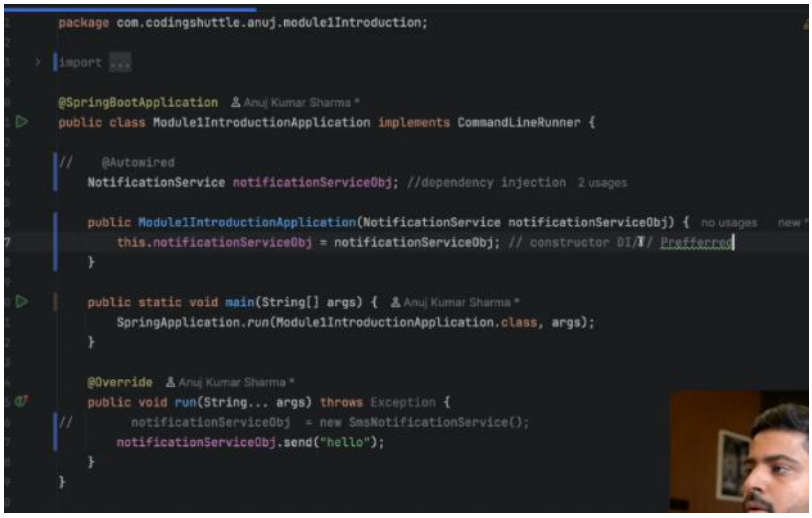
Then make one of em as @Primary

We should use constructor dependencies.

Now, we can see Dependency injection is not happening in constructor, instead happening in field (field dependency injection)



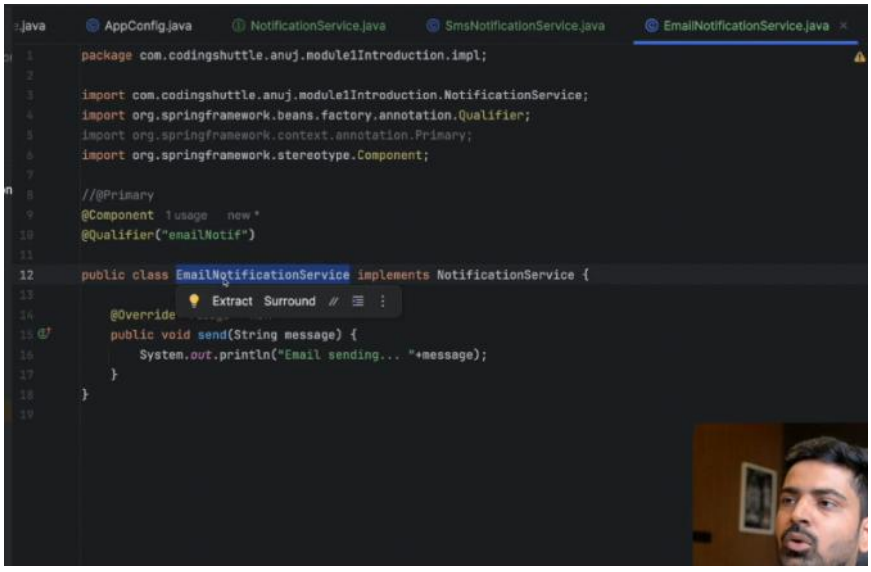
So, we are doing constructor dependency now :



It is preferred because now u can make the notificationService object as final (cant change after initializaation)

So we are making objects immutable

We can use qualifiers like these, instead of using @Primary beans.

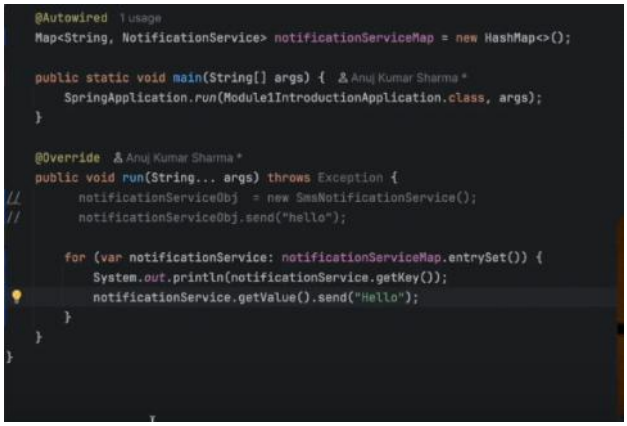


Also, instead of qualifiers also,

We can provide conditional statements to Beans also in application.preoperties, like notification.type=email.

Then use @ConditionalOnProperties on EmailNotificationService class then.

Now consider I wanna send notification to both email and sms, then? I wanna get hold of all the imeplementations. Then in Main Class,



Let me break this down in a **lucid and easy-to-grasp way**:

☑ What is Spring MVC?

Spring MVC is a **web framework** in the Spring ecosystem that follows the **Model-View-Controller (MVC)** pattern.\ This pattern helps **separate concerns**:

- **Model** → Data + Business Logic
- **View** → UI (HTML, JSP, Thymeleaf)
- **Controller** → Handles requests and connects Model & View

☑ Core Idea

The **DispatcherServlet** is the **front controller**.\ Think of it as the **traffic cop**:

- It receives all HTTP requests.
- Decides which controller should handle them.
- Collects the response (Model + View) and sends it back.

☑ Spring MVC Flow (Step-by-Step)

1. **Client sends a request** → e.g., /home
2. **DispatcherServlet intercepts it**
3. **HandlerMapping** finds the right controller method
4. **Controller executes logic** → returns ModelAndView
5. **ViewResolver** picks the correct view (e.g., home.jsp)
6. **Response sent back to client**

Example Controller

```
@Controller
public class HomeController {
    @RequestMapping("/home")
    public ModelAndView home() {
        ModelAndView mav = new ModelAndView();
```

```
        mav.setViewName("home"); // View name
        mav.addObject("message", "Welcome to Spring MVC!"); // Model data
        return mav;
    }
}
```

- URL /home → handled by home() method.
- Returns **ModelAndView** → combines **data** + **view name**.

☑ Key Components

- **DispatcherServlet** → Front Controller
- **HandlerMapping** → Maps URL to controller
- **Controller** → Processes request
- **ModelAndView** → Holds data + view name
- **ViewResolver** → Finds the actual view file

In short:

Spring MVC = **DispatcherServlet + MVC pattern + flexible mappings**\ It makes web apps **organized, scalable, and easy to maintain**.

👉 Do you want me to create a **diagram of the Spring MVC flow** (with arrows showing how request moves through DispatcherServlet, Controller, Model, View)? Or a **one-page cheat sheet** summarizing all components?

