eazy bytes

Spring, SpringBoot, JPA, Hibernate

Zero To Master

Agenda of the course

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Intro to Spring framework

- *What is Spring?*
- *Spring Vs Java EE*
- *Evolution of Spring*
- *Spring release timeline*
- *Different projects inside Spring*

Spring Core

- *Inversion of Control (IoC)*
- *Dependency Injection (DI)*
- *Different approaches for Beans creation*
- *Autowiring, Bean Scopes*
- *Aspect-Oriented Programming (AOP)*

Spring MVC

- *Introduction to MVC pattern*
- *Overview of Web Apps*
- *How Web Apps works ?*
- *Spring MVC internal flow*
- *Create a web App using Spring MVC*
- *Spring MVC validations*

Agenda of the course

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Thymeleaf

- *How to build dynamic web apps using Thymeleaf & Spring*
- *Thymeleaf integration with Spring, Spring MVC, Spring Security*

Spring Boot

- *Why Spring Boot?*
- *Auto-configuration*
- *Build Web Apps using SpringBoot, Thymeleaf, Spring MVC*
- *Spring Boot Dev Tools*
- *Spring Boot H2 Database*
- *Connecting to AWS MYSQL DB*

Spring Security

- *Authentication & Authorization*
- *Securing web Apps/REST APIs using Spring Security*
- *Role based access*
- *Cross-Site Request Forgery (CSRF)*
- *Cross-Origin Resource Sharing (CORS)*

Agenda of the course

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Spring JDBC

- *Problems with Core Java JDBC*
- *Advantages with Spring JDBC*
- *Performing CRUD operations with Spring JDBC*
- *Details about JdbcTemplate*
- *RowMapper*

Spring Data

- *Why do we need ORM frameworks?*
- *Introduction to JPA*
- *Derived Query methods in JPA*
- *OneToOne, OneToMany, ManyToOne, ManyToMany mappings inside JPA/Hibernate*
- *Sorting, Pagination, JPQL*

Spring REST

- *Building Rest Services*
- *Consuming Rest Services using OpenFeign, Web Client, RestTemplate*
- *Securing Rest Services*
- *Spring Data Rest*
- *HAL Explorer*

Agenda of the course

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Logging

- *Logging severities*
- *How to make logging configurations inside Spring Boot*
- *Writing logs into a file*

Properties & Profiles

- *How to define custom properties*
- *How to read properties in Java code*
- *Deep dive on Spring Profiles*
- *Activating a Profile*
- *Conditional Bean creation using Profile*

Actuator

- *Introduction to SpringBoot Actuator*
- *Exploring the APIs of Actuator*
- *Securing Actuator*
- *Viewing Actuator Data in Spring Boot Admin*

Agenda of the course

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DEPLOYING SPRINGBOOT WEBAPP INTO CLOUD (AWS)

aws

WHAT IS SPRING?

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The Spring Framework (shortly, Spring) is a mature, powerful and highly flexible framework focused on building web applications in Java.

Spring makes programming Java quicker, easier, and safer for everybody. It's focus on speed, simplicity, and productivity has made it the world's most popular Java framework.

Whether you're building secure, reactive, cloud-based microservices for the web, or complex streaming data flows for the enterprise, Spring has the tools to help.

Born as an alternative to EJBs in the early 2000s, the Spring framework quickly overtook its opponent with its simplicity, variety of features, and its third-party library integrations.

It is so popular, that its main competitor quit the race when Oracle stopped the evolution of Java EE 8, and the community took over its maintenance via Jakarta EE.

The main reason of Spring framework success is, it regularly introduces features/projects based on the latest market trends, needs of the Dev community. For ex: SpringBoot

Spring is open source. It has a large and active community that provides continuous feedback based on a diverse range of real-world use cases.

JAVA EE RELEASE TIMELINE

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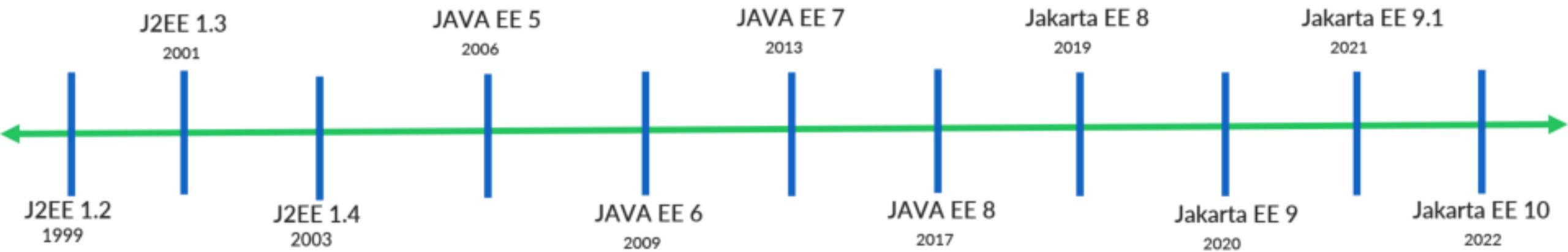

- *Java/Jakarta Enterprise Edition (EE) contains Servlets, JSPs, EJB, JMS, RMI, JPA, JSF, JAXB, JAX-WS, Web Sockets etc.*
- *Components of Java/Jakarta Enterprise Edition (EE) like EJB, Servlets are complex in nature due to which everyone adapted Spring framework for web applications development.*
- *Java EE quit the race against the Spring framework, when Oracle stopped the evolution of Java EE 8, and the community took over its maintenance via Jakarta EE.*
- *Since Oracle owns the trademark for the name "Java", Java EE renamed to Jakarta EE. All the packages are updated with javax.* to jakarta.* namespace change.*

SPRING RELEASE TIMELINE

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SPRING VERSION HISTORY

- *The first version of Spring was written by Rod Johnson, who released the framework with the publication of his book Expert One-on-One J2EE Design and Development in October 2002*
- *Spring came into being in 2003 as a response to the complexity of the early J2EE specifications. While some consider Java EE and Spring to be in competition, Spring is, in fact, complementary to Java EE. The Spring programming model does not embrace the Java EE platform specification; rather, it integrates with carefully selected individual specifications from the EE umbrella*
- *Spring continues to innovate and to evolve. Beyond the Spring Framework, there are other projects, such as Spring Boot, Spring Security, Spring Data, Spring Cloud, Spring Batch, among others.*

SPRING CORE

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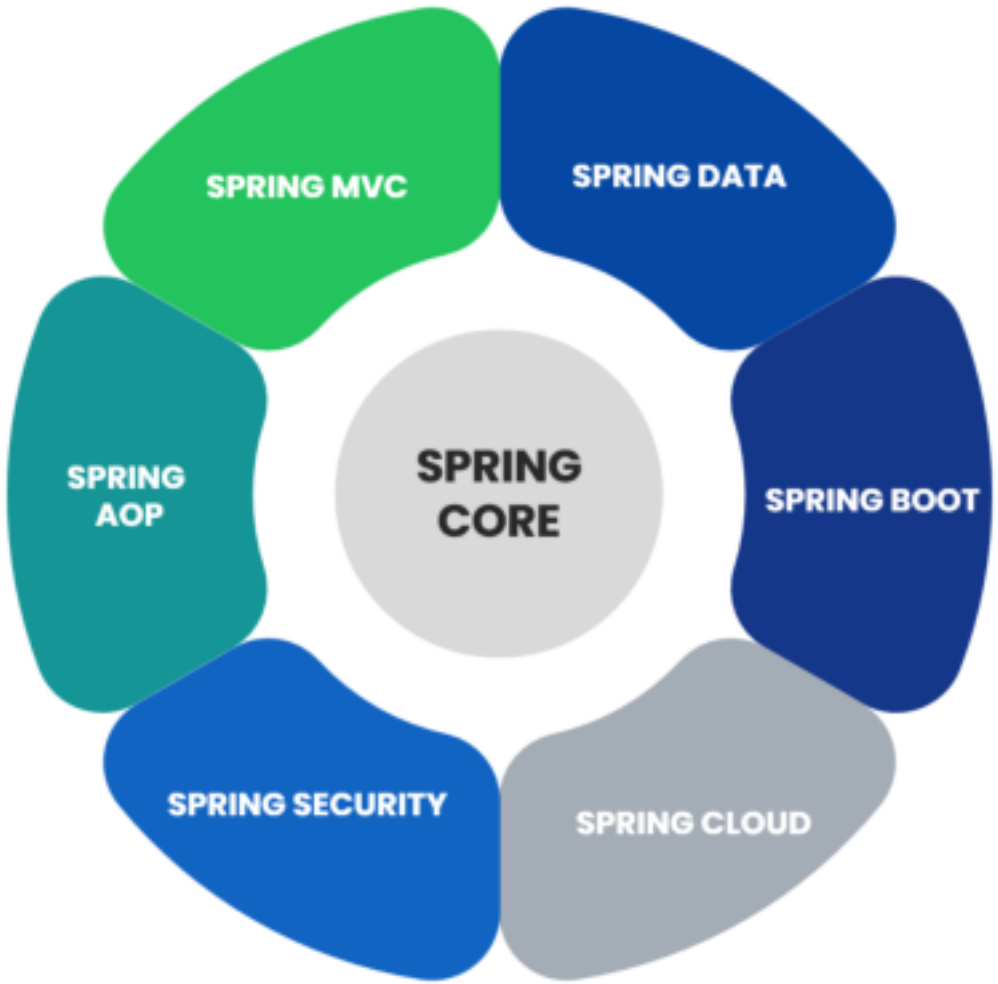

- Spring Core is the heart of entire Spring. It contains some base framework classes, principles and mechanisms.
- The entire Spring Framework and other projects of Spring are developed on top of the Spring Core.
- Spring Core contains following important components,
  - ✓ IoC (Inversion of Control)
  - ✓ DI (Dependency Injection)
  - ✓ Beans
  - ✓ Context
  - ✓ SpEL (Spring Expression Language)
  - ✓ IoC Container

INVERSION OF CONTROL & DEPENDENCY INJECTION

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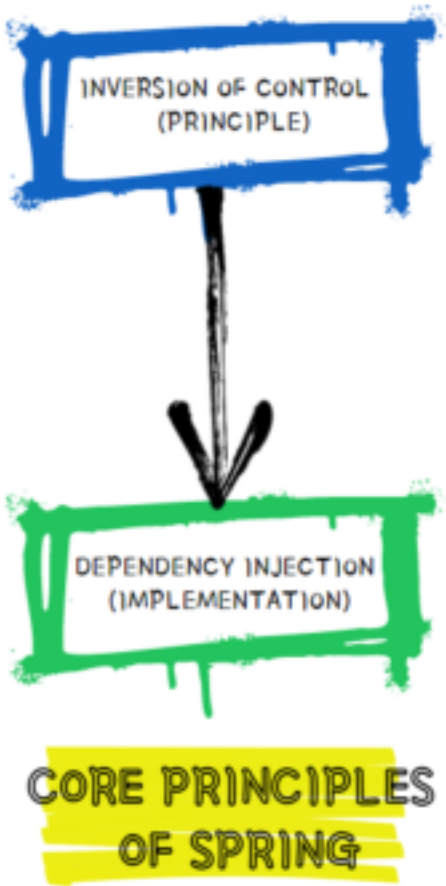

- Inversion of Control (IoC) is a Software Design Principle, independent of language, which does not actually create the objects but describes the way in which object is being created.
- IoC is the principle, where the control flow of a program is inverted: instead of the programmer controlling the flow of a program, the framework or service takes control of the program flow.
- Dependency Injection is the pattern through which Inversion of Control achieved.
- Through Dependency Injection, the responsibility of creating objects is shifted from the application to the Spring IoC container. It reduces coupling between multiple objects as it is dynamically injected by the framework.

ADVANTAGES OF IoC & DI

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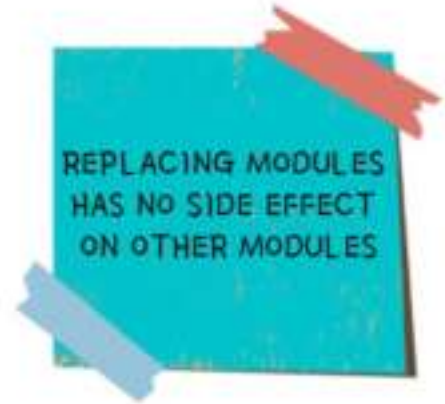

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REAL LIFE LOOSE COUPLING EXAMPLE

TIGHT COUPLING SCENARIO

LOOSE COUPLING SCENARIO

SPRING BEANS, CONTEXT, SpEL

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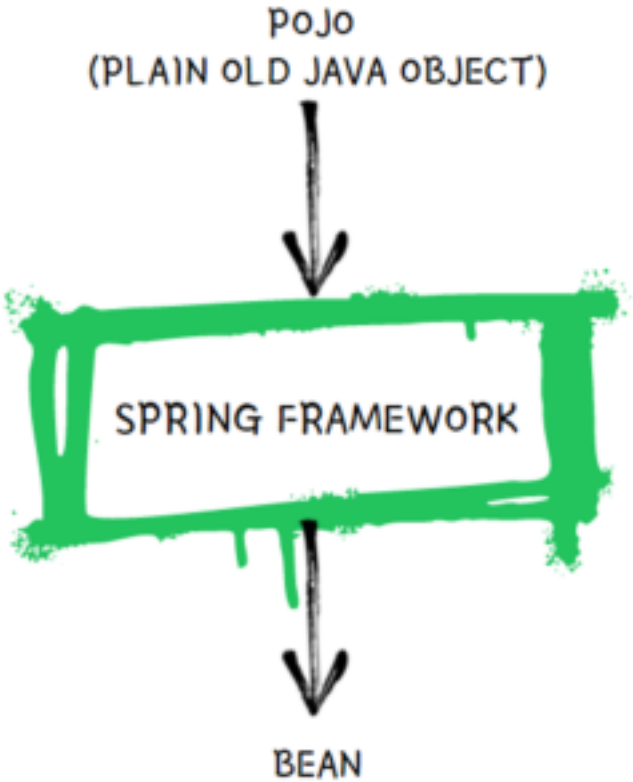

- Any normal Java class that is instantiated, assembled, and otherwise managed by a Spring IoC container is called Spring Bean.
- These beans are created with the configuration metadata that you supply to the container either in the form of XML configs and Annotations.
- Spring IoC Container manages the lifecycle of Spring Bean scope and injecting any required dependencies in the bean.
- Context is like a memory location of your app in which we add all the object instances that we want the framework to manage. By default, Spring doesn't know any of the objects you define in your application. To enable Spring to see your objects, you need to add them to the context.
- The SpEL provides a powerful expression language for querying and manipulating an object graph at runtime like setting and getting property values, property assignment, method invocation etc.

SPRING IoC CONTAINER

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Spring IoC Container

- The IoC container is responsible
  - ✓ to instantiate the application class
  - ✓ to configure the object
  - ✓ to assemble the dependencies between the objects

- There are two types of IoC containers. They are:

  - ✓ org.springframework.beans.factory.BeanFactory
  - ✓ org.springframework.context.ApplicationContext

- The Spring container uses dependency injection (DI) to manage the components/objects that make up an application.

SPRING IoC CONTAINER

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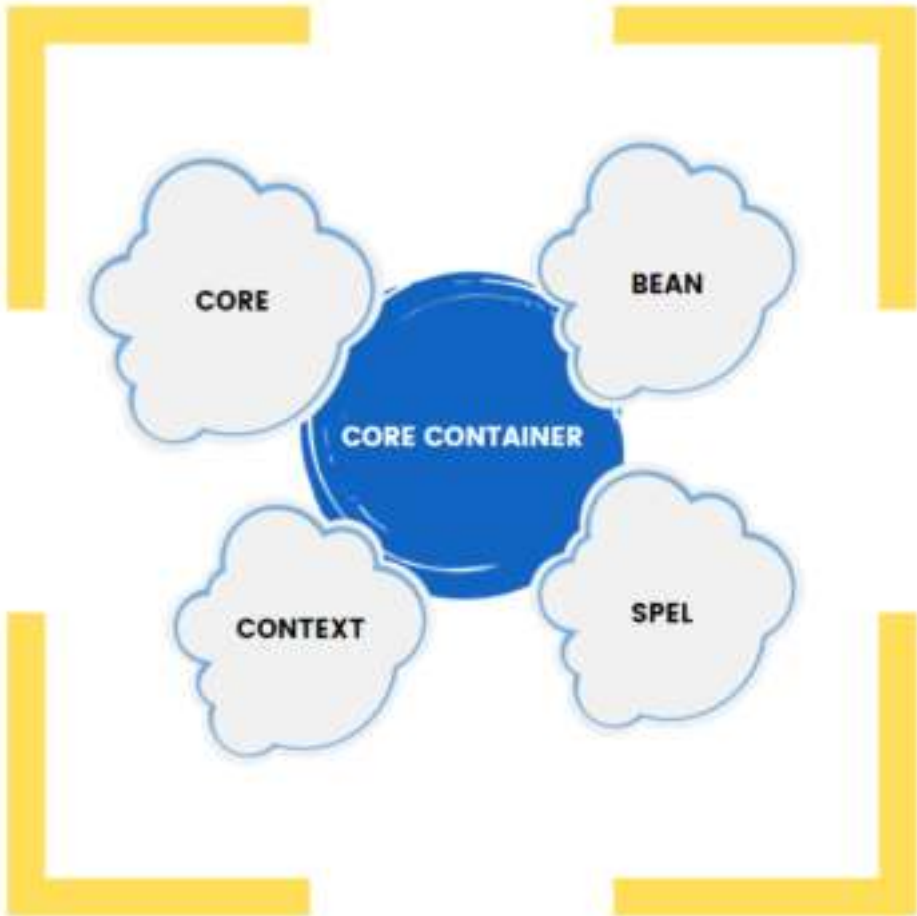

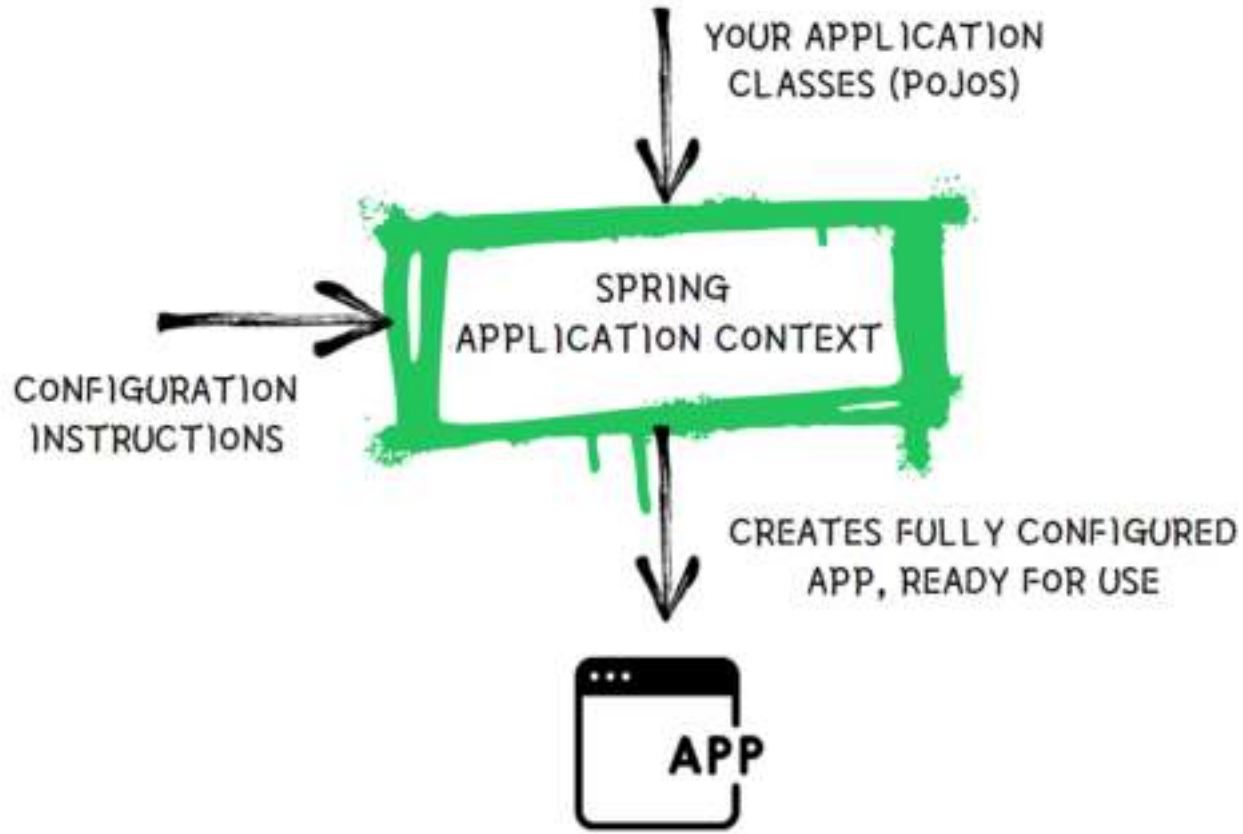

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MAVEN

ADDING NEW BEANS TO SPRING CONTEXT

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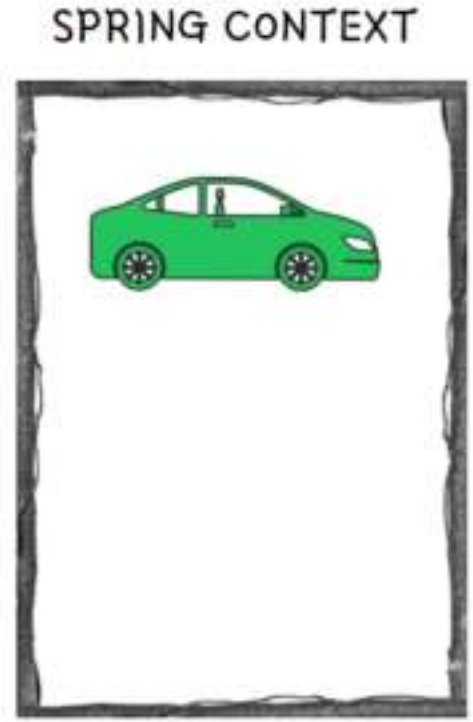
When we create an java object with new () operator directly as shown below, then your Spring Context/Spring IoC Container will not have any clue of the object.

```
Vehicle vehicle = new Vehicle();
```

@Bean annotation lets Spring know that it needs to call this method when it initializes its context and adds the returned object/value to the Spring context/Spring IoC Container.

```
@Bean
Vehicle vehicle() {
    var veh = new Vehicle();
    veh.setName("Audi 8");
    return veh;
}
```



NoUniqueBeanDefinitionException

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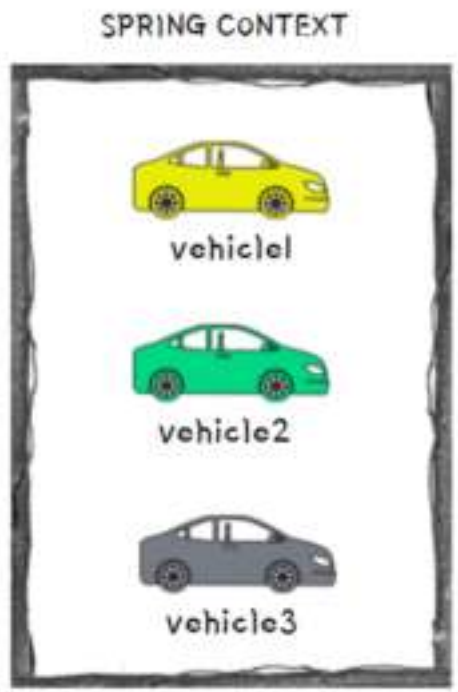
When we create multiple objects of same type and try to fetch the bean from context by type, then Spring cannot guess which instance you've declared you refer to. This will lead to NoUniqueBeanDefinitionException like shown below,

```java
@Bean
Vehicle vehicle1() {
    var veh = new Vehicle();
    veh.setName("Audi");
    return veh;
}

@Bean
Vehicle vehicle2() {
    var veh = new Vehicle();
    veh.setName("Honda");
    return veh;
}

@Bean
Vehicle vehicle3() {
    var veh = new Vehicle();
    veh.setName("Ferrari");
    return veh;
}
```




```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Vehicle veh = context.getBean(Vehicle.class);
```

NoUniqueBeanDefinitionException

Output on Console

```
Exception in thread "main" org.springframework.beans.factory.NoUniqueBeanDefinitionException: No qualifying bean of type
 'com.example.beans.Vehicle' available: expected single matching bean but found 3: vehicle1,vehicle2,vehicle3
    at org.springframework.beans.factory.support.DefaultListableBeanFactory.resolveNamedBean(DefaultListableBeanFactory.java:1062)
    at org.springframework.beans.factory.support.DefaultListableBeanFactory.resolveBean(DefaultListableBeanFactory.java:414)
    at org.springframework.beans.factory.support.DefaultListableBeanFactory.getBean(DefaultListableBeanFactory.java:349)
    at org.springframework.beans.factory.support.DefaultListableBeanFactory.getBean(DefaultListableBeanFactory.java:342)
    at org.springframework.context.support.AbstractApplicationContext.getBean(AbstractApplicationContext.java:1173)
    at com.example.main.Example2.main(Example2.java:10)
```

NoUniqueBeanDefinitionException

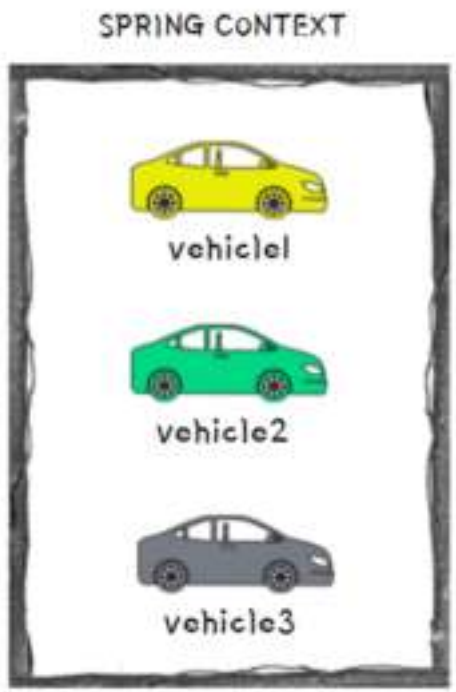
eazy bytes

To avoid NoUniqueBeanDefinitionException in these kind of scenarios, we can fetch the bean from the context by mentioning it's name like shown below,

```java
@Bean
Vehicle vehicle1() {
    var veh = new Vehicle();
    veh.setName("Audi");
    return veh;
}

@Bean
Vehicle vehicle2() {
    var veh = new Vehicle();
    veh.setName("Honda");
    return veh;
}

@Bean
Vehicle vehicle3() {
    var veh = new Vehicle();
    veh.setName("Ferrari");
    return veh;
}
```




```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Vehicle veh = context.getBean( name: "vehicle1",Vehicle.class);
System.out.println("Vehicle name from Spring Context is: " + veh.getName());
```

Output on Console

```
Vehicle name from Spring Context is: Audi
```

DIFFERENT WAYS TO NAME A BEAN

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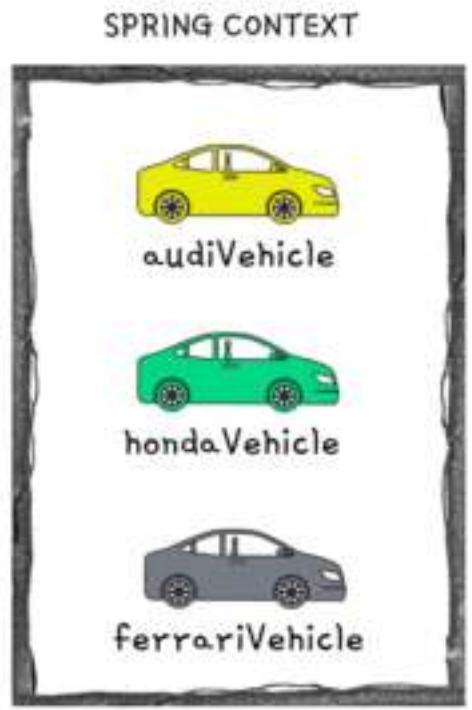
By default, Spring will consider the method name as the bean name. But if we have a custom requirement to define a separate bean name, then we can use any of the below approach with the help of @Bean annotation,

```java
@Bean(name="audiVehicle")
Vehicle vehicle1() {
    var veh = new Vehicle();
    veh.setName("Audi");
    return veh;
}

@Bean(value="hondaVehicle")
Vehicle vehicle2() {
    var veh = new Vehicle();
    veh.setName("Honda");
    return veh;
}

@Bean("ferrariVehicle")
Vehicle vehicle3() {
    var veh = new Vehicle();
    veh.setName("Ferrari");
    return veh;
}
```




```java
Vehicle veh1 = context.getBean( name: "audiVehicle",Vehicle.class);
System.out.println("Vehicle name from Spring Context is: " + veh1.getName());

Vehicle veh2 = context.getBean( name: "hondaVehicle",Vehicle.class);
System.out.println("Vehicle name from Spring Context is: " + veh2.getName());

Vehicle veh3 = context.getBean( name: "ferrariVehicle",Vehicle.class);
System.out.println("Vehicle name from Spring Context is: " + veh3.getName());
```

Output on Console

```
Vehicle name from Spring Context is: Audi
Vehicle name from Spring Context is: Honda
Vehicle name from Spring Context is: Ferrari
```

@Primary Annotation

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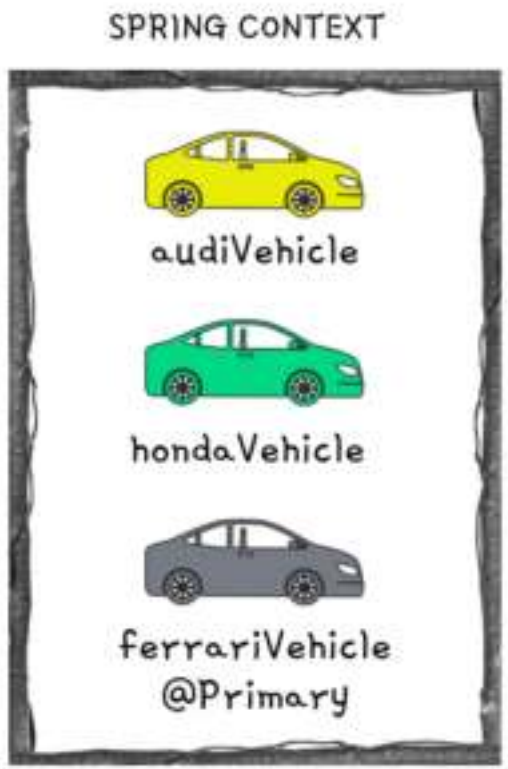
When you have multiple beans of the same kind inside the Spring context, you can make one of them primary by using @Primary annotation. Primary bean is the one which Spring will choose if it has multiple options and you don't specify a name. In other words, it is the default bean that Spring Context will consider in case of confusion due to multiple beans present of same type.

```java
@Bean(name="audiVehicle")
Vehicle vehicle1() {
    var veh = new Vehicle();
    veh.setName("Audi");
    return veh;
}

@Bean(value="hondaVehicle")
Vehicle vehicle2() {
    var veh = new Vehicle();
    veh.setName("Honda");
    return veh;
}

@Primary
@Bean("ferrariVehicle")
Vehicle vehicle3() {
    var veh = new Vehicle();
    veh.setName("Ferrari");
    return veh;
}
```




```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Primary Vehicle name from Spring Context is: " + vehicle.getName());
```

Output on Console

```
Primary Vehicle name from Spring Context is: Ferrari
```

@Component Annotation

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@Component is one of the most commonly used stereotype annotation by developers. Using this we can easily create and add a bean to the Spring context by writing less code compared to the @Bean option. With stereotype annotations, we need to add the annotation above the class for which we need to have an instance in the Spring context.

