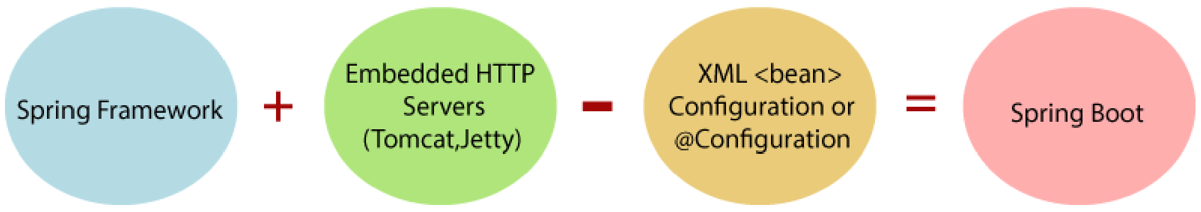
Spring Boot Tutorial

- Spring Boot Tutorial provides basic and advanced concepts of Spring Framework. Our Spring Boot Tutorial is designed for beginners and professionals both.
- Spring Boot is a Spring module that provides the RAD (Rapid Application Development) feature to the Spring framework.
- Our Spring Boot Tutorial includes all topics of Spring Boot such, as features, project, maven project, starter project wizard, Spring Initializr, CLI, applications, annotations, dependency management, properties, starters, Actuator, JPA, JDBC, etc.

What is Spring Boot

- Spring Boot is a project that is built on the top of the Spring Framework.
- It provides an easier and faster way to set up, configure, and run both simple and web-based applications.
- It is a Spring module that provides the **RAD (*Rapid Application Development*)** feature to the Spring Framework. It is used to create a stand-alone Spring-based application that you can just run because it needs minimal Spring configuration.


Spring Framework
+
Embedded HTTP Servers (Tomcat,Jetty)
-
XML <bean> Configuration or @Configuration
=
Spring Boot

- In short, Spring Boot is the combination of **Spring Framework** and **Embedded Servers**
- In Spring Boot, there is no requirement for XML configuration (deployment descriptor).
- It uses convention over configuration software design paradigm that means it decreases the effort of the developer
- We can use Spring **STS IDE** or **Spring Initializr** to develop Spring Boot Java applications.

Why should we use Spring Boot Framework?

We should use Spring Boot Framework because:

- The dependency injection approach is used in Spring Boot.
- It contains powerful database transaction management capabilities.

- It simplifies integration with other Java frameworks like JPA/Hibernate ORM, Struts, etc.
- It reduces the cost and development time of the application.

Along with the Spring Boot Framework, many other Spring sister projects help to build applications addressing modern business needs. There are the following Spring sister projects are as follows:

- **Spring Data:** It simplifies data access from the relational and **NoSQL** databases.
- **Spring Batch:** It provides powerful **batch** processing.
- **Spring Security:** It is a security framework that provides robust **security** to applications.
- **Spring Social:** It supports integration with **social networking** like LinkedIn.
- **Spring Integration:** It is an implementation of Enterprise Integration Patterns. It facilitates integration with other **enterprise applications** using lightweight messaging and declarative adapters.

Advantages of Spring Boot

- It creates **stand-alone** Spring applications that can be started using Java **-jar**

  .
- It tests web applications easily with the help of different **Embedded** HTTP servers such as **Tomcat, Jetty,** etc. We don't need to deploy WAR files.
- It provides opinionated '**starter**' POMs to simplify our Maven configuration.
- It provides **production-ready** features such as **metrics, health checks,** and **externalized configuration**.
- There is no requirement for **XML** configuration.
- It offers a **CLI** tool for developing and testing the Spring Boot application.
- It offers the number of **plug-ins**.
- It also minimizes writing multiple **boilerplate codes** (the code that has to be included in many places with little or no alteration), XML configuration, and annotations.
- It **increases productivity** and reduces development time.

Limitations of Spring Boot

- Spring Boot can use dependencies that are not going to be used in the application.

- These dependencies increase the size of the application.

Goals of Spring Boot

The main goal of Spring Boot is to reduce **development, unit test,** and **integration test** time.

- Provides Opinionated Development approach
- Avoids defining more Annotation Configuration
- Avoids writing lots of import statements
- Avoids XML Configuration.

By providing or avoiding the above points, Spring Boot Framework reduces **Development time, Developer Effort,** and **increases productivity**.

Prerequisite of Spring Boot

To create a Spring Boot application, following are the prerequisites. In this tutorial, we will use **Spring Tool Suite** (STS) IDE.

- Java 1.8
- Maven 3.0+
- Spring Framework 5.0.0.BUILD-SNAPSHOT
- An IDE (Spring Tool Suite) is recommended.

Spring Boot Features

- Web Development
- SpringApplication
- Application events and listeners
- Admin features
- Externalized Configuration
- Properties Files
- YAML Support
- Type-safe Configuration
- Logging
- Security

Web Development

- It is a well-suited Spring module for web application development.
- We can easily create a self-contained HTTP application that uses embedded servers like **Tomcat, Jetty,** or Undertow.
- We can use the **spring-boot-starter-web** module to start and run the application quickly.

SpringApplication

- The SpringApplication is a class that provides a convenient way to bootstrap a Spring application.
- It can be started from the main method. We can call the application just by calling a static run() method.

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

Application Events and Listeners

- Spring Boot uses events to handle the variety of tasks.
- It allows us to create factories file that is used to add listeners.
- We can refer it to using the **ApplicationListener key**.

Always create factories file in META-INF folder like **META-INF/spring.factories**.

Admin Support

- Spring Boot provides the facility to enable admin-related features for the application.
- It is used to access and manage applications remotely.
- We can enable it in the Spring Boot application by using **spring.application.admin.enabled** property.

Externalized Configuration

- Spring Boot allows us to externalize our configuration so that we can work with the same application in different environments.
- The application uses YAML files to externalize configuration.

Properties Files

- Spring Boot provides a rich set of **Application Properties**.
- So, we can use that in the properties file of our project.

- The properties file is used to set properties like **server-port =8080 or 8081** and many others. It helps to organize application properties.

YAML Support

- It provides a convenient way of specifying the hierarchical configuration.
- It is a superset of JSON. The SpringApplication class automatically supports YAML.
- It is an alternative of properties file.

Type-safe Configuration

- The strong type-safe configuration is provided to govern and validate the configuration of the application.
- Application configuration is always a crucial task which should be type-safe.
- We can also use annotation provided by this library.

Logging

- Spring Boot uses Common logging for all internal logging.
- Logging dependencies are managed by default.
- We should not change logging dependencies if no customization is needed.

Security

- Spring Boot applications are spring bases web applications.
- So, it is secure by default with basic authentication on all HTTP endpoints.
- A rich set of Endpoints is available to develop a secure Spring Boot application.

Spring	**Spring Boot**
Spring Framework is a widely used Java EE framework for building applications .	**Spring Boot Framework** is widely used to develop **REST APIs**.
It aims to simplify Java EE development that makes developers more productive.	It aims to shorten the code length and provide the easiest way to develop **Web Applications**.
The primary feature of the Spring Framework is **dependency injection**.	The primary feature of Spring Boot is **Autoconfiguration**. It automatically configures the classes based on the requirement.

It helps to make things simpler by allowing us to develop **loosely coupled** applications.	It helps to create a **stand-alone** application with less configuration.
The developer writes a lot of code (**boilerplate code**) to do the minimal task.	It **reduces** boilerplate code.
To test the Spring project, we need to set up the sever explicitly.	Spring Boot offers **embedded server** such as **Jetty** and **Tomcat**, etc.
It does not provide support for an in-memory database .	It offers several plugins for working with an embedded and **in-memory** database such as **H2**.
Developers manually define dependencies for the Spring project in **pom.xml**.	Spring Boot comes with the concept of **starter** in pom.xml file that internally takes care of downloading the dependencies **JARs** based on Spring Boot Requirement.

Spring Boot	**Spring MVC**
Spring Boot is a module of Spring for packaging the Spring-based application with sensible defaults .	**Spring MVC** is a model view controller-based web framework under the Spring framework .
It provides default configurations to build **Spring-powered** framework .	It provides **ready to use** features for building a web application.
There is no need to build configuration manually.	It requires build configuration manually.
There is **no requirement** for a deployment descriptor.	A Deployment descriptor is **required**.
It avoids boilerplate code and wraps dependencies together in a single unit.	It specifies each dependency separately.
It **reduces** development time and increases productivity.	It takes **more** time to achieve the same.