JPA dependency and H2 dependency added for JPA.

You will notice that we are repeating the code for Employee Entity and Employee DTO, but DTO is for security purposes.

@PathVariable is used for mandatory values that are a part of the URL path, typically to identify a specific resource (e.g., /users/{id}). @RequestParam is used for optional values from the query string, which are appended after a ? and used for filtering or other parameters (e.g., /products?category=electronics). The choice between them depends on whether the parameter is an identifier within the resource's hierarchy or a filter for that resource.

The Presentation Layer, DTO and Controllers

Here's the Spring Boot code for the two files you requested:

1. EmployeeDTO.java

This is the Data Transfer Object (DTO) with the specified attributes, getters, setters, and constructors.

```
package com.example.demo.dto;
import java.time.LocalDate;
public class EmployeeDTO {
    private Long id;
    private String name;
    private String email;
    private int age;
    private LocalDate dateOfJoining;
    private boolean isActive;
    // Default constructor
    public EmployeeDTO() {
    }
    // Parameterized constructor
    public EmployeeDTO(Long id, String name, String email, int age, LocalDate dateOfJoining, boolean
isActive) {
        this.id = id;
        this.name = name;
        this.email = email;
        this.age = age;
        this.dateOfJoining = dateOfJoining;
        this.isActive = isActive;
    }
    // Getters and Setters
    public Long getId() {
        return id;
    }
    public void setId(Long id) {
        this.id = id;
    }
    public String getName() {
        return name;
    }
    public void setName(String name) {
        this.name = name;
    }
    public String getEmail() {
        return email;
    }
    public void setEmail(String email) {
        this.email = email;
    }
    public int getAge() {
        return age;
    }
    public void setAge(int age) {
        this.age = age;
    }
    public LocalDate getDateOfJoining() {
        return dateOfJoining;
    }
    public void setDateOfJoining(LocalDate dateOfJoining) {
        this.dateOfJoining = dateOfJoining;
    }
    public boolean isActive() {
        return isActive;
    }
    public void setActive(boolean active) {
```

```
        isActive = active;
    }
}
```

2. EmployeeController.java

This controller defines a @GetMapping endpoint that returns a dummy EmployeeDTO object.

```
package com.example.demo.controller;
importController;
import java.time.LocalDate;
@RestController
public class EmployeeController {
    @GetMapping("/employee")
    public EmployeeDTO getEmployee() {
        // Returning dummy employee details
        return new EmployeeDTO(
                1L,
                "John Doe",
                "john.doe@example.com",
                30,
                LocalDate.of(2020, 5, 15),
                true
        );
    }
}
```

☑ This will create a simple Spring Boot REST API with one endpoint:\ **GET /employee** → returns a JSON representation of the dummy EmployeeDTO.

Do you want me to also provide:

- **pom.xml dependencies** for Spring Boot setup?
- A **complete project structure** (with Application.java)?
- Or **add Swagger/OpenAPI documentation** for the endpoint?

The Persistence Layer and JPA Repository

Absolutely! Here are the three files you asked for—clean, ready to drop into a Spring Boot project.

1) EmployeeEntity.java

JPA entity with fields: name, id, email, age, dateOfJoining, isActive. The id uses GenerationType.AUTO.

```
package com.example.demo.entity;
import jakarta.persistence.Entity;
import jakarta.persistence.GeneratedValue;
import jakarta.persistence.GenerationType;
import jakarta.persistence.Id;
import jakarta.persistence.Table;
```

```
import java.time.LocalDate;
@Entity
@Table(name = "employees")
public class EmployeeEntity {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;
    private String name;
    private String email;
    private int age;
    private LocalDate dateOfJoining;
    private boolean isActive;
    // Default constructor
    public EmployeeEntity() {
    }
    // Parameterized constructor (optional)
    public EmployeeEntity(Long id, String name, String email, int age, LocalDate dateOfJoining,
boolean isActive) {
        this.id = id;
        this.name = name;
        this.email = email;
        this.age = age;
        this.dateOfJoining = dateOfJoining;
        this.isActive = isActive;
    }
    // Getters and setters
    public Long getId() { return id; }
    public void setId(Long id) { this.id = id; }
    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public String getEmail() { return email; }
    public void setEmail(String email) { this.email = email; }
    public int getAge() { return age; }
    public void setAge(int age) { this.age = age; }
    public LocalDate getDateOfJoining() { return dateOfJoining; }
    public void setDateOfJoining(LocalDate dateOfJoining) { this.dateOfJoining = dateOfJoining; }
    public boolean isActive() { return isActive; }
    public void setActive(boolean active) { isActive = active; }
}
```

2) EmployeeRepository.java

Spring Data JPA repository interface.

```
package com.example.demo.repository;
import com.example.demo.entity.EmployeeEntity;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.stereotype.Repository;
@Repository
public interface EmployeeRepository extends JpaRepository<EmployeeEntity, Long> {
}
```

3) EmployeeController.java

Constructor-based dependency injection; GET /employees/{employeeId} returns EmployeeEntity by ID (or null if not found).

```
package com.example.demo.controller;
import com.example.demo.entity.EmployeeEntity;
import com.example.demo.repository.EmployeeRepository;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
```

```
import org.springframework.web.bind.annotation.RestController;
@RestController
@RequestMapping("/employees")
public class EmployeeController {
    private final EmployeeRepository employeeRepository;
    // Constructor Dependency Injection
    public EmployeeController(EmployeeRepository employeeRepository) {
        this.employeeRepository = employeeRepository;
    }
    @GetMapping("/{employeeId}")
    public EmployeeEntity getEmployeeById(@PathVariable(name = "employeeId") Long id) {
        return employeeRepository.findById(id).orElse(null);
    }
}
```

Optional tips (if you're wiring this up quickly)

- **Dependencies** (in pom.xml):

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
</dependency>
<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>
```

- **H2 quick config** (in application.properties):

```
spring.datasource.url=jdbc:h2:mem:testdb
spring.jpa.hibernate.ddl-auto=update
spring.h2.console.enabled=true
```

- If you return LocalDate in JSON, Spring Boot/Jackson handles it out-of-the-box. If you need a custom format, add:

```
// @JsonFormat(pattern = "yyyy-MM-dd")
private LocalDate dateOfJoining;
```

Want me to add a **POST endpoint to create an employee**, or map EmployeeEntity to your EmployeeDTO for cleaner API responses?

That single line packs a lot of meaning in Spring Data JPA. Let's break it down:

@Repository

- Marks this interface as a **Spring Bean** of type repository.
- Spring will **detect it during component scanning** and create an implementation automatically.
- Also enables **exception translation** (converts JPA exceptions into Spring's DataAccessException hierarchy).

public interface EmployeeRepository extends JpaRepository<EmployeeEntity, Long>

- This declares an **interface**, not a class. You don't write any implementation.
- JpaRepository<T, ID> is a **generic interface** provided by Spring Data JPA:
  - T → The **entity type** you want to manage (EmployeeEntity).
  - ID → The **type of the primary key** in that entity (Long because your @Id field is Long).

What happens under the hood?

- Spring Data JPA sees this interface and **creates a proxy implementation at runtime**.
- That implementation uses the **JPA EntityManager** to perform CRUD operations.
- All standard methods are ready for you:
  - findById(Long id)
  - findAll()
  - save(EmployeeEntity entity)
  - deleteById(Long id)
  - and many more.

How is it mapped to EmployeeEntity?

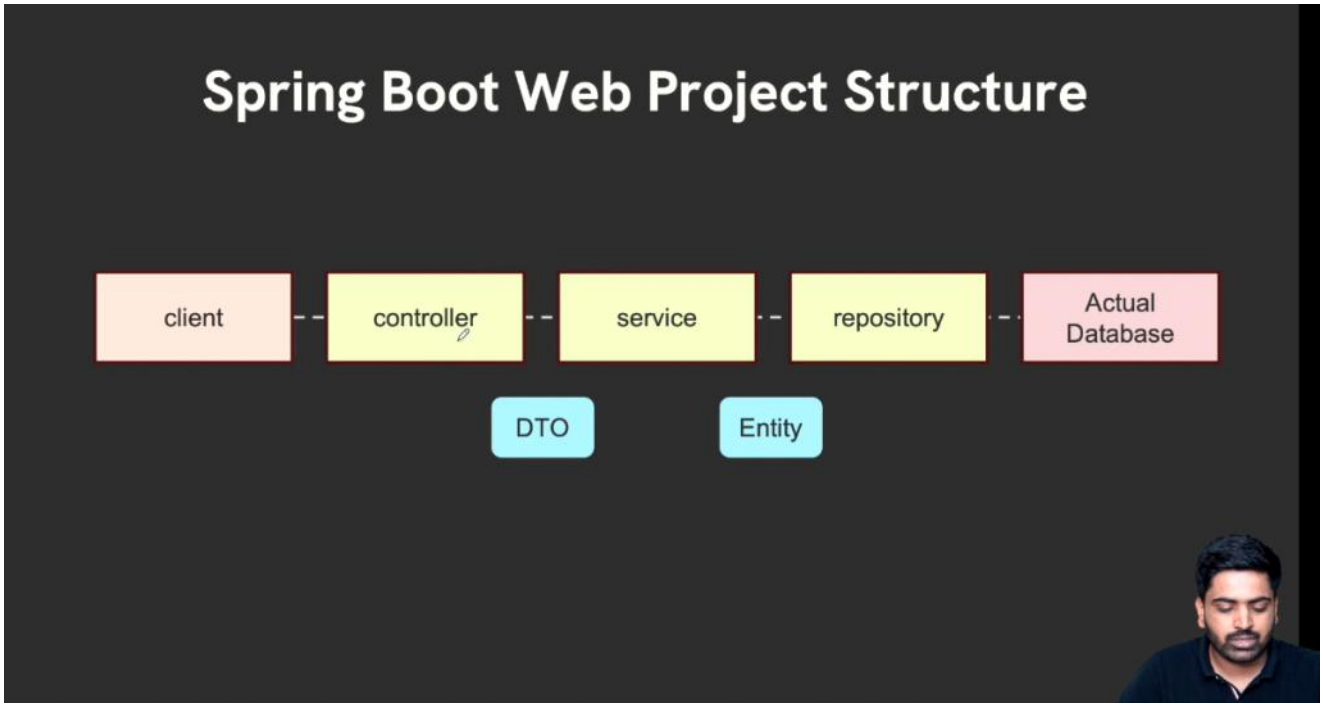
- Because you passed EmployeeEntity as the first generic type, Spring knows:
  - Which **table** to query → from @Entity and @Table annotations.
  - Which **columns** to map → from the fields in EmployeeEntity.
- Hibernate (the JPA provider) translates repository calls into SQL queries for the employees table.

In short:

This line means:

> "Create a Spring-managed repository bean that provides all CRUD operations for the EmployeeEntity class, whose primary key is of type Long, without me writing any SQL or implementation."

☑ Would you like me to **show all the methods you automatically get from JpaRepository** and also **how you can add custom query methods like findByEmail without writing SQL**?

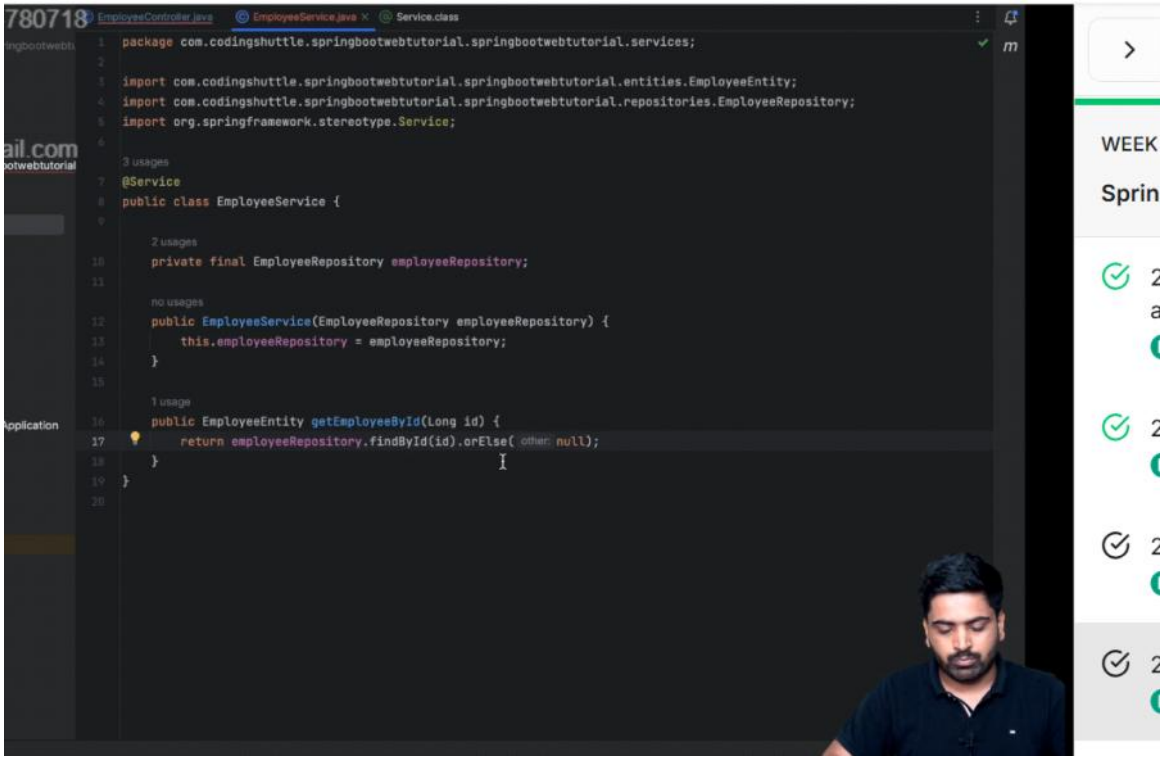


The Service Layer

we would be removing EmployeeRepository object from EMployeeController as it is not a good practice.
Rather add EmployeeService object there.

Use repositroy in service/