Using @ComponentScan annotation over the configuration class, instruct Spring on where to find the classes you marked with stereotype annotations.

```java
@Component
public class Vehicle {

    private String name;

    public String getName() { return name; }

    public void setName(String name) { this.name = name; }

    public void printHello(){
        System.out.println(
            "Printing Hello from Component Vehicle Bean");
    }
}
```


```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Component Vehicle name from Spring Context is: " + vehicle.getName());
vehicle.printHello();
```

Output on Console

```
Component Vehicle name from Spring Context is: null
Printing Hello from Component Vehicle Bean
```

```java
@Configuration
@ComponentScan(basePackages = "com.example.beans")
public class ProjectConfig {

}
```

Spring Stereotype Annotations

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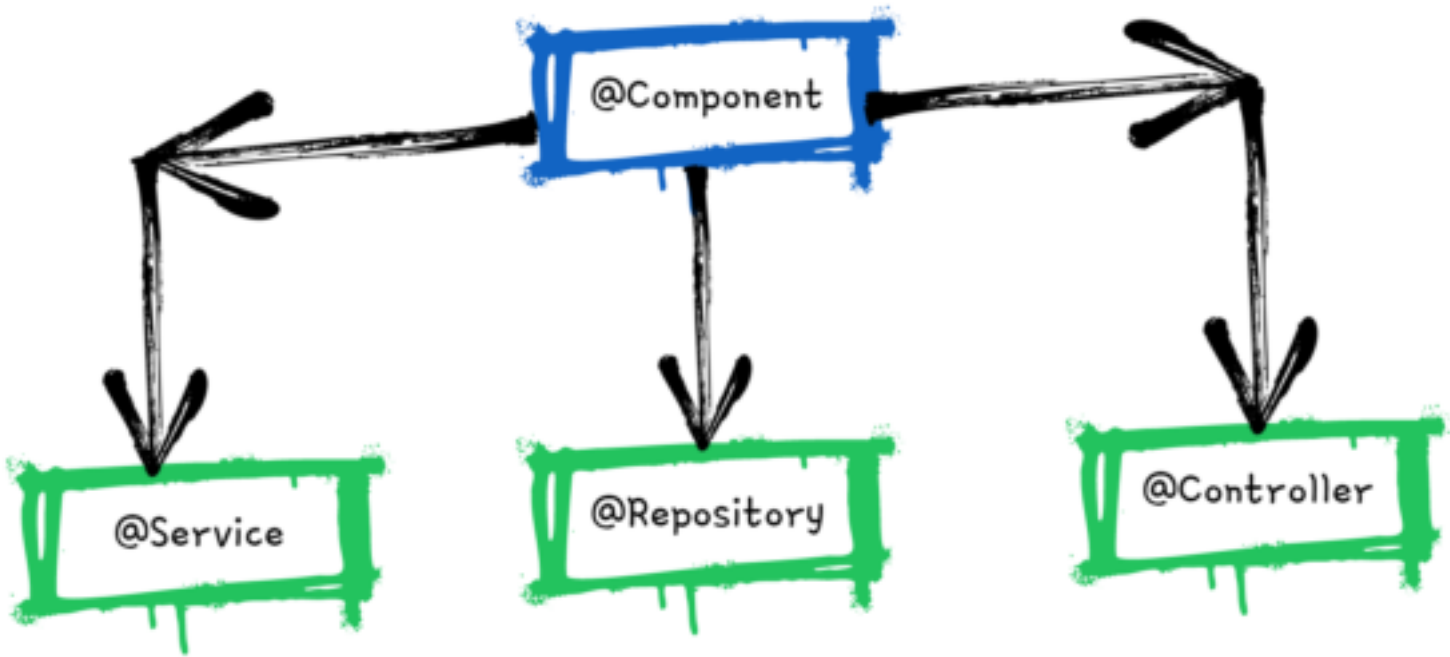
- *Spring provides special annotations called Stereotype annotations which will help to create the Spring beans automatically in the application context.*
- *The stereotype annotations in spring are @Component, @Service, @Repository and @Controller*



@Component is used as general on top of any Java class. It is the base for other annotations.

@Service can be used on top of the classes inside the service layer especially where we write business logic and make external API calls.

@Repostiory can be used on top of the classes which handles the code related to Database access related operations like Insert, Update, Delete etc.

@Controller can be used on top of the classes inside the Controller layer of MVC applications.

@Bean Vs @Component

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@Bean

- One or more instances of the class can be added to the Spring Context
- We can create an object instance of any type of class including present inside libraries like String etc.
- Usually we need to write more code like separate methods to create beans instances
- Developer will have full control in creating and configuring the bean
- Spring framework creates the bean based on the instructions and values provided by Developer

@Component

- Only one instance of the class can be added to the Spring context
- We can create an object instance for application class only which are created by Dev team
- Bean instances can be created with very less code like using @Component on top of the class
- Developer will not have any control in creating and configuring the bean
- Spring framework takes charge of creating the bean and post that Developer will have access to it

@PostConstruct Annotation

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- *We have seen that when we are using stereotype annotations, we don't have control while creating a bean. But what if we want to execute some instructions post Spring creates the bean. For the same, we can use @PostConstruct annotation.*
- *We can define a method in the component class and annotate that method with @PostConstruct, which instructs Spring to execute that method after it finishes creating the bean.*
- *Spring borrows the @PostConstruct annotation from Java EE.*

```java
@Component
public class Vehicle {

    private String name;

    public String getName() { return name; }

    public void setName(String name) { this.name = name; }

    @PostConstruct
    public void initialize() {
        this.name = "Honda";
    }

    public void printHello(){...}
}
```

```java
@Configuration
@ComponentScan(basePackages = "com.example.beans")
public class ProjectConfig {

}
```


```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Component Vehicle name from Spring Context is: " + vehicle.getName());
vehicle.printHello();
```

Output on Console

```
Component Vehicle name from Spring Context is: Honda
Printing Hello from Component Vehicle Bean
```

@PreDestroy Annotation

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- *@PreDestory annotation can be used on top of the methods and Spring will make sure to call this method just before clearing and destroying the context.*
- *This can be used in the scenarios where we want to close any IO resources, Database connections etc.*
- *Spring borrows the @PreDestory annotation also from Java EE.*

```java
@Component
public class Vehicle {

    private String name;

    public String getName() { return name; }

    public void setName(String name) { this.name = name; }

    @PreDestroy
    public void destroy() {
        System.out.println(
                "Destroying Vehicle Bean");
    }
}
```

```java
@Configuration
@ComponentScan(basePackages = "com.example.beans")
public class ProjectConfig {

}
```


```java
var context = new AnnotationConfigApplicationContext
                (ProjectConfig.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Component Vehicle name from " +
        "Spring Context is: " + vehicle.getName());
vehicle.printHello();
context.close();
```

Output on Console

```
Component Vehicle name from Spring Context is: Honda
Printing Hello from Component Vehicle Bean
Destroying Vehicle Bean
```

ADDING NEW BEANS PROGRAMMATICALLY

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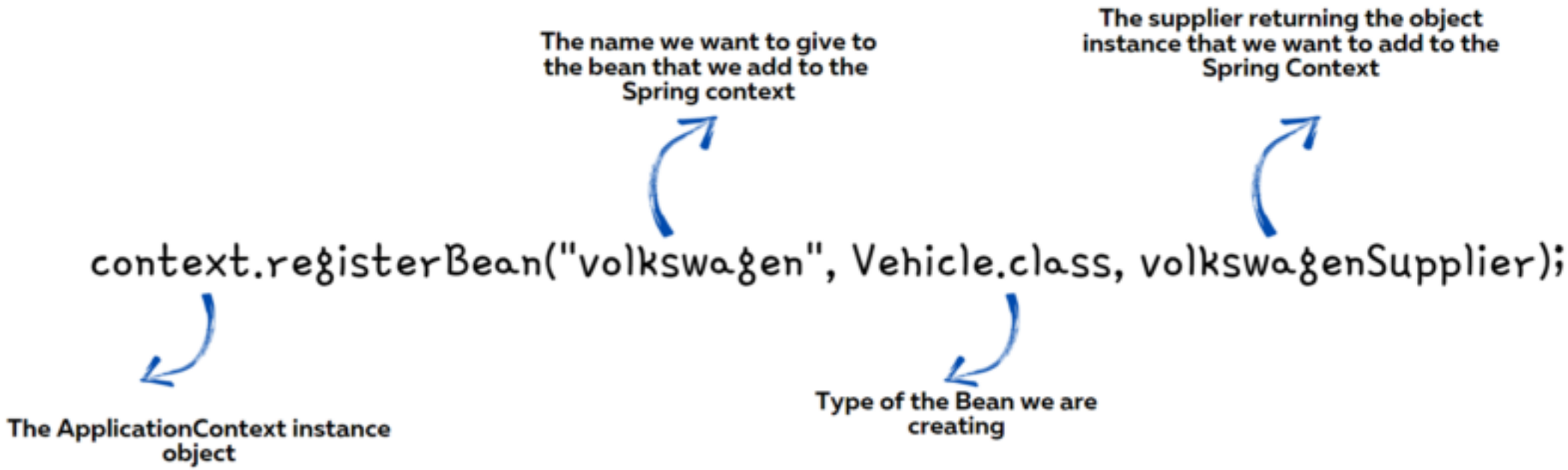
- *Sometimes we want to create new instances of an object and add them into the Spring context based on a programming condition. For the same, from Spring 5 version, a new approach is provided to create the beans programmatically by invoking the registerBean() method present inside the context object.*



ADDING NEW BEANS PROGRAMMATICALLY

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```
if((randomNumber% 2) == 0){
    context.registerBean( beanName: "volkswagen",
            Vehicle.class,volkswagenSupplier);
}else{
    context.registerBean( beanName: "audi",
            Vehicle.class,audiSupplier);
}
```

ADDING NEW BEANS USING XML CONFIGs

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- *In the initial versions of Spring, the bean and other configurations used to be done using XML. But over the time, Spring team brings annotation based configurations to make developers life easy. Today we can see XML configurations only in the older applications built based on initial versions of Spring.*
- *It is good to understand on how to create a bean inside Spring context using XML style configurations. So that, it will be useful if ever there is a scenario where you need to work in a project based on initial versions of Spring.*

```xml
<bean id="vehicle" class="com.example.beans.Vehicle">
    <property name="name" value="Honda" />
</bean>
```


```java
var context = new ClassPathXmlApplicationContext( configLocation: "beans.xml");
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
```

Output on Console

```
Vehicle name from Spring Context is: Honda
```

BEHIND THE SCENES OF A WEB APP

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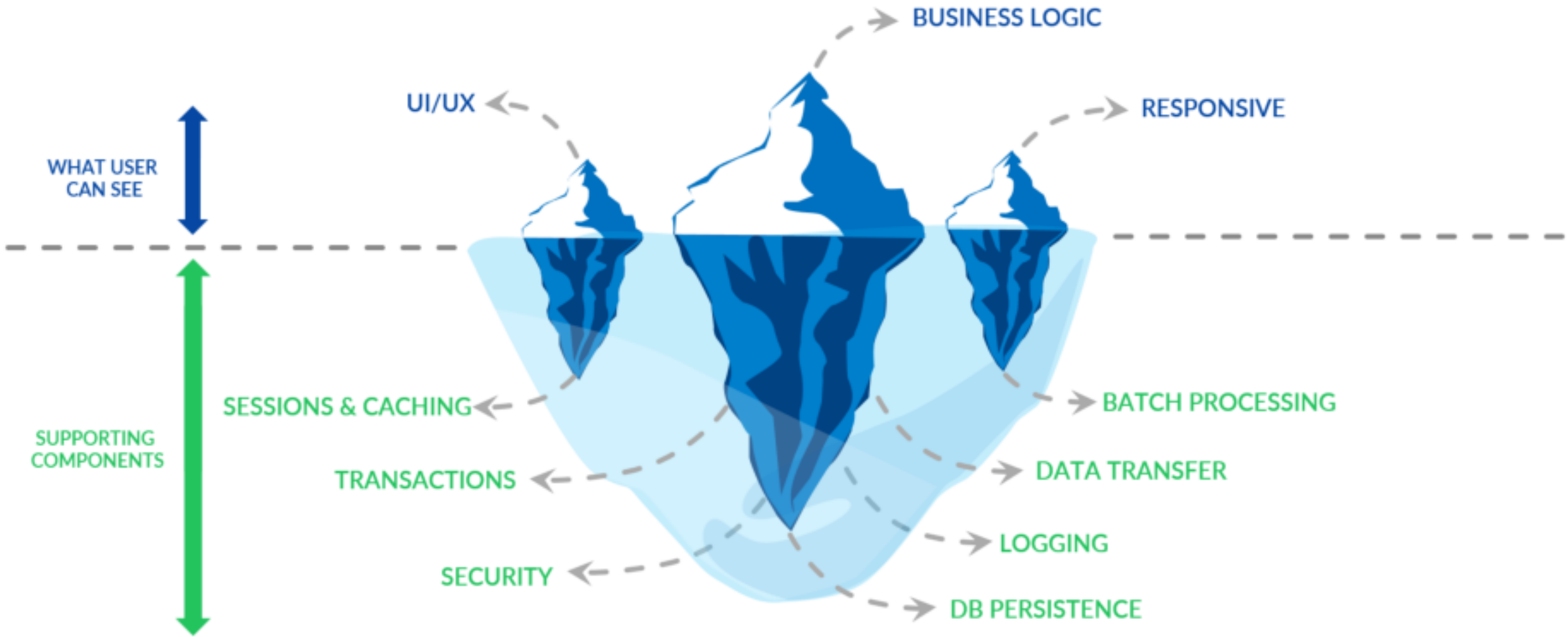

WHY SHOULD WE USE FRAMEWORKS?

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CHEF VICKY

Uses best readily available best ingredients like Cheese, Pizza Dough etc. to prepare Pizza

- Pizza preparation time is less
- Can easily scale his restaurant pizza orders
- Gets consistent taste for his pizzas
- Focus more on the pizza preparation
- Less efforts and more results/revenue

CHEF SANJEEV

Prepare all the ingredients like Cheese, Pizza Dough etc. by himself to prepare Pizza

- Pizza preparation time is more
- Scaling his restaurant pizza orders is not an option
- May not get a consistent taste for his pizzas
- Focus more on the raw material & ingredients
- More efforts and less results/revenue

WHY SHOULD WE USE FRAMEWORKS?

eazy bytes

DEV SANJEEV

Uses best readily available best frameworks like Spring, Angular etc. to build a web app

- Leverage Security, Logging etc. from frameworks
- Can easily scale his application
- App will work in an predictable manner
- Focus more on the business logic
- Less efforts and more results/revenue

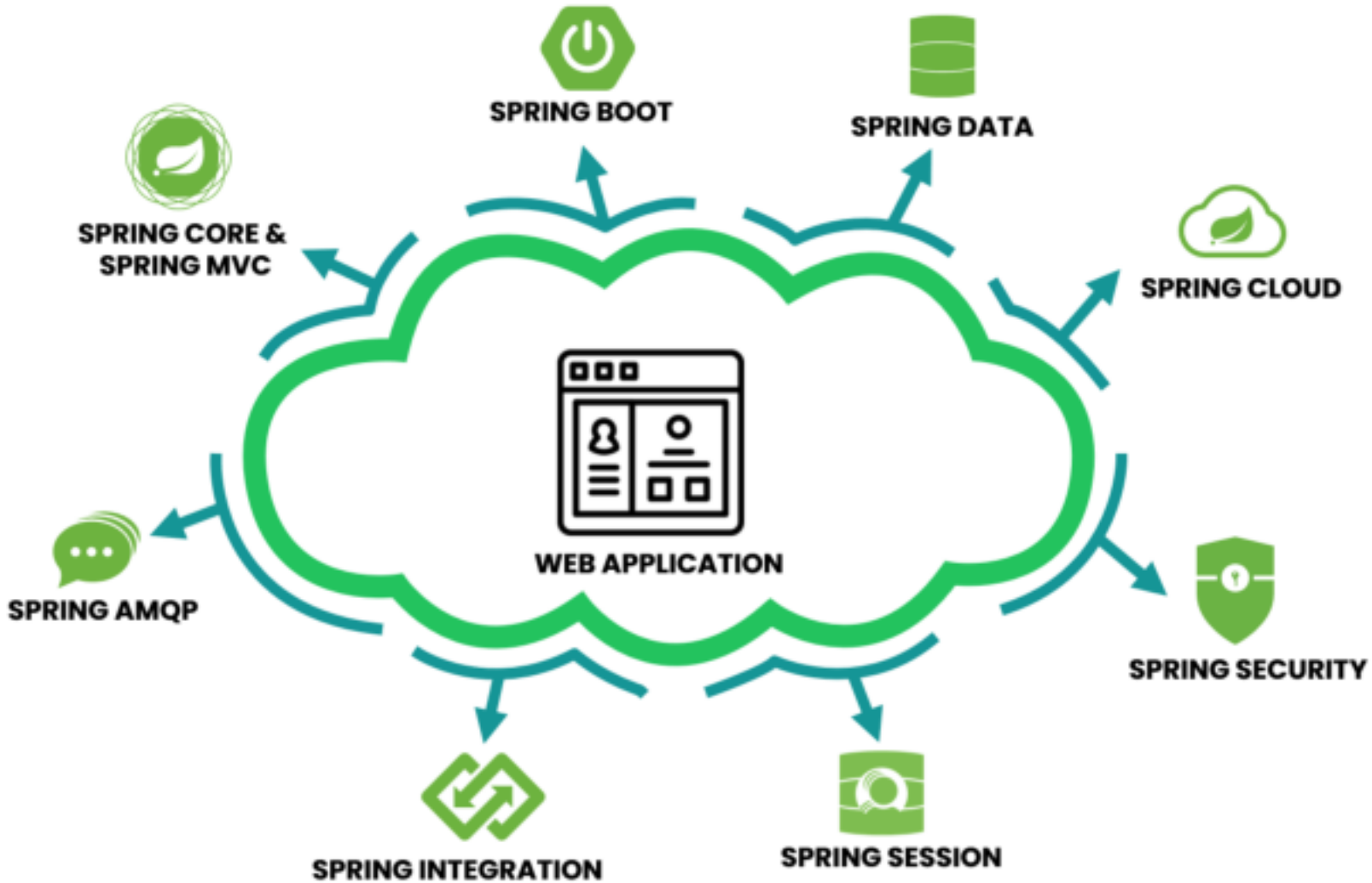
DEV VICKY

Build his own code by himself to build a web app

- Need to build code for Security, Logging etc.
- Scaling his is not an option till he test everything
- App may not work in an predictable manner
- Focus more on the supporting components
- More efforts and less results/revenue

SPRING PROJECTS

eazy bytes



* *These projects are few important projects from Spring but not a complete list.*

SPRING PROJECTS

eazy bytes

JSP/JSF | HTML/CSS | Servlets | JDBC | SOAP | J2EE

JSP/JSF | HTML/CSS | jQuery/ Bootstrap | SOAP/REST | MVC | ORM

Angular | React JS | HTML/CSS | REST | ORM/JPA | Cloud

Angular | React JS | HTML/CSS | REST | ORM/JPA | Microservices | Cloud | Docker/K8s

EVOLUTION OF APPLICATION DEVELOPMENT OVER YEARS

SPRING CORE & SPRING MVC

SPRING BOOT

SPRING DATA

SPRING SECURITY

INTEGRATION

SPRING CLOUD

Spring for Apache Kafka

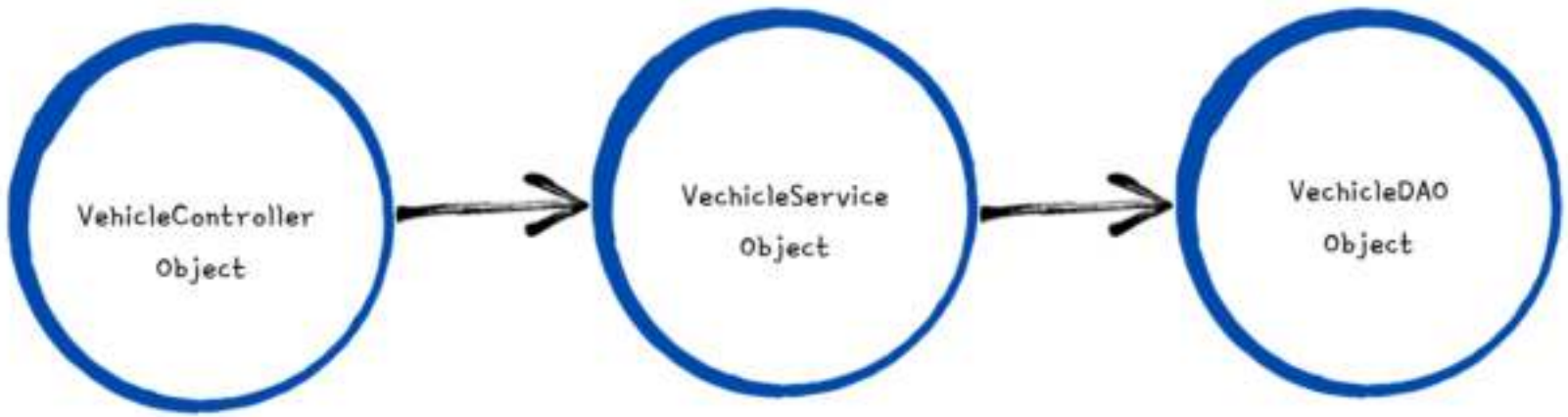
SPRING CLOUD DATA FLOW

EVOLUTION OF SPRING FRAMEWORK OVER YEARS

INTRODUCTION TO BEANS WIRING INSIDE SPRING

eazy bytes

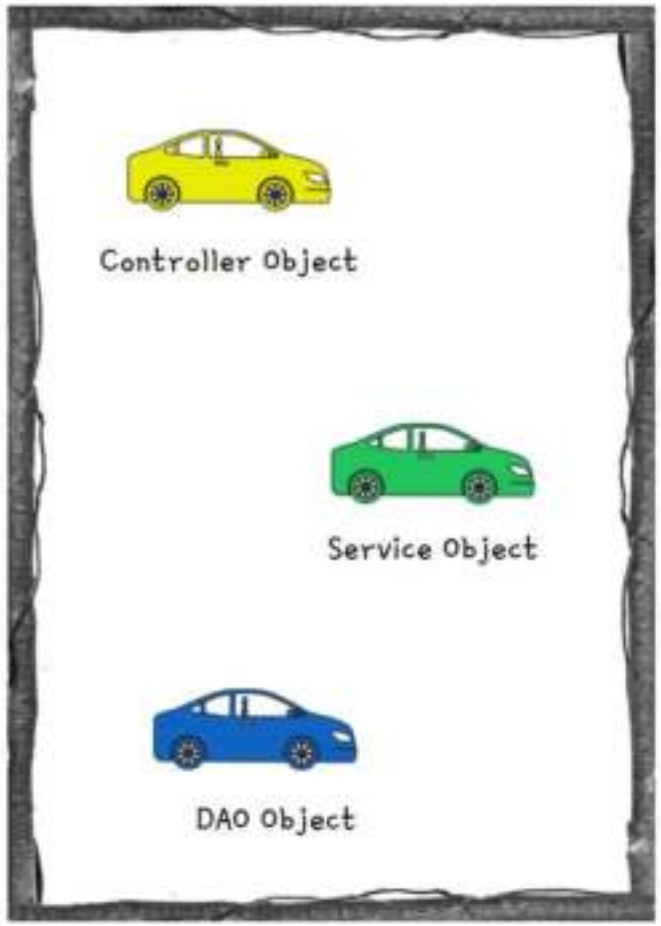
- *Inside Java web applications, usually the objects delegate certain responsibilities to other objects. So in this scenarios, objects will have dependency on others.*
- *In very similar lines when we create various beans using Spring, it our responsibility to understand the dependencies that beans have and wire them. This concept inside is called Wiring/Autowiring.*



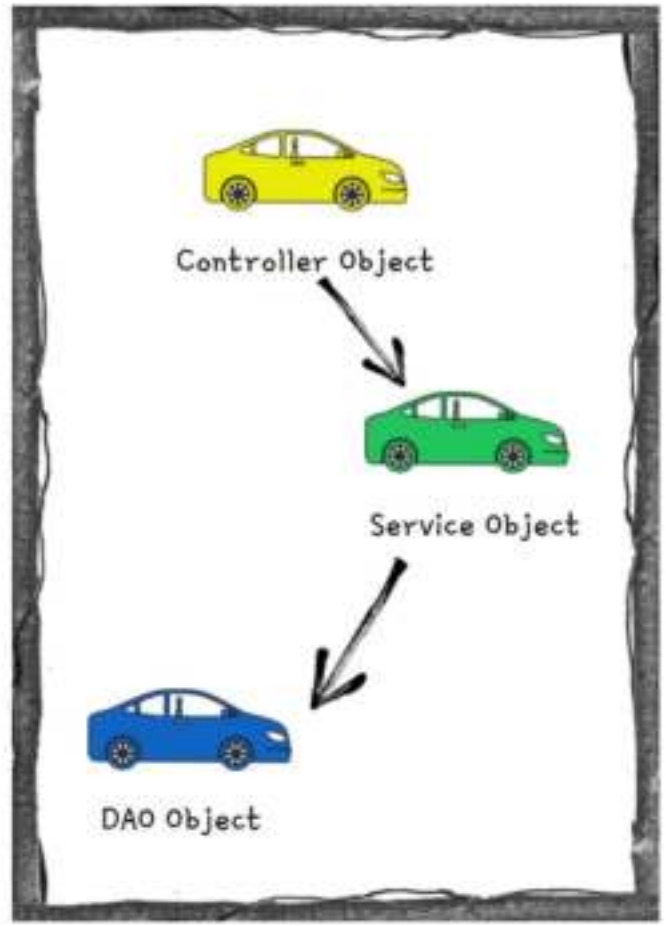
INTRODUCTION TO BEANS WIRING INSIDE SPRING

eazy bytes

SPRING CONTEXT WITH OUT WIRING



SPRING CONTEXT WITH WIRING & DI



NO WIRING SCENARIO INSIDE SPRING

eazy bytes

Consider a scenario where we have two java classes Person and Vehicle. The Person class has a dependency on the Vehicle. Based on the below code, we are only creating the beans inside the Spring Context and no wiring will be done. Due to this both this beans present inside the Spring context with out knowing about each other.

```java
public class Vehicle {

    private String name;
```

```java
public class Person {

    private String name;
    private Vehicle vehicle;
```

```java
@Bean
public Vehicle vehicle() {
    Vehicle vehicle = new Vehicle();
    vehicle.setName("Toyota");
    return vehicle;
}

@Bean
public Person person() {
    Person person = new Person();
    person.setName("Lucy");
    return person;
}
```

WIRING BEANS USING METHOD CALL

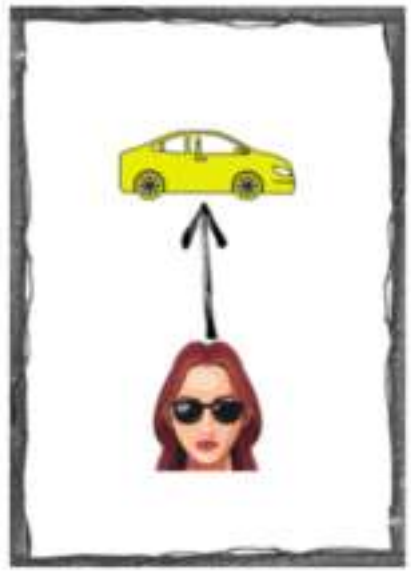
eazy bytes

- *Here in the below code, we are trying to wire or establish a relationship between Person and Vehicle, by invoking the vehicle() bean method from person() bean method. Now inside Sprint Context, person owns the vehicle.*
- *Spring will make sure to have only 1 vehicle bean is created and also vehicle bean will be created first always as person bean has dependency on it.*

```java
@Bean
public Vehicle vehicle() {
    Vehicle vehicle = new Vehicle();
    vehicle.setName("Toyota");
    return vehicle;
}

@Bean
public Person person() {
    Person person = new Person();
    person.setName("Lucy");
    person.setVehicle(vehicle());
    return person;
}
```

SPRING CONTEXT



```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Person person = context.getBean(Person.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Person name from Spring Context is: " + person.getName());
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
System.out.println("Vehicle that Person own is: " + person.getVehicle());
```

Output on Console

```
Vehicle bean created by Spring
Person bean created by Spring
Person name from Spring Context is: Lucy
Vehicle name from Spring Context is: Toyota
Vehicle that Person own is: Vehicle name is - Toyota
```

WIRING BEANS USING METHOD PARAMETERS

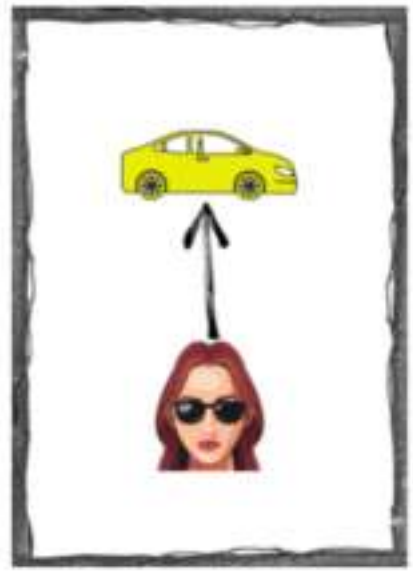
eazy bytes

- *Here in the below code, we are trying to wire or establish a relationship between Person and Vehicle, by passing the vehicle as a method parameter to the person() bean method. Now inside Sprint Context, person owns the vehicle.*
- *Spring injects the vehicle bean to the person bean using Dependency Injection*
- *Spring will make sure to have only 1 vehicle bean is created and also vehicle bean will be created first always as person bean has dependency on it.*

```java
@Bean
public Vehicle vehicle() {
    Vehicle vehicle = new Vehicle();
    vehicle.setName("Toyota");
    return vehicle;
}

/*...*/
@Bean
public Person person(Vehicle vehicle) {
    Person person = new Person();
    person.setName("Lucy");
    person.setVehicle(vehicle);
    return person;
}
```

SPRING CONTEXT



```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Person person = context.getBean(Person.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Person name from Spring Context is: " + person.getName());
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
System.out.println("Vehicle that Person own is: " + person.getVehicle());
```

Output on Console

```
Vehicle bean created by Spring
Person bean created by Spring
Person name from Spring Context is: Lucy
Vehicle name from Spring Context is: Toyota
Vehicle that Person own is: Vehicle name is - Toyota
```

Inject Beans using @Autowired on class fields

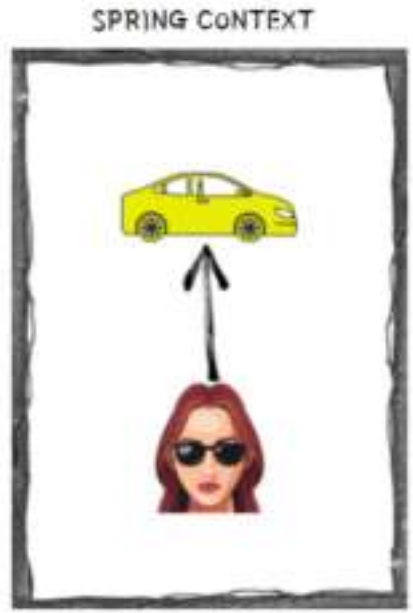
eazy bytes

- *The @Autowired annotation marks on a field, setter method, constructor is used to auto-wire the beans that is 'injecting beans'(Objects) at runtime by Spring Dependency Injection mechanism.*
- *With the below code, Spring injects/auto-wire the vehicle bean to the person bean through a class field and dependency injection.*
- *The below style is not recommended for production usage as we can't mark the fields as final.*

```java
@Component
public class Person {

    private String name="Lucy";

    /*...*/
    @Autowired
    private Vehicle vehicle;
```




```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Person person = context.getBean(Person.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Person name from Spring Context is: " + person.getName());
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
System.out.println("Vehicle that Person own is: " + person.getVehicle());
```

Output on Console