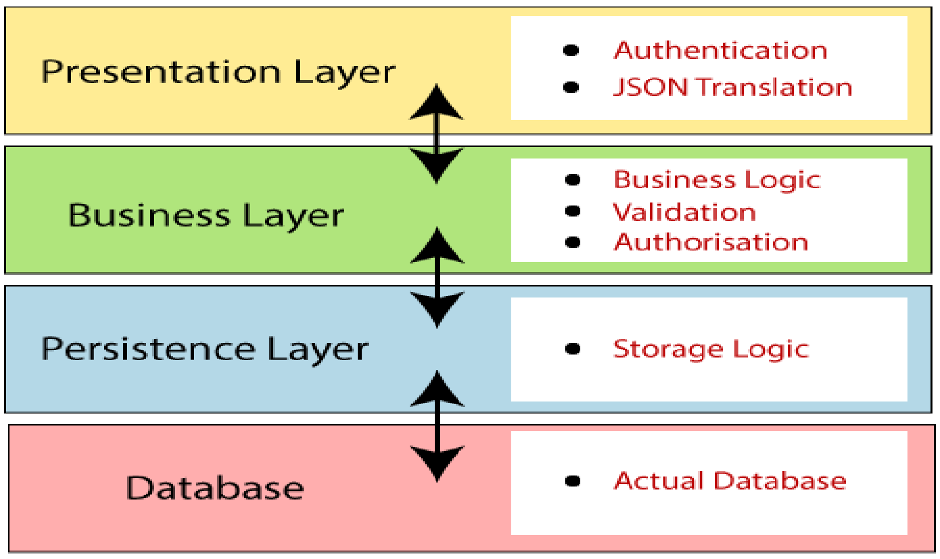
Spring Boot Architecture

- Spring Boot is a module of the Spring Framework.
- It is used to create stand-alone, production-grade Spring Based Applications with minimum efforts.
- It is developed on top of the core Spring Framework.

Spring Boot follows a layered architecture in which each layer communicates with the layer directly below or above (hierarchical structure) it.

Before understanding the **Spring Boot Architecture**, we must know the different layers and classes present in it. There are **four** layers in Spring Boot are as follows:

- **Presentation Layer**
- **Business Layer**
- **Persistence Layer**
- **Database Layer**



Presentation Layer:

- The presentation layer handles the HTTP requests, translates the JSON parameter to object, and authenticates the request and transfer it to the business layer. In short, it consists of **views** i.e., frontend part.

Business Layer:

- The business layer handles all the **business logic**.
- It consists of service classes and uses services provided by data access layers.

- It also performs **authorization** and **validation**.

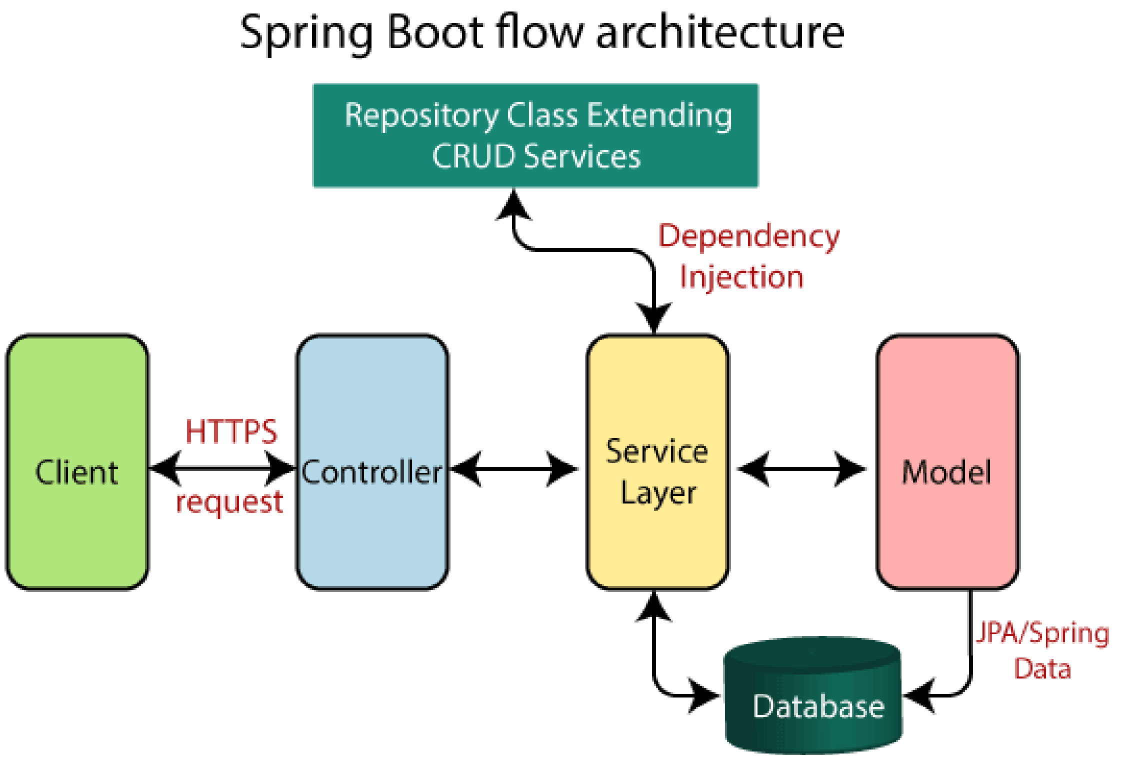
Persistence Layer:

- The persistence layer contains all the **storage logic** and translates business objects from and to database rows.

Database Layer:

- In the database layer, **CRUD** (create, retrieve, update, delete) operations are performed.

Spring Boot Flow Architecture



- Now we have validator classes, view classes, and utility classes.
- Spring Boot uses all the modules of Spring-like Spring MVC, Spring Data, etc. The architecture of Spring Boot is the same as the architecture of Spring MVC, except one thing: there is no need for **DAO** and **DAOImpl** classes in Spring boot.
- Creates a data access layer and performs CRUD operation.
- The client makes the HTTP requests (PUT or GET).
- The request goes to the controller, and the controller maps that request and handles it. After that, it calls the service logic if required.
- In the service layer, all the business logic performs. It performs the logic on the data that is mapped to JPA with model classes.

- A JSP page is returned to the user if no error occurred.

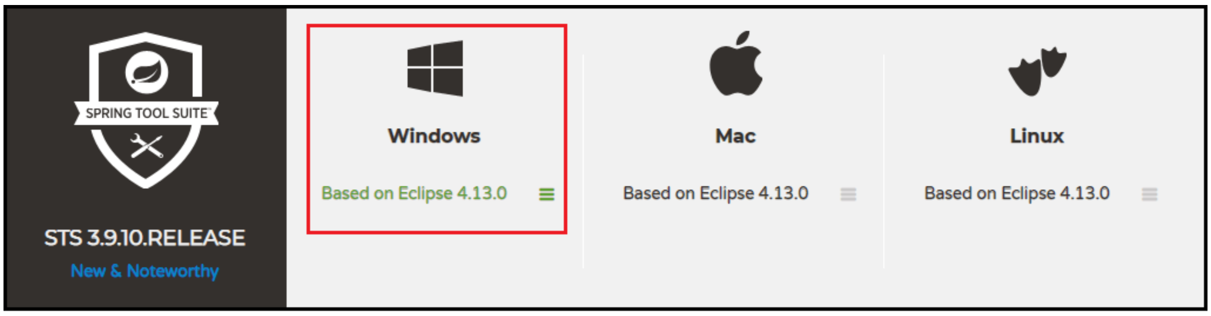
Download and Install STS IDE

Spring Tool Suite (STS) IDE

- Spring Tool Suite is an IDE to develop Spring applications. It is an Eclipse-based development environment.
- It provides a ready-to-use environment to implement, run, deploy, and debug the application.
- It validates our application and provides quick fixes for the applications.

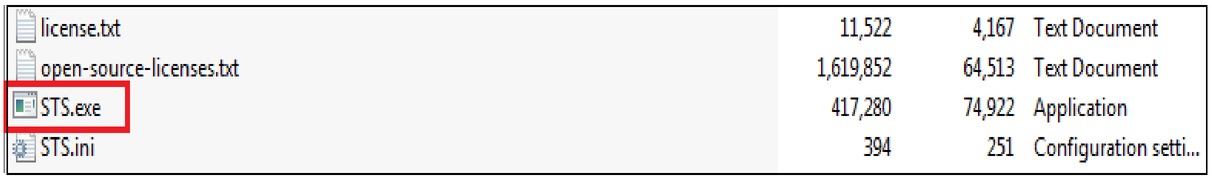
Installing STS

Step 1: Download Spring Tool Suite from https://spring.io/tools3/sts/all. Click on the platform which you are using. In this tutorial, we are using the Windows platform.