```java
package com.codingshuttle.springbootwebtutorial.springbootwebtutorial.services;

import com.codingshuttle.springbootwebtutorial.springbootwebtutorial.entities.EmployeeEntity;
import com.codingshuttle.springbootwebtutorial.springbootwebtutorial.repositories.EmployeeRepository;
import org.springframework.stereotype.Service;

3 usages
@Service
public class EmployeeService {

    2 usages
    private final EmployeeRepository employeeRepository;

    no usages
    public EmployeeService(EmployeeRepository employeeRepository) {
        this.employeeRepository = employeeRepository;
    }

    1 usage
    public EmployeeEntity getEmployeeById(Long id) {
        employeeRepository.findById(id)
    }
}
```



Creating a new employee

EmployeeCrontroller.java

```java
@PostMapping
public EmployeeEntity createNewEmployee(@RequestBody EmployeeEntity inputEmployee) {
    return employeeService.createNewEmployee(inputEmployee);
}
```

EmployeeService.java

```
1 usage
public EmployeeEntity createNewEmployee(EmployeeEntity inputEmployee) {
    return employeeRepository.save(inputEmployee);
}
}
```

So we can see controller is completely stripped of the repository and we are usig service in controller.
And the service is using repository.

But in the controller, we are stil using Entity. But we shudn't, rather we should use DTO.

Add model Mapper dependency.So, in employeeService, use:

```
1 usage  1 related problem
public EmployeeDTO getEmployeeById(Long id) {
    EmployeeEntity employeeEntity = employeeRepository.findById(id).orElse( other: null);
    ModelMapper mapper = new ModelMapper();
    return mapper.map(employeeEntity, EmployeeDTO.class);
}
```

EmployeeController

```
@GetMapping(path = "/{employeeId}")
public EmployeeDTO getEmployeeById(@PathVariable(name = "employeeId") Long id) {
    return employeeService.getEmployeeById(id);
}
```

MapperConfig

```
EmployeeController.java  EmployeeService.java  MapperConfig.java  EmployeeEntity.java  pom.xml (springbootwebtutorial)  Service
1  package com.codingshuttle.springbootwebtutorial.springbootwebtutorial.configs;
2
3
4  import org.modelmapper.ModelMapper;
5  import org.springframework.context.annotation.Bean;
6
   no usages
7  public class MapperConfig {
8
       no usages
9      @Bean
10     public ModelMapper getModelMapper() {
11         return new ModelMapper();
12     }
13
14 }
15
```

Now constructor inject modelmapper object in EmployeeService

Nice work, Arka — the base setup is clean. 👌 \ You're absolutely right: it's better to **introduce a service layer** and **return DTOs** from the controller rather than exposing your JPA entities directly. Below is a drop-in refactor with:

- EmployeeService + EmployeeServiceImpl
- EmployeeDTO (with validation)
- A simple EmployeeMapper (manual, no extra dependency)
- Controller refactored to use the service and return DTOs
- A POST /employees endpoint that returns 201 Created and sets a Location header
- Minimal exception handling (404 for not found)
  If you'd prefer automatic mapping, I can swap in **ModelMapper** or **MapStruct**—just say the word.

1) DTO
src/main/java/com/example/demo/dto/EmployeeDTO.java

```
package com.example.demo.dto;
import com.fasterxml.jackson.annotation.JsonFormat;
import jakarta.validation.constraints.*;
import java.time.LocalDate;
public class EmployeeDTO {
    private Long id;
    @NotBlank(message = "Name is required")
    private String name;
    @NotBlank(message = "Email is required")
    @Email(message = "Email must be valid")
    private String email;
    @Min(value = 18, message = "Age must be at least 18")
    @Max(value = 70, message = "Age must be at most 70")
    private Integer age;
    @PastOrPresent(message = "Date of joining cannot be in the future")
    @JsonFormat(pattern = "yyyy-MM-dd")
    private LocalDate dateOfJoining;
    @NotNull(message = "Active flag is required")
    private Boolean active;
    public EmployeeDTO() {}
    public EmployeeDTO(Long id, String name, String email, Integer age, LocalDate dateOfJoining,
Boolean active) {
        this.id = id;
        this.name = name;
        this.email = email;
        this.age = age;
        this.dateOfJoining = dateOfJoining;
        this.active = active;
    }
    // Getters and setters
    public Long getId() { return id; }
    public void setId(Long id) { this.id = id; }
    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public String getEmail() { return email; }
    public void setEmail(String email) { this.email = email; }
    public Integer getAge() { return age; }
```

```
    public void setAge(Integer age) { this.age = age; }
    public LocalDate getDateOfJoining() { return dateOfJoining; }
    public void setDateOfJoining(LocalDate dateOfJoining) { this.dateOfJoining = dateOfJoining; }
    public Boolean getActive() { return active; }
    public void setActive(Boolean active) { this.active = active; }
}
```

2) Mapper (manual)

src/main/java/com/example/demo/mapper/EmployeeMapper.java