```
Vehicle bean created by Spring
Person bean created by Spring
Person name from Spring Context is: Lucy
Vehicle name from Spring Context is: Toyota
Vehicle that Person own is: Vehicle name is - Toyota
```

@Autowired(required = false) *will help to avoid the NoSuchBeanDefinitionException if the bean is not available during Autowiring process.*

Inject Beans using @Autowired on setter method

eazy bytes

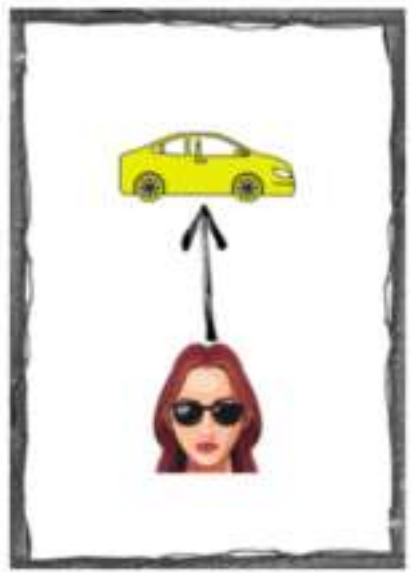
- *The @Autowired annotation marks on a field, setter method, constructor is used to auto-wire the beans that is 'injecting beans'(Objects) at runtime by Spring Dependency Injection mechanism.*
- *With the below code, Spring injects/auto-wire the vehicle bean to the person bean through a setter method and dependency injection.*
- *The below style is not recommended for production usage as we can't mark the fields as final and not readable friendly.*

```java
@Component
public class Person {

    private String name="Lucy";
    private Vehicle vehicle;

    @Autowired
    public void setVehicle(Vehicle vehicle) {
        this.vehicle = vehicle;
    }
```

SPRING CONTEXT



```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Person person = context.getBean(Person.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Person name from Spring Context is: " + person.getName());
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
System.out.println("Vehicle that Person own is: " + person.getVehicle());
```

Output on Console

```
Vehicle bean created by Spring
Person bean created by Spring
Person name from Spring Context is: Lucy
Vehicle name from Spring Context is: Toyota
Vehicle that Person own is: Vehicle name is - Toyota
```

Inject Beans using @Autowired with constructor

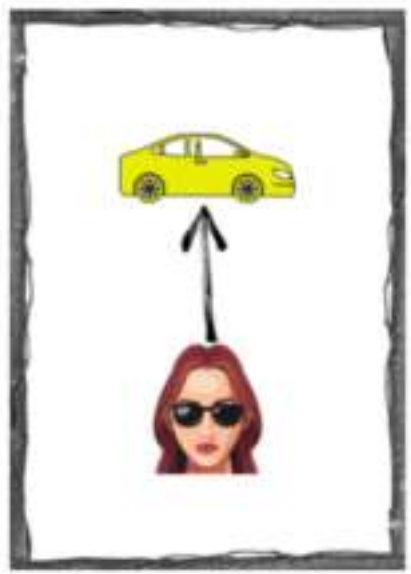
eazy bytes

- *The @Autowired annotation marks on a field, setter method, constructor is used to auto-wire the beans that is 'injecting beans'(Objects) at runtime by Spring Dependency Injection mechanism.*
- *With the below code, Spring injects/auto-wire the vehicle bean to the person bean through a constructor and dependency injection.*
- *From Spring version 4.3, when we only have one constructor in the class, writing the @Autowired annotation is optional*

```java
@Component
public class Person {

    private String name="Lucy";
    private final Vehicle vehicle;

    @Autowired
    public Person(Vehicle vehicle){
        System.out.println("Person bean created by Spring");
        this.vehicle = vehicle;
    }
```




```java
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
Person person = context.getBean(Person.class);
Vehicle vehicle = context.getBean(Vehicle.class);
System.out.println("Person name from Spring Context is: " + person.getName());
System.out.println("Vehicle name from Spring Context is: " + vehicle.getName());
System.out.println("Vehicle that Person own is: " + person.getVehicle());
```

Output on Console

```
Vehicle bean created by Spring
Person bean created by Spring
Person name from Spring Context is: Lucy
Vehicle name from Spring Context is: Toyota
Vehicle that Person own is: Vehicle name is - Toyota
```

How Autowiring works with multiple Beans of same type

eazy bytes

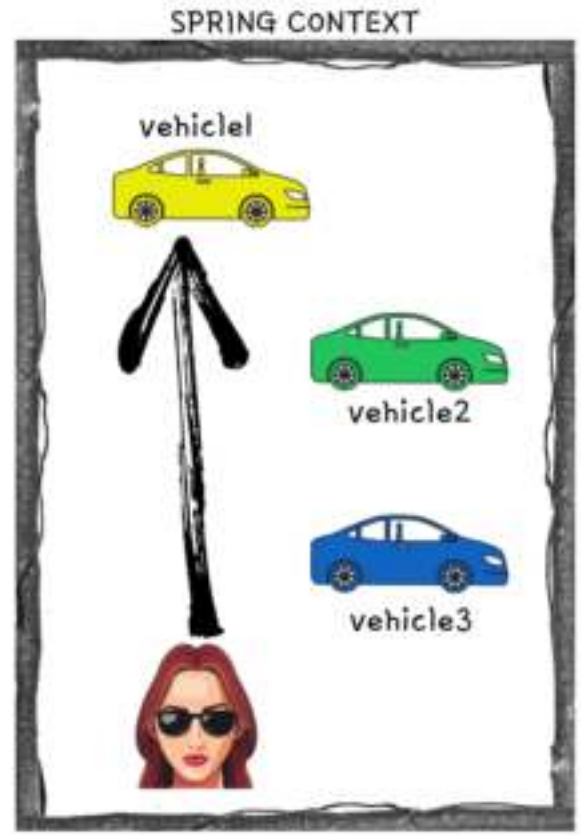
- *By default Spring tries autowiring with class type. But this approach will fail if the same class type has multiple beans.*
- *If the Spring context has multiple beans of same class type like below, then Spring will try to auto-wire based on the parameter name/field name that we use while configuring autowiring annotation.*
- *In the below scenario, we used 'vehicle1' as constructor parameter. Spring will try to auto-wire with the bean which has same name like shown in the image below.*

```java
@Component
public class Person {

    private String name="Lucy";
    private final Vehicle vehicle;

    @Autowired
    public Person(Vehicle vehicle1){
        System.out.println("Person bean created by Spring");
        this.vehicle = vehicle1;
    }
```

STEP 1



How Autowiring works with multiple Beans of same type

eazy bytes

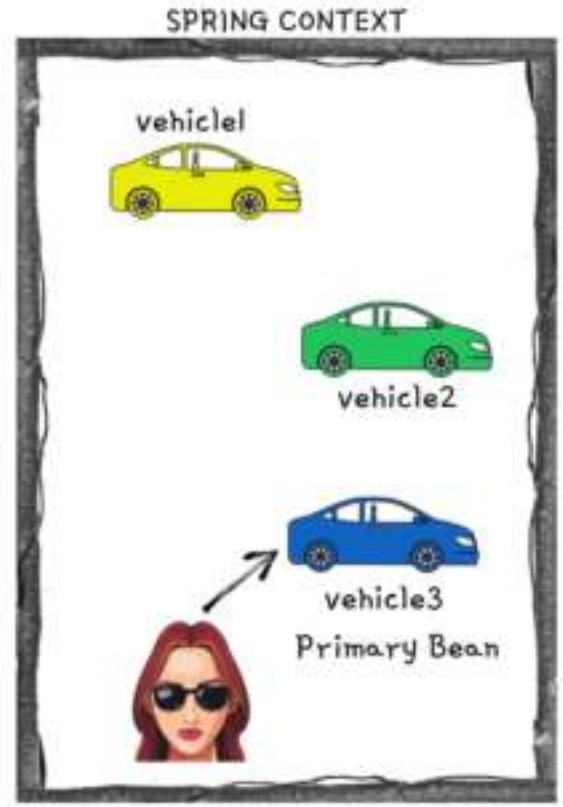
- *If the parameter name/field name that we use while configuring autowiring annotation is not matching with any of the bean names, then Spring will look for the bean which has @Primary configured.*
- *In the below scenario, we used 'vehicle' as constructor parameter. Spring will try to auto-wire with the bean which has same name and since it can't find a bean with the same name, it will look for the bean with @Primary configured like shown in the image below.*

```java
@Component
public class Person {

    private String name="Lucy";
    private final Vehicle vehicle;

    @Autowired
    public Person(Vehicle vehicle){
        System.out.println("Person bean created by Spring");
        this.vehicle = vehicle;
    }
```

STEP 2



How Autowiring works with multiple Beans of same type

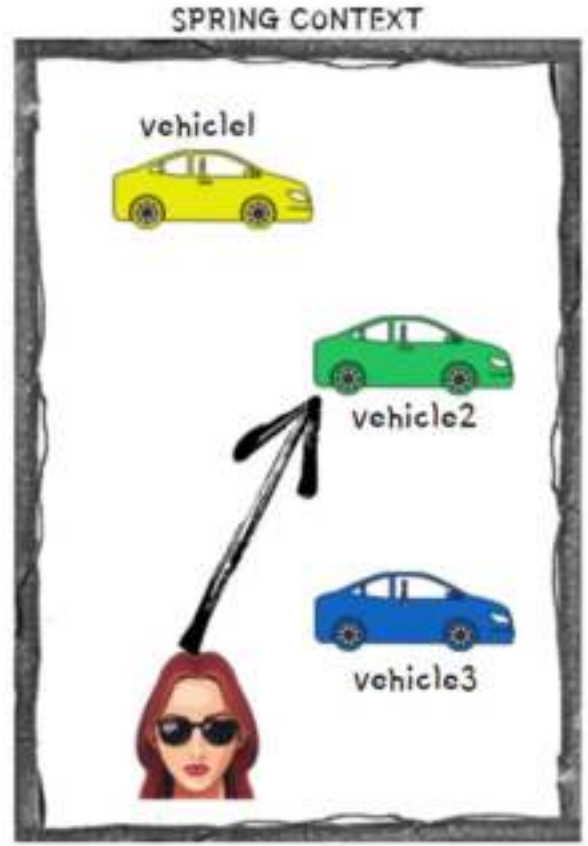
eazy bytes

- *If the parameter name/field name that we use while configuring autowiring annotation is not matching with any of the bean names and even Primary bean is not configured, then Spring will look if @Qualifier annotation is used with the bean name matching with Spring context bean names.*
- *In the below scenario, we used 'vehicle2' with @Qualifier annotation. Spring will try to auto-wire with the bean which has same name like shown in the image below.*

```java
@Component
public class Person {

    private String name="Lucy";
    private final Vehicle vehicle;

    @Autowired
    public Person(@Qualifier("vehicle2") Vehicle vehicle){
        System.out.println("Person bean created by Spring");
        this.vehicle = vehicle;
    }
```



STEP 3

Understanding & Avoiding Circular dependencies

eazy bytes

- *A Circular dependency will happen if 2 beans are waiting for each to create inside the Spring context in order to do auto-wiring.*
- *Consider the below scenario, where Person has a dependency on Vehicle and Vehicle has a dependency on Person. In such scenarios, Spring will throw UnsatisfiedDependencyException due to circular reference.*
- *As a developer, it is our responsibility to make sure we are defining the configurations/dependencies that will result in circular dependencies.*

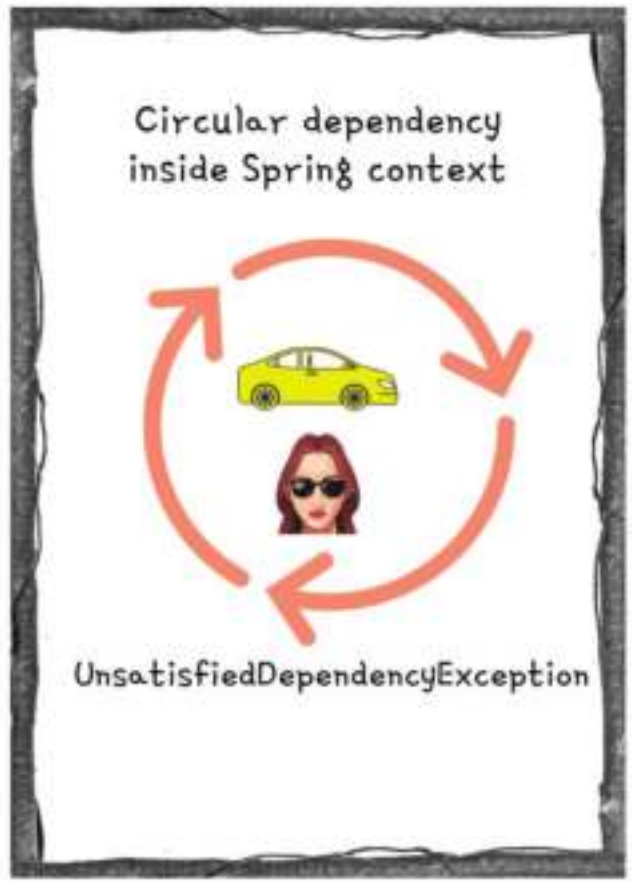
```java
@Component
public class Person {

    private String name="Lucy";
    private Vehicle vehicle;

    @Autowired
    public void setVehicle(Vehicle vehicle) {
        this.vehicle = vehicle;
    }
```

```java
public class Vehicle {

    private String name;
    @Autowired
    private Person person;
```



ASSIGNMENT RELATED TO BEANS, AUTOWIRING, DI

eazy bytes

Speakers interface with makeSound() method

SonySpeakers Bean implementation of Speakers

BoseSpeakers Bean implementation of Speakers

Vehicle Bean has a dependency on VehicleServices Bean, to play music and move the vehicle

VehicleServices bean depend on the implementations of Speakers and Tyres to serve vehicle bean requests.

Person Bean has a dependency on Vehicle Bean

Your application should play music from one of the Speakers implementations & move using one of the Tyres implementation. It should also give flexibility to switch between the implementations easily.

BridgeStoneTyres Bean implementation of Tyres

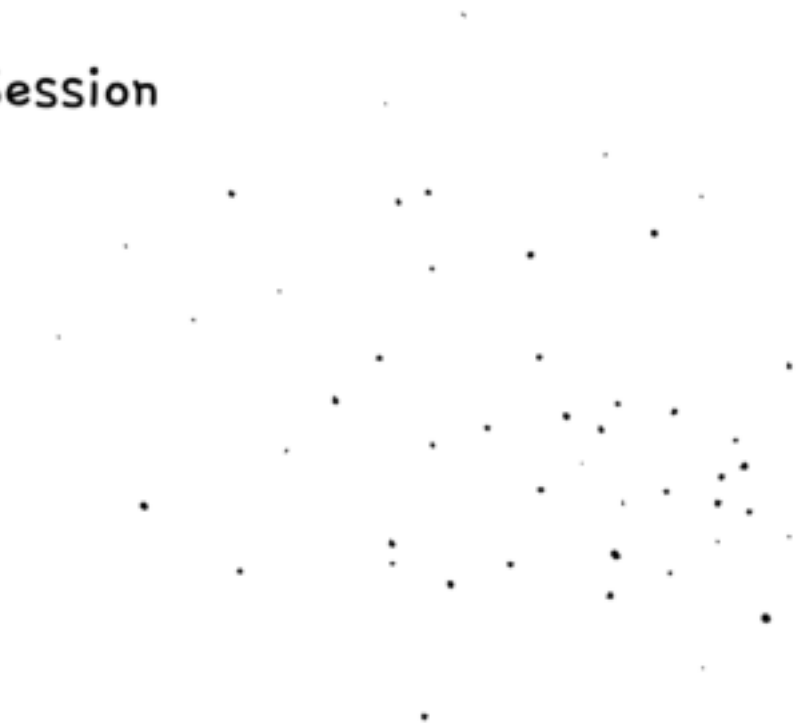
MichelinTyres Bean implementation of Tyres

Tyres interface with rotate() method

eazy bytes

Bean Scopes inside Spring

1. Singleton
2. Prototype
3. Request
4. Session
5. Application



SINGLETON BEAN SCOPE

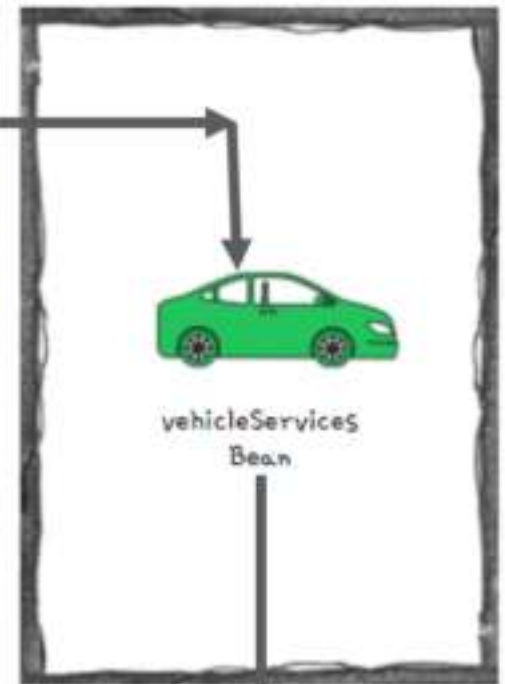
eazy bytes

- *Singleton is the default scope of a bean in Spring. In this scope, for a single bean we always get a same instance when you refer or autowire inside your application.*
- *Unlike Singleton design pattern where we have only 1 instance in entire app, inside Singleton scope Spring will make sure to have only 1 instance per unique bean. For example, if you have multiple beans of same type, then Spring Singleton scope will maintain 1 instance per each bean declared of same type.*

```
@Component
@Scope(BeanDefinition.SCOPE_SINGLETON)
public class VehicleServices {
```

Creates a single bean inside Spring context

```
VehicleServices vehicleServices1 = context.
        getBean(VehicleServices.class);
VehicleServices vehicleServices2 = context.
        getBean( name: "vehicleServices",VehicleServices.class);
```



The two variables refers to the same bean inside Spring context

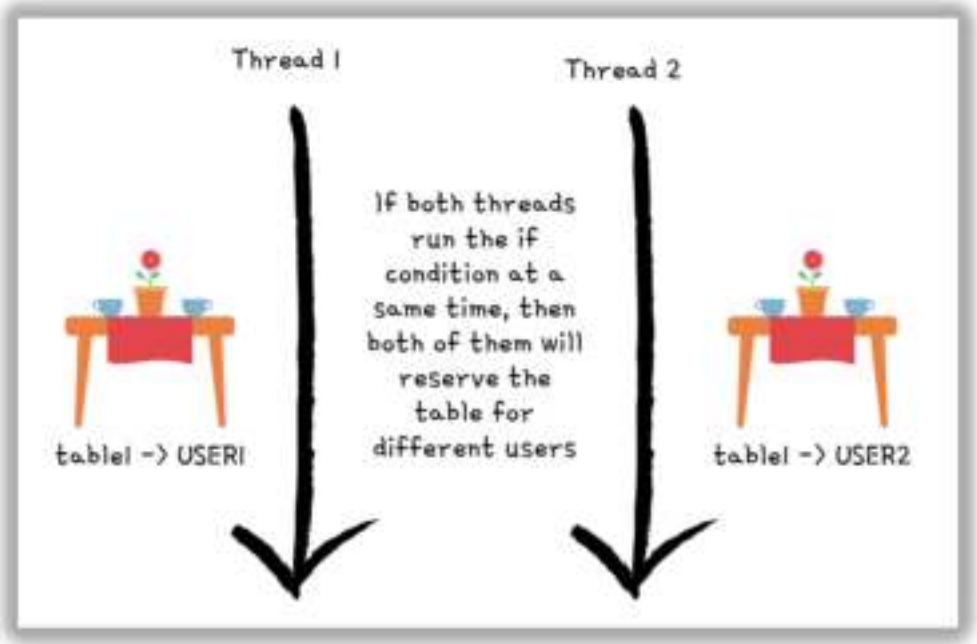
RACE CONDITION

eazy bytes

- *A race condition occurs when two threads access a shared variable at the same time. The first thread reads the variable, and the second thread reads the same value from the variable. Then the first thread and second thread perform their operations on the value, and they race to see which thread can write the value last to the shared variable. The value of the thread that writes its value last is preserved, because the thread is writing over the value that the previous thread wrote.*

```
// Shared Value inside a object
Map<String, String> reservedTables = new HashMap<>();

// thread -1
if (!reservedTables.containsKey("table1")){
    reservedTables.put("table1","USER1");
}
// thread - 2
if (!reservedTables.containsKey("table1")){
    reservedTables.put("table1","USER2");
}
```



USE CASES OF SINGLETON BEANS

eazy bytes

Singleton Beans use cases

- ✓ Since the same instance of singleton bean will be used by multiple threads inside your application, it is very important that these beans are immutable.
- ✓ This scope is more suitable for beans which handles service layer, repository layer business logics.

1. Building mutable singleton beans, will result in the race conditions inside multi thread environments.
2. There are ways to avoid race conditions due to mutable singleton beans with the help of synchronization.
3. But it is not recommended, since it brings lot of complexity and performance issues inside your app. So please don't try to build mutable singleton beans.

EAGER & LAZY INSTANTIATION

eazy bytes

- *By default Spring will create all the singleton beans eagerly during the startup of the application itself. This is called Eager instantiation.*
- *We can change the default behavior to initialize the singleton beans lazily only when the application is trying to refer to the bean. This approach is called Lazy instantiation.*

Sample demo of Lazy instantiation

```
@Component(value="personBean")
@Lazy
public class Person {
```


```
var context = new AnnotationConfigApplicationContext(ProjectConfig.class);
System.out.println("Before retrieving the Person bean from the Spring Context");
Person person = context.getBean(Person.class);
System.out.println("After retrieving the Person bean from the Spring Context");
```

Output on Console

```
Before retrieving the Person bean from the Spring Context
Person bean created by Spring
After retrieving the Person bean from the Spring Context
```

Eager Vs Lazy

eazy bytes

Eager instantiation

- This is the default behavior inside Spring framework
- The singleton bean will be created during the startup of the application
- The server will not start if bean is not able to create due to any dependent exceptions
- Spring context will occupy lot of memory if we try to use eager for all beans inside a application
- Eager can be followed for all the beans which are required very commonly inside a application

Lazy instantiation

- This is not a default behavior and need to configure explicitly using @Lazy
- The singleton bean will be created when the app is trying to refer the bean for the first time
- Application will throw an exception runtime if bean creation is failed due to any dependent exceptions
- The performance will be impacted if we try to use lazy for all beans inside a application
- Lazy can be followed for the beans that are used in a very remote scenario inside a application

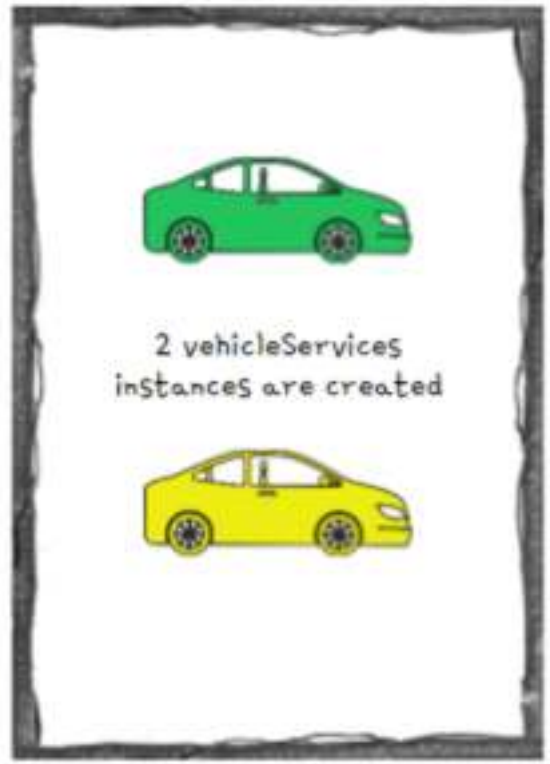
PROTOTYPE BEAN SCOPE

eazy bytes

- *With prototype scope, every time we request a reference of a bean, Spring will create a new object instance and provide the same.*
- *Prototype scope is rarely used inside the applications and we can use this scope only in the scenarios where your bean will frequently change the state of the data which will result race conditions inside multi thread environment. Using prototype scope will not create any race conditions.*

```
@Component
@Scope(BeanDefinition.SCOPE_PROTOTYPE)
public class VehicleServices {
```

```
VehicleServices vehicleServices1 = context.
        getBean(VehicleServices.class);
VehicleServices vehicleServices2 = context.
        getBean( name: "vehicleServices",VehicleServices.class);
```



Singleton Vs Prototype

eazy bytes

Singleton Scope

- This is the default scope inside Spring framework
- The same object instance will be returned every time we refer a bean inside the code
- We can configure to create the beans during the start up or when the first time referred
- Immutable objects can be idle for Singleton scope
- Most commonly used scope

Prototype Scope

- Need to explicitly configure using @Scope(BeanDefinition.SCOPE_PROTOTYPE)
- New object instance will be returned every time we refer a bean inside the code
- Spring always creates the new object when we try to refer the bean. No eager instantiation is possible
- Mutable objects can be idle for prototype scope
- Very rarely used scope

ASPECT-ORIENTED PROGRAMMING (AOP)

eazy bytes

Aspect-Oriented Programming

- ✓ An aspect is simply a piece of code the Spring framework executes when you call specific methods inside your app.
- ✓ Spring AOP enables Aspect-Oriented Programming in spring applications. In AOP, aspects enable the modularization of concerns such as transaction management, logging or security that cut across multiple types and objects (often termed crosscutting concerns).

1. AOP provides the way to dynamically add the cross-cutting concern before, after or around the actual logic using simple pluggable configurations.
2. AOP helps in separating and maintaining many non-business logic related code like logging, auditing, security, transaction management.
3. AOP is a programming paradigm that aims to increase modularity by allowing the separation of cross-cutting concerns. It does this by adding additional behavior to existing code without modifying the code itself.

More details : https://docs.spring.io/spring-framework/docs/current/reference/html/core.html#aop-ataspectj

ASPECT-ORIENTED PROGRAMMING (AOP)

eazy bytes

```java
public String moveVehicle(boolean started){
    Instant start = Instant.now();
    logger.info( msg: "method execution start");
    String status = null;
    if(started){
        status = tyres.rotate();
    }else{
        logger.log(Level.SEVERE, msg: "Vehicle not started to perform the" +
                " operation");
    }
    logger.info( msg: "method execution end");
    Instant finish = Instant.now();
    long timeElapsed = Duration.between(start, finish).toMillis();
    logger.info( msg: "Time took to execute the method : "+timeElapsed);
    return status;
}
```

There is so much of non business logic code along with the main business logic

AOP MAGIC

```java
public String moveVehicle(boolean started){
    return tyres.rotate();
}
```

With AOP magic, all the non business logic is moved to different location which will make method clean & clear

ASPECT-ORIENTED PROGRAMMING (AOP)

eazy bytes

AOP Jargons

- ✓ **When we define an Aspect or doing configurations, we need to follow WWW (3 Ws)**
  - **WHAT -> Aspect**
  - **WHEN -> Advice**
  - **WHICH -> Pointcut**

1. WHAT code or logic we want the Spring to execute when you call a specific method. This is called as Aspect.
2. WHEN the Spring need to execute the given Aspect. For example is it before or after the method call. This is called as Advice.
3. WHICH method inside App that framework needs to intercept and execute the given Aspect. This is called as a Pointcut.

- Join point which defines the event that triggers the execution of an aspect. Inside Spring, this event is always a method call.
- Target object is the bean that declares the method/pointcut which is intercepted by an aspect.

ASPECT-ORIENTED PROGRAMMING (AOP)

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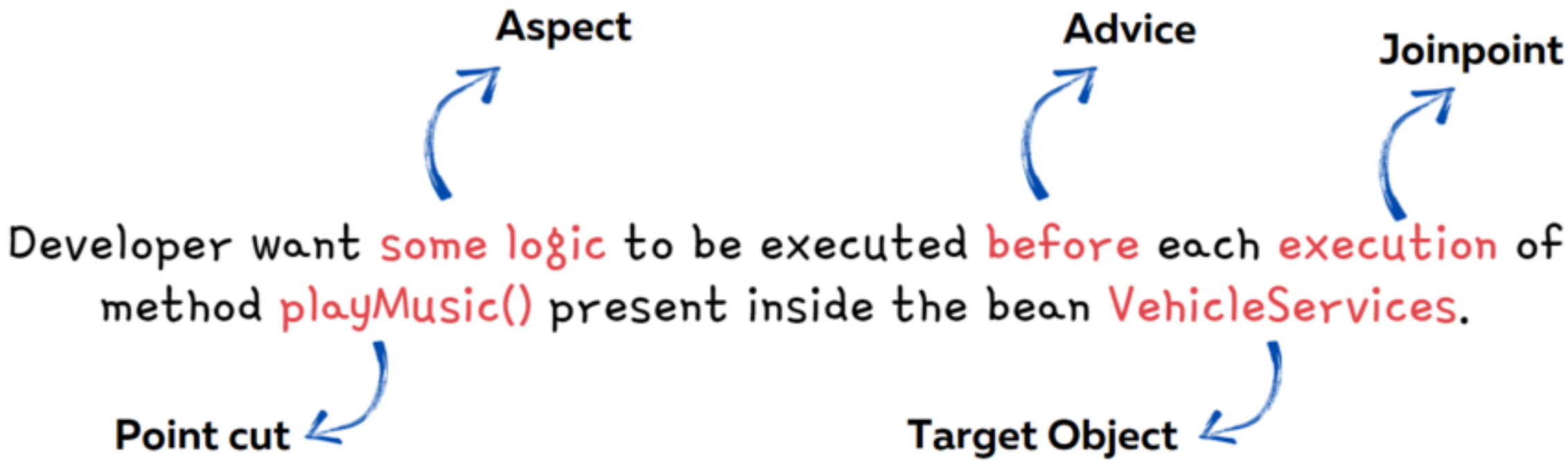
Typical Scenario of AOP implementation



WEAVING INSIDE AOP

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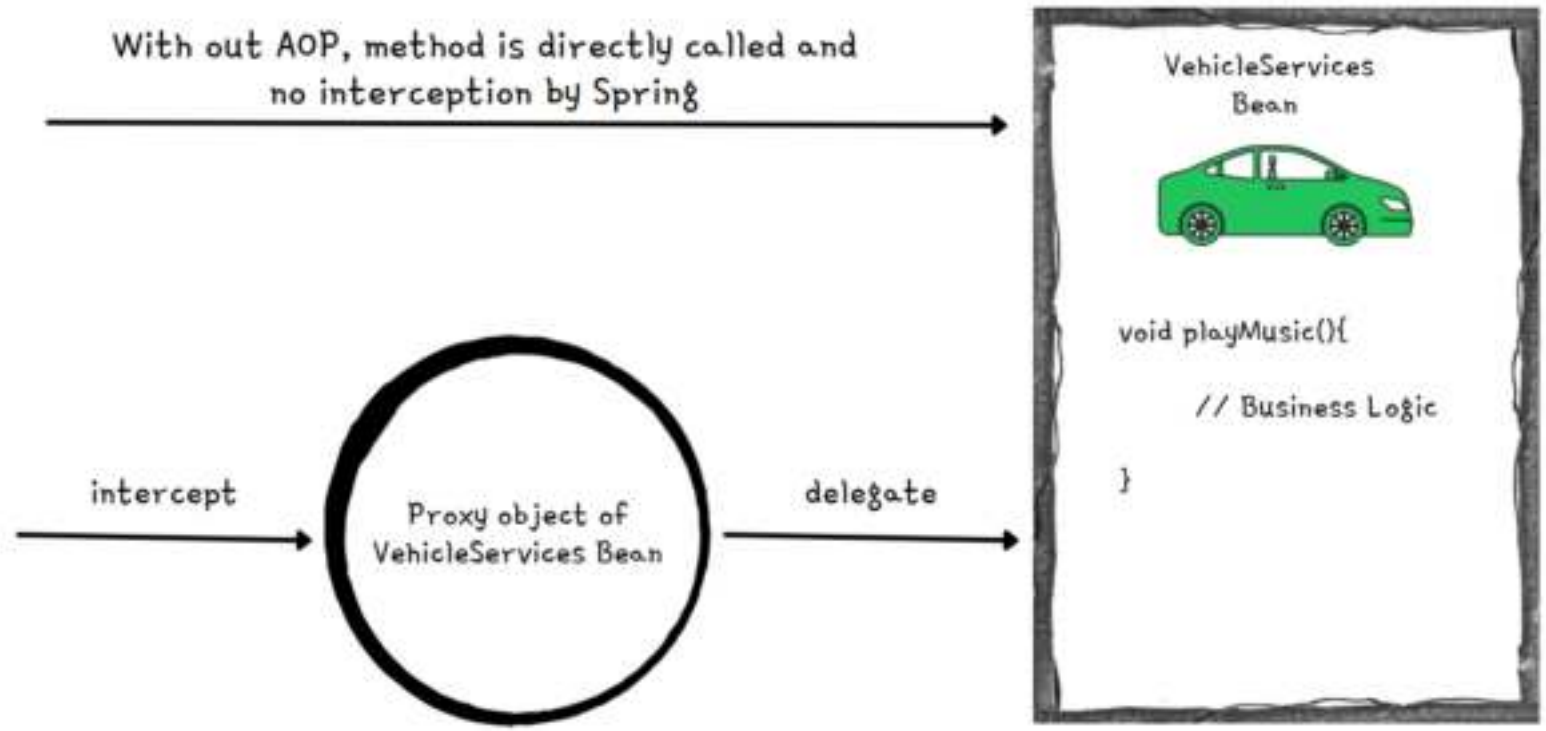
- *When we are implementing AOP inside our App using Spring framework, it will intercept each method call and apply the logic defined in the Aspect.*
- *But how does this works ? Spring does this with the help of proxy object. So we try to invoke a method inside a bean, Spring instead of directly giving reference of the bean instead it will give a proxy object that will manage the each call to a method and apply the aspect logic. This process is called Weaving.*



ADVICE TYPES INSIDE AOP

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Type of Advices in Spring AOP

- ✓ @Before
- ✓ @AfterReturning
- ✓ @AfterThrowing
- ✓ @After
- ✓ @Around

1. Before advice runs before a matched method execution.
2. After returning advice runs when a matched method execution completes normally.
3. After throwing advice runs when a matched method execution exits by throwing an exception
4. After (finally) advice runs no matter how a matched method execution exits.
5. Around advice runs "around" a matched method execution. It has the opportunity to do work both before and after the method runs and to determine when, how, and even if the method actually gets to run at all.

CONFIGURING ADVICES INSIDE AOP

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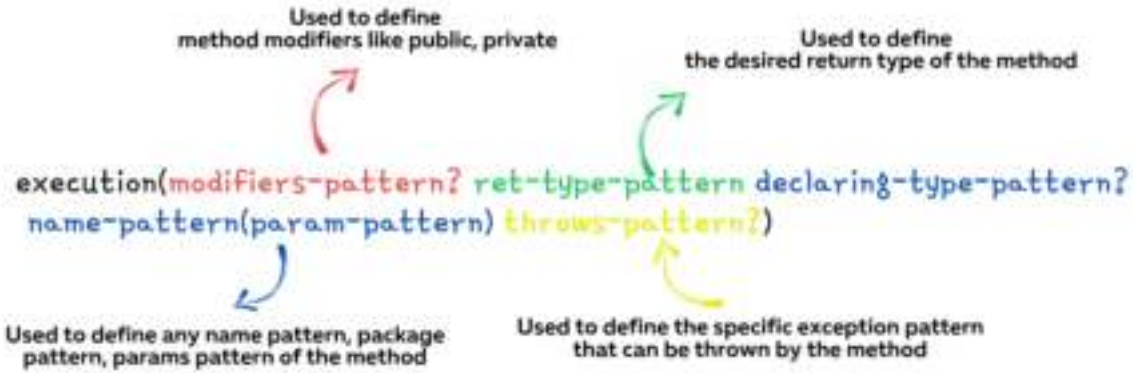
- *We can use the AspectJ pointcut expression to provide details to Spring about what kind of methods it needs to intercept by mentioning details around modifier, return type, name pattern, package name pattern, params pattern, exceptions pattern etc.*
- *Below is the format of the same,*



Execution expression approach

- *Like shown below, we can mention the pointcut expressions as an input after advise annotations that we use,*