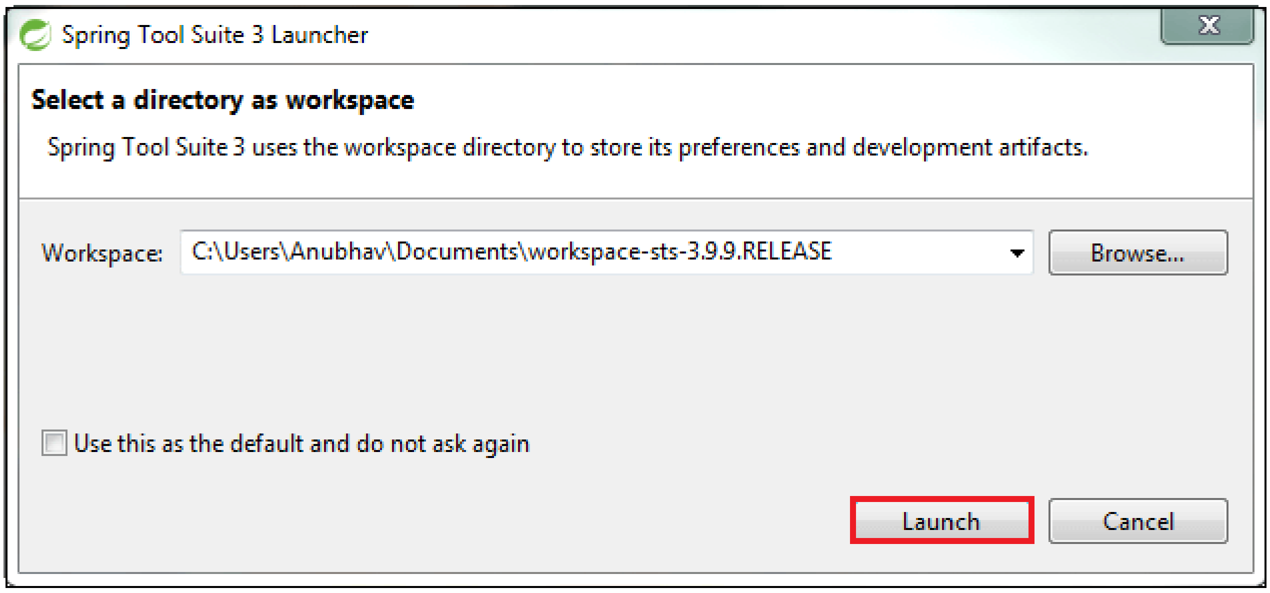
Step 2: Extract the **zip** file and install the STS.

sts-bundle -> sts-3.9.9.RELEASE -> Double-click on the **STS.exe**.



license.txt	11,522	4,167	Text Document
open-source-licenses.txt	1,619,852	64,513	Text Document
STS.exe	417,280	74,922	Application
STS.ini	394	251	Configuration setti...

Step 3: Spring Tool Suite 3 Launcher dialog box appears on the screen. Click on the **Launch** button. You can change the Workspace if you want.

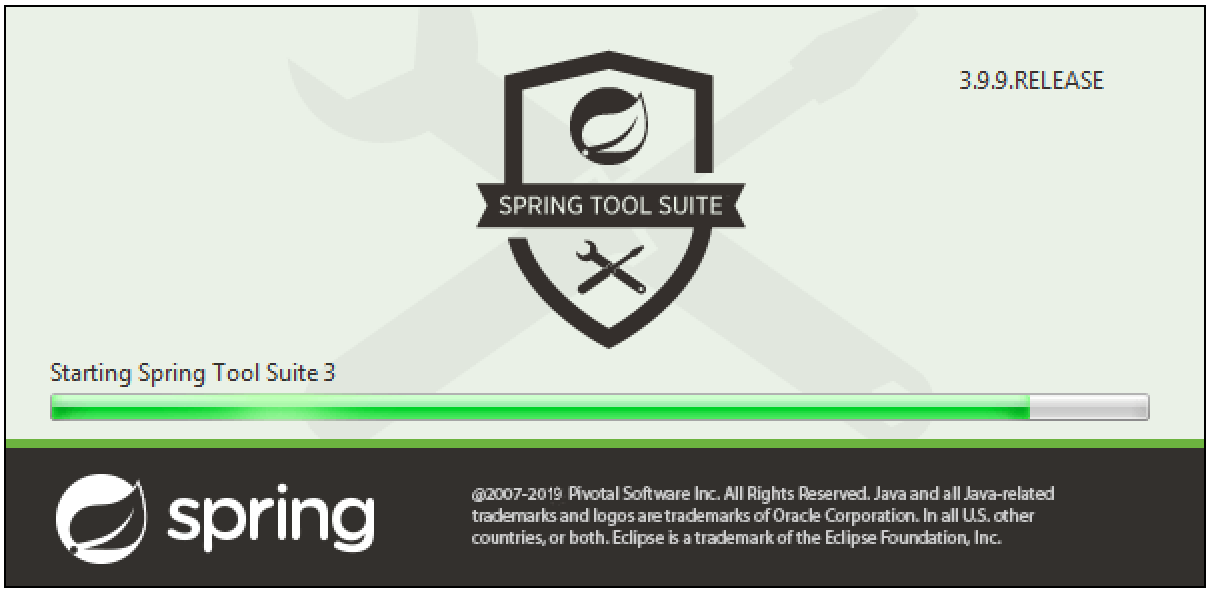

Spring Tool Suite 3 Launcher

Select a directory as workspace

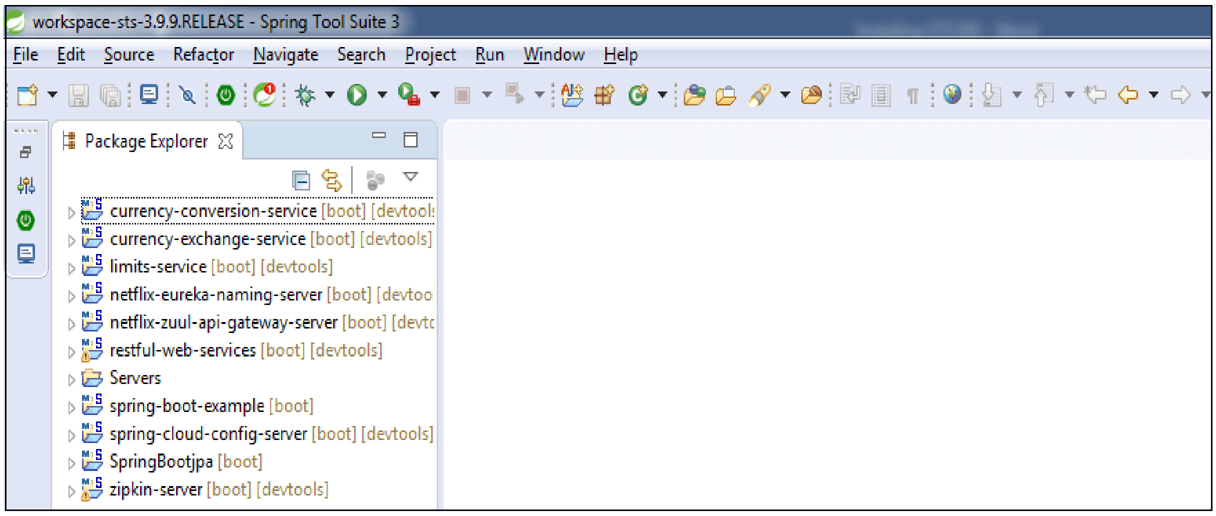
Spring Tool Suite 3 uses the workspace directory to store its preferences and development artifacts.

Workspace: C:\Users\Anubhav\Documents\workspace-sts-3.9.9.RELEASE

Step 4: It starts launching the STS.


3.9.9.RELEASE
SPRING TOOL SUITE
Starting Spring Tool Suite 3
spring
@2007-2019 Pivotal Software Inc. All Rights Reserved. Java and all Java-related trademarks and logos are trademarks of Oracle Corporation. In all U.S. other countries, or both. Eclipse is a trademark of the Eclipse Foundation, Inc.

The STS user interface looks like the following:


workspace-sts-3.9.9.RELEASE - Spring Tool Suite 3
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer

currency-conversion-service [boot] [devtool
currency-exchange-service [boot] [devtools]
limits-service [boot] [devtools]
netflix-eureka-naming-server [boot] [devtoo
netflix-zuul-api-gateway-server [boot] [devt
restful-web-services [boot] [devtools]
Servers
spring-boot-example [boot]
spring-cloud-config-server [boot] [devtools]
SpringBootjpa [boot]
zipkin-server [boot] [devtools]

Creating a Spring Boot Project

Following are the steps to create a simple Spring Boot Project.

Step 1: Open the Spring initializr https://start.spring.io.

Step 2: Provide the **Group** and **Artifact** name. We have provided Group name **com.javatpoint** and Artifact **spring-boot-example**.

Step 3: Now click on the **Generate** button.

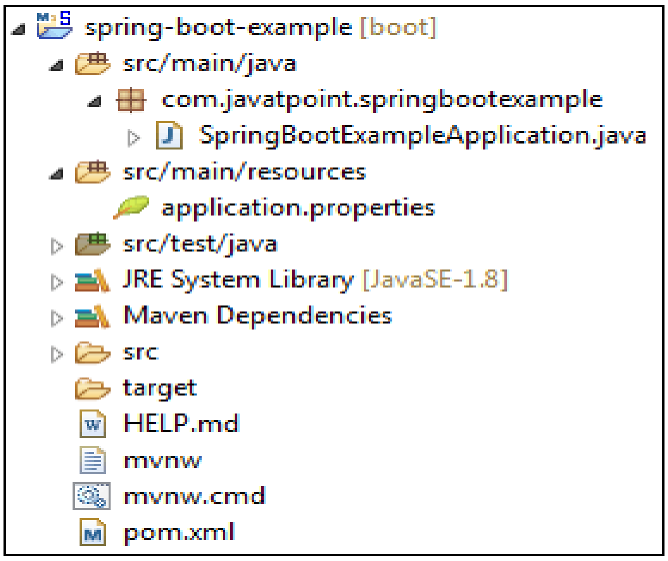
When we click on the Generate button, it starts packing the project in a **.rar** file and downloads the project.