```
package com.example.demo.mapper;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.entity.EmployeeEntity;
public final class EmployeeMapper {
    private EmployeeMapper() {}
    public static EmployeeDTO toDTO(EmployeeEntity entity) {
        if (entity == null) return null;
        return new EmployeeDTO(
                entity.getId(),
                entity.getName(),
                entity.getEmail(),
                entity.getAge(),
                entity.getDateOfJoining(),
                entity.isActive()
        );
    }
    public static EmployeeEntity toEntity(EmployeeDTO dto) {
        if (dto == null) return null;
        EmployeeEntity entity = new EmployeeEntity();
        entity.setId(dto.getId()); // usually null on create
        entity.setName(dto.getName());
        entity.setEmail(dto.getEmail());
        entity.setAge(dto.getAge() != null ? dto.getAge() : 0);
        entity.setDateOfJoining(dto.getDateOfJoining());
        entity.setActive(dto.getActive() != null && dto.getActive());
        return entity;
    }
    public static void copyToEntity(EmployeeDTO dto, EmployeeEntity entity) {
        if (dto.getName() != null) entity.setName(dto.getName());
        if (dto.getEmail() != null) entity.setEmail(dto.getEmail());
        if (dto.getAge() != null) entity.setAge(dto.getAge());
        if (dto.getDateOfJoining() != null) entity.setDateOfJoining(dto.getDateOfJoining());
        if (dto.getActive() != null) entity.setActive(dto.getActive());
    }
}
```

3) Service Layer

src/main/java/com/example/demo/service/EmployeeService.java

```
package com.example.demo.service;
import com.example.demo.dto.EmployeeDTO;
import java.util.List;
public interface EmployeeService {
    EmployeeDTO getById(Long id);
    EmployeeDTO create(EmployeeDTO dto);
    List<EmployeeDTO> getAll();
    EmployeeDTO update(Long id, EmployeeDTO dto);
```

```
    void delete(Long id);
}
```

src/main/java/com/example/demo/service/impl/EmployeeServiceImpl.java

```
package com.example.demo.service.impl;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.entity.EmployeeEntity;
import com.example.demo.exception.ResourceNotFoundException;
import com.example.demo.mapper.EmployeeMapper;
import com.example.demo.repository.EmployeeRepository;
import com.example.demo.service.EmployeeService;
import org.springframework.stereotype.Service;
import java.util.List;
import java.util.stream.Collectors;
@Service
public class EmployeeServiceImpl implements EmployeeService {
    private final EmployeeRepository employeeRepository;
    public EmployeeServiceImpl(EmployeeRepository employeeRepository) {
        this.employeeRepository = employeeRepository;
    }
    @Override
    public EmployeeDTO getById(Long id) {
        EmployeeEntity entity = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        return EmployeeMapper.toDTO(entity);
    }
    @Override
    public EmployeeDTO create(EmployeeDTO dto) {
        EmployeeEntity toSave = EmployeeMapper.toEntity(dto);
        toSave.setId(null); // ensure auto-generated
        EmployeeEntity saved = employeeRepository.save(toSave);
        return EmployeeMapper.toDTO(saved);
    }
    @Override
    public List<EmployeeDTO> getAll() {
        return employeeRepository.findAll().stream()
                .map(EmployeeMapper::toDTO)
                .collect(Collectors.toList());
    }
    @Override
    public EmployeeDTO update(Long id, EmployeeDTO dto) {
        EmployeeEntity existing = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        EmployeeMapper.copyToEntity(dto, existing);
        EmployeeEntity updated = employeeRepository.save(existing);
        return EmployeeMapper.toDTO(updated);
    }
    @Override
    public void delete(Long id) {
        EmployeeEntity existing = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        employeeRepository.delete(existing);
    }
}
```

4) Exceptions

src/main/java/com/example/demo/exception/ResourceNotFoundException.java

```
package com.example.demo.exception;
public class ResourceNotFoundException extends RuntimeException {
    public ResourceNotFoundException(String message) { super(message); }
}
```

src/main/java/com/example/demo/exception/GlobalExceptionHandler.java

```
package com.example.demo.exception;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.MethodArgumentNotValidException;
import org.springframework.web.bind.annotation.ExceptionHandler;
import org.springframework.web.bind.annotation.RestControllerAdvice;
import java.util.HashMap;
import java.util.Map;
@RestControllerAdvice
public class GlobalExceptionHandler {
    @ExceptionHandler(ResourceNotFoundException.class)
    public ResponseEntity<Map<String, Object>> handleNotFound(ResourceNotFoundException ex) {
        Map<String, Object> body = new HashMap<>();
        body.put("error", "Not Found");
        body.put("message", ex.getMessage());
        return ResponseEntity.status(HttpStatus.NOT_FOUND).body(body);
    }
    @ExceptionHandler(MethodArgumentNotValidException.class)
    public ResponseEntity<Map<String, Object>>
handleValidation(MethodArgumentNotValidException ex) {
        Map<String, Object> body = new HashMap<>();
        body.put("error", "Validation Failed");
        Map<String, String> fieldErrors = new HashMap<>();
        ex.getBindingResult().getFieldErrors()
                .forEach(err -> fieldErrors.put(err.getField(), err.getDefaultMessage()));
        body.put("details", fieldErrors);
        return ResponseEntity.badRequest().body(body);
    }
}
```

5) Controller (refactored)

src/main/java/com/example/demo/controller/EmployeeController.java

```
package com.example.demo.controller;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.service.EmployeeService;
import jakarta.validation.Valid;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.*;
import org.springframework.web.util.UriComponentsBuilder;
import java.util.List;
@RestController
@RequestMapping("/employees")
public class EmployeeController {
    private final EmployeeService employeeService;
    // Constructor Dependency Injection
    public EmployeeController(EmployeeService employeeService) {
        this.employeeService = employeeService;
    }
    // GET /employees/{id}
    @GetMapping("/{employeeId}")
    public ResponseEntity<EmployeeDTO> getEmployeeById(@PathVariable("employeeId") Long id) {
```

```
        EmployeeDTO dto = employeeService.getById(id);
        return ResponseEntity.ok(dto);
    }
    // GET /employees
    @GetMapping
    public ResponseEntity<List<EmployeeDTO>> getAllEmployees() {
        return ResponseEntity.ok(employeeService.getAll());
    }
    // POST /employees
    @PostMapping
    public ResponseEntity<EmployeeDTO> createEmployee(
            @Valid @RequestBody EmployeeDTO employeeDTO,
            UriComponentsBuilder uriBuilder) {
        EmployeeDTO created = employeeService.create(employeeDTO);
        return ResponseEntity
                .created(uriBuilder.path("/employees/{id}").buildAndExpand(created.getId()).toUri())
                .body(created);
    }
    // PUT /employees/{id}
    @PutMapping("/{employeeId}")
    public ResponseEntity<EmployeeDTO> updateEmployee(
            @PathVariable("employeeId") Long id,
            @Valid @RequestBody EmployeeDTO employeeDTO) {
        return ResponseEntity.ok(employeeService.update(id, employeeDTO));
    }
    // DELETE /employees/{id}
    @DeleteMapping("/{employeeId}")
    public ResponseEntity<Void> deleteEmployee(@PathVariable("employeeId") Long id) {
        employeeService.delete(id);
        return ResponseEntity.noContent().build();
    }
}
```

6) Your existing Entity/Repository are fine

(Keeping your EmployeeEntity and EmployeeRepository as-is.)

src/main/java/com/example/demo/entity/EmployeeEntity.java