```
@Configuration
@ComponentScan(basePackages = {"com.example.implementation",
        "com.example.services", "com.example.aspects"})
@EnableAspectJAutoProxy
public class ProjectConfig {

}
```

```
@Aspect
@Component
public class LoggerAspect {

    @Around("execution(* com.example.services.*.*(..))")
    public void log(ProceedingJoinPoint joinPoint) throws Throwable {
        // Aspect logic
    }

}
```

CONFIGURING ADVICES INSIDE AOP

eazy bytes

- *Alternatively, we can use Annotation style of configuring Advices inside AOP. Below are the three steps that we follow for the same,*

```
@Retention(RetentionPolicy.RUNTIME)
@Target(ElementType.METHOD)
public @interface LogAspect {
}
```

→ *Step 1: Create an annotation type*

Annotations approach

```
@LogAspect
public String playMusic(boolean started, Song song){
    // Business Logic
}
```

→ *Step 2: Mention the same annotation on top of the method which we want to intercept using AOP*

```
@Around("@annotation(com.example.interfaces.LogAspect)")
public void logWithAnnotation(ProceedingJoinPoint joinPoint) throws Throwable {
    // Aspect Logic
}
```

→ *Step 3: Use the annotation details to configure on top of the aspect method to advice*

OVERVIEW OF A WEB APP

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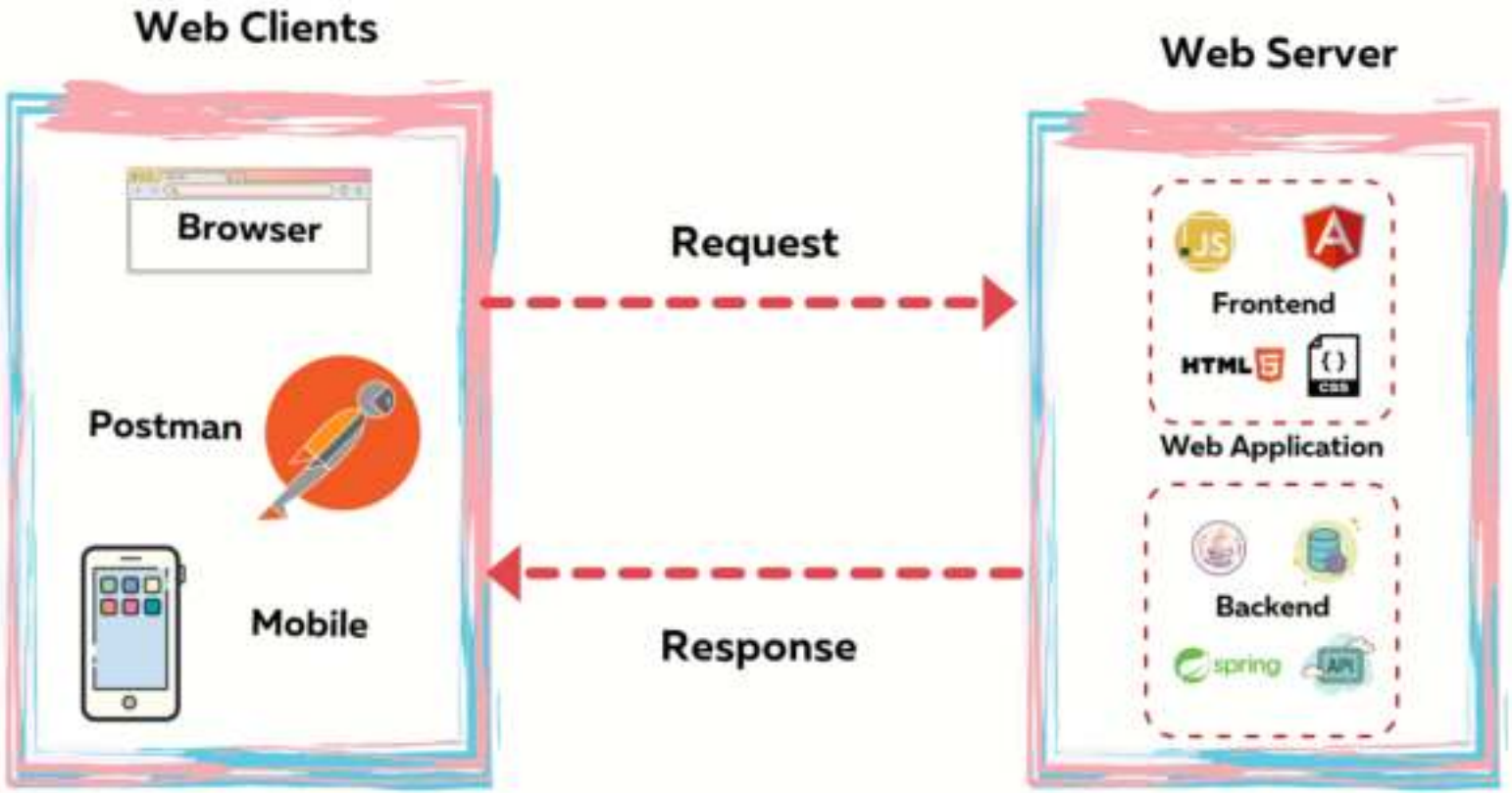

1. The Web clients sends a request using protocols like HTTP to Web Application asking some data
like list of images, videos, text etc.

2. The web server where web app is deployed receives the client requests and process the data it receives. Post that it will respond to the client's request in the format of HTML, JSON etc.

3. In Java web apps, Servlet Container (Web Server) takes care of translating the HTTP messages for Java code to understand. One of the mostly used servlet container is Apache Tomcat.

4. Servlet Container converts the HTTP messages into ServletRequest and hand over to Servlet method as a parameter. Similarly, ServletResponse returns as an output to Servlet Container from Servlet.

Usually Web Applications can be,
1) Only Frontend (Static Web Apps)
2) Only Backend (APIs)
3) Frontend + Backend (Ecommerce Apps)

ROLE OF SERVLETS INSIDE WEB APPs

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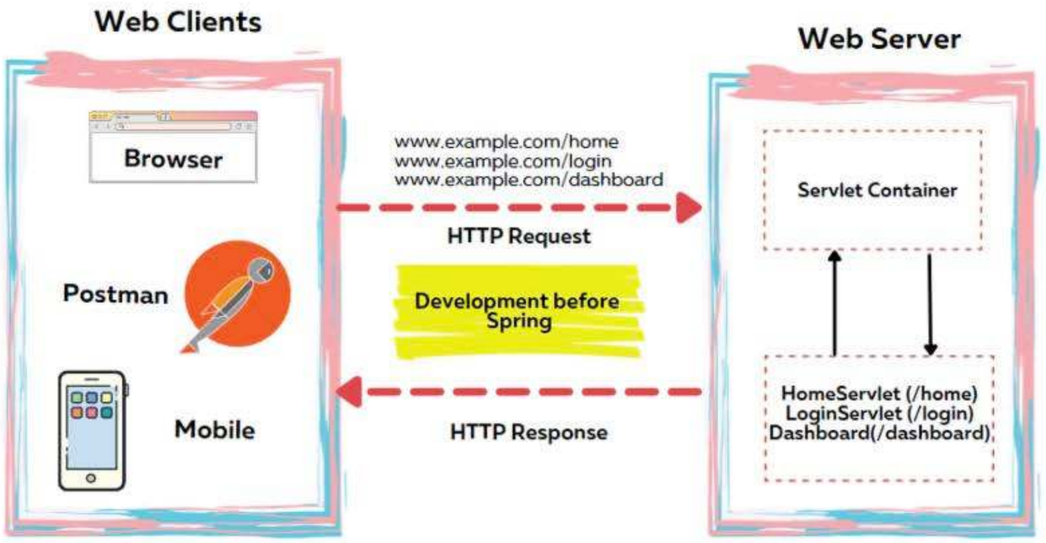


Before Spring

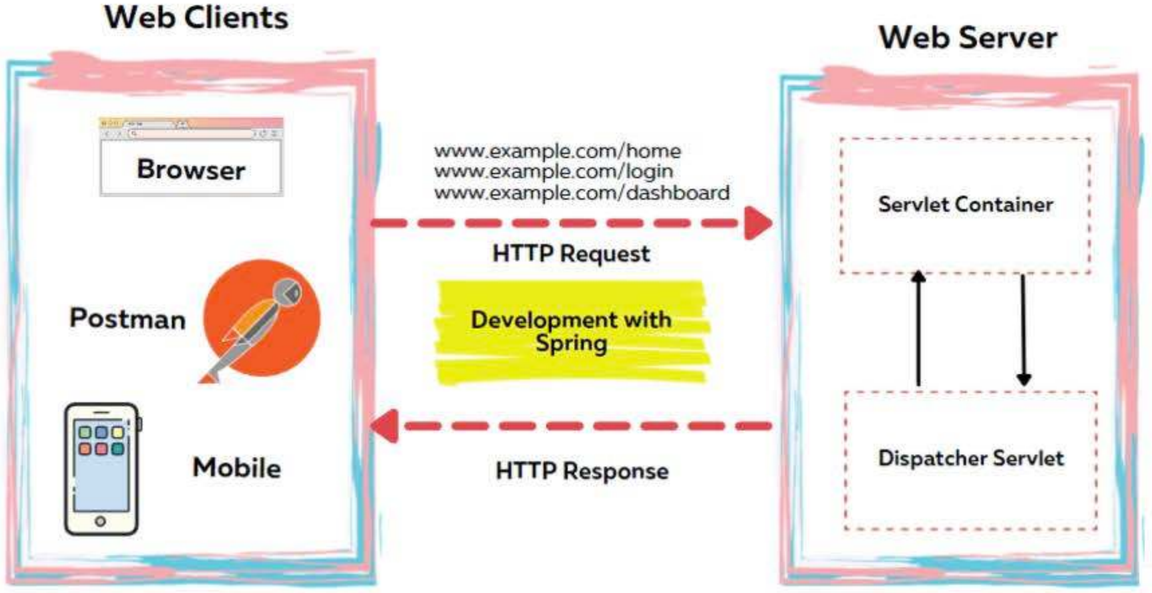
1. Before Spring, developer has to create a new servlet instance, configure it in the servlet container, and assign it to a specific URL path

2. When the client sends a request, Tomcat calls a method of the servlet associated with the path the client requested. The servlet gets the values on the request and builds the response that Tomcat sends back to the client.

With Spring

1. With Spring, it defines a servlet called Dispatcher Servlet which maintain all the URL mapping inside a web application.

2. The servlet container calls this Dispatcher Servlet for any client request, allowing the servlet to manage the request and the response. This way Spring internally does all the magic for Developers with out the need of defining the servlets inside a Web app.



EVOLUTION OF WEB APPs INSIDE JAVA ECO YSYTEM

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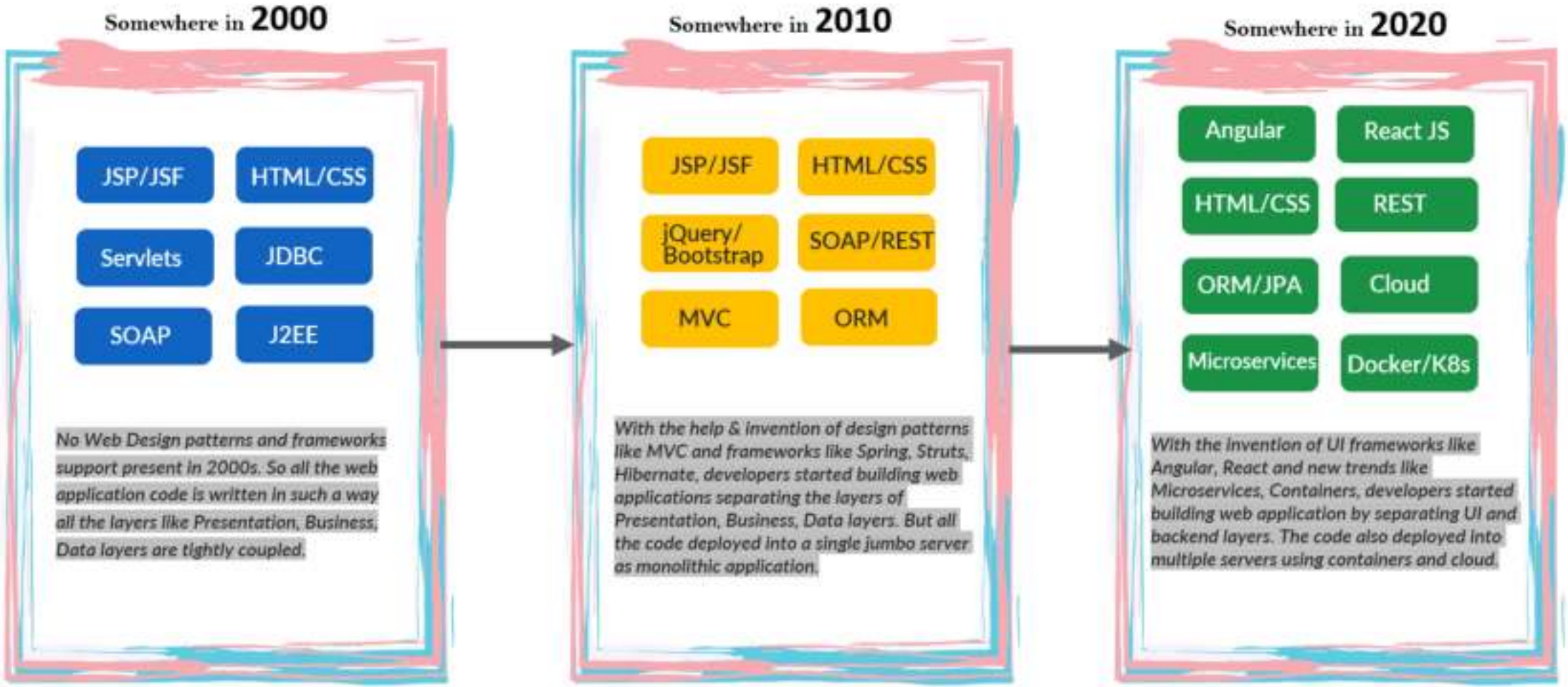

DEVELOPING WEB APPLICATIONS USING SPRING

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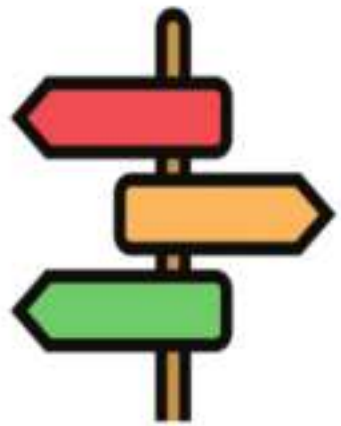
APPROACH 1

- Web Apps which holds UI elements like HTML, CSS, JS and backend logic
- Here the App is responsible to fully prepare the view along with data in response to a client request
- Spring Core, Spring MVC, SpringBoot, Spring Data, Spring Rest, Spring Security will be used



Approaches to build web applications using Spring framework

APPROACH 2

- Web Apps which holds only backend logic. These Apps send data like JSON to separate UI Apps built based on Angular, React etc.
- Here the App is responsible to only process the request and respond with only data ignoring view.
- Spring Core, SpringBoot, Spring Data, Spring Rest, Spring Security will be used

Spring MVC is the key differentiator between these two approaches.

SPRINGBOOT : THE HERO OF SPRING FRAMEWORK

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1. Spring Boot was introduced in April 2014 to reduce some of the burdens while developing a Java web application.
2. Before SpringBoot, Developer need to configure a servlet container, establish link b/w Tomcat and Dispatcher servlet, deploy into a server, define lot of dependencies.....
3. But with SpringBoot, we can create Web Apps skeletons with in seconds or at least in 1-2 mins ☺. It helps eliminating all the configurations we need to do.
4. Spring Boot is now one of the most appreciated projects in the Spring ecosystem. It helps us to create Spring apps more efficiently and focus on the business code.
5. SpringBoot is a mandatory skill now due to the latest trends like Full Stack Development, Microservices, Serverless, Containers, Docker etc.

BEFORE & AFTER SPRINGBOOT

eazy bytes

- Configure a Maven/Gradle project with all the dependencies needed
- Understand how servlets work & configure the DispatcherServlet inside web.xml
- Package the web application into a WAR file. Deploy the same into a server
- Deal with complicated class loading strategies, application monitoring and management

- Spring boot automatically configures the bare minimum components of a Spring application.
- Spring Boot applications embed a web server so that we do not require an external application server.
- Spring Boot provides several useful production-ready features out of the box to monitor and manage the application

eazy bytes

SpringBoot important features

SpringBoot Starters

Spring Boot groups related dependencies used for a specific purpose as starter projects. We don't need to figure out all the must-have dependencies you need to add to your project for one particular purpose nor which versions you should use for compatibility.

Example : spring-boot-starter-web

Autoconfiguration

Based on the dependencies present in the classpath, Spring Boot guess and auto configure the spring beans, property configurations etc. However, auto-configuration backs away from the default configuration if it detects user-configured beans with custom configurations

To achieve autoconfiguration SpringBoot follows the convention-over-configuration principle.

Actuator & DevTools

Spring Boot provides a pre-defined list of actuator endpoints. Using this production ready endpoints, we can monitor app health, metrics etc.

DevTools includes features such as automatic detection of application code changes, LiveReload server to automatically refresh any HTML changes to the browser all w/o server restart.

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Quick Recap

1. https://start.spring.io/ is the website which can be used to generate web projects skeleton based on the dependencies required for an application.

2. We can identify the Spring Boot main class by looking for an annotation @SpringBootApplication.

3. A single @SpringBootApplication annotation can be used to enable those three features, that is:

   - @EnableAutoConfiguration: enable Spring Boot's auto-configuration mechanism
   - @ComponentScan: enable @Component scan on the package where the application is located
   - @SpringBootConfiguration: enable registration of extra beans in the context or the import of additional configuration classes. An alternative to Spring's standard @Configuration annotation

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Quick Recap

4 The @RequestMapping annotation provides “routing” information. It tells Spring that any HTTP
request with the given path should be mapped to the corresponding method. It is a Spring MVC annotation and not specific to Spring Boot.

5 server.port and server.servlet.context-path properties can be mentioned inside the application.properties to change the default port number and context path of a web application.

6 Mentioning server.port=0 will start the web application at a random port number every time.

7 Mentioning debug=true will print the Autoconfiguration report on the console. We can mention the
exclusion list as well for SpringBoot auto-configuration by using the below config,

```
@SpringBootApplication(exclude = { DataSourceAutoConfiguration.class })
```

QUICK TIP

eazy bytes

Do you know, we can configure multiple paths against a single method using Spring MVC annotations ?

```
@Controller
public class HomeController {

    @RequestMapping(value={"", "/", "home"})
    public String displayHomePage(Model model) {
        // Business Logic
    }

}
```

INTRODUCTION TO THYMELEAF

eazy bytes

- *Thymeleaf is a modern server-side Java template engine for both web and standalone environments. This allow developers to build dynamic content inside the web applications.*
- *Thymeleaf has great integration with Spring especially with Spring MVC, Spring Security etc.*
- *The Thymeleaf + Spring integration packages offer a SpringResourceTemplateResolver implementation which uses all the Spring infrastructure for accessing and reading resources in applications, and which is the recommended implementation in Spring-enabled applications.*

```
<table>
    <thead>
    <tr>
        <th th:text="#{msgs.headers.name}">Name</th>
        <th th:text="#{msgs.headers.price}">Price</th>
    </tr>
    </thead>
    <tbody>
    <tr th:each="prod: ${allProducts}">
        <td th:text="${prod.name}">Oranges</td>
        <td th:text="${#numbers.formatDecimal(prod.price, 1, 2)}">0.99</td>
    </tr>
    </tbody>
</table>
```

Other famous template engines supported by Spring:

1. Jakarta Server Pages (JSP)
2. Jakarta Server Faces (JSF)
3. Apache FreeMarker
4. Groovy

For more details, pls refer https://www.thymeleaf.org/

SPRINGBOOT DEVTOOLS

eazy bytes

- *The Spring Boot DevTools provides features like Automatic restart & LiveReload that make the application development experience a little more pleasant for developers.*
- *It can be added into any of the SpringBoot project by adding the below maven dependency,*

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

DevTools maintains 2 class loaders. one with classes that doesn't change and other one with classes that change. When restart needed it only reload the second class loader which makes restarts faster as well.

DevTools includes an embedded LiveReload server that can be used to trigger a browser refresh when a resource is changed. LiveReload related browser extensions are freely available for Chrome, Firefox

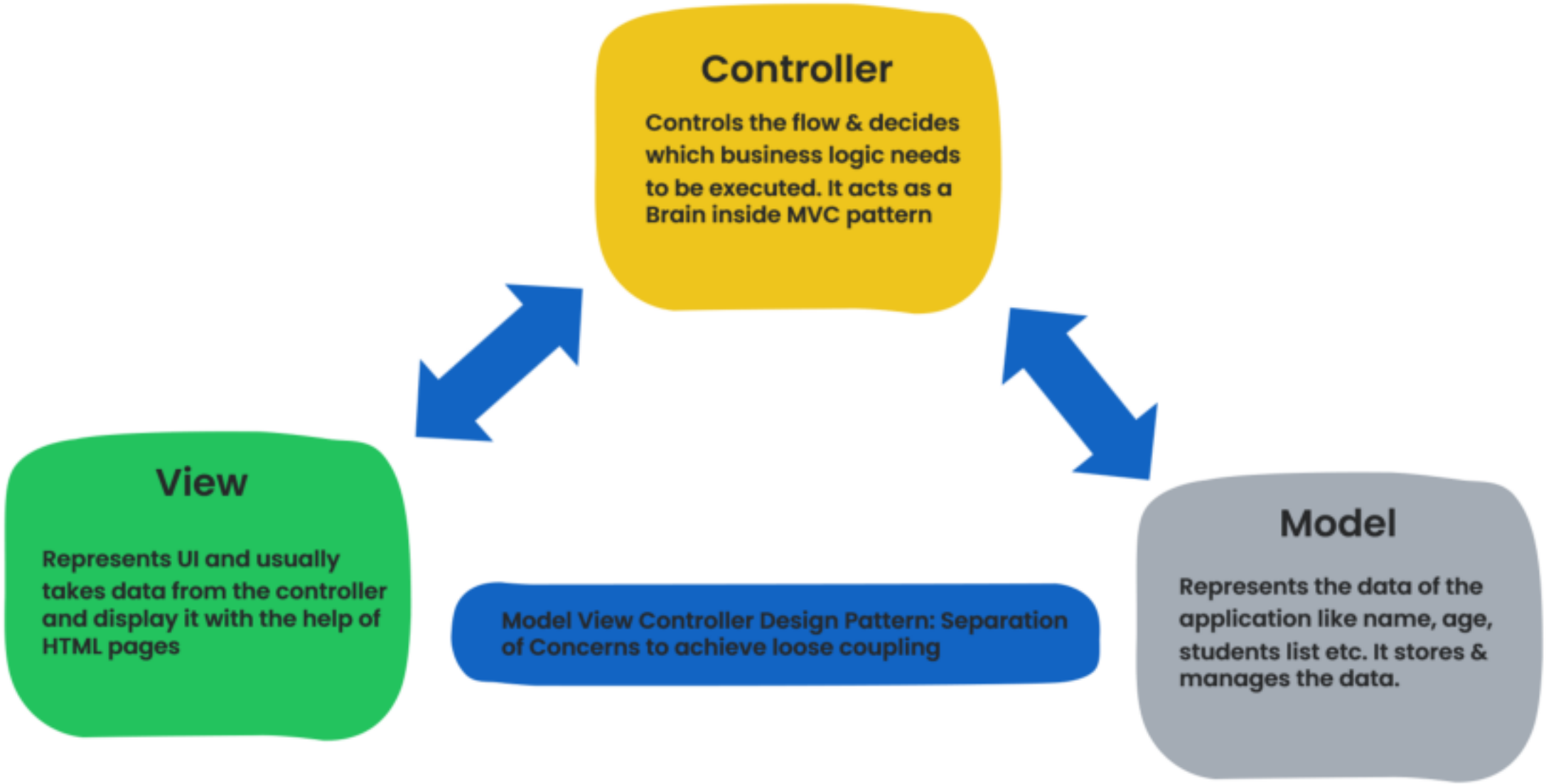
DevTools triggers a restart when ever a build is triggered through IDE or by maven commands etc.

DevTools disables the caching options by default during development.

Repackaged archives do not contain DevTools by default.

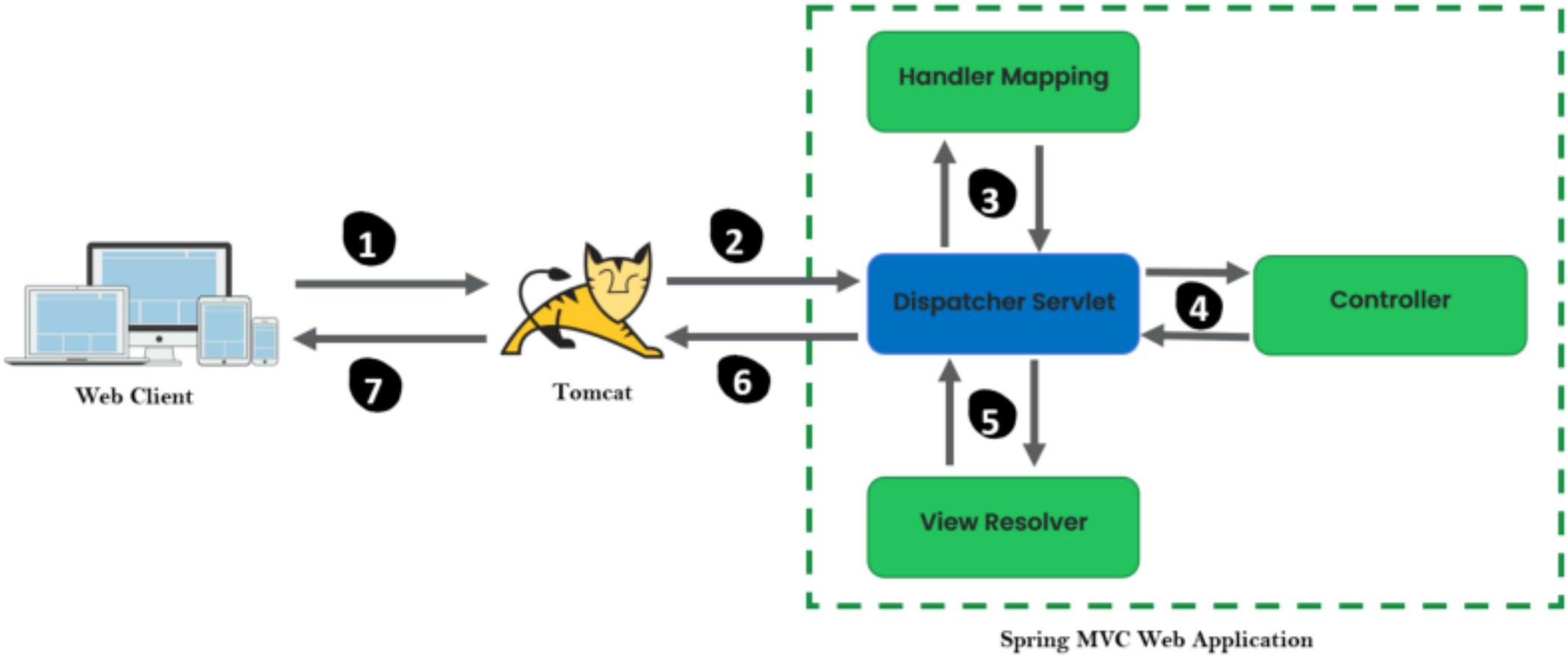
INTRODUCTION TO MVC PATTERN

eazy bytes



SPRING MVC ARCHITECTURE & INTERNAL FLOW

eazy bytes



SPRING MVC ARCHITECTURE & INTERNAL FLOW

eazy bytes

1. Web Client makes HTTP request

2. Servlet Containers like Tomcat accepts the HTTP requests and handovers the Servlet Request to Dispatcher Servlet inside Spring Web App.

3. The Dispatcher Servlet will check with the Handler Mapping to identify the controller and method names to invoke based on the HTTP method, path etc.

4. The Dispatcher Servlet will invoke the corresponding controller & method. After execution, the controller will provide a view name and data that needs to be rendered in the view.

5. The Dispatcher Servlet with the help of a component called View Resolver finds the view and render it with the data provided by the controller.

6. The Servlet Container or Tomcat accepts the Servlet Response from the Dispatcher servlet and convert the same to HTTP response before returning to the client.

7. The browser or client intercepts the HTTP response and display the view, data etc.

QUICK TIP

eazy bytes

Do you know, we can register view controllers that create a direct mapping between the URL and the view name using the ViewControllerRegistry. This way, there's no need for any Controller between the two.