Step 4: Extract the **RAR** file.

Step 5: Import the folder.

File -> Import -> Existing Maven Project -> Next -> Browse -> Select the project -> Finish

It takes some time to import the project. When the project imports successfully, we can see the project directory in the **Package Explorer**. The following image shows the project directory:



```
spring-boot-example [boot]
  src/main/java
    com.javatpoint.springbootexample
      SpringBootExampleApplication.java
  src/main/resources
    application.properties
  src/test/java
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  HELP.md
  mvnw
  mvnw.cmd
  pom.xml
```

SpringBootExampleApplication.java

```java
package com.javatpoint.springbootexample;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
@SpringBootApplication
public class SpringBootExampleApplication
{
public static void main(String[] args)
{
SpringApplication.run(SpringBootExampleApplication.class, args);
}
}
```

pom.xml

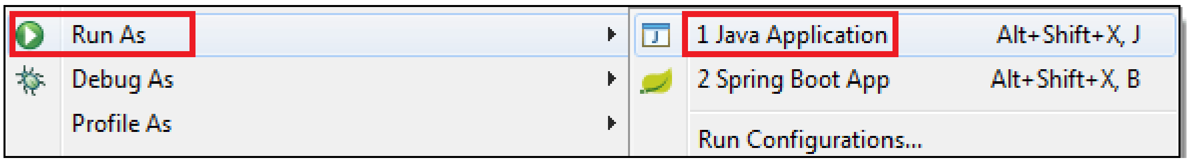
```xml
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 https://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
<parent>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-parent</artifactId>
<version>2.2.2.BUILD-SNAPSHOT</version>
```

```
<relativePath/> <!-- lookup parent from repository -->
</parent>
<groupId>com.javatpoint</groupId>
<artifactId>spring-boot-example</artifactId>
<version>0.0.1-SNAPSHOT</version>
<name>spring-boot-example</name>
<description>Demo project for Spring Boot</description>
<properties>
<java.version>1.8</java.version>
</properties>
<dependencies>
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter</artifactId>
</dependency>
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-test</artifactId>
<scope>test</scope>
<exclusions>
<exclusion>
<groupId>org.junit.vintage</groupId>
<artifactId>junit-vintage-engine</artifactId>
</exclusion>
</exclusions>
</dependency>
</dependencies>
<build>
<plugins>
<plugin>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-maven-plugin</artifactId>
</plugin>
</plugins>
</build>
<repositories>
<repository>
```

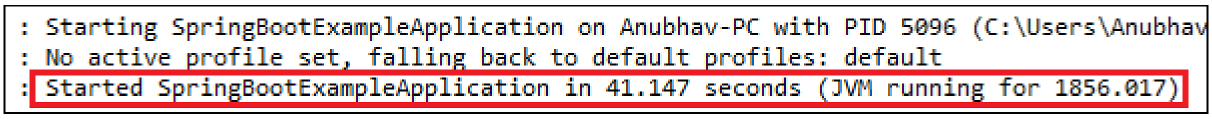
```xml
<id>spring-milestones</id>
<name>Spring Milestones</name>
<url>https://repo.spring.io/milestone</url>
</repository>
<repository>
<id>spring-snapshots</id>
<name>Spring Snapshots</name>
<url>https://repo.spring.io/snapshot</url>
<snapshots>
<enabled>true</enabled>
</snapshots>
</repository>
</repositories>
<pluginRepositories>
<pluginRepository>
<id>spring-milestones</id>
<name>Spring Milestones</name>
<url>https://repo.spring.io/milestone</url>
</pluginRepository>
<pluginRepository>
<id>spring-snapshots</id>
<name>Spring Snapshots</name>
<url>https://repo.spring.io/snapshot</url>
<snapshots>
<enabled>true</enabled>
</snapshots>
</pluginRepository>
</pluginRepositories>
</project>
```

Step 6: Run the **SpringBootExampleApplication.java** file.

Right-click on the file -> Run As -> Java Applications



The following image shows the application runs successfully.



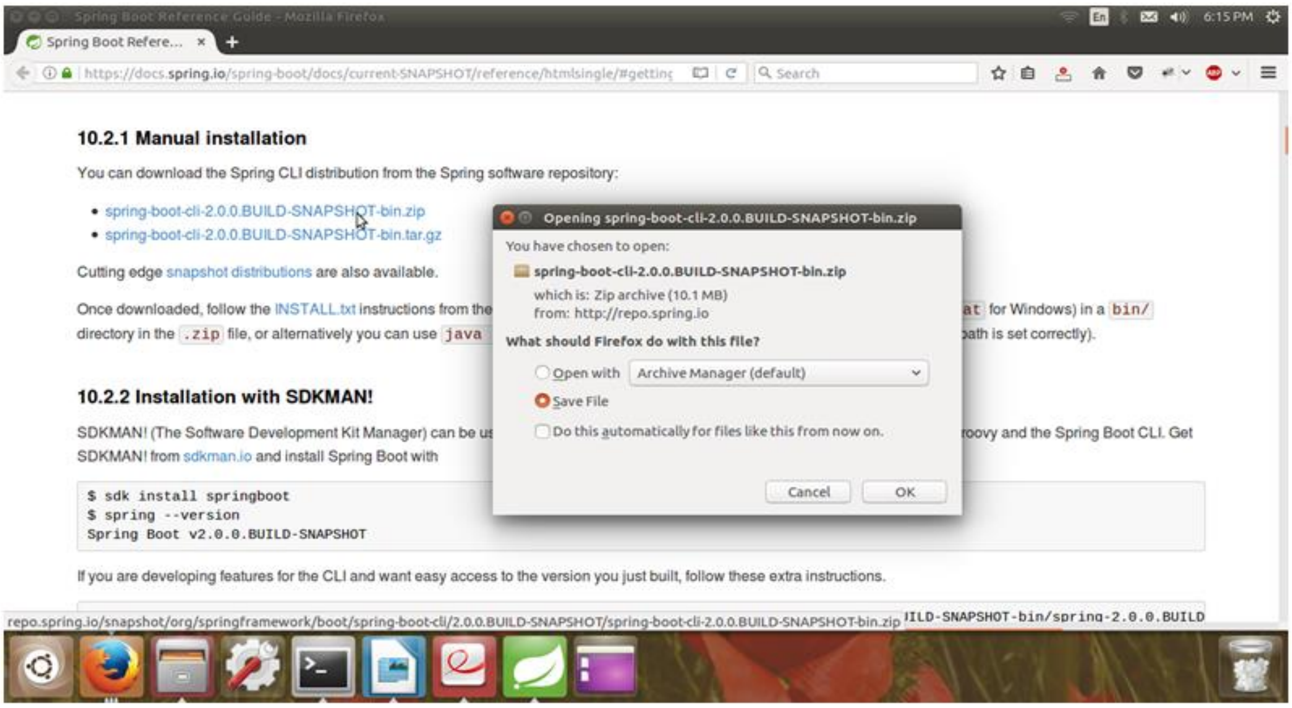
```
: Starting SpringBootExampleApplication on Anubhav-PC with PID 5096 (C:\Users\Anubhav
: No active profile set, falling back to default profiles: default
: Started SpringBootExampleApplication in 41.147 seconds (JVM running for 1856.017)
```

Download Project

Spring Boot CLI

It is a tool which you can download from the official site of Spring Framework. Here, we are explaining steps.

Download the CLI tool from official site as we are doing here.



Spring Boot Reference Guide - Mozilla Firefox
Spring Boot Refere...
https://docs.spring.io/spring-boot/docs/current-SNAPSHOT/reference/htmlsingle/#getting
Search
6:15 PM

10.2.1 Manual installation

You can download the Spring CLI distribution from the Spring software repository:

- spring-boot-cli-2.0.0.BUILD-SNAPSHOT-bin.zip
- spring-boot-cli-2.0.0.BUILD-SNAPSHOT-bin.tar.gz

Cutting edge snapshot distributions are also available.

Once downloaded, follow the INSTALL.txt instructions from the … at for Windows) in a bin/ directory in the .zip file, or alternatively you can use java … path is set correctly).

