**SPRING CORE**

* **Spring** : spring framework is a **Dependency Injection framework** to make java application loosely coupled. Spring was **develoved by Rod Johnson in 2003** and it is the most used and popular framework of java for **J2EE** or application development.

Spring provides alot of modules such as **Spring MVC, Spring Security, Spring Core**. With the help of these our application development becomes more easy.

1. **What is loosely coupled?**

**Loosely coupled** means We can make changes easily in our application.

1. **Why spring is called as dependency injection framework?**

Because it **injects dependencies** or objects itself.

Spring provides **IOC** with the help of which we perform **dependency injection**.

1. **What is dependency injection?**

It is the main functionality provided by Spring **IOC**. Dependency injection is a **design pattern** and a **core part of IOC**, by following which we can develop applications.

**Dependency** means one class is dependent on another class to do the work. In java we create object using new keyword. And if we do this then our application will become **tightly coupled**.

So what does Spring do is, the object we were creating using **new** keyword. Now it will be done by **dependency injection**. It will automatically create the object at **runtime** and will **inject** that object in another class.

**Dependency Injection** is a specific implementation of the IoC principle. It refers to the technique of passing **(injecting) dependencies** (objects) into a class at runtime rather than the class creating them itself. This can be done through **constructor injection, setter injection, or method injection**.

**Advantages:**

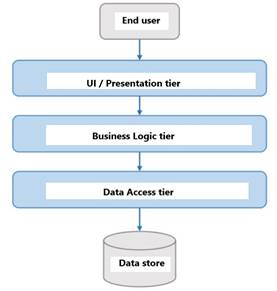
1. **Clean code**
2. **Decoupling** is more effective.
3. Classes become **easier to test**.
4. **What is IOC?**

**Inversion of control** is a design principle in which the **control of object creation and management** is transferred from the **application code to a container** or framework.

1. **Where this design pattern (Dependency Injection) required?**

It is particularly useful in **scenarios where decoupling components, managing configurations, and improving code quality are priorities**. By leveraging DI, developers can create more **flexible** and **robust applications** that are easier to manage and evolve over time.

1. **Design pattern / N-tier pattern / Layered architecture pattern**

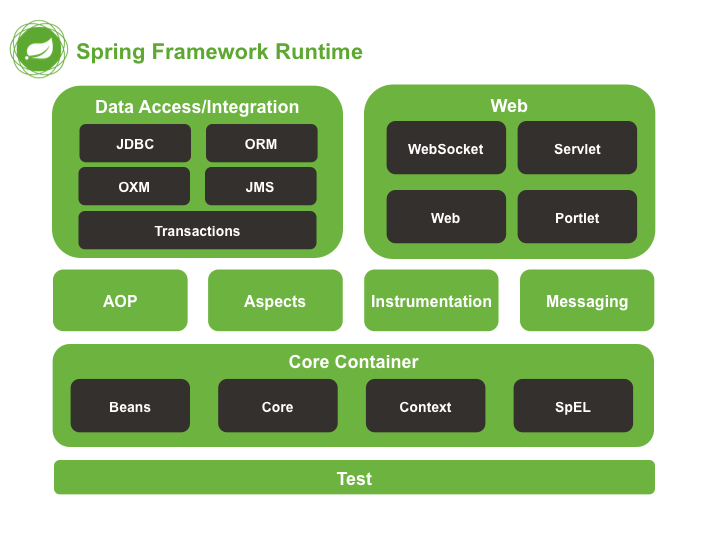


we always follow design patterns while developing a application. This process happens on server side.

1. **UI Layer (ProductController) :** It is a simple java **class**. This class needs to access some services or some business logics. It has the capabilities to accept requests. It will simply use the services of other class (**ProductService).** We do not write logic in this class.
2. **Business/Service Layer (Product Service) :** Business logics are written there and the **ProductController** will simply use these logics. Business layer **does not directly communicate with database**. It only provides business services.
3. **Data Access Layer (ProductDao) :** It communicates with database and send that to service layer.

**Spring Dependency Injection** will create the object of **ProductDao** and will inject it to **ProductService**.And will create the object of **ProductService** and will inject it to **ProductController**. This process will take place by I**OC container.**

* **Spring Modules :**



1. **Core container :** The core container consists of the Core, Beans, Context, and Expression Language Models.