```
package com.example.demo.entity;
import jakarta.persistence.*;
import java.time.LocalDate;
@Entity
@Table(name = "employees")
public class EmployeeEntity {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;
    private String name;
    private String email;
    private int age;
    private LocalDate dateOfJoining;
    private boolean isActive;
    public EmployeeEntity() {}
    public EmployeeEntity(Long id, String name, String email, int age, LocalDate dateOfJoining,
boolean isActive) {
        this.id = id;
        this.name = name;
        this.email = email;
        this.age = age;
        this.dateOfJoining = dateOfJoining;
        this.isActive = isActive;
```

```
    }
    public Long getId() { return id; }
    public void setId(Long id) { this.id = id; }
    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public String getEmail() { return email; }
    public void setEmail(String email) { this.email = email; }
    public int getAge() { return age; }
    public void setAge(int age) { this.age = age; }
    public LocalDate getDateOfJoining() { return dateOfJoining; }
    public void setDateOfJoining(LocalDate dateOfJoining) { this.dateOfJoining = dateOfJoining; }
    public boolean isActive() { return isActive; }
    public void setActive(boolean active) { isActive = active; }
}
```

src/main/java/com/example/demo/repository/EmployeeRepository.java

```
package com.example.demo.repository;
import com.example.demo.entity.EmployeeEntity;
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.stereotype.Repository;
@Repository
```

7) pom.xml dependencies

Add validation support (Spring Boot 3 needs this starter explicitly):

```
<dependencies>
    <!-- Web & JPA & H2 (as you had) -->
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
    <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>
    <!-- Validation -->
    <dependency>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-validation</artifactId>
    </dependency>
</dependencies>
```

If you choose **ModelMapper**:

```
<dependency>
    <groupId>org.modelmapper</groupId>
    <artifactId>modelmapper</artifactId>
    <version>3.2.0</version>
</dependency>
```

…and we'll add a @Bean config and swap the mapper implementation.

8) application.properties (as you had)

```
spring.datasource.url=jdbc:h2:mem:testdb
spring.jpa.hibernate.ddl-auto=update
```

```
spring.h2.console.enabled=true
spring.h2.console.path=/h2-console
```

9) Quick test with cURL

Create an employee

```
curl -i -X POST http://localhost:8080/employees \
  -H "Content-Type: application/json" \
  -d '{
    "name": "Ada Lovelace",
    "email": "ada@example.com",
    "age": 30,
    "dateOfJoining": "2023-12-01",
    "active": true
  }'
```

Get by id

```
curl -i http://localhost:8080/employees/1
```

List all

Update

```
curl -i -X PUT http://localhost:8080/employees/1 \
  -H "Content-Type: application/json" \
  -d '{
    "name": "Ada L.",
    "email": "ada.l@example.com",
    "age": 31,
    "active": false
  }'
```

Delete

```
curl -i -X DELETE http://localhost:8080/employees/1
```

Why this structure?

- **Service layer** keeps business logic away from web concerns and repositories.
- **DTOs** avoid leaking persistence details and let you shape API contracts independently.
- **Validation** ensures clean inputs at the boundary.
- **Consistent HTTP semantics** (201 Created, 404 Not Found, 204 No Content) make your API predictable.

Want me to switch the mapper to ModelMapper or MapStruct, or add pagination/sorting to GET /employees? Also, if you prefer more REST-hardened responses (e.g., Problem Details RFC 7807), I can wire that up too.

ModelMapper concepts

Awesome — let's wire in **ModelMapper** and remove the manual mapper.\ Below are the exact changes you can drop into your project.

Highlights:

- ModelMapper @Bean with strict matching + skip-null mapping for updates
- Custom property maps so EmployeeEntity.isActive ↔ EmployeeDTO.active map correctly
- Service refactored to use ModelMapper for create/get/list/update

1) Add dependency (pom.xml)

```
<dependencies>
   <!-- existing dependencies -->
   <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-web</artifactId>
   </dependency>
   <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>
   <!-- validation (needed for @Valid and constraint annotations) -->
   <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-validation</artifactId>
   </dependency>
   <!-- ModelMapper -->
   <dependency>
      <groupId>org.modelmapper</groupId>
      <artifactId>modelmapper</artifactId>
      <version>3.2.0</version>
   </dependency>
</dependencies>
```

2) Keep your DTO (no change)

src/main/java/com/example/demo/dto/EmployeeDTO.java

```
package com.example.demo.dto;
import com.fasterxml.jackson.annotation.JsonFormat;
import jakarta.validation.constraints.*;
import java.time.LocalDate;
public class EmployeeDTO {
   private Long id;
   @NotBlank(message = "Name is required")
   private String name;
   @NotBlank(message = "Email is required")
   @Email(message = "Email must be valid")
   private String email;
   @Min(value = 18, message = "Age must be at least 18")
   @Max(value = 70, message = "Age must be at most 70")
   private Integer age;
   @PastOrPresent(message = "Date of joining cannot be in the future")
   @JsonFormat(pattern = "yyyy-MM-dd")
   private LocalDate dateOfJoining;
   @NotNull(message = "Active flag is required")
   private Boolean active;
   public EmployeeDTO() {}
   public EmployeeDTO(Long id, String name, String email, Integer age, LocalDate dateOfJoining,
Boolean active) {
      this.id = id;
      this.name = name;
      this.email = email;
      this.age = age;
      this.dateOfJoining = dateOfJoining;
      this.active = active;
```

```
    }
    // Getters & setters
    public Long getId() { return id; }
    public void setId(Long id) { this.id = id; }
    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public String getEmail() { return email; }
    public void setEmail(String email) { this.email = email; }
    public Integer getAge() { return age; }
    public void setAge(Integer age) { this.age = age; }
    public LocalDate getDateOfJoining() { return dateOfJoining; }
    public void setDateOfJoining(LocalDate dateOfJoining) { this.dateOfJoining = dateOfJoining; }
    public Boolean getActive() { return active; }
    public void setActive(Boolean active) { this.active = active; }
}
```

3) ModelMapper configuration

src/main/java/com/example/demo/config/ModelMapperConfig.java