10.2.2 Installation with SDKMAN!

SDKMAN! (The Software Development Kit Manager) can be us … roovy and the Spring Boot CLI. Get SDKMAN! from sdkman.io and install Spring Boot with

```
$ sdk install springboot
$ spring --version
Spring Boot v2.0.0.BUILD-SNAPSHOT
```

If you are developing features for the CLI and want easy access to the version you just built, follow these extra instructions.

repo.spring.io/snapshot/org/springframework/boot/spring-boot-cli/2.0.0.BUILD-SNAPSHOT/spring-boot-cli-2.0.0.BUILD-SNAPSHOT-bin.zip ILD-SNAPSHOT-bin/spring-2.0.0.BUILD

Opening spring-boot-cli-2.0.0.BUILD-SNAPSHOT-bin.zip

You have chosen to open:

spring-boot-cli-2.0.0.BUILD-SNAPSHOT-bin.zip

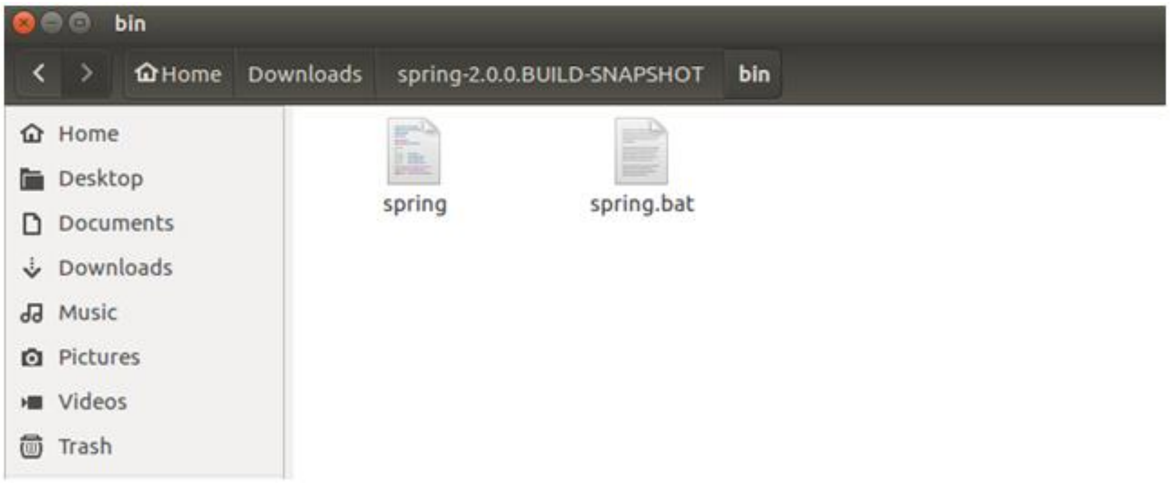
which is: Zip archive (10.1 MB)
from: http://repo.spring.io

What should Firefox do with this file?

Open with: Archive Manager (default) [✓ Save File]

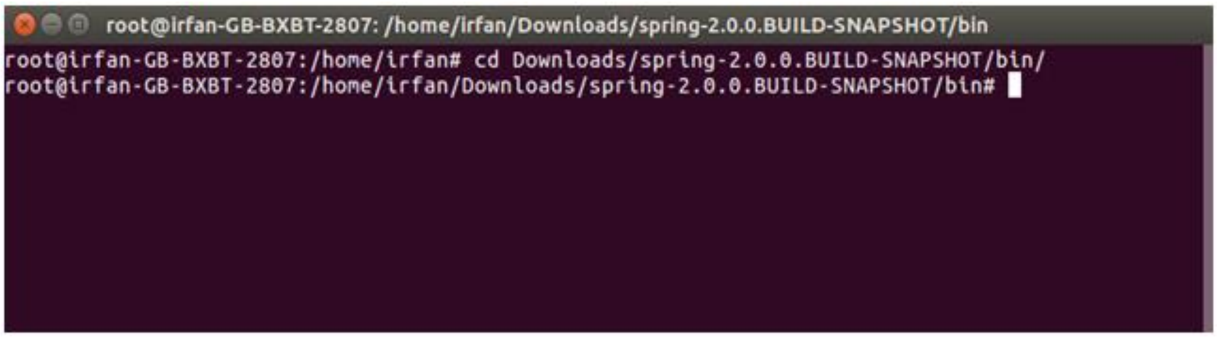
Do this automatically for files like this from now on.

After downloading, extract the zip file. It contains a bin folder, in which spring setup is stored. We can use it to execute Spring Boot application.



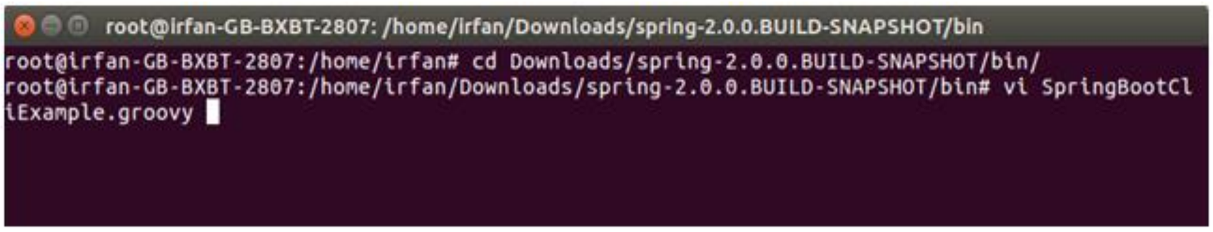
CLI executes groovy files. So, first, we need to create a groovy file for Spring Boot application.

Open terminal and cd into the bin location of cli folder.



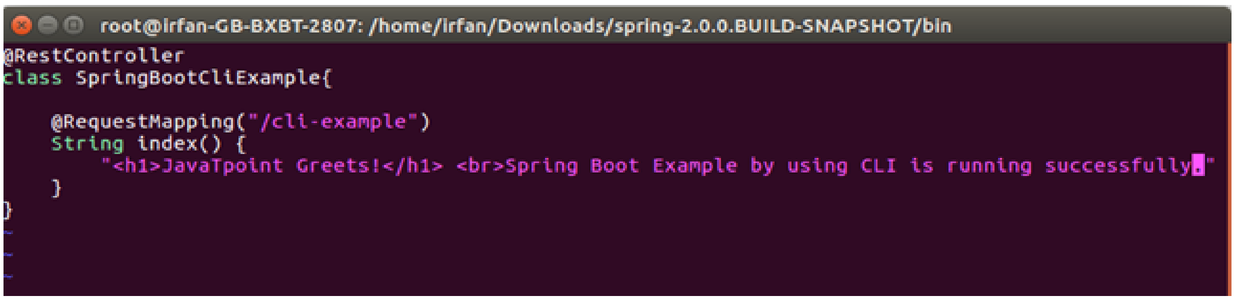
```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
root@irfan-GB-BXBT-2807:/home/irfan# cd Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin/
root@irfan-GB-BXBT-2807:/home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin#
```

Create a groovy file.



```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
root@irfan-GB-BXBT-2807:/home/irfan# cd Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin/
root@irfan-GB-BXBT-2807:/home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin# vi SpringBootCl
iExample.groovy
```

Create a controller in the groovy file.



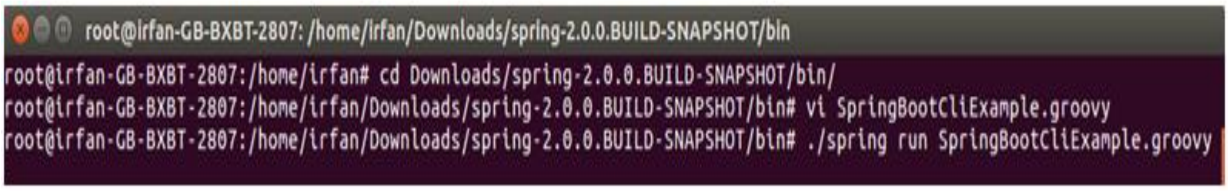
```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
@RestController
class SpringBootCliExample{

    @RequestMapping("/cli-example")
    String index() {
        "<h1>JavaTpoint Greets!</h1> <br>Spring Boot Example by using CLI is running successfully."
    }
}
~
~
~
```

Execute this file

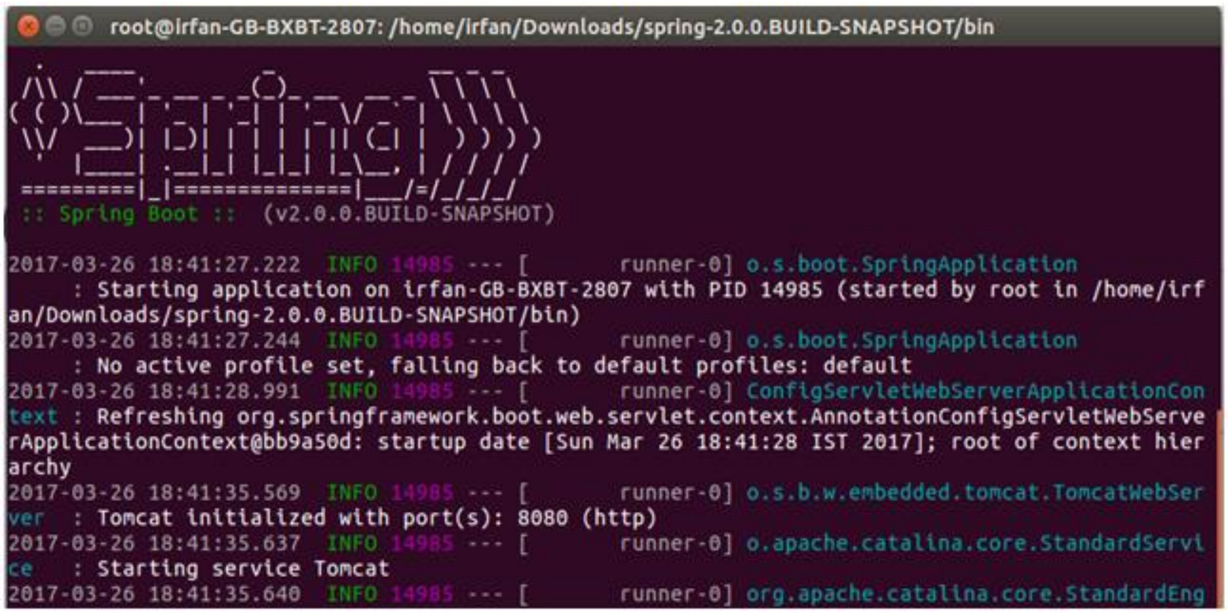
By using the following command.