* The **Core and Beans** modules **provide** the **fundamental parts of the framework**, including the **IOC and DI features,** The **BeanFactory** is the advanced version of the **factory pattern**. As it **removes** the **need** of **Singletons** and allows us to **decouple** our code. We canset up (or configure) how our objects should be created and what they depend on (like what tools they need to work) separately from the main part of our program.
* The **Context** module **inherits** the **features from bean module** and **adds** support for **internationalization**(using for e.g. resource bundles), **Event-propagation, resource-loading**, and the transparent **creation** of **contexts**. The context module also supports **J2EE features** such as EJB, JMX, and basic remoting.
* The **spEL** (**Spring Expression Language**) module provides a **powerful** **expression** language for querying and manipulating an **object graph** at **runtime**.

1. **Data Access/ Integration :** The DA layer consists of the **JDBC, ORM, OXM, JMS, and Transaction modules.**

* The **JDBC** module provides a **JDBC-abstraction layer** that **removes** the **need** to do **tedious JDBC coding** (Repetative JDBC code) and parsing of **db-vendor specific error codes** (understanding and handling error codes from different databases).
* The **ORM** module **provides integration layers** for popular object-ralational mapping APIs, including **JPA, JDO**, and **Hibernate**. Using the ORM package we can use all of these **O/R-mapping frameworks.**
* The **OXM** module **provides** an **abstraction layer** that supports Object/XML mapping implementations for JAXB, Castor, XMLBeans, JiBX, and XStream.
* The **Java Messaging Service(JMS)** module **contains features** for **producing** and **consuming messages**.
* The **Transaction** module supports **programmatic and declarative transaction management** for classes that implement special interfaces and for all your POJOs (plain old java objects).

1. **WEB :** The **Web** layer consists of the Web, Web-servlet, WebSocket, and Web-Portlet modules.

* Spring’s **WEB** module provides basic **web-oriented integration features** such as multipart file-upload functionality and the initialization of the IOC container using servlet listeners and a web-oriented application context. It also contains the web-related parts of Spring’s remoting support.
* The **Web-Servlet** module **contains Spring’s** model-view-container(**MVC**) **implementation for web apps**. Spring’s MVC framework provides a clean separation between domain model code and web forms, and integrates with all the other features of the Spring Framework.
* The **Web-Portlet** module **provides** the **MVC implementation** to be used in a **portlet environment** and mirrors the functionality of Web-Servlet module.

1. **AOP and Instrumentation :**

* Spring’s **AOP aspect-oriented programming** implementation **allows** us **to define method-interceptors and pointcuts** to cleanly decouple code that implement s functionality that should be separated.
* The **Instrumentation** module provides **class instrumentation support** and **classloader implementations** to be used in certain application servers.
* The **Messaging Application** serves a foundation for **messaging based application**. There are so many annotations in this to map messages with methods.

1. **Test :** the **Test** module provides support for **unit testing and integration testing** with Junit and TestNG. It also provides mock objects that you can use to test your code in isolation(separately).

* **Spring IOC Container :**

**IOC** is also known as DI. It is a process whereby objects define their **dependencies**. Only through **constructor arguments**, argument to a **factory method**, or **properties** that are set on the object instance after it is constructed or returned from a factory method. The container then **injects** those **dependencies** when it creates the **bean**.

This process is fundamentally **inverse** (in traditional programming, the app. code calls liberaries or frameworks but with **IOC**, the framework calls the app. code). hence it is called **Inversion of control**. It is responsible for some work such as **Object creation, holding that object** in memory, and **injecting** the object in another object. It maintains the overall lifecycle of an **object**(from creation to destruction). The control of object is transferred from the application code to container.

for this, we have to provide two things to **IOC container**:

1. **Beans** : the **beans** are java **classes** that the container has to manage.
2. **Config** : (**config files or XML configuration**) it specifies how these beans are related and how their dependencies should be injected.

**Spring container** will use this configurations and will create the objects and will perform the injection. And then our app. code will use these objects.

* **Application context : AC** is a sub-interface of **Bean factory.** It adds easier integration with **Spring’s AOP** features such as **WebApplicationContext** for use in web applications.

this context basically extends the **Bean factory.** It also has some additional properties but as AC is an interface we can not create its **object**. But it is common to create an instance of