```java
@Configuration
public class WebConfig implements WebMvcConfigurer {

    @Override
    public void addViewControllers(ViewControllerRegistry registry) {
        registry.addViewController( urlPathOrPattern: "/courses").setViewName("courses");
        registry.addViewController( urlPathOrPattern: "/about").setViewName("about");
    }

}
```

REDUCING BOILERPLATE CODE WITH LOMBOK

eazy bytes

- *Java expects lot of boilerplate code inside POJO classes like getters and setters.*
- *Lombok, which is a Java library provides you with several annotations aimed at avoiding writing Java code known to be repetitive and/or boilerplate.*
- *It can be added into any of the Java project by adding the below maven dependency,*

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

Project Lombok works by plugging into your build process. Then, it will auto-generate the Java bytecode into your .class files required to implement the desired behavior, based on the annotations you used.

Most commonly used Lombok annotations,

@Getter, @Setter
@NoArgsConstructor
@RequiredArgsConstructor
@AllArgsConstructor
@ToString, @EqualsAndHashCode
@Data

@Data is a shortcut annotation that combines the features of below annotations together,

@ToString
@EqualsAndHashCode
@Getter, @Setter
@RequiredArgsConstructor

REDUCING BOILERPLATE CODE WITH LOMBOK

eazy bytes

```java
/*
@Data annotation is provided by Lombok library which generates getter, setter,
equals(), hashCode(), toString() methods & Constructor at compile time.
This makes our code short and clean.
* */
@Data
public class Contact {

    private String name;
    private String mobileNum;
    private String email;
    private String subject;
    private String message;
}
```

Contact.java

Inherited members (Ctrl+F12) Anonymous Classes (Ctrl+I) Lambdas (Ctrl+L)

- Contact
  - Contact()
  - canEqual(Object): boolean
  - equals(Object): boolean ↑Object
  - getEmail(): String
  - getMessage(): String
  - getMobileNum(): String
  - getName(): String
  - getSubject(): String
  - hashCode(): int ↑Object
  - setEmail(String): void
  - setMessage(String): void
  - setMobileNum(String): void
  - setName(String): void
  - setSubject(String): void
  - toString(): String ↑Object
  - email: String
  - message: String
  - mobileNum: String
  - name: String
  - subject: String

A sample outline of a Java POJO class with @Data annotation used. The source code will not have boilerplate code but the compiled byte code will have.

@RequestParam Annotation

eazy bytes

- *In Spring @RequestParam annotation is used to map either query parameters or form data.*
- *For example, if we want to get parameters value from a HTTP GET requested URL then we can use @RequestParam annotation like in below example.*

http://localhost:8080/holidays?festival=true&federal=true

```
@GetMapping("/holidays")
public String displayHolidays(@RequestParam(required = false) boolean festival,
                              @RequestParam(required = false) boolean federal) {
    // Business Logic
    return "holidays.html";
}
```

- ✓ The @RequestParam annotation supports attributes like name, required, value, defaultvalue. We can use them in our application based on the requirements.

- ✓ The name attribute indicates the name of the request parameter to bind to.
- ✓ The required attribute is used to make a field either optional or mandatory. If it is mandatory, an exception will throw in case of missing fields.

- ✓ The value attribute is similar to name elements and can be used as an alias.
- ✓ defaultValue for the parameter is to handle missing values or null values. If the parameter does not contain any value then this default value will be considered.

@PathVariable Annotation

eazy bytes

- *The @PathVariable annotation is used to extract the value from the URI. It is most suitable for the RESTful web service where the URL contains some value. Spring MVC allows us to use multiple @PathVariable annotations in the same method.*
- *For example, if we want to get the value from a requested URI path, then we can use @PathVariable annotation like in below example.*

http://localhost:8080/holidays/all
http://localhost:8080/holidays/federal
http://localhost:8080/holidays/festival

```
@GetMapping("/holidays/{display}")
public String displayHolidays(@PathVariable String display) {
    //Business Logic
    return "holidays.html";
}
```

✓ **The @PathVariable annotation supports attributes like name, required, value similar to @RequestParam. We can use them in our application based on the requirements.**

VALIDATION WITH SPRING BOOT

eazy bytes

- *Bean Validation (https://beanvalidation.org/) is the standard for implementing validations in the Java ecosystem. It's well integrated with Spring and Spring Boot.*
- *Below is the maven dependency that we can add to implement Bean validations in any Spring/SpringBoot project,*

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

Bean Validation works by defining constraints to the fields of a class by annotating them with certain annotations.

We can put the @Valid annotation on method parameters and fields to tell Spring that we want a method parameter or field to be validated.

Below are the important packages where validations related annotations can be identified,

- ✓ jakarta.validation.constraints.*
- ✓ org.hibernate.validator.constraints.*

eazy bytes

Important Validation Annotations

jakarta.validation.constraints.*

- ✓ @Digits
- ✓ @Email
- ✓ @Max
- ✓ @Min
- ✓ @NotBlank
- ✓ @NotEmpty
- ✓ @NotNull
- ✓ @Pattern
- ✓ @Size

org.hibernate.validator.constraints.*

- ✓ @CreditCardNumber
- ✓ @Length
- ✓ @Currency
- ✓ @Range
- ✓ @URL
- ✓ @UniqueElements
- ✓ @EAN
- ✓ @ISBN

VALIDATION WITH SPRING BOOT

eazy bytes

- *Sample validations declaration inside a java POJO class,*

```java
@Data
public class Contact {

    @NotBlank(message="Email must not be blank")
    @Email(message = "Please provide a valid email address" )
    private String email;

    @NotBlank(message="Subject must not be blank")
    @Size(min=5, message="Subject must be at least 5 characters long")
    private String subject;

    @NotBlank(message="Message must not be blank")
    @Size(min=10, message="Message must be at least 10 characters long")
    private String message;
}
```

VALIDATION WITH SPRING BOOT

eazy bytes

- *We can put the @Valid annotation on method parameters to tell Spring framework that we want a particular POJO object needs to be validated based on the validation annotation configurations. For any issues, framework populates the error details inside the Errors object. The errors can be used to display on the UI to the user. Sample example code is below,*

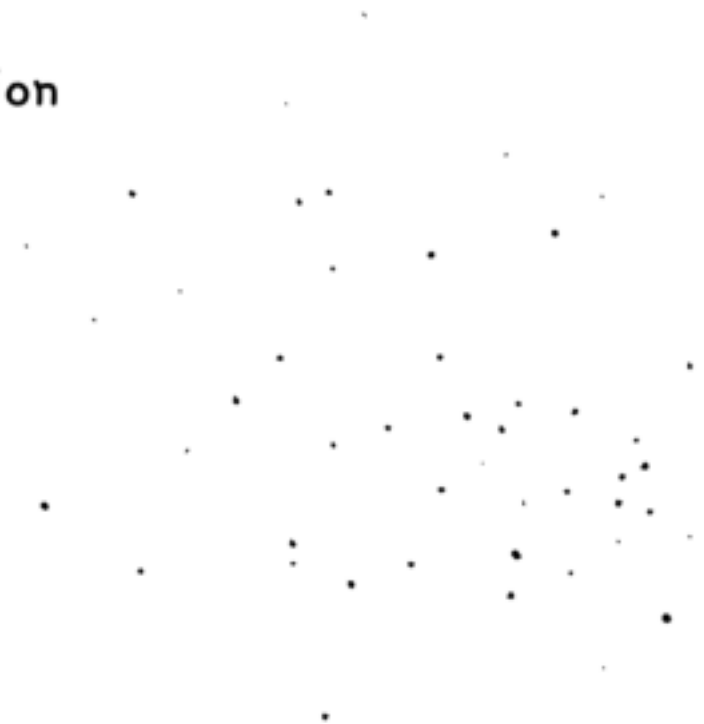
```
@RequestMapping(value = "/saveMsg",method = POST)
public String saveMessage(@Valid @ModelAttribute("contact") Contact contact, Errors errors) {

    if(errors.hasErrors()){
        log.error("Contact form validation failed due to : " + errors.toString());
        return "contact.html";
    }
    contactService.saveMessageDetails(contact);
    return "redirect:/contact";
}
```

```
<ul>
    <li class="alert alert-danger" role="alert" th:each="error : ${#fields.errors('contact.*')}"
        th:text="${error}" />
</ul>
```

eazy bytes

Bean Scopes inside Spring

1. Singleton
2. Prototype
3. Request
4. Session
5. Application



SPRING WEB SCOPES

eazy bytes

Web Scopes inside Spring

- ✓ **Request (@RequestScope)**
- ✓ **Session (@SessionScope)**
- ✓ **Application (@ApplicationScope)**

1. **Request Scope** - Spring creates an instance of the bean class for every HTTP request. The instance exists only for that specific HTTP request.
2. **Session Scope** - Spring creates an instance and keeps the instance in the server's memory for the full HTTP session. Spring links the instance in the context with the client's session.
3. **Application Scope** - The instance is unique in the app's context, and it's available while the app is running.

SPRING WEB SCOPES

eazy bytes

Key points of Spring Web scopes

Request Scope

- ✓ Spring creates a lot of instances of this bean in the app's memory for each HTTP request. So these type of beans are short lived.
- ✓ Since Spring creates a lot of instances, please make sure to avoid time consuming logic while creating the instance.
- ✓ Can be considered for the scenarios where the data needs to be reset after new request or page refresh etc..

Session Scope

- ✓ Session scoped beans have longer life & they are less frequently garbage collected.
- ✓ Avoid keeping too much information inside session data as it impacts performance. Never store sensitive information as well.
- ✓ Can be considered for the scenarios where the same data needs to be accessed across multiple pages like user information.

Application Scope

- ✓ In the application scope, Spring creates a bean instance per web application runtime.
- ✓ It is similar to singleton scope, with one major difference. Singleton scoped bean is singleton per ApplicationContext where application scoped bean is singleton per ServletContext.
- ✓ Can be considered for the scenarios where we want to store Drop Down values, Reference table values which won't change for all the users.

SPRING SECURITY

eazy bytes

- *Spring Security is a powerful and highly customizable authentication and access-control framework. It is the de-facto standard for securing Spring-based applications.*
- *Below is the maven dependency that we can add to implement security using Spring Security project in any of the SpringBoot projects.*

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

Spring Security is a framework that provides authentication, authorization, and protection against common attacks.

Spring Security helps developers with easier configurations to secure a web application by using standard username/password authentication mechanism.

Spring Security provides out of the box features to handle common security attacks like CSRF, CORs. It also has good integration with security standards like JWT, OAUTH2 etc.

AUTHENTICATION & AUTHORIZATION

eazy bytes

AUTHENTICATION

- In authentication, the identity of users are checked for providing the access to the system.
- Authentication done before authorization
- It needs usually user's login details
- If authentication fails usually we will get 401 error response
- For example as a Bank customer/employee in order to perform actions in the app, we need to prove our identity

AUTHORIZATION

- In authorization, person's or user's authorities are checked for accessing the resources.
- Authorization always happens after authentication.
- it needs user's privilege or roles
- If authorization fails usually we will get 403 error response
- Once logged into the application, my roles, authorities will decide what kind of actions I can do

QUICK TIP

eazy bytes

Do you know,

- ✓ **As soon as we add spring security dependency to a web application, be default it protects all the pages/APIs inside it. It will redirect to the inbuilt login page to enter credentials.**
- ✓ **The default credentials are user and password is randomly generated & printed on the console.**
- ✓ **We can configure custom credentials using the below properties to get started for POCs etc. But for PROD applications, Spring Security supports user credentials configuration inside DB, LDAP, OAUTH2 Server etc.**

```
spring.security.user.name = eazybytes
spring.security.user.password = 12345
```

DEFAULT SECURITY CONFIGURATIONS IN SPRING SECURITY

eazy bytes

By default, Spring Security framework protects all the paths present inside the web application. This behaviour is due to the code present inside the method defaultSecurityFilterChain(HttpSecurity http) of class SpringBootWebSecurityConfiguration

```
@Bean
@Order(SecurityProperties.BASIC_AUTH_ORDER)
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    http.authorizeHttpRequests((requests) -> requests.anyRequest().authenticated());
    http.formLogin(withDefaults());
    http.httpBasic(withDefaults());
    return http.build();
}
```

CONFIGURE permitAll() WITH SPRING SECURITY

eazy bytes

- *Using permitAll() configurations we can allow full/public access to a specific resource/path or all the resources/paths inside a web application.*
- *Below is the sample configuration that we can do in order to allow any requests in a Web application with out security,*

```
@Configuration
public class ProjectSecurityConfig {

  @Bean
  SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {

    http.authorizeHttpRequests((requests) -> requests.anyRequest().permitAll())
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();

  }
```

- Form Login provides support for username and password being provided through an html form
- HTTP Basic Auth uses an HTTP header in order to provide the username and password when making a request to a server.

CONFIGURE denyAll() WITH SPRING SECURITY

eazy bytes

- *Using denyAll() configurations we can deny access to a specific resource/path or all the resources/paths inside a web application regardless of user authentication.*
- *Below is the sample configuration that we can do in order to deny any requests that is coming into a web application,*

```
@Configuration
public class ProjectSecurityConfig {

  @Bean
  SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {

    http.authorizeHttpRequests((requests) -> requests.anyRequest().denyAll())
        .formLogin(Customizer.withDefaults())
        .httpBasic(Customizer.withDefaults());
    return http.build();

  }
```

- Usually denyAll() is used to retire a specific API temporarily with out removing the code
- permitAll() is used to allow public access to public APIs, paths, CSS, images, JS files etc.

CONFIGURE CUSTOM SECURITY CONFIGs & CSRF DISABLE

eazy bytes

- *We can apply custom security configurations based on our requirements for each API/URL like below.*
- *permitAll() can be used to allow access w/o security and authenticated() can be used to protect a web page/API.*
- *By default any requests with HTTP methods that can update data like POST, PUT will be stopped with 403 error due to CSRF protection. We can disable the same for now and enable it in the coming sections when we started generating CSRF tokens.*
- *Below is the sample configuration that we can do to implement custom security configs and disable CSRF,*

```
@Configuration
public class ProjectSecurityConfig {

   @Bean
   SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
      http.csrf((csrf) -> csrf.disable())
            .authorizeHttpRequests((requests) -> requests
               .requestMatchers("", "/", "/home").permitAll()
               .requestMatchers("/holidays/**").permitAll()
               .requestMatchers("/contact").permitAll()
               .requestMatchers("/saveMsg").permitAll()
               .requestMatchers("/courses").permitAll()
               .requestMatchers("/about").permitAll()
               .requestMatchers("/assets/**").permitAll())
            .formLogin(Customizer.withDefaults())
            .httpBasic(Customizer.withDefaults());
      return http.build();
   }
```

IN-MEMORY AUTHENTICATION IN SPRING SECURITY

eazy bytes

- *Spring Security provide support for username/password based authentication based on the users stored in application memory.*
- *Like mentioned below, we can configure any number of users & their roles, passwords using in-memory authentication,*

```java
@Configuration
public class ProjectSecurityConfig {

  @Bean
  SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {...}

  @Bean
  public InMemoryUserDetailsManager userDetailsService() {

    UserDetails user = User.withDefaultPasswordEncoder()
        .username("user").password("12345").roles("USER").build();

    UserDetails admin = User.withDefaultPasswordEncoder()
        .username("admin").password("54321").roles("USER", "ADMIN").build();
    return new InMemoryUserDetailsManager(user, admin);
  }

}
```

in-memory authentication is idle for POC Web Apps or any internal Web App that get used only in non-prod environments. NEVER EVER use in-memory authentication for PROD web applications.

CONFIGURING LOGIN & LOGOUT PAGE

eazy bytes

- *Spring Security allows us to configure a custom login page to our web application instead of using the Spring Security default provided login page.*
- *Similarly we can configure logout page as well.*
- *Below is the sample configuration that we can follow,*

```
@Bean
SecurityFilterChain defaultSecurityFilterChain(HttpSecurity http) throws Exception {
    http.csrf((csrf) -> csrf.disable())
            .authorizeHttpRequests((requests) -> requests.requestMatchers("/dashboard").authenticated()
            .requestMatchers("", "/", "/home").permitAll()
            .requestMatchers("/holidays/**").permitAll()
            .requestMatchers("/contact").permitAll()
            .requestMatchers("/saveMsg").permitAll()
            .requestMatchers("/courses").permitAll()
            .requestMatchers("/about").permitAll()
            .requestMatchers("/login").permitAll()
            .requestMatchers("/assets/**").permitAll())
            .formLogin(loginConfigurer -> loginConfigurer.loginPage("/login")
                    .defaultSuccessUrl("/dashboard").failureUrl("/login?error=true").permitAll())
            .logout(logoutConfigurer -> logoutConfigurer.logoutSuccessUrl("/login?logout=true")
                    .invalidateHttpSession(true).permitAll())
            .httpBasic(Customizer.withDefaults());
    return http.build();
}
```

Configured login page will be shown, if the user tries to access the secured page/resource with out a valid authenticated session. The same behavior applies for default login page provided by Spring Security

QUICK TIP

eazy bytes

Do you know, Thymeleaf has a great integration with Spring Security. More details can be found at https://www.thymeleaf.org/doc/articles/springsecurity.html

Step 1 : Add the below dependency in the pom.xml

```
<dependency>
    <groupId>org.thymeleaf.extras</groupId>
    <artifactId>thymeleaf-extras-springsecurity6</artifactId>
</dependency>
```

Step 2 : Add the below XML name space which enable us to use Thymeleaf Security related tags

```
<html lang="en" xmlns:th="http://www.thymeleaf.org"
      xmlns:sec="http://www.thymeleaf.org/thymeleaf-extras-springsecurity6">
```

Step 3 : Use any of the Thymeleaf Security tags inside HTML code based on Authentication details,

sec:authorize="isAnonymous()" , sec:authorize="isAuthenticated()" , sec:authorize="hasRole('ROLE_ADMIN')"
sec:authentication="name" , sec:authentication="principal.authorities"

@ControllerAdvice & @ExceptionHandler

eazy bytes

- *@ControllerAdvice is a specialization of the @Component annotation which allows to handle exceptions across the whole application in one global handling component. You can think of it as an interceptor of exceptions thrown by methods annotated with @RequestMapping or one of the shortcuts like @GetMapping etc.*
- *We can define the exception handle logic inside a method and annotate it with @ExceptionHandler*
- *Below is the sample configuration that we can follow,*

```
@ControllerAdvice
public class GlobalExceptionController {

    @ExceptionHandler(Exception.class)
    public ModelAndView exceptionHandler(Exception exception){
        ModelAndView errorPage = new ModelAndView();
        errorPage.setViewName("error");
        errorPage.addObject("errormsg", exception.getMessage());
        return errorPage;
    }

}
```

Combination of @ControllerAdvice & @ExceptionHandler can handle the exceptions across all the controllers inside a web application globally.

QUICK TIP

eazy bytes

Do you know,

- ✓ If a method annotated with `@ExceptionHandler` present inside a `@Controller` class, then the exception handling logic will be applicable for any exceptions occurred in that specific controller class.
- ✓ If the same `@ExceptionHandler` annotated method present inside a `@ControllerAdvice` class, then the exception handling logic will be applicable for any exceptions occurred across all the controller classes.
- ✓ Using `@ExceptionHandler` annotation, we can handle any number of exceptions like below sample code,

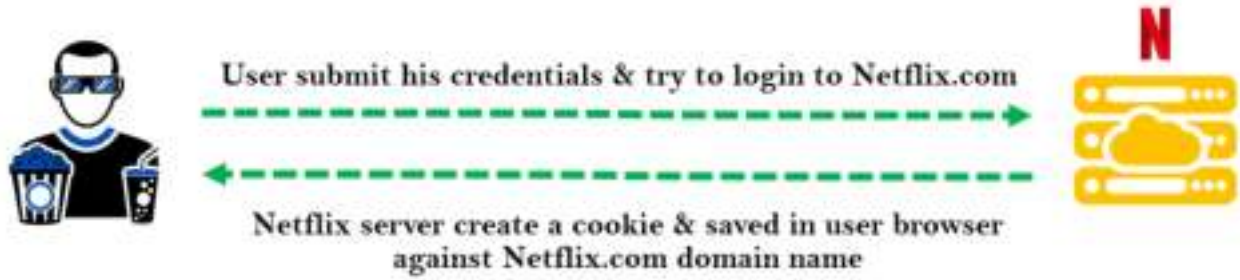
```
@ExceptionHandler({NullPointerException.class,
                   ArrayIndexOutOfBoundsException.class,
                   IOException.class})
public ModelAndView handleException(RuntimeException ex)
{
    //Exception handling logic
}
```

CROSS-SITE REQUEST FORGERY (CSRF)

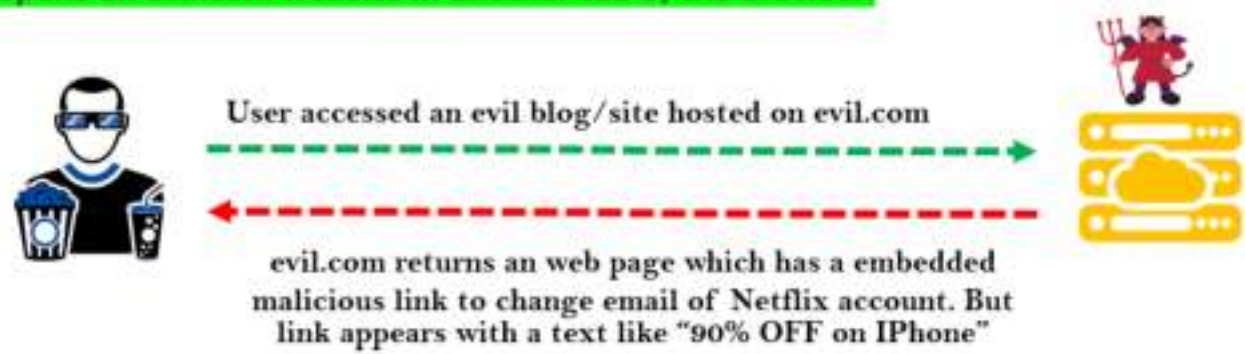
eazy bytes

- *A typical Cross-Site Request Forgery (CSRF or XSRF) attack aims to perform an operation in a web application on behalf of a user without their explicit consent. In general, it doesn't directly steal the user's identity, but it exploits the user to carry out an action without their will.*
- *Consider you are using a website netflix.com and the attacker's website evil.com.*

Step 1 : The Netflix user login to Netflix.com and the backend server of Netflix will provide a cookie which will store in the browser against the domain name Netflix.com



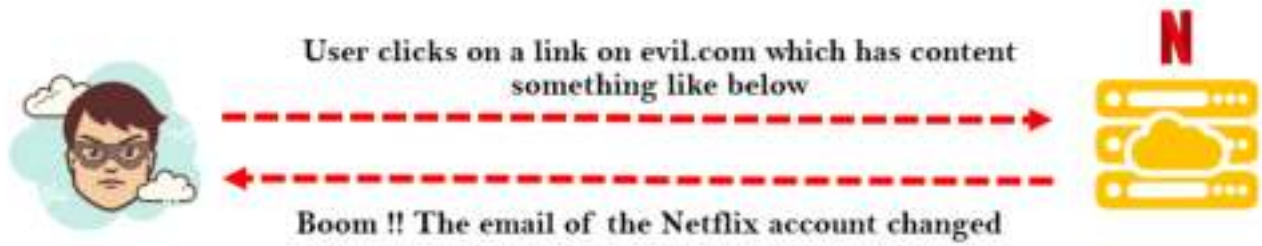
Step 2 : The same Netflix user opens an evil.com website in another tab of the browser.



CROSS-SITE REQUEST FORGERY (CSRF)

eazy bytes

Step 3 : User tempted and clicked on the malicious link which makes a request to Netflix.com. And since the login cookie already present in the same browser and the request to change email is being made to the same domain Netflix.com, the backend server of Netflix.com can't differentiate from where the request came. So here the evil.com forged the request as if it is coming from a Netflix.com UI page.




```
<form action="https://netflix.com/changeEmail"
  method="POST" id="form">
    <input type="hidden" name="email" value="user@evil.com">
<form>

<script>
    document.getElementById('form').submit()
</script>
```

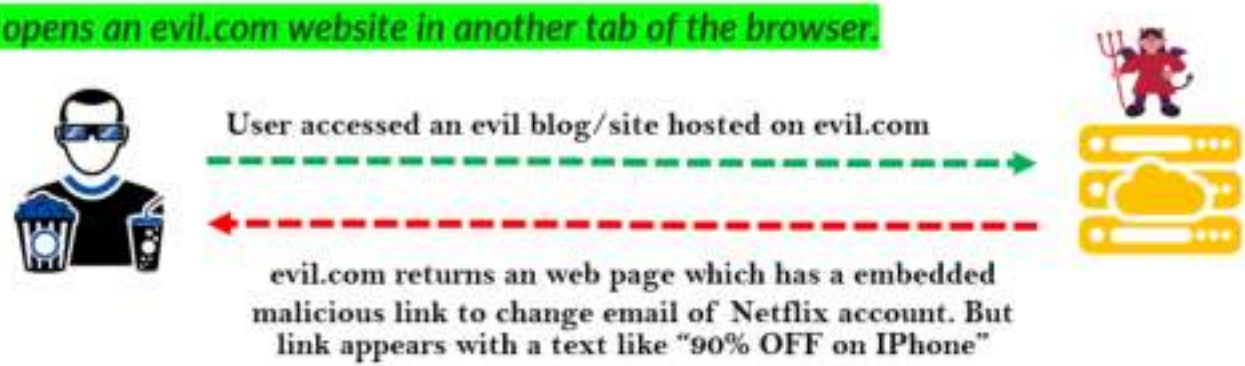
SOLUTION TO CSRF

eazy bytes

- To defeat a CSRF attack, applications need a way to determine if the HTTP request is legitimately generated via the application's user interface. The best way to achieve this is through a CSRF token. A CSRF token is a secure random token that is used to prevent CSRF attacks. The token needs to be unique per user session and should be of large random value to make it difficult to guess.
- Let's see how this solve CSRF attack by taking the previous Netflix example again,

Step 1 : The Netflix user login to Netflix.com and the backend server of Netflix will provide a cookie which will store in the browser against the domain name Netflix.com along with a randomly generated unique CSRF token for this particular user session. CSRF token is inserted within hidden parameters of HTML forms to avoid exposure to session cookies.

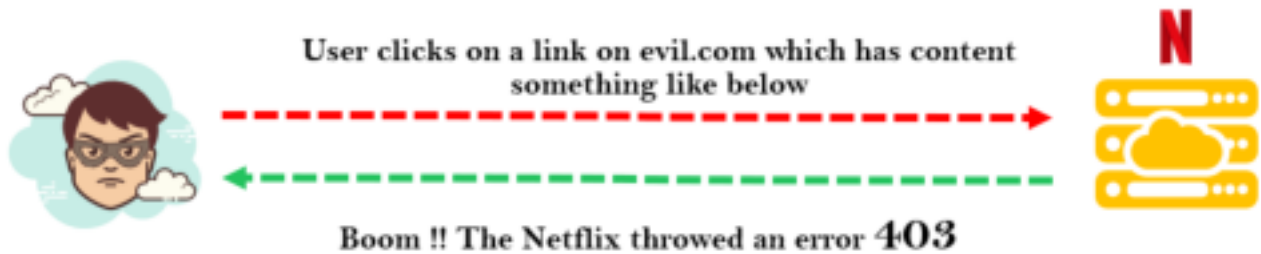
Step 2 : The same Netflix user opens an evil.com website in another tab of the browser.



SOLUTION TO CSRF

eazy bytes

Step 3 : User tempted and clicked on the malicious link which makes a request to Netflix.com. And since the login cookie already present in the same browser and the request to change email is being made to the same domain Netflix.com. This time the Netflix.com backend server expects CSRF token along with the cookie. The CSRF token must be same as initial value generated during login operation



The CSRF token will be used by the application server to verify the legitimacy of the end-user request if it is coming from the same App UI or not. The application server rejects the request if the CSRF token fails to match the test.

QUICK TIP

eazy bytes

Do you know,

- ✓ **By default, Spring Security enables CSRF fix for all the HTTP methods which results in data change like POST, DELETE etc. But not for GET.**

- ✓ **Using Spring Security configurations we can disable the CSRF protection for complete application or for only few paths based on our requirements like below.**

  - ***http.csrf((csrf) -> csrf.disable())***
  - ***http.csrf((csrf) -> csrf.ignoringRequestMatchers("/saveMsg"))***

- ✓ **Thymeleaf has great integration & support with Spring Security to generate a CSRF token. We just need to add the below code in login html form code and Thymeleaf will automatically appends the CSRF token for the remaining pages/forms inside the web application,**

```
<input type="hidden" th:name="${_csrf.parameterName}" th:value="${_csrf.token}" />
```

SPRING BOOT & H2 DATABASE

eazy bytes

- *H2 is an embedded, open-source, and in-memory database. SpringBoot supports integration with H2 DB which can be used for POC applications and excellent for examples/testing.*
- *Below is the maven dependency that we can add to any SpringBoot projects in order to use internal memory H2 Database,*

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

Since it is a internal memory DB, we need to create the schema and data that is needed during startup of the App. Any updates to the data will be lost after restarting the server.

To create schema & data for the H2 DB, we can add schema.sql & data.sql inside the maven project's resources folder. Any table creation scripts and DB records scripts can be present inside schema.sql and data.sql respectively.

By default, the H2 web console is available at /h2-console. You can customize the console's path by using the spring.h2.console.path property.

The default credentials of H2 DB are username is sa and password is "" (Empty)

eazy bytes

Key points of JDBC

Intro to JDBC

- ✓JDBC or Java Database Connectivity is a specification from Core Java that provides a standard abstraction for java apps to communicate with various databases.
- ✓JDBC API along with the database driver is capable of accessing databases
- ✓JDBC is a base framework or standard for frameworks like Hibernate, Spring Data JPA, MyBatis etc.

Steps in JDBC to access DB

We need to follow the below steps to access DB using JDBC,

1) Load Driver Class
2) Obtain a DB connection
3) Obtain a statement using connection object
4) Execute the query
5) Process the result set
6) Close the connection

Problem with JDBC

- ✓Developers are forced to follow all the steps mentioned to perform any kind of operation with DB which results in lot of duplicate code at many places.
- ✓Developers needs to handle the checked exceptions that will throw from the API.
- ✓JDBC is database dependent

INTRO TO JDBC & PROBLEMS WITH IT

eazy bytes

```
public Optional<Contact> findById(int id) {
    Connection connection = null;
    PreparedStatement statement = null;
    ResultSet resultSet = null;
    try {
        Class.forName("com.mysql.jdbc.Driver");
        connection = DriverManager.getConnection("url","username","pwd");
        statement = connection.prepareStatement(
                "select id, name, message from contact");
        statement.setInt(1, id);
        resultSet = statement.executeQuery();
        Contact contact = null;
        if(resultSet.next()) {
            contact = new Contact(
                    resultSet.getInt("id"),
                    resultSet.getString("name"),
                    resultSet.getString("message"));
        }
        return Optional.of(contact);
    } catch (SQLException e) {
        // ??? What should be done here ???
    } finally {
        if (resultSet != null) {
            try {
                resultSet.close();
            } catch (SQLException e) {}
        }
        if (statement != null) {
            try {
                statement.close();
            } catch (SQLException e) {}
        }
        if (connection != null) {
            try {
                connection.close();
            } catch (SQLException e) {}
        }
    }
    return null;
}
```

Sample program using JDBC to fetch a record from the database table. You can see there is lot of boilerplate code present

JDBC Program.txt

INTRO TO SPRING JDBC

eazy bytes

- *Spring JDBC simplifies the use of JDBC and helps to avoid common errors. It executes core JDBC workflow, leaving application code to provide SQL and extract results. It does this magic by providing JDBC templates which developers can use inside their applications.*
- *Below is the maven dependency that we need to add to any Spring/SpringBoot projects in order to use Spring JDBC provided templates,*

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

Spring provides many templates for JDBC related activities. Among them, the famous ones are JdbcTemplate , NamedParameterJdbcTemplate.

JdbcTemplate is the classic and most popular Spring JDBC approach. This provides "lowest-level" approach and all others templates uses JdbcTemplate under the covers.

NamedParameterJdbcTemplate wraps a JdbcTemplate to provide named parameters instead of the traditional JDBC ? placeholders. This approach provides better documentation and ease of use when you have multiple parameters for an SQL statement.

Spring JDBC - who does what?

Action	Spring JDBC	Developer
Define connection parameters		✕
Open the connection	✕	
Specify the SQL statement		✕
Declare parameters and provide parameter values		✕
Prepare and run the statement	✕	
Set up the loop to iterate through the results (if any).	✕	
Do the work for each iteration		✕
Process any exception	✕	
Handle transactions	✕	
Close the connection, the statement, and the resultset	✕	

USING JdbcTemplate

eazy bytes

- *JdbcTemplate is the central class in the JDBC core package. It handles the creation and release of resources, which helps you avoid common errors, such as forgetting to close the connection. It performs the basic tasks of the core JDBC workflow (such as statement creation and execution), leaving application code to provide SQL and extract results.*

- *You can use JdbcTemplate within a DAO implementation through direct instantiation with a DataSource reference, or you can configure it in a Spring IoC container and give it to DAOs as a bean reference.*

- *We need to follow the below steps in order to configure JdbcTemplate inside a Spring Web application (With out Spring Boot)*

Step 1 : First we need to create a Data Source Bean inside Web application with the DB credentials like mentioned below.