1. ./spring run SpringBootCliExample.groovy



```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
root@irfan-GB-BXBT-2807:/home/irfan# cd Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin/
root@irfan-GB-BXBT-2807:/home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin# vi SpringBootCliExample.groovy
root@irfan-GB-BXBT-2807:/home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin# ./spring run SpringBootCliExample.groovy
```

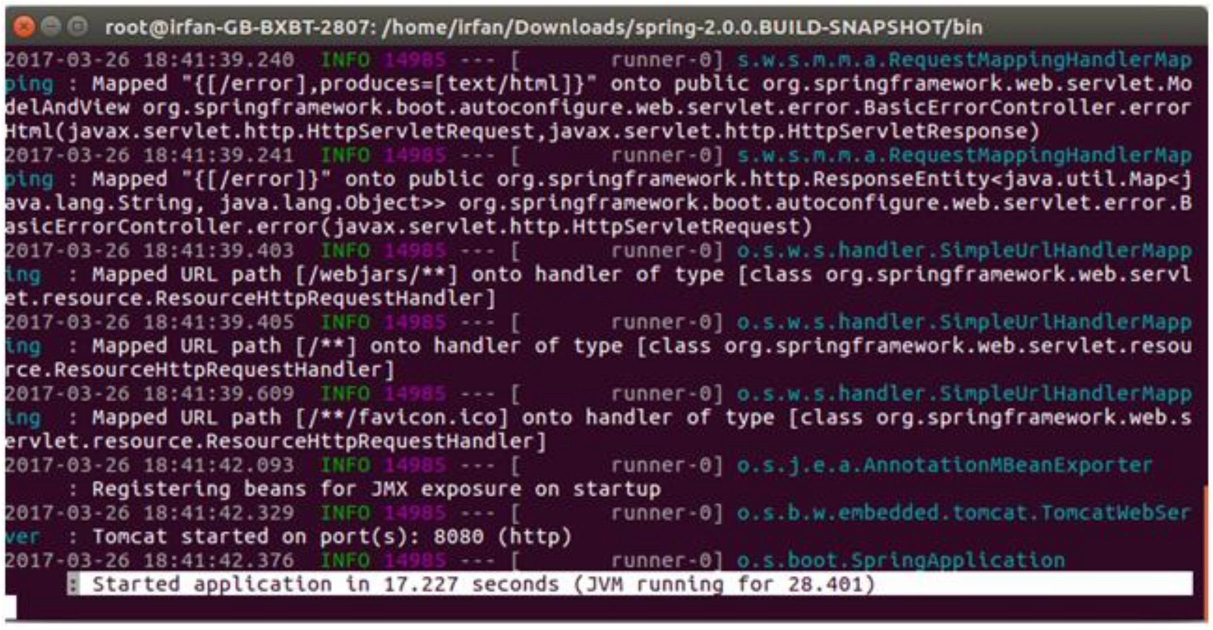
After executing the above command, it starts the execution and produces the following output.



```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::  (v2.0.0.BUILD-SNAPSHOT)

2017-03-26 18:41:27.222  INFO 14985 --- [       runner-0] o.s.boot.SpringApplication
     : Starting application on irfan-GB-BXBT-2807 with PID 14985 (started by root in /home/irf
an/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin)
2017-03-26 18:41:27.244  INFO 14985 --- [       runner-0] o.s.boot.SpringApplication
     : No active profile set, falling back to default profiles: default
2017-03-26 18:41:28.991  INFO 14985 --- [       runner-0] ConfigServletWebServerApplicationCon
text : Refreshing org.springframework.boot.web.servlet.context.AnnotationConfigServletWebServe
rApplicationContext@bb9a50d: startup date [Sun Mar 26 18:41:28 IST 2017]; root of context hier
archy
2017-03-26 18:41:35.569  INFO 14985 --- [       runner-0] o.s.b.w.embedded.tomcat.TomcatWebSer
ver  : Tomcat initialized with port(s): 8080 (http)
2017-03-26 18:41:35.637  INFO 14985 --- [       runner-0] o.apache.catalina.core.StandardServi
ce   : Starting service Tomcat
2017-03-26 18:41:35.640  INFO 14985 --- [       runner-0] org.apache.catalina.core.StandardEng
```

And after lots of lines. It shows the current status of application as follow.

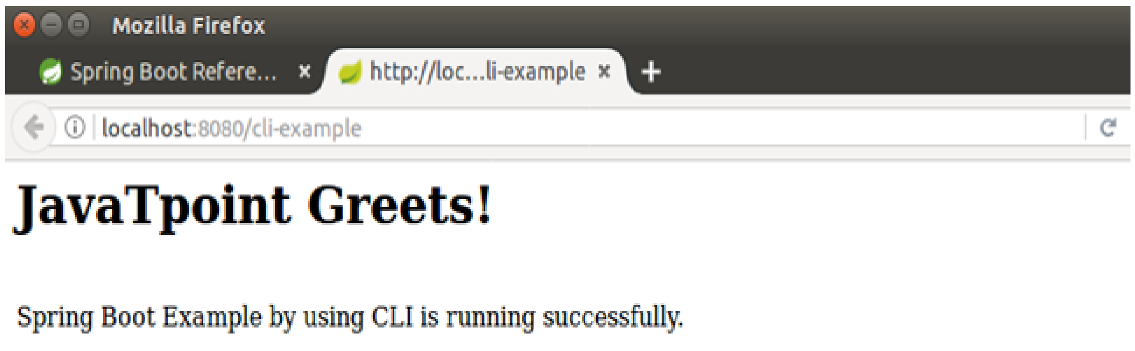


```
root@irfan-GB-BXBT-2807: /home/irfan/Downloads/spring-2.0.0.BUILD-SNAPSHOT/bin
2017-03-26 18:41:39.240  INFO 14985 --- [       runner-0] s.w.s.m.m.a.RequestMappingHandlerMap
ping : Mapped "{[/error],produces=[text/html]}" onto public org.springframework.web.servlet.Mo
delAndView org.springframework.boot.autoconfigure.web.servlet.error.BasicErrorController.error
Html(javax.servlet.http.HttpServletRequest,javax.servlet.http.HttpServletResponse)
2017-03-26 18:41:39.241  INFO 14985 --- [       runner-0] s.w.s.m.m.a.RequestMappingHandlerMap
ping : Mapped "{[/error]}" onto public org.springframework.http.ResponseEntity<java.util.Map<j
ava.lang.String, java.lang.Object>> org.springframework.boot.autoconfigure.web.servlet.error.B
asicErrorController.error(javax.servlet.http.HttpServletRequest)
2017-03-26 18:41:39.403  INFO 14985 --- [       runner-0] o.s.w.s.handler.SimpleUrlHandlerMapp
ing  : Mapped URL path [/webjars/**] onto handler of type [class org.springframework.web.servl
et.resource.ResourceHttpRequestHandler]
2017-03-26 18:41:39.405  INFO 14985 --- [       runner-0] o.s.w.s.handler.SimpleUrlHandlerMapp
ing  : Mapped URL path [/**] onto handler of type [class org.springframework.web.servlet.resou
rce.ResourceHttpRequestHandler]
2017-03-26 18:41:39.609  INFO 14985 --- [       runner-0] o.s.w.s.handler.SimpleUrlHandlerMapp
ing  : Mapped URL path [/**/favicon.ico] onto handler of type [class org.springframework.web.s
ervlet.resource.ResourceHttpRequestHandler]
2017-03-26 18:41:42.093  INFO 14985 --- [       runner-0] o.s.j.e.a.AnnotationMBeanExporter
     : Registering beans for JMX exposure on startup
2017-03-26 18:41:42.329  INFO 14985 --- [       runner-0] o.s.b.w.embedded.tomcat.TomcatWebSer
ver  : Tomcat started on port(s): 8080 (http)
2017-03-26 18:41:42.376  INFO 14985 --- [       runner-0] o.s.boot.SpringApplication
     : Started application in 17.227 seconds (JVM running for 28.401)
```

This project is running on the port 8080. So, we can invoke it on any browser by using the following url.