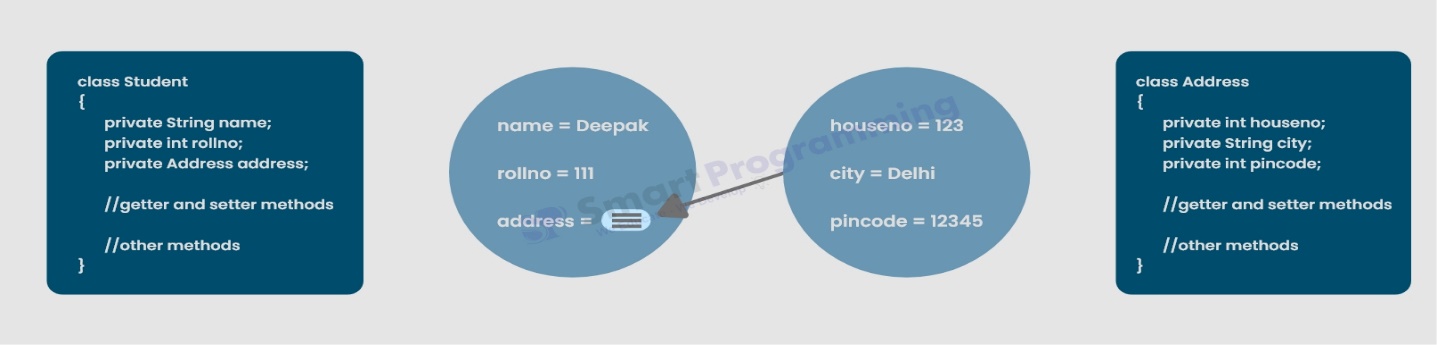
* **ClasspathXMLApplicationContext,**
* **AnnotationConfigApplicationContext,** and
* **FileSystemXMLApplicationContext.**

So that we will be able to get values/object from container.

1. **ClasspathXMLApplicationContext** searches **XML configuration** from java **classpath**.
2. **AnnotationConfigApplicationContext** searches **beans** on which we have used **annotations**. When using annotations we use this context.
3. **FileSystemXMLApplicationContext** searches **configuration** **files** from **file system**. We searching any config file from file system we use this context.

but we mostly use **ClasspathXMLApplicationContext** because we write XML and keep them in classpath.

* **How the DI is perfomed by IOC Container?**



**Injection: inserting/injecting a obj in another object.**

The student class needs the object of Address class. It means we can say that, Student class is totally dependent on Address class. So we will have to perform DI with the help of IOC container.

Steps:

1. The container will create an obj of Address class and will set the values of all the variables automatically.
2. Then it will create the obj of Student as well and will set the values of all the variables automatically.
3. Then it will inject the obj of Address class in Student class.
4. When it will inject all the dependencies at runtime. then we can ask for the obj of Student class from the container for use.
5. All the dependency management will be performed automatically at runtime by IOC container. and the obj of Student class is ready to use.

* **Ways of Injecting Dependencies :**

The DI can be done in **two ways** by IOC container :

1. Using **Setter Injection(**property Injection**)**
2. Using **Constructor Injection**

To set any value IOC will use only these two ways.

1. **Setter injection** : in Setter Injection, we **create a method to set the values in variables.** When IOC container creates an object of the class which has Setter methods then, to set the values in the variables it will call all the Setter methods of that class and will inject the object automatically.
   * + - **When to use Setter Injection?**

Setter injection should primarily only be used **for optional dependencies** that can be assigned reasonable default values within the class. Otherwise, not-null checks must be performed everywhere the code uses the dependency. One **benefit** of Setter Injection is that **setter methods make objects** of that class **amenable** to reconfiguration or re-injection later.

* + - * **How it can be accomplished?**

Setter-based DI can be accomplished **by** the IOC container **calling setter methods on** your **beans after invoking** a **no argument constructor** or **a no-argument static factory method** to instantiate your bean(java class).

When putting values the IOC container automatically calls the Setter methods while creating object of the class.

1. **Constructor Injection :** Constructor-based DI is **accomplished by the container invoking a constructor** with a number of arguments, each representing a dependency.

* **Configuration file :**

The configuration file is an **XML file**. Where we declare **beans and its dependencies**. To give any info about a class we use config file.

Humare pass kitni beans he, un beans ka name kya he, vo kis-kis par depend kr rhi he. Ye sari info IOC container ko batane k liye hum config file ka use karte he.

Start of XML file :

**<beans>** // beans represents number of beans(java classes).//

<bean> --------- </bean> //in bean tag we write java class and its dependend’s.

<bean> -------------- </bean>

<bean> -------------- </bean>

// for multiple classes each bean tag is used for single class purpose.//

<bean> -------------- </bean>

**</beans>**

* **Data Types(Dependencies) :**

**While injecting dependencies** the IOC Container checks type of data as well. Means which type we are going to inject.

**Types of data types** of DI that can be handled by the IOC container :

1. **Primitive data types :** byte, short, char, int, float, double, long, Boolean.
2. **Collection type :** List, Set, Map, and Properties.
3. **Reference type :** other class object(user-defined e.g. Student, Car etc). It is a **non-primitive** data type. Which means the IOC Container will inject the object of a user-defined class into another user-defined class.