```
package com.example.demo.config;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.entity.EmployeeEntity;
import org.modelmapper.Conditions;
import org.modelmapper.ModelMapper;
import org.modelmapper.PropertyMap;
import org.modelmapper.config.Configuration;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration as SpringConfiguration;
@SpringConfiguration
public class ModelMapperConfig {
    @Bean
    public ModelMapper modelMapper() {
        ModelMapper mapper = new ModelMapper();
        // Strict matching to avoid accidental mappings
        mapper.getConfiguration()
                .setFieldMatchingEnabled(true)
                .setFieldAccessLevel(Configuration.AccessLevel.PRIVATE)
                .setSkipNullEnabled(true) // helpful for patch/update
                .setMatchingStrategy(org.modelmapper.convention.MatchingStrategies.STRICT);
        // Entity -> DTO: map boolean isActive -> Boolean active
        mapper.addMappings(new PropertyMap<EmployeeEntity, EmployeeDTO>() {
            @Override
            protected void configure() {
                map().setActive(source.isActive());
                // age is primitive in entity; map directly (ModelMapper handles primitives)
            }
        });
        // DTO -> Entity: map Boolean active -> boolean isActive (default false if null)
        mapper.addMappings(new PropertyMap<EmployeeDTO, EmployeeEntity>() {
            @Override
            protected void configure() {
                // If DTO.active is null, leave entity flag unchanged (for update flows).
                when(Conditions.isNotNull()).map().setActive(source.getActive());
            }
        });
        return mapper;
    }
}
```

Notes:

- setSkipNullEnabled(true) ensures update operations don't overwrite existing values with null unintentionally.
- We added explicit mapping for isActive ↔ active because the field names differ.

4) Service layer (refactored to use ModelMapper)

src/main/java/com/example/demo/service/EmployeeService.java

```
package com.example.demo.service;
import com.example.demo.dto.EmployeeDTO;
import java.util.List;
public interface EmployeeService {
    EmployeeDTO getById(Long id);
    EmployeeDTO create(EmployeeDTO dto);
    List<EmployeeDTO> getAll();
    EmployeeDTO update(Long id, EmployeeDTO dto);
    void delete(Long id);
}
```

src/main/java/com/example/demo/service/impl/EmployeeServiceImpl.java

```
package com.example.demo.service.impl;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.entity.EmployeeEntity;
import com.example.demo.exception.ResourceNotFoundException;
import com.example.demo.repository.EmployeeRepository;
import com.example.demo.service.EmployeeService;
import org.modelmapper.ModelMapper;
import org.springframework.stereotype.Service;
import java.util.List;
import java.util.stream.Collectors;
@Service
public class EmployeeServiceImpl implements EmployeeService {
    private final EmployeeRepository employeeRepository;
    private final ModelMapper modelMapper;
    public EmployeeServiceImpl(EmployeeRepository employeeRepository, ModelMapper
modelMapper) {
        this.employeeRepository = employeeRepository;
        this.modelMapper = modelMapper;
    }
    @Override
    public EmployeeDTO getById(Long id) {
        EmployeeEntity entity = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        return modelMapper.map(entity, EmployeeDTO.class);
    }
    @Override
    public EmployeeDTO create(EmployeeDTO dto) {
        // Map DTO -> Entity, ensure id is null for auto-generation
        EmployeeEntity toSave = modelMapper.map(dto, EmployeeEntity.class);
        toSave.setId(null);
        EmployeeEntity saved = employeeRepository.save(toSave);
        return modelMapper.map(saved, EmployeeDTO.class);
    }
    @Override
    public List<EmployeeDTO> getAll() {
        return employeeRepository.findAll().stream()
                .map(e -> modelMapper.map(e, EmployeeDTO.class))
                .collect(Collectors.toList());
    }
    @Override
    public EmployeeDTO update(Long id, EmployeeDTO dto) {
        EmployeeEntity existing = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        // Apply non-null fields from DTO onto existing entity
        modelMapper.map(dto, existing);
        EmployeeEntity updated = employeeRepository.save(existing);
```

```
        return modelMapper.map(updated, EmployeeDTO.class);
    }
    @Override
    public void delete(Long id) {
        EmployeeEntity existing = employeeRepository.findById(id)
                .orElseThrow(() -> new ResourceNotFoundException("Employee not found with id " + id));
        employeeRepository.delete(existing);
    }
}
```

5) Controller (already using service & DTO)

src/main/java/com/example/demo/controller/EmployeeController.java

```
package com.example.demo.controller;
import com.example.demo.dto.EmployeeDTO;
import com.example.demo.service.EmployeeService;
import jakarta.validation.Valid;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.*;
import org.springframework.web.util.UriComponentsBuilder;
import java.util.List;
@RestController
@RequestMapping("/employees")
public class EmployeeController {
    private final EmployeeService employeeService;
    // Constructor Dependency Injection
    public EmployeeController(EmployeeService employeeService) {
        this.employeeService = employeeService;
    }
    // GET /employees/{id}
    @GetMapping("/{employeeId}")
    public ResponseEntity<EmployeeDTO> getEmployeeById(@PathVariable("employeeId") Long id) {
        return ResponseEntity.ok(employeeService.getById(id));
    }
    // GET /employees
    @GetMapping
    public ResponseEntity<List<EmployeeDTO>> getAllEmployees() {
        return ResponseEntity.ok(employeeService.getAll());
    }
    // POST /employees
    @PostMapping
    public ResponseEntity<EmployeeDTO> createEmployee(
            @Valid @RequestBody EmployeeDTO employeeDTO,
            UriComponentsBuilder uriBuilder) {
        EmployeeDTO created = employeeService.create(employeeDTO);
        return ResponseEntity
                .created(uriBuilder.path("/employees/{id}").buildAndExpand(created.getId()).toUri())
                .body(created);
    }
    // PUT /employees/{id}
    @PutMapping("/{employeeId}")
    public ResponseEntity<EmployeeDTO> updateEmployee(
            @PathVariable("employeeId") Long id,
            @Valid @RequestBody EmployeeDTO employeeDTO) {
        return ResponseEntity.ok(employeeService.update(id, employeeDTO));
    }
    // DELETE /employees/{id}
    @DeleteMapping("/{employeeId}")
    public ResponseEntity<Void> deleteEmployee(@PathVariable("employeeId") Long id) {
        employeeService.delete(id);
        return ResponseEntity.noContent().build();
    }
```

6) Exceptions (unchanged)

src/main/java/com/example/demo/exception/ResourceNotFoundException.java

```
package com.example.demo.exception;
public class ResourceNotFoundException extends RuntimeException {
    public ResourceNotFoundException(String message) { super(message); }
}
```

src/main/java/com/example/demo/exception/GlobalExceptionHandler.java