1. localhost:8080:/cli-example

It will produce the following output.



JavaTpoint Greets!

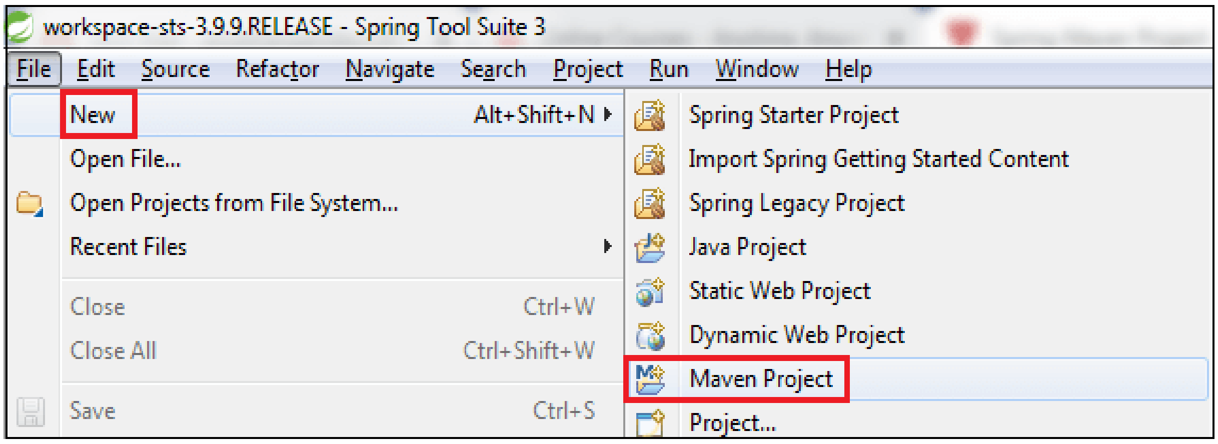
Spring Boot Example by using CLI is running successfully.

Creating a Spring Boot Project Using STS

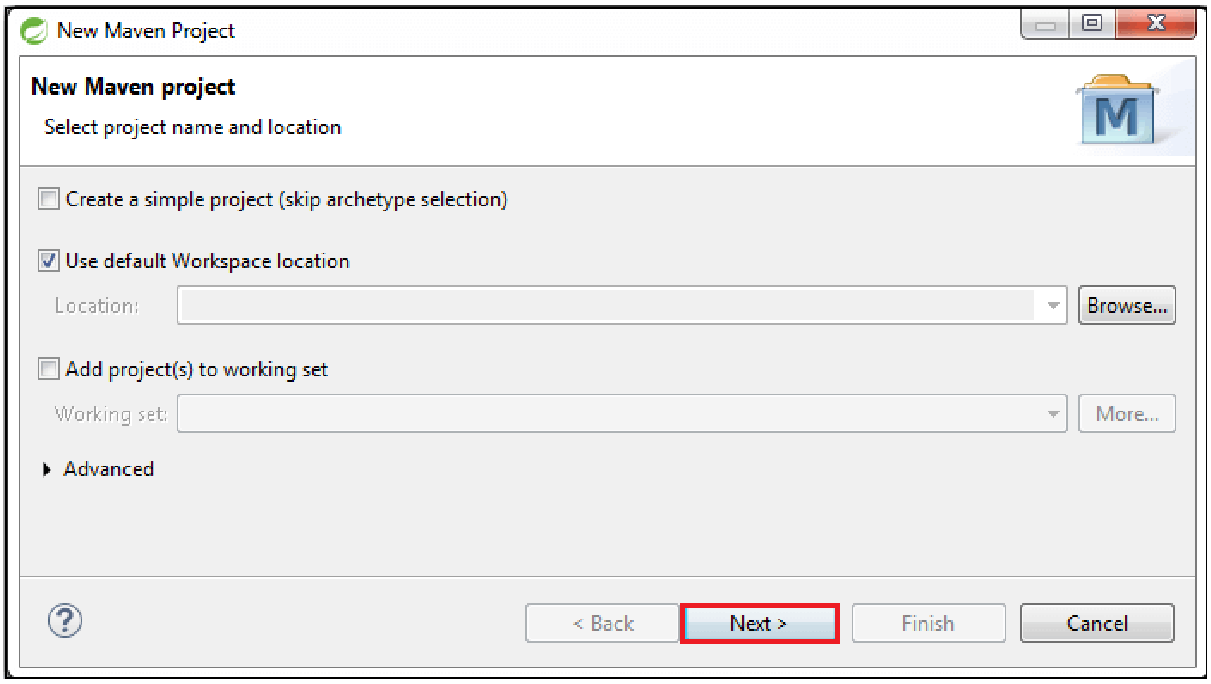
We can also use Spring Tool Suite to create a Spring project. In this section, we will create a **Maven Project** using **STS**.

Step 1: Open the Spring Tool Suite.

Step 2: Click on the File menu -> New -> Maven Project

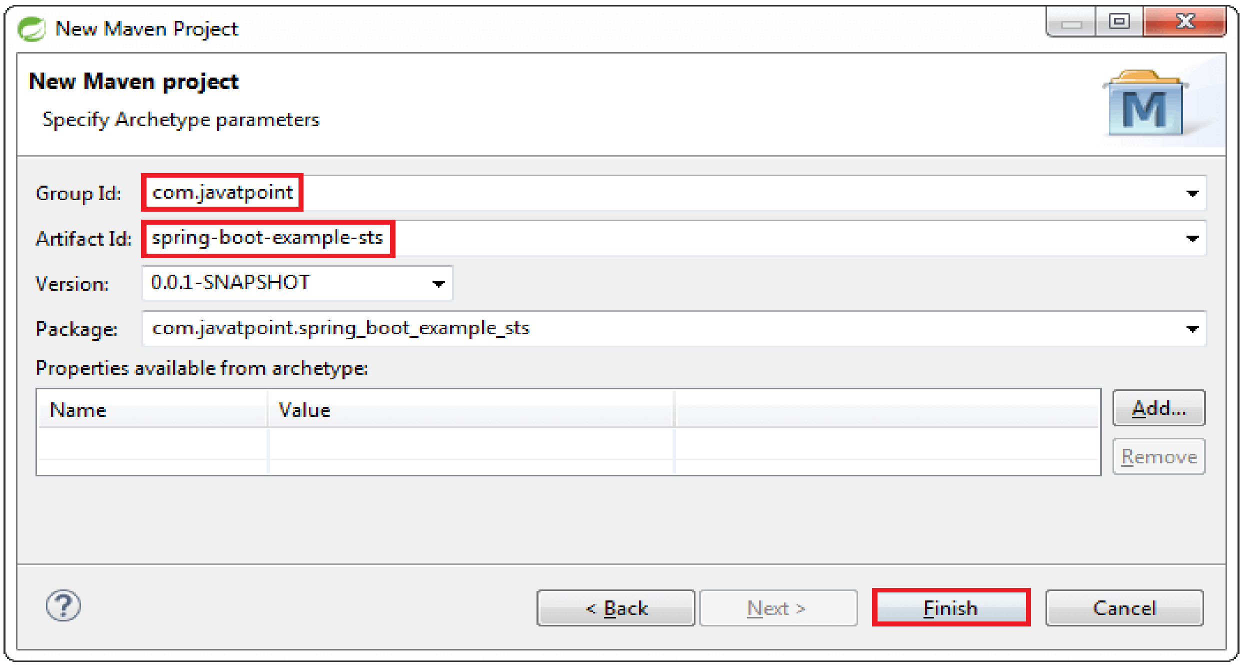


It shows the New Maven Project wizard. Click on the **Next** button.


New Maven Project
New Maven project
Select project name and location
Create a simple project (skip archetype selection)
Use default Workspace location
Location:
Browse...
Add project(s) to working set
Working set:
More...
Advanced
< Back
Next >
Finish
Cancel

Step 3: Select the **maven-archetype-quickstart** and click on the **Next** button.

Step 4: Provide the **Group Id** and **Artifact Id**. We have provided Group Id **com.javatpoint** and Artifact Id **spring-boot-example-sts**. Now click on the **Finish** button.



New Maven project

Specify Archetype parameters

Group Id: com.javatpoint

Artifact Id: spring-boot-example-sts

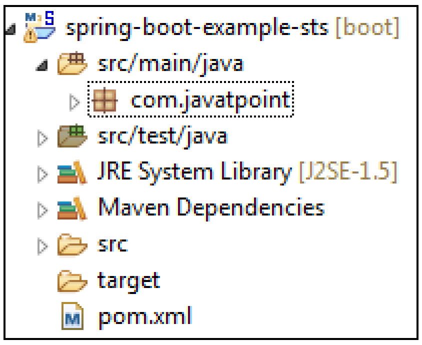
Version: 0.0.1-SNAPSHOT

Package: com.javatpoint.spring_boot_example_sts

Properties available from archetype:

Name	Value

When we click on the Finish button, it creates the project directory, as shown in the following image.



```
spring-boot-example-sts [boot]
  src/main/java
    com.javatpoint
  src/test/java
  JRE System Library [J2SE-1.5]
  Maven Dependencies
  src
  target
  pom.xml
```

Step 5: Open the **App.java** file. We found the following code that is by default.