```
@Bean
public DataSource myDataSource() {
    DriverManagerDataSource dataSource = new DriverManagerDataSource();
    dataSource.setDriverClassName("com.mysql.jdbc.Driver");
    dataSource.setUrl("jdbc:mysql://localhost:3306/eazyschool");
    dataSource.setUsername("user");
    dataSource.setPassword("password");
    return dataSource;
}
```

USING JdbcTemplate

eazy bytes

Step 2 : Inside any Repository/DAO classes where we want to execute queries, we need to create a bean/object of JdbcTemplate by injecting data source bean

```
@Repository
public class PersonDAOImpl implements PersonDAO {
    JdbcTemplate jdbcTemplate;

    @Autowired
    public PersonDAOImpl(DataSource dataSource) {
        jdbcTemplate = new JdbcTemplate(dataSource);
    }

}
```

- *Instances of the JdbcTemplate class are thread-safe, once configured. This is important because if needed we can configure a single instance of a JdbcTemplate and then safely inject this shared reference into multiple DAOs (or repositories).*

USING JdbcTemplate

eazy bytes

Sample usage of JdbcTemplate for SELECT queries,

```
// The following query gets the number of rows in a table
int rowCount = this.jdbcTemplate.queryForObject("select count(*) from person", Integer.class);
```

```
// The following query uses a bind variable
int countOfPersonsNamedJoe = this.jdbcTemplate.queryForObject(
        "select count(*) from person where first_name = ?", Integer.class, "Joe");
```

```
// The following query looks for a string column based on a condition:
String lastName = this.jdbcTemplate.queryForObject("select last_name from person where id = ?",
        String.class, 1212L);
```

USING JdbcTemplate

eazy bytes

Sample usage of JdbcTemplate for Updating (INSERT, UPDATE, and DELETE)

```
// The following example inserts a new entry
this.jdbcTemplate.update("insert into person (first_name, last_name) values (?, ?)",
        "Jon", "Doe");
```

```
// The following example updates an existing entry
this.jdbcTemplate.update("update person set last_name = ? where id = ?",
        "Maria", 5276L);
```

```
// The following example deletes an entry
this.jdbcTemplate.update("delete from person where id = ?", 5276L);
```

USING JdbcTemplate

eazy bytes

Other JdbcTemplate Operations

```
// You can use the execute(..) method to run any arbitrary SQL. Consequently, the method is often
// used for DDL statements.
this.jdbcTemplate.execute("create table person (id integer, name varchar(100))");
```

```
// The following example invokes a stored procedure
this.jdbcTemplate.update("call SUPPORT.REFRESH_PERSON_SUMMARY(?)",5276L);
```

USING ROWMAPPER

eazy bytes

- *RowMapper interface allows to map a row of the relations with the instance of user-defined class. It iterates the ResultSet internally and adds it into the collection. So we don't need to write a lot of code to fetch the records as ResultSetExtractor.*
- *RowMapper saves a lot of code becuase it internally adds the data of ResultSet into the collection.*
- *It defines only one method mapRow that accepts ResultSet instance and int as parameters. Below is the sample usage of it,*

```
private final RowMapper<Person> personRowMapper = (resultSet, rowNum) -> {
    Person person = new Person();
    person.setFirstName(resultSet.getString("first_name"));
    person.setLastName(resultSet.getString("last_name"));
    return person;
};
```

```
public List<Person> findAllPersons() {
    return this.jdbcTemplate.query("select first_name, last_name from person",personRowMapper);
}
```

QUICK TIP

eazy bytes

Do you know, if the column names in a table and field names inside a POJO/Bean are matching, then we can use BeanPropertyRowMapper which is provided by Spring framework.

Spring BeanPropertyRowMapper, class saves you a lot of time since we don't have to define the mappings like we do inside a RowMapper implementation.

```
public List<Holiday> findAllHolidays() {
    String sql = "SELECT * FROM HOLIDAYS";
    var rowMapper = BeanPropertyRowMapper.newInstance(Holiday.class);
    return jdbcTemplate.query(sql, rowMapper);
}
```

USING NamedParameterJdbcTemplate

eazy bytes

- *The NamedParameterJdbcTemplate class adds support for programming JDBC statements by using named parameters, as opposed to programming JDBC statements using only classic placeholder ('?') arguments. The NamedParameterJdbcTemplate class wraps a JdbcTemplate and delegates to the wrapped JdbcTemplate to do much of its work.*

- *The following example shows how to use NamedParameterJdbcTemplate*

```
private NamedParameterJdbcTemplate namedParameterJdbcTemplate;

public void setDataSource(DataSource dataSource) {
    this.namedParameterJdbcTemplate = new NamedParameterJdbcTemplate(dataSource);
}

public int countOfPersonsByFirstName(String firstName) {
    String sql = "select count(*) from Person where first_name = :first_name";
    SqlParameterSource namedParameters = new MapSqlParameterSource("first_name", firstName);
    return this.namedParameterJdbcTemplate.queryForObject(sql, namedParameters, Integer.class);
}
```

QUICK TIP

eazy bytes

Do you know, with Spring Boot working with JdbcTemplate is very easy. Spring Boot auto configures DataSource, JdbcTemplate and NamedParameterJdbcTemplate classes based on the DB connection details mentioned in the property file and you can @Autowire them directly into your own repository classes, as shown in the following example.

You can customize some properties of the template by using the spring.jdbc.template.* properties, like mentioned below,

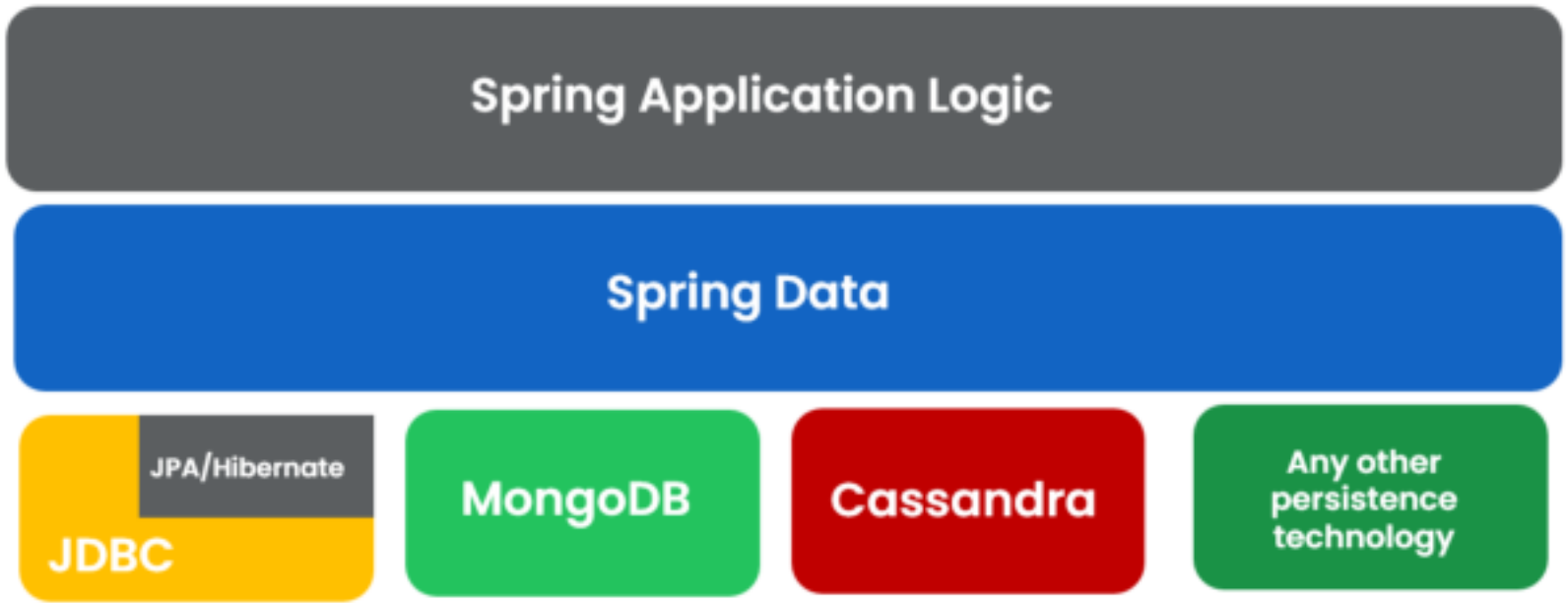
spring.jdbc.template.max-rows=500

```java
@Repository
public class HolidaysRepository {

    private final JdbcTemplate jdbcTemplate;

    @Autowired
    public HolidaysRepository(JdbcTemplate jdbcTemplate) {
        this.jdbcTemplate = jdbcTemplate;
    }
```

INTRO TO SPRING DATA

eazy bytes

Spring Data is a Spring ecosystem project that simplifies the persistence layer's development by providing implementations according to the persistence technology we use. This way, we only need to write a few lines of code to define the repositories of our Spring app.



Spring Data is a high-level layer that simplifies the persistence implementation by unifying the various technologies under the same abstractions.

INTRO TO SPRING DATA

eazy bytes

- *Whichever persistence technology your app uses, Spring Data provides a common set of interfaces (contracts) you extend to define the app's persistence capabilities.*
- *The central interface in the Spring Data repository abstraction is Repository*

Repository is the most abstract contract. If you extend this contract, your app recognizes the interface you write as a particular Spring Data repository. Still, you won't inherit any predefined operations (such as adding a new record, retrieving all the records, or getting a record by its primary key). The Repository interface doesn't declare any method (it is a marker interface).

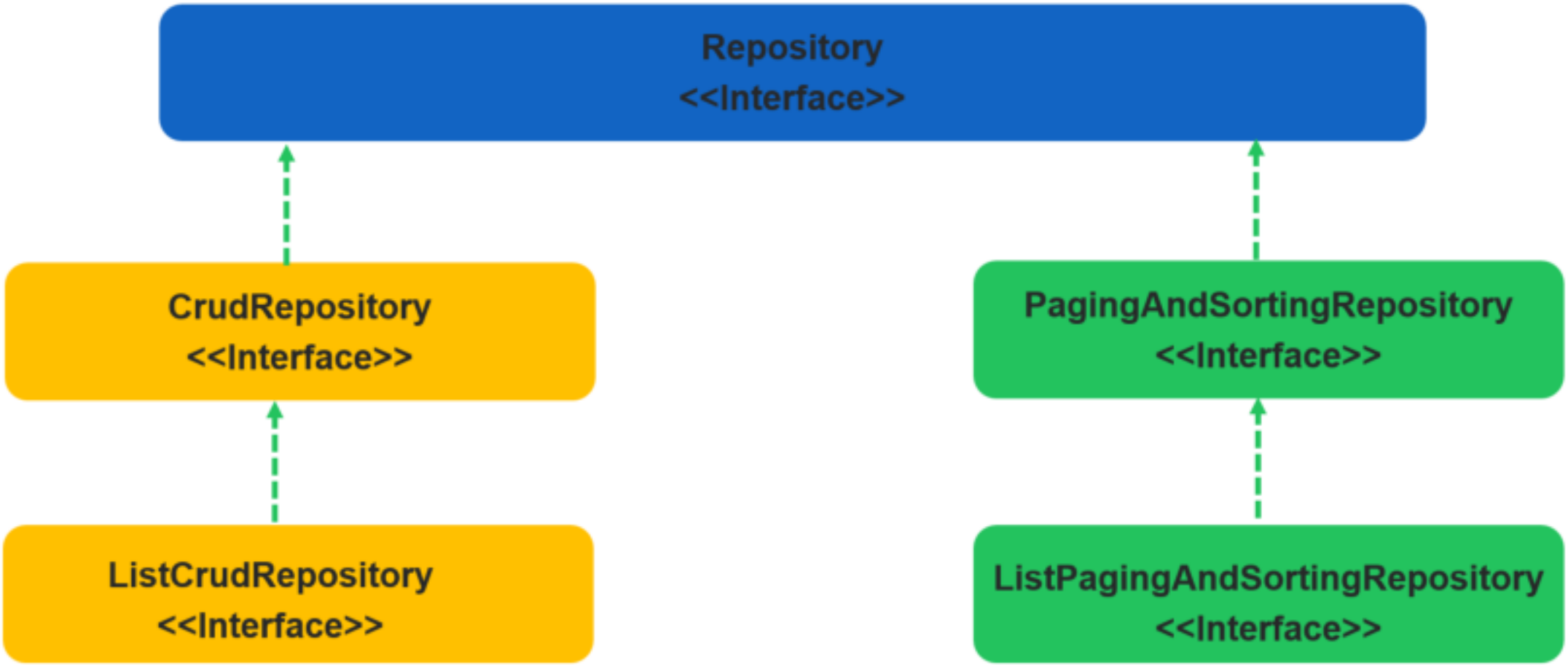
CrudRepository is the simplest Spring Data contract that also provides some persistence capabilities. If you extend this contract to define your app's persistence capabilities, you get the simplest operations for creating, retrieving, updating, and deleting records. **ListCrudRepository** is an extension to CrudRepository returning List instead of Iterable where ever applicable.

PagingAndSortingRepository provide methods to retrieve entities using the pagination and sorting abstraction. **ListPagingAndSortingRepository** an extension to PagingAndSortingRepository returning List instead of Iterable where ever applicable.

INTRO TO SPRING DATA

eazy bytes

To implement your app's repositories using Spring Data, you extend specific interfaces. The main interfaces that represent Spring Data contracts are Repository, CrudRepository, ListCrudRepository, PagingAndSortingRepository and ListPagingAndSortingRepository. You extend one of these contracts to implement your app's persistence capabilities.



QUICK TIP

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Do you know,

- ✓ We should not confuse between @Repository annotation and Spring Data Repository interface.
- ✓ Spring Data provides multiple interfaces that extend one another by following the principle called interface segregation. This helps apps to extend what they want instead of always following fat implementation.
- ✓ Some Spring Data modules might provide specific contracts to the technology they represent. For example, using Spring Data JPA, you also can extend the JpaRepository interface directly and similarly using Spring Data Mongo module to your app provides a particular contract named MongoRepository

INTRO TO SPRING DATA

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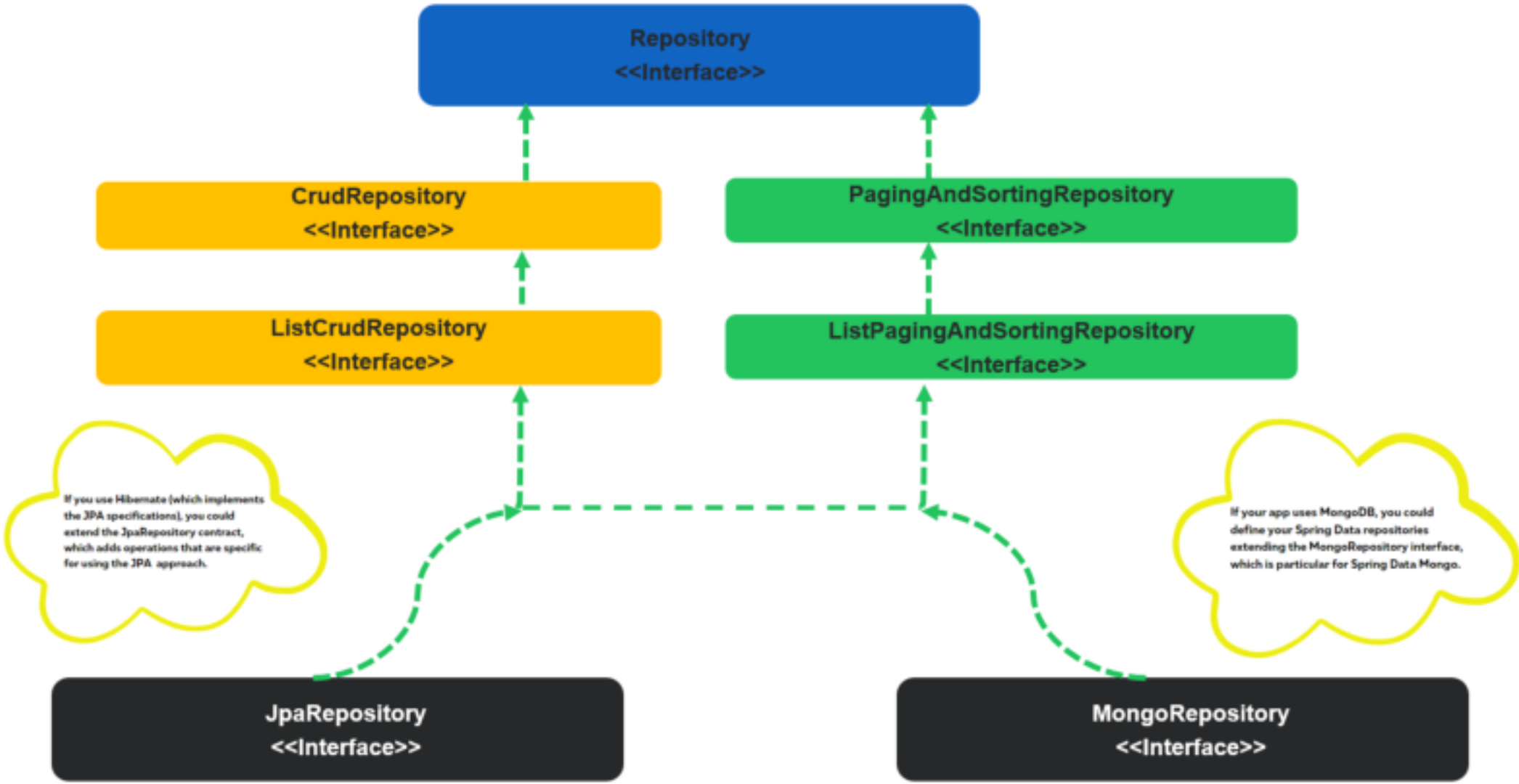

INTRO TO SPRING DATA JPA

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- *Spring Data JPA is available to Spring Boot applications with the JPA starter. This starter dependency not only brings in Spring Data JPA, but also transitively includes Hibernate as the JPA implementation.*
- *Below is the maven dependency that we need to add to any SpringBoot projects in order to use Spring Data JPA,*

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

JPA is just a specification that defines an object-relational mapping (ORM) standard for storing, accessing, and managing Java objects in a relational database. Hibernate is the most popular and widely used implementation of JPA specifications. By default, Spring Data JPA uses Hibernate as a JPA provider.

- *We need to follow the below steps in order to query a DB using Spring Data JPA inside a Spring Boot applications,*

Step 1 : We need to indicate a java POJO class as an entity class by using annotations like @Entity, @Table, @Column

```
@Entity
@Table(name="contact_msg")
public class Contact extends BaseEntity{

    @Id
    @GeneratedValue(strategy= GenerationType.AUTO,generator="native")
    @GenericGenerator(name = "native",strategy = "native")
    @Column(name = "contact_id")
    private int contactId;
```

INTRO TO SPRING DATA JPA

eazy bytes

Step 2 : We need to create interfaces for a given table entity by extending framework provided Repository interfaces. This helps us to run the basic CRUD operations on the table w/o writing method implementations.

```
@Repository
public interface ContactRepository extends CrudRepository<Contact, Integer> {


}
```

Step 3 : Enable JPA functionality and scanning by using the annotations @EnableJpaRepositories and @EntityScan

```
@SpringBootApplication
@EnableJpaRepositories("com.eazybytes.eazyschool.repository")
@EntityScan("com.eazybytes.eazyschool.model")
public class EazyschoolApplication {
```

INTRO TO SPRING DATA JPA

eazy bytes

Step 4 : We can inject repository beans into any controller/service classes and execute the required DB operations.

```java
@Service
public class ContactService {

    @Autowired
    private ContactRepository contactRepository;

    public boolean saveMessageDetails(Contact contact){
        boolean isSaved = false;
        Contact savedContact = contactRepository.save(contact);
        if(null != savedContact && savedContact.getContactId()>0) {
            isSaved = true;
        }
        return isSaved;
    }
```

Derived Query Methods in Spring Data JPA

eazy bytes

- *With Spring Data JPA, we can use the method names to derive a query and fetch the results w/o writing code manually like with traditional JDBC*
- *As a developer we Just need to define the query methods in a repository interface that extends one of the Spring Data's repositories such as CrudRepository. Spring Data JPA will create queries and implementation at runtime automatically by parsing these method names.*
- *Below are few examples,*

```
// find persons by last name
List<Person> findByLastName(String lastName);
```

```
// find person by email
Person findByEmail(String email);
```

```
// find person by email and last name
Person findByEmailAndLastname(String email, String lastname);
```

QUICK TIP

eazy bytes

Do you know a derived query method name has two main components separated by the first By keyword.

1. The introducer clause like find, read, query, count, or get which tells Spring Data JPA what you want to do with the method. This clause can contain further expressions, such as Distinct to set a distinct flag on the query to be created.

2. The criteria clause that starts after the first By keyword. The first By acts as a delimiter to indicate the start of the actual query criteria. The criteria clause is where you define conditions on entity properties and concatenate them with And and Or keywords.

Using readBy, getBy, and queryBy in place of findBy will behave the same. For example, readByEmail(String email) is same as findByEmail(String email).

Derived Query Methods in Spring Data JPA

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Supported keywords inside method names

Keyword	Sample method name	Sample Query that form by JPA
Distinct	findDistinctByLastnameAndFirstname	select distinct … where x.lastname = ?1 and x.firstname = ?2
And	findByLastnameAndFirstname	… where x.lastname = ?1 and x.firstname = ?2
Or	findByLastnameOrFirstname	… where x.lastname = ?1 or x.firstname = ?2
Is, Equals	findByFirstname,findByFirstnameIs,findBy FirstnameEquals	… where x.firstname = ?1
Between	findByStartDateBetween	… where x.startDate between ?1 and ?2
LessThan	findByAgeLessThan	… where x.age < ?1
LessThanEqual	findByAgeLessThanEqual	… where x.age <= ?1
GreaterThan	findByAgeGreaterThan	… where x.age > ?1
GreaterThanEqual	findByAgeGreaterThanEqual	… where x.age >= ?1
After	findByStartDateAfter	… where x.startDate > ?1
Before	findByStartDateBefore	… where x.startDate < ?1

Derived Query Methods in Spring Data JPA

eazy bytes

Supported keywords inside method names

Keyword	Sample method name	Sample Query that form by JPA
IsNull, Null	findByAge(Is)Null	… where x.age is null
IsNotNull, NotNull	findByAge(Is)NotNull	… where x.age not null
Like	findByFirstnameLike	… where x.firstname like ?1
NotLike	findByFirstnameNotLike	… where x.firstname not like ?1
StartingWith	findByFirstnameStartingWith	… where x.firstname like ?1 (parameter bound with appended %)
EndingWith	findByFirstnameEndingWith	… where x.firstname like ?1 (parameter bound with prepended %)
Containing	findByFirstnameContaining	… where x.firstname like ?1 (parameter bound wrapped in %)
OrderBy	findByAgeOrderByLastnameDesc	… where x.age = ?1 order by x.lastname desc
Not	findByLastnameNot	… where x.lastname <> ?1
In	findByAgeIn(Collection<Age> ages)	… where x.age in ?1
NotIn	findByAgeNotIn(Collection<Age> ages)	… where x.age not in ?1

Derived Query Methods in Spring Data JPA

eazy bytes

Supported keywords inside method names

Keyword	Sample method name	Sample Query that form by JPA
True	findByActiveTrue()	… where x.active = true
False	findByActiveFalse()	… where x.active = false
IgnoreCase	findByFirstnameIgnoreCase	… where UPPER(x.firstname) = UPPER(?1)

Spring Data JPA is a powerful tool that provides an extra layer of abstraction on top of an existing JPA providers like Hibernate. The derived query feature is one of the most loved features of Spring Data JPA.

Auditing Support By Spring Data JPA

eazy bytes

- *Spring Data provides sophisticated support to transparently keep track of who created or changed an entity and when the change happened. To benefit from that functionality, you have to equip your entity classes with auditing metadata that can be defined either using annotations or by implementing an interface.*
- *Additionally, auditing has to be enabled either through Annotation configuration or XML configuration to register the required infrastructure components.*
- *Below are the steps that needs to be followed,*

Step 1 : We need to use the annotations to indicate the audit related columns inside DB tables. Spring Data JPA ships with an entity listener that can be used to trigger the capturing of auditing information. We must register the AuditingEntityListener to be used for all the required entities.

```java
@Data
@MappedSuperclass
@EntityListeners(AuditingEntityListener.class)
public class BaseEntity {

    @CreatedDate
    @Column(updatable = false)
    private LocalDateTime createdAt;
    @CreatedBy
    @Column(updatable = false)
    private String createdBy;
    @LastModifiedDate
    @Column(insertable = false)
    private LocalDateTime updatedAt;
    @LastModifiedBy
    @Column(insertable = false)
    private String updatedBy;
}
```

@CreatedDate, @CreatedBy, @LastModifiedDate, @LastModifiedBy are the key annotations that support JPA auditing

Auditing Support By Spring Data JPA

eazy bytes

Step 2 : Date related info will be fetched from the server by JPA but for CreatedBy & UpdatedBy we need to let JPA know how to fetch that info by implementing AuditorAware interface like shown below.

```
@Component("auditAwareImpl")
public class AuditAwareImpl implements AuditorAware<String> {

    @Override
    public Optional<String> getCurrentAuditor() {
            return Optional.ofNullable(SecurityContextHolder.getContext()
                    .getAuthentication().getName());
    }
}
```

Step 3 : Enable JPA auditing by annotating a configuration class with the @EnableJpaAuditing annotation.

```
@SpringBootApplication
@EnableJpaRepositories("com.eazybytes.eazyschool.repository")
@EntityScan("com.eazybytes.eazyschool.model")
@EnableJpaAuditing(auditorAwareRef = "auditAwareImpl")
public class EazyschoolApplication {
```

QUICK TIP

eazy bytes

Do you know we can print the queries that are being formed and executed by Spring Data JPA by enabling the below properties,

spring.jpa.show-sql=true

spring.jpa.properties.hibernate.format_sql=true

- ✓ **show-sql property will print the query on the console/logs where as format_sql property will print the queries in a readable friendly style.**
- ✓ **But please make sure to leverage them in non-prod environments only as they impact the performance of the web application.**

Spring MVC Custom Validations

eazy bytes

We have seen before using Bean validations like Max, Min, Size etc. we can do validations on the input received. Now let's try to define custom validations that are specific to our business requirements. For the same we need to follow the below steps,

Step 1 : Suppose if we have a requirement to not allow some weak passwords inside our user registration form, we first need to create a custom annotation like below. Here we need to provide the class name where the actual validation logic present.