```
package com.example.demo.exception;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.MethodArgumentNotValidException;
import org.springframework.web.bind.annotation.ExceptionHandler;
import org.springframework.web.bind.annotation.RestControllerAdvice;
import java.util.HashMap;
import java.util.Map;
@RestControllerAdvice
public class GlobalExceptionHandler {
    @ExceptionHandler(ResourceNotFoundException.class)
    public ResponseEntity<Map<String, Object>> handleNotFound(ResourceNotFoundException ex) {
        Map<String, Object> body = new HashMap<>();
        body.put("error", "Not Found");
        body.put("message", ex.getMessage());
        return ResponseEntity.status(HttpStatus.NOT_FOUND).body(body);
    }
    @ExceptionHandler(MethodArgumentNotValidException.class)
    public ResponseEntity<Map<String, Object>>
handleValidation(MethodArgumentNotValidException ex) {
        Map<String, Object> body = new HashMap<>();
        body.put("error", "Validation Failed");
        Map<String, String> fieldErrors = new HashMap<>();
        ex.getBindingResult().getFieldErrors()
                .forEach(err -> fieldErrors.put(err.getField(), err.getDefaultMessage()));
        body.put("details", fieldErrors);
        return ResponseEntity.badRequest().body(body);
    }
```

7) Entity & Repository (unchanged)

You can keep your existing EmployeeEntity and EmployeeRepository exactly as you shared.

8) Optional: a “PATCH-like” partial update

If you want true partial updates (only provided fields applied), keep setSkipNullEnabled(true) in the ModelMapper config (already done). Then you can add:

```
@PatchMapping("/{employeeId}")
public ResponseEntity<EmployeeDTO> patchEmployee(
        @PathVariable("employeeId") Long id,
        @RequestBody EmployeeDTO partialDto) {
    return ResponseEntity.ok(employeeService.update(id, partialDto));
```

(No @Valid here if you want to allow missing fields.)

9) Quick test

- **Create**:

```
curl -i -X POST http://localhost:8080/employees \
  -H "Content-Type: application/json" \
  -d '{
    "name": "Ada Lovelace",
```

```
  "email": "ada@example.com",
  "age": 30,
  "dateOfJoining": "2023-12-01",
  "active": true
```

- **Get**:

- **Update**:

```
curl -i -X PUT http://localhost:8080/employees/1 \
  -H "Content-Type: application/json" \
  -d '{
    "name": "Ada L.",
    "email": "ada.l@example.com",
    "age": 31,
    "active": false
```

Want me to add pagination & sorting (e.g., GET /employees?page=0&size=20&sort=name,asc) or switch to MapStruct for compile-time safety? Also happy to add Problem Details (RFC 7807) responses or OpenAPI/Swagger docs for your API.

Great question! Let's go **step by step** and make this super clear for you.\ We'll cover:
☑ What is ModelMapper?\ ☑ Why use it in Spring Boot?\ ☑ How to set it up (step-by-step)\ ☑ How to use it for **Entity ↔ DTO mapping**\ ☑ Bonus: How to handle custom mappings

1. What is ModelMapper?

ModelMapper is a Java library that **automatically maps one object to another** based on matching property names.\ Example:

- EmployeeEntity has name, email, age
- EmployeeDTO also has name, email, age\ ModelMapper can copy values from Entity → DTO or DTO → Entity **without writing boilerplate code**.

2. Why use it in Spring Boot?

- Avoid writing repetitive dto.setName(entity.getName()) code.
- Keeps your code clean and maintainable.
- Works well with layered architecture (Controller → Service → Repository).

3. Step-by-Step Setup

Step 1: Add dependency in pom.xml

```
<dependency>
  <groupId>org.modelmapper</groupId>
  <artifactId>modelmapper</artifactId>
```

```
    <version>3.2.0</version>
```

Step 2: Create a Config class

This makes ModelMapper a Spring Bean so you can inject it anywhere.

```
package com.example.demo.config;
import org.modelmapper.ModelMapper;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
@Configuration
public class ModelMapperConfig {
    @Bean
    public ModelMapper modelMapper() {
        return new ModelMapper();
    }
}
```

☑ Now you can use @Autowired ModelMapper mapper; in your service.

Step 3: Create DTO and Entity

Example:

```
public class EmployeeDTO {
    private Long id;
    private String name;
    private String email;
    private Integer age;
    private Boolean active;
    // getters & setters
}

@Entity
public class EmployeeEntity {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;
    private String name;
    private String email;
    private int age;
    private boolean isActive;
    // getters & setters
}
```

Step 4: Use ModelMapper in Service

```
@Service
public class EmployeeService {
    private final EmployeeRepository employeeRepository;
    private final ModelMapper modelMapper;
    public EmployeeService(EmployeeRepository employeeRepository, ModelMapper modelMapper) {
        this.employeeRepository = employeeRepository;
        this.modelMapper = modelMapper;
    }
    public EmployeeDTO getEmployee(Long id) {
        EmployeeEntity entity = employeeRepository.findById(id)
                .orElseThrow(() -> new RuntimeException("Not found"));
        return modelMapper.map(entity, EmployeeDTO.class);
    }
    public EmployeeDTO createEmployee(EmployeeDTO dto) {
        EmployeeEntity entity = modelMapper.map(dto, EmployeeEntity.class);
        EmployeeEntity saved = employeeRepository.save(entity);
        return modelMapper.map(saved, EmployeeDTO.class);
```

```
    }
}
```
☑ No manual mapping needed!

4. Custom Mapping (for different field names)

If your DTO has active and Entity has isActive, you need to configure:

```
@Bean
public ModelMapper modelMapper() {
    ModelMapper mapper = new ModelMapper();
    mapper.typeMap(EmployeeEntity.class, EmployeeDTO.class)
          .addMapping(EmployeeEntity::isActive, EmployeeDTO::setActive);
    mapper.typeMap(EmployeeDTO.class, EmployeeEntity.class)
          .addMapping(EmployeeDTO::getActive, EmployeeEntity::setActive);
    return mapper;
}
```

5. Bonus: Skip Nulls for Partial Updates

```
mapper.getConfiguration().setSkipNullEnabled(true);
```
This means if DTO has null fields, they won't overwrite existing entity values.

☑ Summary

- Add dependency
- Create @Configuration class with @Bean ModelMapper
- Inject ModelMapper in Service
- Use mapper.map(source, Destination.class)
- Add custom mappings if field names differ
- Enable skipNull for updates

Next Steps

Do you want me to: ✓ Show **full working Spring Boot project structure** with ModelMapper?\ ✓ Or explain **Java Streams & Lambdas** (since you asked earlier) in the context of mapping?\ ✓ Or give you **unit test examples** for ModelMapper mappings?
Which one would help you most right now?