```
@Documented
@Constraint(validatedBy = PasswordStrengthValidator.class)
@Target( { ElementType.METHOD, ElementType.FIELD })
@Retention(RetentionPolicy.RUNTIME)
public @interface PasswordValidator {
    String message() default "Please choose a strong password";
    Class<?>[] groups() default {};
    Class<? extends Payload>[] payload() default {};
}
```

Spring MVC Custom Validations

eazy bytes

Step 2 : We need to create a class that implements ConstraintValidator interface and overriding the isValid() method like shown below,

```
public class PasswordStrengthValidator implements
        ConstraintValidator<PasswordValidator, String> {

    List<String> weakPasswords;

    @Override
    public void initialize(PasswordValidator passwordValidator) {
        weakPasswords = Arrays.asList("12345", "password", "qwerty");
    }

    @Override
    public boolean isValid(String passwordField,
                           ConstraintValidatorContext cxt) {
        return passwordField != null && (!weakPasswords.contains(passwordField));
    }
}
```

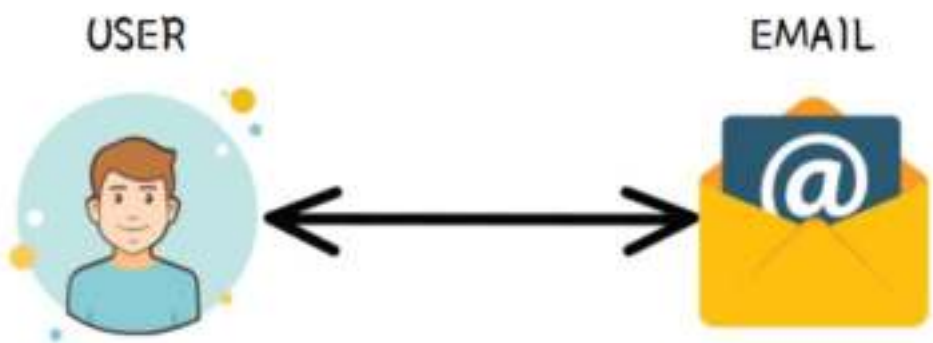
Step 3 : Finally we can mention the annotation that we created on top of the field inside a POJO class,

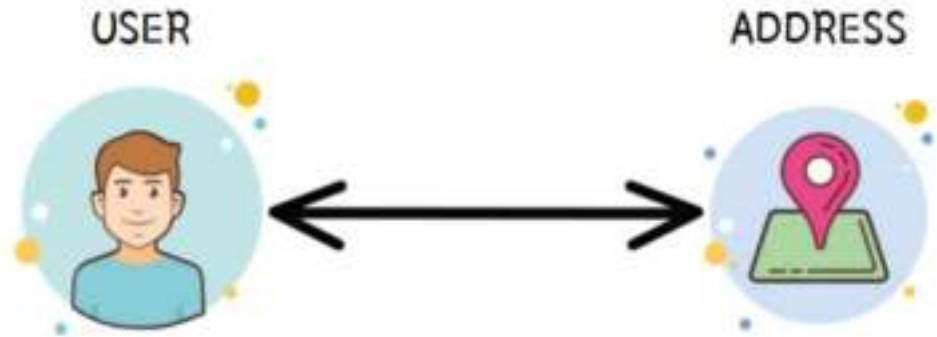
```
@NotBlank(message="Password must not be blank")
@Size(min=5, message="Password must be at least 5 characters long")
@PasswordValidator
private String pwd;
```

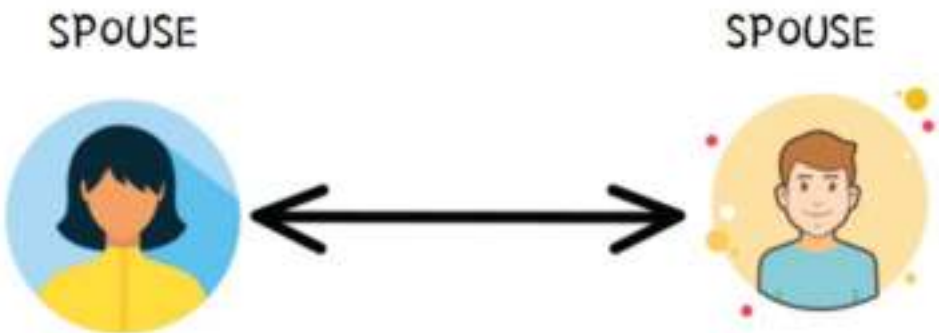
One to One Relationship inside JPA

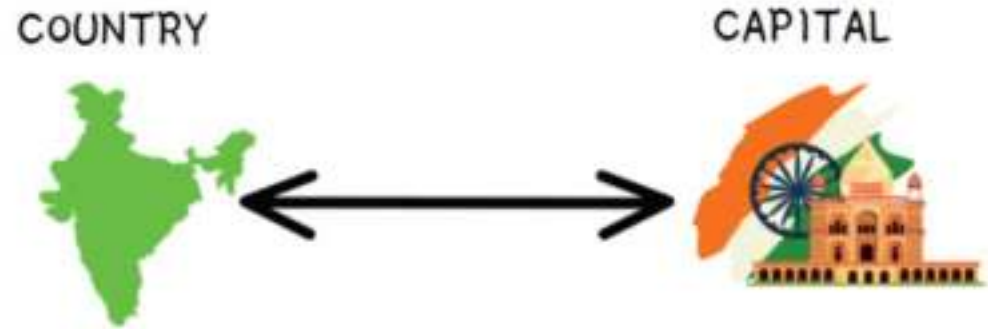
eazy bytes

- *First, what is a one-to-one relationship? It's a relationship where a record in one entity (table) is associated with exactly one record in another entity (table).*
- *Below are few real-life examples of one-to-one relationships,*









One to One Relationship inside JPA

eazy bytes

- *Spring Data JPA allow developers to build one-to-one relationship between the entities with simple configurations. For example if we want to build a one-to-one between Person and Address entities, then we can configure like mentioned below.*

```
@Data
@Entity
public class Person {

    @OneToOne(fetch = FetchType.EAGER,cascade = CascadeType.ALL, targetEntity = Address.class)
    @JoinColumn(name = "address_id", referencedColumnName = "addressId",nullable = true)
    private Address address;
}
```

- *In Spring Data JPA, a one-to-one relationship between two entities is declared by using the @OneToOne annotation. Using it we can configure FetchType, cascade effects, targetEntity.*
- *The @JoinColumn annotation is used to specify the foreign key column relationship details between the 2 entities. "name" defines the name of the foreign key column, referencedColumnName indicates the field name inside the target entity class, nullable defines whether foreign key column can be nullable or not.*

JPA FETCH

eazy bytes

- *Based on the fetch configurations that developer has done, JPA allows entities to load the objects with which they have a relationship.*

We can declare the fetch value in the @OneToOne, @OneToMany, @ManyToOne and @ManyToMany annotations. These annotations have an attribute called fetch that serves to indicate the type of fetch we want to perform. It have two valid values: FetchType.EAGER and FetchType.LAZY

With LAZY configuration, we are telling JPA that we want to lazily load the relation entities, so when retrieving an entity, its relations will not be loaded until unless we try refer the related entity using getter method. On the contrary, with EAGER it will load it's relation entities as well.

By default all ToMany relationships are LAZY, while ToOne relationships are EAGER.

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Key points of Cascade Types

Intro to Cascade

- ✓ JPA allows us to propagate entity state changes from Parents to Child entities. This concept is calling Cascading in JPA.
- ✓ The cascade configuration option accepts an array of CascadeTypes.

Cascade Types

The cascade types supported by JPA are as below:

1) CascadeType.PERSIST
2) CascadeType.MERGE
3) CascadeType.REFRESH
4) CascadeType.REMOVE
5) CascadeType.DETACH
6) CascadeType.ALL

Best Practices

- ✓ Cascading makes sense only for Parent – Child associations (where the Parent entity state transition being cascaded to its Child entities). Cascading from Child to Parent is not very useful and not recommended.
- ✓ There is no default cascade type in JPA. By default, no operation is cascaded.

CASCADE TYPES

eazy bytes

CascadeType.PERSIST : means that save() or persist() operations cascade to related entities.

CascadeType.MERGE : means that related entities are merged when the owning entity is merged.

CascadeType.REFRESH : means the child entity also gets reloaded from the database whenever the parent entity is refreshed.

CascadeType.REMOVE : means propagates the remove operation from parent to child entity.

CascadeType.DETACH : means detach all child entities if a "manual detach" occurs for parent.

CascadeType.ALL : is shorthand for all of the above cascade operations.

Spring Security AuthenticationProvider

eazy bytes

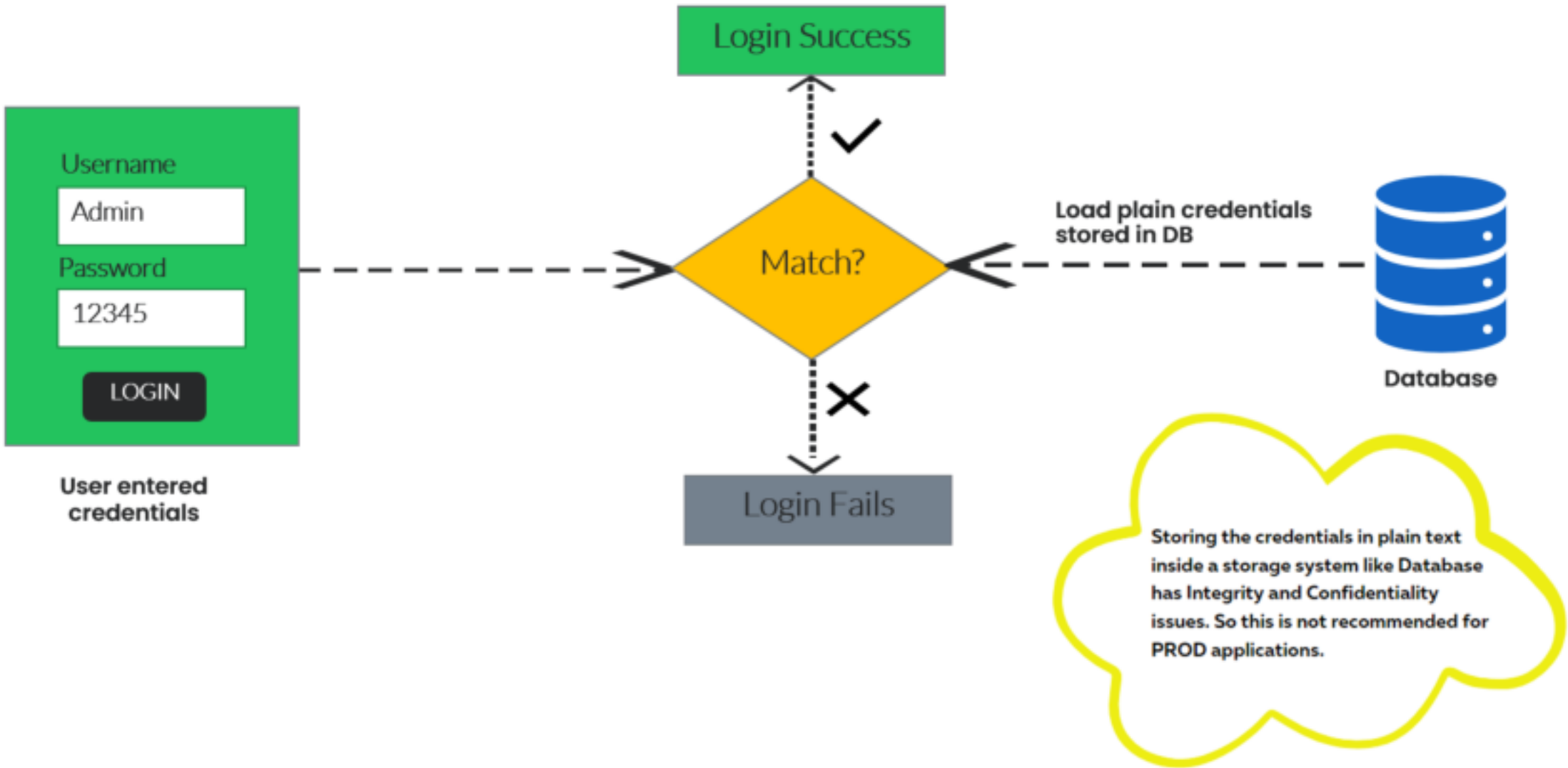
- *As of now we are performing the login operation using the inMemoryAuthentication. But the idle way is to perform login check against a DB table or any other storage system which is more secure.*
- *For the same, Spring Security allow us to write our own custom logic to authenticate a user based on our requirements by implementing AuthenticationProvider interface. Below is the sample implementation of the same,*

```
@Component
public class EazySchoolUsernamePwdAuthenticationProvider implements AuthenticationProvider
{
    @Override
    public Authentication authenticate(Authentication authentication)
            throws AuthenticationException {
        String name = authentication.getName();
        String password = authentication.getCredentials().toString();
        if (authenticateUserBasedonYourRequirement()) {
            return new UsernamePasswordAuthenticationToken(
                    name, password, new ArrayList<>());
        } else {
            return null;
        }
    }

    @Override
    public boolean supports(Class<?> authentication) {
        return authentication.equals(UsernamePasswordAuthenticationToken.class);
    }
}
```

How Passwords Validated W/O PasswordEncoder

eazy bytes



eazy bytes

Different ways of Pwd management

Encoding

- ✓ Encoding is defined as the process of converting data from one form to another and has nothing to do with cryptography.
- ✓ It involves no secret and completely reversible.
- ✓ Encoding can't be used for securing data. Below are the various publicly available algorithms used for encoding.

Ex: ASCII, BASE64, UNICODE

Encryption

- ✓ Encryption is defined as the process of transforming data in such a way that guarantees confidentiality.
- ✓ To achieve confidentiality,encryption requires the use of a secret which, in cryptographic terms, we call a "key".
- ✓ Encryption can be reversible by using decryption with the help of the "key". As long as the "key" is confidential, encryption can be considered as secured.

Hashing

- ✓ In hashing, data is converted to the hash value using some hashing function.
- ✓ Data once hashed is non-reversible. One cannot determine the original data from a hash value generated.
- ✓ Given some arbitrary data along with the output of a hashing algorithm, one can verify whether this data matches the original input data without needing to see the original data

QUICK TIP

eazy bytes

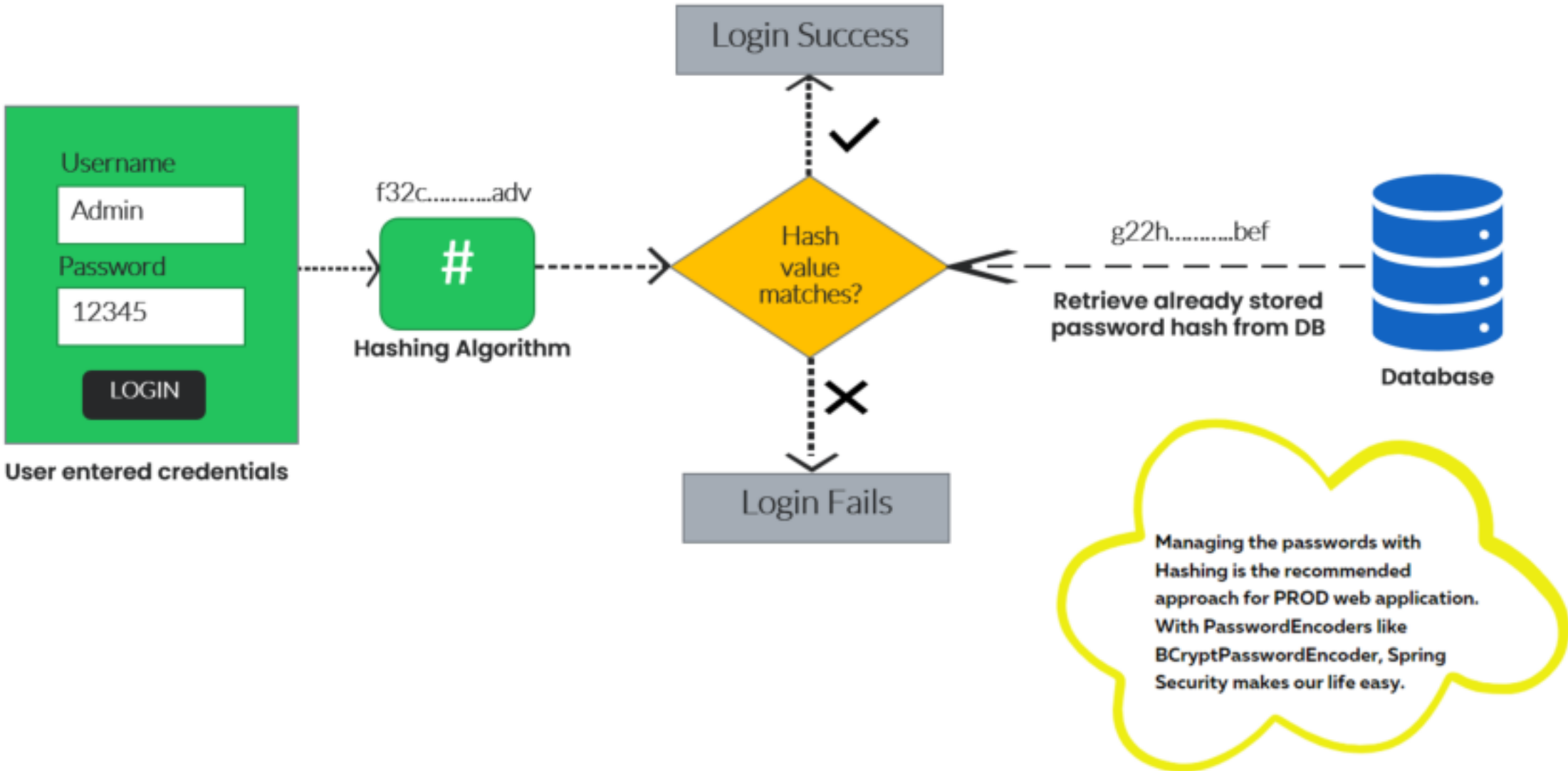
Do you know Spring Security provides various PasswordEncoders to help developers with hashing of the secured data like password.

Different Implementations of PasswordEncoders provided by Spring Security

- ✓ **NoOpPasswordEncoder (No hashing stores in plain text)**
- ✓ **StandardPasswordEncoder**
- ✓ **Pbkdf2PasswordEncoder**
- ✓ **BCryptPasswordEncoder (Most Commonly used)**
- ✓ **SCryptPasswordEncoder**

How Passwords Validated With Hashing &PasswordEncoder

eazy bytes



QUICK TIP

eazy bytes

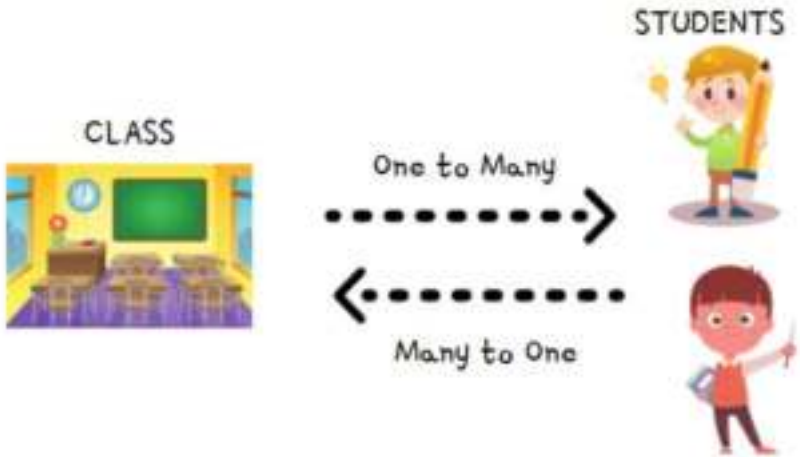
Do you know we can disable the javax bean validations by the Spring Data JPA using the below property,

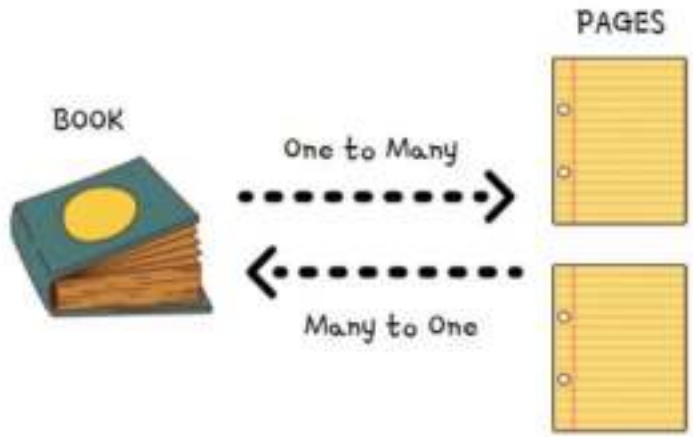
spring.jpa.properties.javax.persistence.validation.mode=none

One to Many & Many to One Relationship inside JPA

eazy bytes

- *A one-to-many relationship refers to the relationship between two entities/tables A and B in which one element/row of A may only be linked to many elements/rows of B, but a member of B is linked to only one element/row of A.*
- *The opposite of one-to-many is many-to-one relationship.*
- *Below are few real-life examples of one-to-many and many-to-one relationships.*





One to Many & Many to One Relationship inside JPA

eazy bytes

- *Spring Data JPA allow developers to build one-to-many & many-to-one relationships between the entities with simple configurations. Below are the sample configurations between Class and Persons,*

```java
@Entity
public class Person extends BaseEntity{

    @ManyToOne(fetch = FetchType.LAZY, optional = true)
    @JoinColumn(name = "class_id", referencedColumnName = "classId", nullable = true)
    private EazyClass eazyClass;
}
```

- *The @ManyToOne annotation is used to define a many-to-one relationship between two entities. The child entity, that has the join column, is called the owner of the relationship.*
- *The @JoinColumn annotation is used to specify the foreign key column details.*

- *A one-to-many relationship between two entities is defined by using the @OneToMany annotation. It also declares the mappedBy element to indicate the entity that owns the bidirectional relationship. Usually, the child entity is one that owns the relationship and the parent entity contains the @OneToMany annotation.*

```java
@Entity
@Table(name = "class")
public class EazyClass extends BaseEntity{

    @OneToMany(mappedBy = "eazyClass", fetch = FetchType.LAZY,
            cascade = CascadeType.PERSIST,targetEntity = Person.class)
    private Set<Person> persons;
}
```

Many to Many inside JPA

eazy bytes

- *A many-to-many relationship refers to the relationship between two entities/tables A and B in which one element/row of A are associated with many elements/rows of B and vice versa.*
- *Below are few real-life examples of many-to-many relationship,*

Many to Many inside JPA

eazy bytes

- *Spring Data JPA allow developers to build many-to-many relationship between the entities with simple configurations. Below are the sample configurations between Courses and Persons,*

```
@Entity
public class Person extends BaseEntity{

    @ManyToMany(fetch = FetchType.EAGER, cascade = CascadeType.PERSIST)
    @JoinTable(name = "person_courses",
            joinColumns = {
                    @JoinColumn(name = "person_id", referencedColumnName = "personId")},
            inverseJoinColumns = {
                    @JoinColumn(name = "course_id", referencedColumnName = "courseId")})
    private Set<Courses> courses = new HashSet<>();
}
```

- *A many-to-many relationship between two entities is defined by using the @ManyToMany annotation.*
- *The @JoinTable annotation defines the join table between two entities*

- *In a bidirectional relationship of @ManyToMany, only one entity can own the relationship. Here we choose Courses as the owning entity. We usually mention mappedBy parameter on the owning entity.*

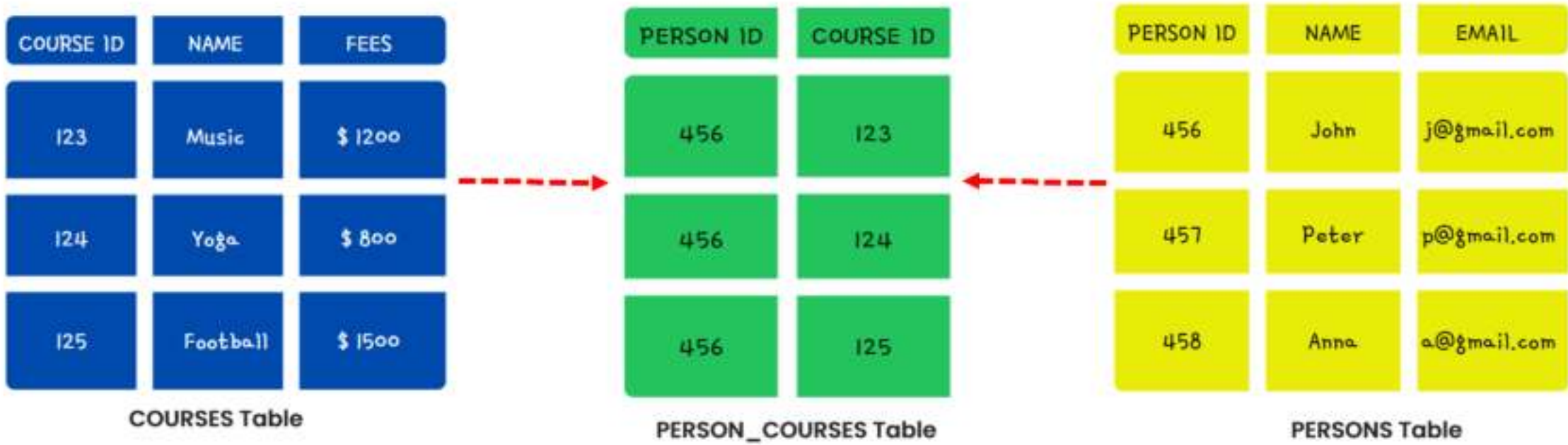
```
@Entity
public class Courses extends BaseEntity{

    @ManyToMany(mappedBy = "courses", fetch = FetchType.EAGER
            ,cascade = CascadeType.PERSIST)
    private Set<Person> persons = new HashSet<>();
}
```

Many to Many inside JPA

eazy bytes

- *Why do we really need a third table in Many to Many relationship? Lets assume we have below tables and records which has many-many relationship between them.*
- *If we need to represent multiple courses that a same student enrolled, the best way is to maintain a middle third table like shown below. Otherwise we need to maintain lot of duplicate rows inside Person table.*



eazy bytes

Sorting

Introduction

✓ Spring Data JPA supports Sorting to Query results with easier configurations.

✓ Spring Data JPA provides default implementations of Sorting with the help of PagingAndSortingRepository interface

✓ There are two ways to achieve Sorting in Spring Data JPA:

1) Static Sorting
2) Dynamic Sorting

Static Sorting

✓ Static sorting refers to the mechanism where the retrieved data is always sorted by specified columns and directions. The columns and sort directions are defined at the development time and cannot be changed at runtime.

✓ Below is an examples of Static Sorting,

```
List<Person> findByOrderByNameDesc()
```

Dynamic Sorting

✓ By using dynamic sorting, you can choose the sorting column and direction at runtime to sort the query results.

✓ Dynamic sorting provides more flexibility in choosing sort columns and directions with the help of Sort parameter to your query method. The Sort class is just a specification that provides sorting options for database queries. Below is an example,

```
Sort sort=Sort.by("name").descending()
.and(Sort.by("age"));
```

eazy bytes

Pagination

Introduction

- ✓Spring Data JPA supports Pagination which helps easy to manage & display large amount of data in various pages inside web applications
- ✓Just like the special Sort parameter, we have for the dynamic sorting, Spring Data JPA supports another special parameter called Pageable for paginating the query results.
- ✓We can combine both pagination and dynamic sorting with the help of Pageable

Dynamic Sorting

- ✓ Whenever we want to apply pagination to query results, all we need to do is just add Pageable parameter to the query method definition and set the return by Page<T> like below,

```
Pageable pageable = PageRequest.of(0, 5, Sort.by("name").
descending());

Page<Person> findByName(String name, Pageable pageable);
```

eazy bytes

Custom Queries with JPA

Introduction

✓Derived queries are good as long as they are not complex. As the number of query parameters goes beyond 3 to 4, you need a more flexible strategy.

✓For such complicated or custom scenarios, Spring Data JPA allow developers to write their own queries with the help of below annotations,

@Query
@NamedQuery
@NamedNativeQuery

@Query Annotation

✓ The @Query annotation defines queries directly on repository methods. This gives you full flexibility to run any query without following the method naming conventions.

✓ With the help of @Query annotation we can write queries in the form of JPQL or Native SQL query.

✓ When ever we are writing a native SQL query then we need to mention nativeQuery = true inside @Query annotation

Named Queries

✓ For bigger applications where they may have 1000s of queries scatted across the application, it would make sense for them to maintain all these queries in a single place logically by using annotations, properties and XML files.

✓ We can create named queries easily with the below annotations on top of an entity class,

@NamedQuery - Used to define a JPQL named query.

@NamedNativeQuery - Used to define a native SQL named query.

JPQL inside Spring Data JPA

eazy bytes

JPQL

Introduction

- ✓ The Java Persistence Query Language (JPQL) is a platform-independent object-oriented query language defined as part of the Java Persistence API (JPA) specification.
- ✓ JPQL is used to make queries against entities stored in a relational database. It is heavily inspired by SQL, and its queries resemble SQL queries in syntax, but operate against JPA entity objects rather than directly with database tables.
- ✓ The only drawback of using JPQL is that it supports a subset of the SQL standard. So, it may not be a great choice for complex queries.

JPQL Example

- ✓ Below is an example of JPQL. You can observe we are using the entity names and fields present inside it instead of using table and column names,

```
@Query("SELECT c FROM Contact c WHERE c.contactId = ?1
ORDER BY c.createdAt DESC")
List<Contact> findByIdOrderByCreatedDesc(long id);
```

Sorting Examples

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Static Sorting using derived query from method name

```
List<Person> findByNameOrderByAgeDesc(String name);
```

Static Sorting using @Query annotation with JPQL

```
@Query("SELECT p FROM person p WHERE p.age > ?1 ORDER BY p.name DESC")
List<Person> findByAgeGreaterThanJPQL(int age);
```

Static Sorting using @Query annotation with native query

```
@Query(value = "SELECT * FROM person p WHERE p.name = :givenName ORDER BY p.age ASC",
        nativeQuery = true)
List<Person> findByGivenNameNativeSQL(@Param("givenName") String givenName);
```

Sorting Examples

eazy bytes

Static Sorting using NamedQuery & NamedNativeQuery annotations

```
@NamedQuery(name = "Person.findByAgeGreaterThanNamedJPQL",
        query = "SELECT p FROM Person p WHERE p.age > :age ORDER BY p.name ASC")
@NamedNativeQuery(name = "Person.findAllNamedNativeSQL",
        query = "SELECT * FROM person p ORDER BY p.age DESC")
@Entity
public class Person extends BaseEntity{
```

Dynamic Sorting using Sort parameter. The Sort parameter can be passed with @Query, @NamedQuery annotations. Sort fields can be add dynamically as well based on the request params from the UI/API.

```
Sort sort = Sort.by("name").descending().and(Sort.by("age"));
List<Person> persons = personRepository.findByName("John", sort);
```

Spring Data JPA does not support dynamic sorting for native SQL queries, as it would require the updating of the actual SQL query defined, which cannot be done correctly by the Spring Data JPA.

Pagination Examples

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Below is an example where we are telling to JPA to fetch the first page by considering the total page size as 5

```
Pageable pageable = PageRequest.of(0, 5);
Page<Contact> msgPage = contactRepository.findByStatus("Open",pageable);
```

Below is an example where we are applying both pagination & sorting dynamically based on the input received.

```
public Page<Contact> findMsgsWithOpenStatus(int pageNum,String sortField,
                                            String sortDir){
    int pageSize = 5;
    Pageable pageable = PageRequest.of(pageNum - 1, pageSize,
            sortDir.equals("asc") ? Sort.by(sortField).ascending()
                    : Sort.by(sortField).descending());
    Page<Contact> msgPage = contactRepository.findByStatus("Open",pageable);
    return msgPage;
}
```

Dynamic sorting is not supported by named queries. So while using Pagination along with Named Queries, make sure that Pageable instance does not contain a Sort object.

@Query Examples

eazy bytes

@Query example with positional parameters

```
// Positional parameters
@Query("SELECT c FROM Contact c WHERE c.status = ?1 AND c.name = ?2 ORDER BY c.createdAt DESC")
List<Contact> findByGivenQueryOrderByCreatedDesc(String status, String name);
```

@Query example with named parameters

```
// named parameters
@Query("SELECT c FROM Contact c WHERE c.status = :status AND c.name = :name ORDER BY c.createdAt DESC")
List<Contact> findByGivenQueryOrderByCreatedDesc(@Param("status") String status,
                                                 @Param("name") String name);
```

@Query Examples

eazy bytes

Using @Query, we can also run UPDATE, DELETE, INSERT as well

```
@Transactional
@Modifying
@Query("UPDATE Contact c SET c.status = ?1 WHERE c.contactId = ?2")
int updateStatusById(String status, int id);
```

Whenever we are using queries that change the state of the database, they should be treated differently. We need to explicitly tell Spring Data JPA that our custom query changes the data by annotating the repository method with an additional @Modifying annotation. It will then execute the custom query as an update operation.

On whichever method/class we declare @Transactional the boundary of transaction starts and boundary ends when method execution completes. Lets say you are updating entity1 and entity2. Now while saving entity2 an exception occur, then as enitiy1 comes in same transaction so entity1 will be rollback with entity2.Any exception will result in rollback of all JPA transactions with DB.

@NamedQuery & @ NamedNativeQuery Examples

eazy bytes

@NamedQuery example declared on top of the entity class

```
@Entity
@NamedQuery(name="Contact.findOpenMsgs",query = "SELECT c FROM Contact c WHERE c.status = :status")
public class Contact extends BaseEntity{
```

@NamedNativeQuery example declared on top of the entity class

```
@Entity
@NamedNativeQuery(name = "Contact.findOpenMsgsNative",
        query = "SELECT * FROM contact_msg c WHERE c.status = :status",resultClass = Contact.class)
public class Contact extends BaseEntity{
```

For @NamedQuery as long as the method name inside Repository class matches with the name of the query we should be good. Where as for @NamedNativeQuery apart from query name & method name match, we should also mention @Query(nativeQuery = true) on top of the Repository method.

QUICK TIP

eazy bytes

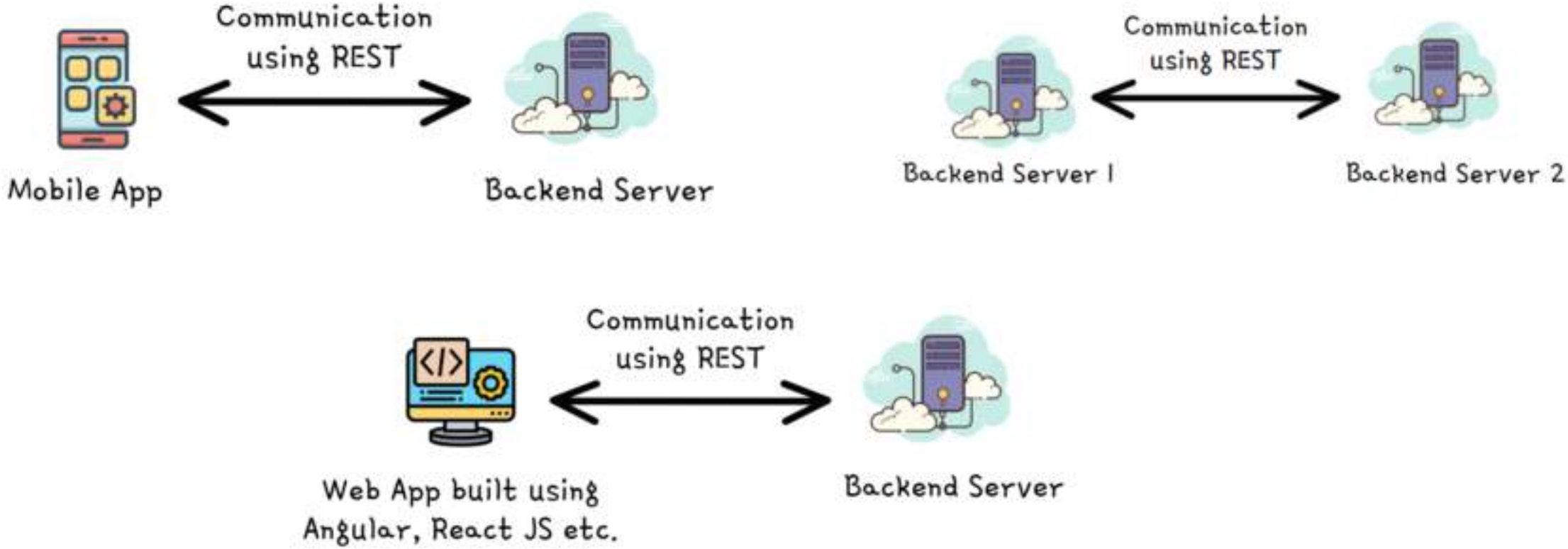
Do you know we can create multiple named queries and named native queries using the annotations @NamedQueries and @NamedNativeQueries. Below is the syntax of the same,

```
@NamedQueries({
        @NamedQuery(name = "one", query = "?"),
        @NamedQuery(name = "two", query = "?")
})

@NamedNativeQueries({
        @NamedNativeQuery(name = "one", query = "?“, resultClass = ?),
        @NamedNativeQuery(name = "two", query = "?“, , resultClass = ?)
})
```

Implementing REST Services

eazy bytes

- *REST (Representational state transfer) services are one of the most often encountered ways to implement communication between two web apps. REST offers access to functionality the server exposes through endpoints a client can call.*
- *Below are the different use cases where REST services are being used most frequently these days,*



Implementing REST Services

eazy bytes

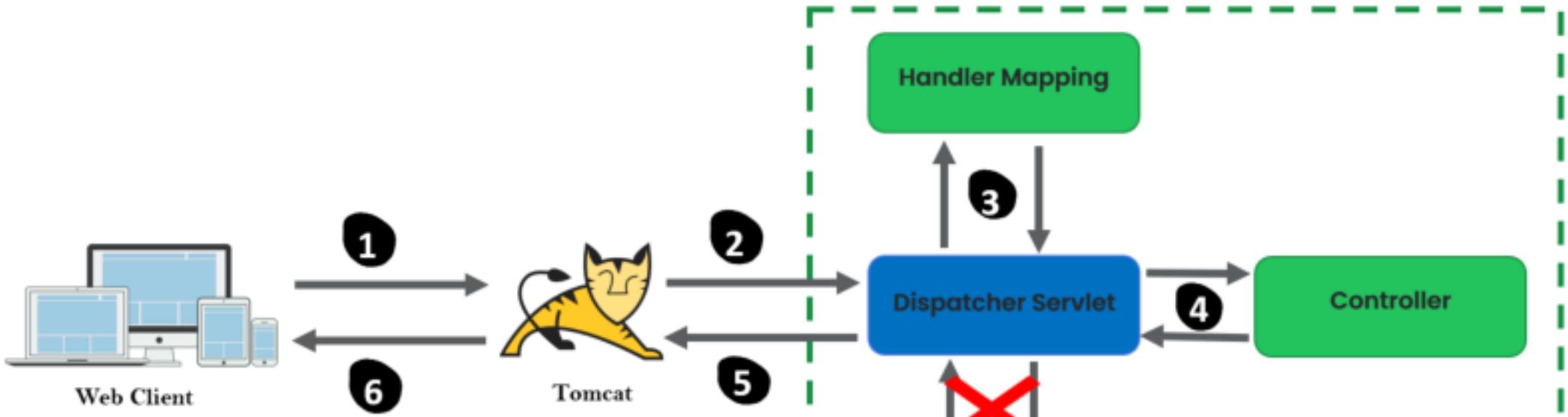
Below is the sample code implementing Rest Service using Spring MVC style but only with the addition of @ResponseBody annotation

```
@Controller
public class ContactRestController {

    @Autowired
    ContactRepository contactRepository;

    @GetMapping("/getMessagesByStatus")
    @ResponseBody
    public List<Contact> getMessagesByStatus(@RequestParam(name = "status") String status) {
        return contactRepository.findByStatus(status);
    }

}
```

The @ResponseBody annotation tells the dispatcher servlet that the controller's action will not return a view name but the data sent directly in the HTTP response.

SPRING MVC ARCHITECTURE WITH REST SERVICE

eazy bytes



Spring MVC Web Application with REST Service

When implementing REST endpoints, the Spring MVC flow changes. The app no longer needs a view resolver because the client needs the data returned by the controller's action directly. Once the controller's action completes, the dispatcher servlet returns the HTTP response without rendering any view.

Implementing REST Services

eazy bytes

Instead of mentioning @ResponseBody on each method inside a Controller class which is a duplicate code, Spring offers the @RestController annotation, a combination of @Controller and @ResponseBody.

```java
@RestController
public class ContactRestController {

    @Autowired
    ContactRepository contactRepository;

    @GetMapping("/getMessagesByStatus")
    public List<Contact> getMessagesByStatus(@RequestParam(name = "status") String status) {
        return contactRepository.findByStatus(status);
    }

}
```

@RestController = @Controller + @ResponseBody

Different Annotation & Classes in REST

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@RestController – can be used to put on top of a call. This will save developers from mentioning @ResponseBody on each methods

@ResponseBody – can be used on top of a method to build a Rest API when we are using @Controller on top of a Java class

ResponseEntity<T> - Allow developers to send response body, status, and headers on the HTTP response.

@RestControllerAdvice – is used to mark the class as a REST controller advice. Along with @ExceptionHandler, this can be used to handle exceptions globally inside app.

RequestEntity<T> - Allow developers to receive the request body, header in a HTTP request.

@RequestHeader & @RequestBody – is used to receive the request body and header individually.

CROSS-ORIGIN RESOURCE SHARING (CORS)

eazy bytes

CORS is a protocol that enables scripts running on a browser client to interact with resources from a different origin. For example, if a UI app wishes to make an API call running on a different domain, it would be blocked from doing so by default due to CORS. So CORS is not a security issue/attack but the default protection provided by browsers to stop sharing the data/communication between different origins.

"other origins" means the URL being accessed differs from the location that the JavaScript is running from, by having:

- a different scheme (HTTP or HTTPS)
- a different domain
- a different port

CROSS-ORIGIN RESOURCE SHARING (CORS)

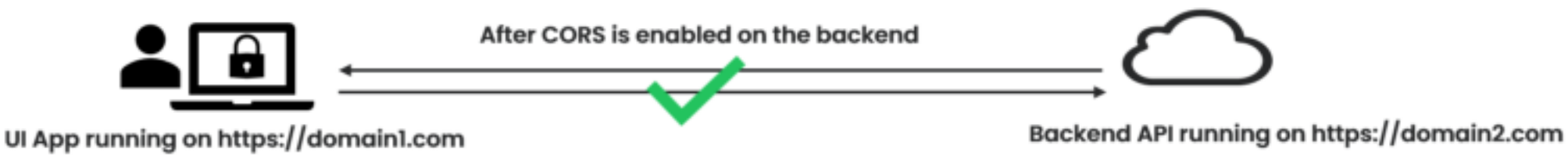
eazy bytes

If we have a valid scenario, where a Web APP UI deployed on a server is trying to communicate with a REST service deployed on another server, then these kind of communications we can allow with the help of @CrossOrigin annotation. @CrossOrigin allows clients from any domain to consume the API.

@CrossOrigin annotation can be mentioned on top of a class or method like mentioned below,

```
@CrossOrigin(origins = "http://localhost:8080") // Will allow on specified domain

@CrossOrigin(origins = "*") // Will allow any domain
```



QUICK TIP

eazy bytes

Do you know Jackson library provide annotations to control the way we send data in REST API JSON response. Below are the few annotations,

@JsonProperty – This annotation can be mentioned on top of any field of a POJO class. While sending the JSON response, instead of sending the field name Jackson will send the property name that we mentioned.

```
@JsonProperty("person_name")
private String name;
```

@JsonIgnore – This annotation will make sure to not send the information present inside the given field. This is useful to filter the data which is sensitive or unnecessary in the response.

```
@JsonIgnore
private LocalDateTime createdAt;
```

We can also use @JsonIgnoreProperties(value = { "createdAt" }) on top of a POJO class if we want to mention multiple fields.

Consuming REST Services

eazy bytes

- *Apart from building the Rest service, often we may need to consume the Rest Services exposed by other third party vendors. So knowing how to consume Rest services is equally important.*
- *Below are the most commonly used approaches that are provided by Spring framework,*

OpenFeign - A tool offered by the Spring Cloud project. Using this very similar to like how build Repositories with Spring Data JPA. In similar way we just need to write interfaces but not implementation code.

RestTemplate—A well-known tool developers have been using since Spring 3 to call REST endpoints. RestTemplate is often used today in Spring apps. But this is deprecated in the favor of WebClient.

WebClient— Created as part of the Spring Web Reactive module, and will be replacing the classic RestTemplate. This is introduced to support all modes of invocation like Sync and Async (non-blocking)

Consuming REST Services using OpenFeign

eazy bytes

In order to consume the REST services using OpenFeign, we need to follow the below steps.

Step 1 : After adding all the required dependencies inside the pom.xml, we need to create a proxy interface with all the details around API that we are going to consume. Inside the interface we need to create method name matching the details of the destination API method we are going to consume.

```
@FeignClient(name = "contact", url = "http://localhost:8080/api/contact",
    configuration = ProjectConfiguration.class)
public interface ContactProxy {

    @RequestMapping(method = RequestMethod.GET, value = "/getMessagesByStatus")
    @Headers(value = "Content-Type: application/json")
    public List<Contact> getMessagesByStatus(@RequestParam("status") String status);

}
```

Consuming REST Services using OpenFeign

eazy bytes

Step 2 : If we need to send the authentication details, then create a bean with the required details,

```
@Bean
public BasicAuthRequestInterceptor basicAuthRequestInterceptor() {
    return new BasicAuthRequestInterceptor("admin@eazyschool.com", "admin");
}
```

Step 3 : Finally we are good to use the proxy object to make a Rest call like shown below,

```
@Autowired
ContactProxy contactProxy;

@GetMapping("/getMessages")
public List<Contact> getMessages(@RequestParam("status") String status) {
    return contactProxy.getMessagesByStatus(status);
}
```

Consuming REST Services using RestTemplate

eazy bytes

In order to consume the REST services using RestTemplate, we need to follow the below steps.

Step 1 : After adding all the required dependencies inside the pom.xml, we need to create a RestTemplate bean along with the authentication details if any like below,

```
@Bean
public RestTemplate restTemplate() {
    RestTemplateBuilder restTemplateBuilder =
            new RestTemplateBuilder();
    return restTemplateBuilder.basicAuthentication
            ("admin@eazyschool.com", "admin").build();
}
```

Consuming REST Services using RestTemplate

eazy bytes

Step 2 : Using RestTemplate methods like exchange(), we can consume a Rest Service like mentioned below,

```
@PostMapping("/saveMsg")
public ResponseEntity<Response> saveMsg(@RequestBody Contact contact){
    String uri = "http://localhost:8080/api/contact/saveMsg";
    HttpHeaders headers = new HttpHeaders();
    headers.add("invocationFrom","RestTemplate");
    HttpEntity<Contact> httpEntity = new HttpEntity<>(contact, headers);
    ResponseEntity<Response> responseEntity = restTemplate.exchange(uri, HttpMethod.POST,
                    httpEntity,Response.class);
    return responseEntity;
}
```

Consuming REST Services using WebClient

eazy bytes

In order to consume the REST services using WebClient, we need to follow the below steps.

Step 1 : After adding all the required dependencies inside the pom.xml, we need to create a WebClient bean along with the authentication details if any like below,

```
@Bean
public WebClient webClient() {
    return WebClient.builder()
            .filter(ExchangeFilterFunctions.
                    basicAuthentication("admin@eazyschool.com", "admin"))
            .build();
}
```

Consuming REST Services using WebClient

eazy bytes

Step 2 : Using WebClient methods like post(), we can consume a Rest Service like mentioned below.

```
@Autowired
WebClient webClient;

@PostMapping("/saveMessage")
public Mono<Response> saveMessage(@RequestBody Contact contact){
    String uri = "http://localhost:8080/api/contact/saveMsg";
    return webClient.post().uri(uri)
            .header("invocationFrom","WebClient")
            .body(Mono.just(contact),Contact.class)
            .retrieve()
            .bodyToMono(Response.class);
}
```

Spring Data REST

eazy bytes

- *Apart from doing a magic of automatically creating repository implementations based on interfaces you define in your code, Spring Data has another feature that can help you define REST APIs for repositories created by Spring Data.*
- *For the same, we have Spring Data REST which is another member of the Spring Data family.*
- *To start using Spring Data REST in our project, we just need to add the following dependency to our pom.xml,*

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

We can check all the REST APIs exposed by Spring Data Rest by opening the URL http://localhost:8080/profile in the browser.

We just need to add the Spring Data Rest starter project and believe it or not, that's the only change is expected from Developer. Post that the application gets auto-configuration that enables automatic creation of a REST API for any repositories that were created by Spring Data

The REST APIs will be created for any kind of implementations like Spring Data JPA, Spring Data Mongo etc. The REST endpoints that Spring Data REST generates are at least as good as (and possibly even better than) the ones Developers creates 😉.

By adding the HAL Explorer along with Spring Data REST, we can look all the APIs exposed by Spring Data REST by opening the http://localhost:8080/ URL in the browser assuming that your App started at 8080 port itself.

HAL Explorer

eazy bytes

- *HAL (Hypertext Application Language) is a simple format that gives a consistent and easy way to hyperlink between resources in your API.*
- *Adopting HAL will make your API explorable, and its documentation easily discoverable from within the API itself. In short, it will make your API easier to work with and therefore more attractive to client developers.*
- *To start using HAL explorer along with Spring Data REST in our project, we just need to add the following dependency to our pom.xml,*

```
<dependency>
    <groupId>org.springframework.data</groupId>
    <artifactId>spring-data-rest-hal-explorer</artifactId>
</dependency>
```

We can check the HAL explorer by opening the URL http://localhost:8080/ in the browser. The UI is an Angular based web application that lets you easily explore HAL and HAL-FORMS based HTTP responses.

QUICK TIP

eazy bytes

Do you know we can change the default path exposed by Spring Data REST using the below configurations. This will change the default path as per your configurations.

```
spring.data.rest.basePath=/data-api
```

Using @RepositoryRestResource annotation, we can also control the way the paths of the repositories are being exposed.

```
@RepositoryRestResource(path = "courses")
```

For some reason, if you don't want to expose a Repository, then we can do the below configuration on top of the Repository class,

```
@RepositoryRestResource(exported = false)
```

eazy bytes

Logging

Introduction

✓By default we don't have to worry about logging if we are using Spring Boot. Most of the configurations and logging done by the Spring Boot itself.

✓Usually we have the following types of logging,

- FATAL (Logback doesn't have)
- ERROR
- WARN
- INFO
- DEBUG
- TRACE

Logging Types

✓ In Java we have many logging frameworks like Java Util logging, Log4J2, SLF4J, Logback. By default, if you use the "Starters", Logback is used for logging.

✓ Appropriate Logback routing is also included in Spring Boot to ensure that dependent libraries that use Java Util Logging, Commons Logging, Log4J, or SLF4J all work correctly.

✓ By default, ERROR-level, WARN-level, and INFO-level messages are logged. But we can change them based on our requirements and environments.

Logging inside SpringBoot

eazy bytes

- We can enable debug logging or trace logging by mentioning the below properties inside application.properties file,

application.properties

```
1  debug=true
2  trace=true
```

Alternatively we can provide the flags while starting the application like mentioned below,

$ java -jar myapp.jar --debug

- The way logging works is if we enable trace then all above severities like Debug, Info, Warn & Error are also printed. Suppose if we enable error logging only, then all lower severities like Warn, Info, Debug, Trace will not be logged.

- If needed we can control the logging at the package level by mentioning properties like below inside application.properties,

application.properties

```
1  logging.level.root=INFO
2  logging.level.com.eazybytes.eazyschool.aspects = ERROR
```

Logging inside SpringBoot

eazy bytes

- *It is often useful to be able to group related loggers together so that they can all be configured at the same time. For example, I may have an requirement to change the logging levels for all my project related packages very frequently. To help with this, Spring Boot allows you to define logging groups. Below is the sample configuration,*

application.properties

```
# Intialize log group eazyschool_error
logging.group.eazyschool_error=com.eazybytes.eazyschool.aspects, com.eazybytes.eazyschool.controller
# Set log level to log group eazyschool_error
logging.level.eazyschool_error=ERROR
```

- *If your terminal supports ANSI, color output is used to aid readability of your logs. You can set the below property to enable the same.*

application.properties

```
spring.output.ansi.enabled=ALWAYS
```

Logging inside SpringBoot

eazy bytes

- *Below is the default logging format in Spring Boot. Below is a sample logger message and format details of it.*

2025-01-21 08:02:46.035 INFO 15084 --- [restartedMain] c.e.eazyschool.EazyschoolApplication : Started EazyschoolApplication in 5.189 seconds (JVM running for 2123.116)

- ✓ Date and Time: Millisecond precision and easily sortable.
- ✓ Log Level: ERROR, WARN, INFO, DEBUG, or TRACE.
- ✓ Process ID.
- ✓ A --- separator to distinguish the start of actual log messages.
- ✓ Thread name: Enclosed in square brackets (may be truncated for console output).
- ✓ Logger name: This is usually the source class name (often abbreviated).
- The log message.

- *By default, Spring Boot logs only to the console and does not write log files. If you want to write log files in addition to the console output, we can create a file with the name logback.xml inside class path and define all our logging requirements in it.*

QUICK TIP

eazy bytes

Do you know Lombok has various annotations to help developers with logging based on the logging framework being used,

@Slf4j will generate the below code and we can use the log variable directly,

```
@Slf4j
public class LogExample {

}
```

will generate:

```
public class LogExample {
    private static final org.slf4j.Logger log = org.slf4j.LoggerFactory.getLogger(LogExample.class);
}
```

Similarly using @CommonsLog, @Log4j2 will generate log variable from the respective library class.

eazy bytes

Configurations

Introduction

✓ Spring Boot lets you externalize your configuration so that you can work with the same application code in different environments. You can use a variety of external configuration sources, include Java properties files, YAML files, environment variables, and command-line arguments.

✓ By default, Spring Boot look for the configurations or properties inside application.properties/yaml present in the classpath location. But we can have other property files as well and make SpringBoot to read from them.

Config/Properties Preferences

✓ Spring Boot uses a very particular order that is designed to allow sensible overriding of values. Properties are considered in the following order (with values from lower items overriding earlier ones):

- Properties present inside files like application.properties
- OS Environmental variables
- Java System properties (System.getProperties())
- JNDI attributes from java:comp/env.
- ServletContext init parameters.
- ServletConfig init parameters.
- Command line arguments.

Reading properties with @Value

eazy bytes

- *We can read the properties/configurations, defined inside a properties file with the help of @Value annotation like shown below.*

application.properties

```
1  eazyschool.pageSize=10
2  eazyschool.contact.successMsg=Your message is submitted successfully.
```

@Value annotation leverages SpEL expressions to read the configurations present inside the properties file

```
@Controller
public class DashboardController {

    @Value("${eazyschool.pageSize}")
    private int defaultPageSize;

    @Value("${eazyschool.contact.successMsg}")
    private String message;
```

Reading properties using Environment

eazy bytes

- *Along with @Value, we can read the properties/configurations loaded with the help of Environment bean as well which is created by Spring framework. Apart from user defined properties, using Environment we can read any environment specific properties as well.*

application.properties

```
eazyschool.pageSize=10
eazyschool.contact.successMsg=Your message is submitted successfully.
```

```
@Controller
public class DashboardController {

    @Autowired
    private Environment environment;

    private void logProperties() {
        log.info(environment.getProperty("eazyschool.pageSize"));
        log.info(environment.getProperty("eazyschool.contact.successMsg"));
        log.info(environment.getProperty("JAVA_HOME"));
    }
```

Reading properties with @ConfigurationProperties

eazy bytes

- SpringBoot allow to load all the properties which are logically together into a java bean. For the same we can use @ConfigurationProperties annotation on top of a java bean by providing the prefix value. We need to make sure to use the names inside bean and properties file.
- Please follow below steps to read the properties using @ConfigurationProperties .

  - Step 1 : We need to maintain the properties like below which have same prefix like 'eazyschool'

application.properties

```
eazyschool.pageSize=10
eazyschool.contact.pageSize=5
eazyschool.contact.successMsg=Your message is submitted successfully.
eazyschool.branches[0]=NewYork
eazyschool.branches[1]=Delhi
eazyschool.branches[2]=Paris
eazyschool.branches[3]=Singapore
```

Reading properties with @ConfigurationProperties

eazy bytes

- *Step 2 : Create a bean like below with all the required details,*

```java
@Component("eazySchoolProps")
@Data
@PropertySource("classpath:some.properties")
@ConfigurationProperties(prefix = "eazyschool")
@Validated
public class EazySchoolProps {

    @Min(value=5, message="must be between 5 and 25")
    @Max(value=25, message="must be between 5 and 25")
    private int pageSize;
    private Map<String, String> contact;
    private List<String> branches;
}
```

@PropertySource – can be used to mention the property file name if we are using something other than application.properties

@ConfigurationProperties – can be used to mention the prefix value that needs to be considered while loading the properties into a given bean

@Validated – can be used if we want to perform validations on the properties based on the validation mentioned on the field

Reading properties with @ConfigurationProperties

eazy bytes

- *Step 3 : Finally we can inject the bean which we created in the previous step and start reading the properties from it using java style like shown below,*

```
@Service
public class ContactService {

    @Autowired
    EazySchoolProps eazySchoolProps;

    public Page<Contact> findMsgsWithOpenStatus(int pageNum,String sortField, String sortDir){
        int pageSize = eazySchoolProps.getPageSize();
        if(null!=eazySchoolProps.getContact() && null!=eazySchoolProps.getContact().get("pageSize")){
            pageSize = Integer.parseInt(eazySchoolProps.getContact().get("pageSize").trim());
        }
```

Reading properties with @PropertySource

eazy bytes

- *Sometimes we maintain properties inside files which has name is not equal to application.properties. In those scenarios, if we try to use the @Value, it will not work.*
- *First we need to communicate to SpringBoot about the property files with the below steps,*

We need to create a class with @Configuration and @PropertySource annotation like mentioned below. Here we need to mention the property file name. Post these changes, we can refer the properties present inside the config.properties using @Value annotation or Environment bean. ignoreResourceNotFound = true will not throw an exception in case the file is missing.

```
@Configuration
@PropertySource(value = "classpath:config.properties", ignoreResourceNotFound = true)
public class AppConfig {

}
```

We can configure multiple property files as well using @PropertySources annotation like mentioned here,

```
@Configuration
@PropertySources({
        @PropertySource(value = "classpath:config.properties",ignoreResourceNotFound = true),
        @PropertySource("classpath:server.properties")
})
public class AppConfig {

}
```

eazy bytes

Profiles

Introduction

- ✓ Spring provides a great tool for grouping configuration properties into so-called profiles(dev, uat, prod) allowing us to activate a bunch of configurations based on the active profile.
- ✓ Profiles are perfect for setting up our application for different environments, but they're also being used in another use cases like Bean creation based on a profile etc.
- ✓ So basically a profile can influence the application properties loaded and beans which are loaded into the Spring context.

Configuring Profiles

- ✓ The default profile is always active. Spring Boot loads all properties in application.properties into the default profile.
- ✓ We can create another profiles by creating property files like below,

  application_prod.properties --------> for prod profile

  application_uat.properties --------> for uat profile
- ✓ We can activate a specific profile using spring.profiles.active property like below,

```
spring.profiles.active=prod
```

QUICK TIP

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Do you know there are many ways to activate a profile. Below are the most commonly used.

- ✓ By mentioning `spring.profiles.active=prod` inside the properties files.
- ✓ Using environment variables like below,

```
export SPRING_PROFILES_ACTIVE=prod
java -jar myApp-0.0.1-SNAPSHOT.jar
```

- ✓ Using Java System property,

```
java "-Dspring-boot.run.profiles=prod" -jar myApp-0.0.1-SNAPSHOT.jar
mvn spring-boot:run "-Dspring-boot.run.profiles=prod"
```

- ✓ Activating a profile programmatically invoking the method `setAdditionalProfiles("prod")` inside SpringApplication class.
- ✓ Using @ActiveProfiles while doing testing,

```
@SpringBootTest
@ActiveProfiles({"uat"})
```

Conditional Bean creation using Profiles

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- *With the help of Profiles we can create the Bean conditionally. Below is an example where we can create different beans based on the active profile,*

```
@Component
@Profile("!prod")
public class EazySchoolNonProdUsernamePwdAuthenticationProvider
        implements AuthenticationProvider
{
```

```
@Component
@Profile("prod")
public class EazySchoolUsernamePwdAuthenticationProvider
        implements AuthenticationProvider
{
```

Spring Boot Actuator

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- *Actuator offers production-ready features such as monitoring and metrics to Spring Boot applications. Actuator's features are provided by way of several endpoints, which are made available over HTTP.*
- *To enable Actuator, we can mention the below dependency inside pom.xml,*

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

Once the Actuator dependency added to the project, we can navigate to http://localhost:8080/actuator to check the list of APIs exposed by it.

In a machine, an actuator is a component that's responsible for controlling and moving a mechanism. In a Spring Boot application, the Spring Boot Actuator plays that same role, enabling us to see inside of a running application and, to some degree, control how the application behaves.

Using endpoints exposed by Actuator, we can know the following type of info,

- ✓ Health
- ✓ Configuration properties
- ✓ Logging levels
- ✓ Memory consumption
- ✓ Beans information
- ✓ Metrics etc.

By default, Actuator doesn't expose many of the endpoints since they have sensitive information. We can expose them using the below property,

```
management.endpoints.web.exposure.include=*
```

Spring Boot Actuator

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API paths provided by Actuator

HTTP method	Path	Description
GET	/auditevents	Produces a report of any audit events that have been fired.
GET	/conditions	Produces a report of autoconfiguration conditions that either passed or failed, leading to the beans created in the application context.
GET	/configprops	Describes all configuration properties along with the current values.
GET	/beans	Describes all the beans in the Spring application context.
GET, POST, DELETE	/env	Produces a report of all property sources and their properties available to the Spring application.
GET	/env/{toMatch}	Describes the value of a single environment property.
GET	/heapdump	Downloads the heap dump.
GET	/health	Returns the aggregate health of the application and (possibly) the health of external dependent applications.
GET	/httptrace	Produces a trace of the most recent 100 requests.
GET	/info	Returns any developer-defined information about the application.
GET	/loggers	Produces a list of packages in the application along with their configured and effective logging levels.

Spring Boot Actuator

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API paths provided by Actuator

HTTP method	Path	Description
GET, POST	/loggers/{name}	Returns the configured and effective logging level of a given logger. The effective logging level can be set with a POST request.
GET	/mappings	Produces a report of all HTTP mappings and their corresponding handler methods.
GET	/scheduledtasks	Lists all scheduled tasks.
GET	/threaddump	Returns a report of all application threads.
GET	/metrics	Returns a list of all metrics categories.
GET	/metrics/{name}	Returns a multidimensional set of values for a given metric.

We can use Spring Boot Admin which is an administrative frontend web application that makes Actuator endpoints more consumable & readable by humans.

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Deploying Spring Boot Applications

Spring Boot's flexible packaging options provide a great deal of choice when it comes to deploying your application.

You can deploy Spring Boot applications to a variety of cloud platforms, to virtual/real machines

Since **AWS** is a famous cloud provider used by majority of the Organizations, let's explore on how to deploy a SpringBoot application using AWS

The SpringBoot Apps can be deployed to

- ✓ Public Clouds like AWS, Azure, GCP
- ✓ Kubernetes
- ✓ Heroku
- ✓ OpenShift etc.

The common approaches to deploy a Spring Boot inside AWS is using either **EC2** or **Elastic Beanstalk**

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AWS EC2 vs AWS Elastic Beanstalk

Amazon Elastic Compute Cloud (EC2) is a virtual cloud infrastructure service offered by AWS that provides users on-demand computing resources through which users can create powerful servers in the cloud. Additionally, EC2 enables users to get a virtual machine up and running in just a few clicks.

With EC2, we can deploy our Spring Boot application into AWS Cloud. But it is a traditional approach and has many drawbacks. When used EC2, the Developer or Organization, **need to take care of installing required software, libraries like Java, Tomcat and handle Auto scaling, load balancing etc. manually.**

Elastic Beanstalk is a service for deploying and scaling web applications and services. Upload your code and Elastic Beanstalk automatically handles the deployment—from capacity provisioning, load balancing, and auto scaling to application health monitoring.

With Beanstalk, Developers can **focus on writing code instead of provisioning and managing infrastructure**.

Elastic Beanstalk supports applications developed in **Go, Java, .NET, Node.js, PHP, Python, and Ruby**. When you deploy your application, Elastic Beanstalk builds the selected supported platform version and provisions one or more AWS resources, such as Amazon EC2 instances, to run your application.

AWS Elastic Beanstalk - How it works

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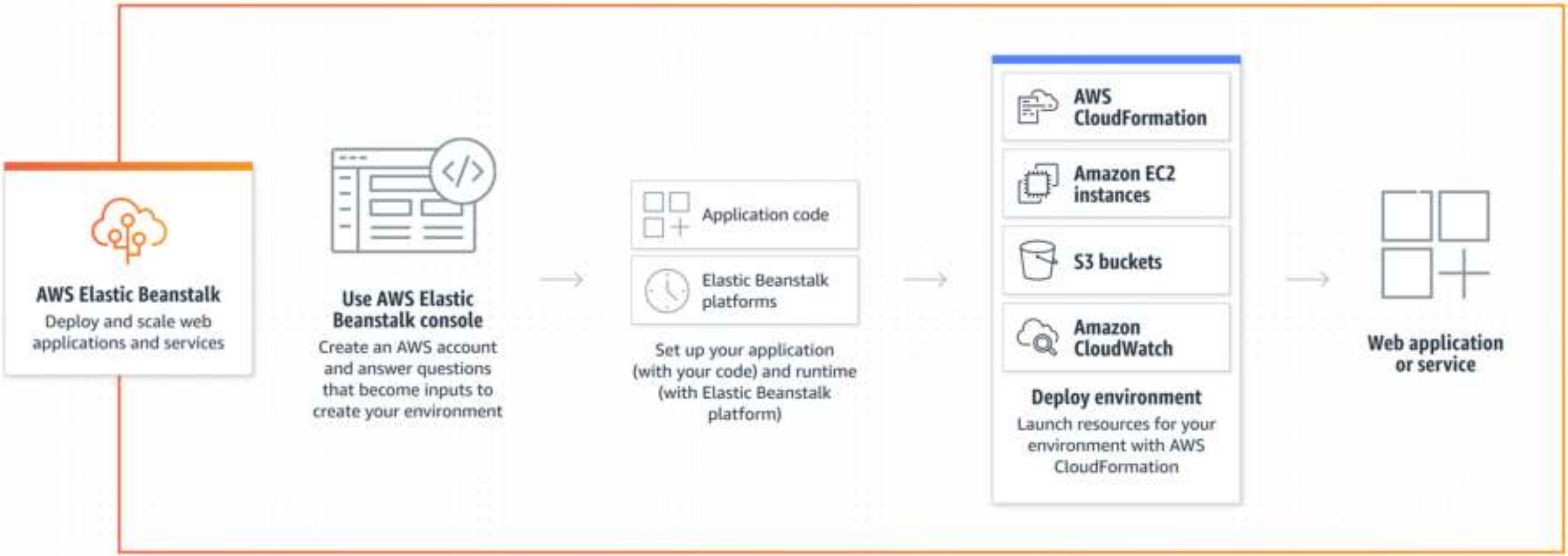

SOURCE: https://aws.amazon.com/elasticbeanstalk/

THANK YOU

See you next time!

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