App.java

```
package com.javatpoint;
public class App
{
public static void main( String[] args )
{
System.out.println( "Hello World!" );
}
}
```

The Maven project has a **pom.xml** file which contains the following default configuration.

pom.xml

```xml
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
<groupId>com.javatpoint</groupId>
<artifactId>spring-boot-example-sts</artifactId>
<version>0.0.1-SNAPSHOT</version>
<packaging>jar</packaging>
<name>spring-boot-example-sts</name>
<url>http://maven.apache.org</url>
<properties>
<project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
</properties>
<dependencies>
<dependency>
<groupId>junit</groupId>
<artifactId>junit</artifactId>
<version>3.8.1</version>
<scope>test</scope>
</dependency>
</dependencies>
</project>
```

Step 6: Add **Java version** inside the **<properties>** tag.

```xml
<java.version>1.8</java.version>
```

Step 7: In order to make a Spring Boot Project, we need to configure it. So, we are adding **spring boot starter parent** dependency in **pom.xml** file. Parent is used to declare that our project is a child to this parent project.

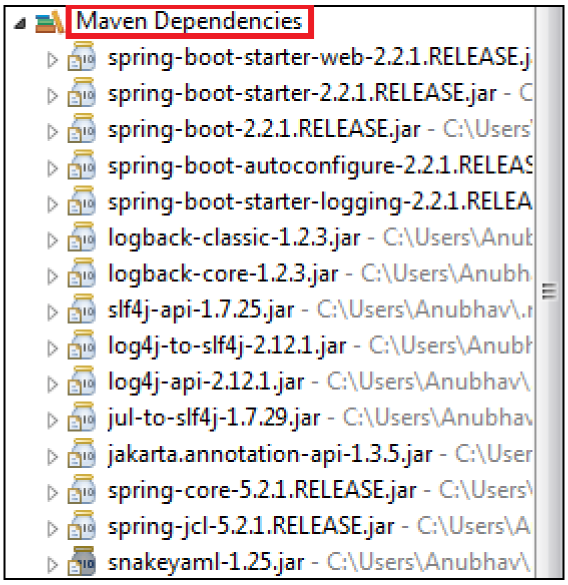
```xml
<dependency>
 <groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-parent</artifactId>
<version>2.2.1.RELEASE</version>
<type>pom</type>
```

```
</dependency>
```

Step 8: Add the **spring-boot-starter-web** dependency in **pom.xml** file.

```
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-web</artifactId>
<version>2.2.1.RELEASE</version>
</dependency>
```

Note: When we add the dependencies in the pom file, it downloads the related jar file. We can see the downloaded jar files in the Maven Dependencies folder of the project directory.



```
Maven Dependencies
  spring-boot-starter-web-2.2.1.RELEASE.j
  spring-boot-starter-2.2.1.RELEASE.jar - C
  spring-boot-2.2.1.RELEASE.jar - C:\Users
  spring-boot-autoconfigure-2.2.1.RELEAS
  spring-boot-starter-logging-2.2.1.RELEA
  logback-classic-1.2.3.jar - C:\Users\Anub
  logback-core-1.2.3.jar - C:\Users\Anubh
  slf4j-api-1.7.25.jar - C:\Users\Anubhav\.
  log4j-to-slf4j-2.12.1.jar - C:\Users\Anubh
  log4j-api-2.12.1.jar - C:\Users\Anubhav\
  jul-to-slf4j-1.7.29.jar - C:\Users\Anubhav
  jakarta.annotation-api-1.3.5.jar - C:\User
  spring-core-5.2.1.RELEASE.jar - C:\Users\
  spring-jcl-5.2.1.RELEASE.jar - C:\Users\A
  snakeyaml-1.25.jar - C:\Users\Anubhav\
```

After adding all the dependencies, the pom.xml file looks like the following:

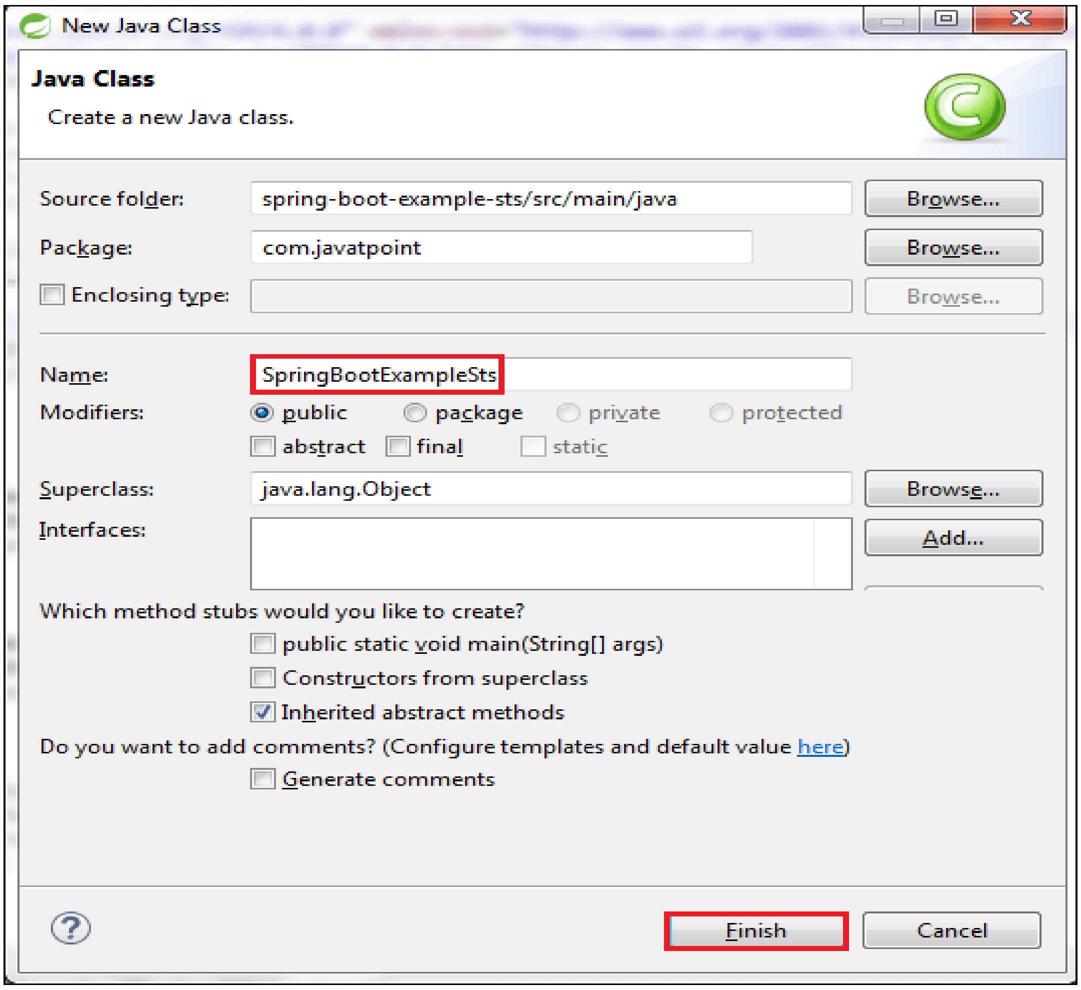
pom.xml

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
<groupId>com.javatpoint</groupId>
<artifactId>spring-boot-example-sts</artifactId>
<version>0.0.1-SNAPSHOT</version>
<packaging>jar</packaging>
<name>spring-boot-example-sts</name>
```

```
<url>http://maven.apache.org</url>
<properties>
<project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
<java.version>1.8</java.version>
</properties>
<dependencies>
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-parent</artifactId>
<version>2.2.1.RELEASE</version>
<type>pom</type>
</dependency>
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-web</artifactId>
<version>2.2.1.RELEASE</version>
</dependency>
<dependency>
<groupId>junit</groupId>
<artifactId>junit</artifactId>
<version>3.8.1</version>
<scope>test</scope>
</dependency>
</dependencies>
</project>
```

Step 9: Create a class with the name **SpringBootExampleSts** in the package **com.javatpoint**.

Right-click on the package name -> New -> Class -> provide the class name -> Finish


New Java Class

Java Class

Create a new Java class.

Source folder: spring-boot-example-sts/src/main/java

Package: com.javatpoint

Enclosing type:

Name: SpringBootExampleSts

Modifiers: [✓ public] package private protected

abstract final static

Superclass: java.lang.Object

Interfaces:

Which method stubs would you like to create?

public static void main(String[] args)

Constructors from superclass

[✓ Inherited abstract methods]

Do you want to add comments? (Configure templates and default value here)

Generate comments

Step 10: After creating the class file, call the static method **run()** of the SpringApplication class. In the following code, we are calling the run() method and passing the class name as an argument.

```
1. SpringApplication.run(SpringBootExampleSts.class, args);
```

Step 11: Annotate the class by adding an annotation **@SpringBootApplication**.

@SpringBootApplication

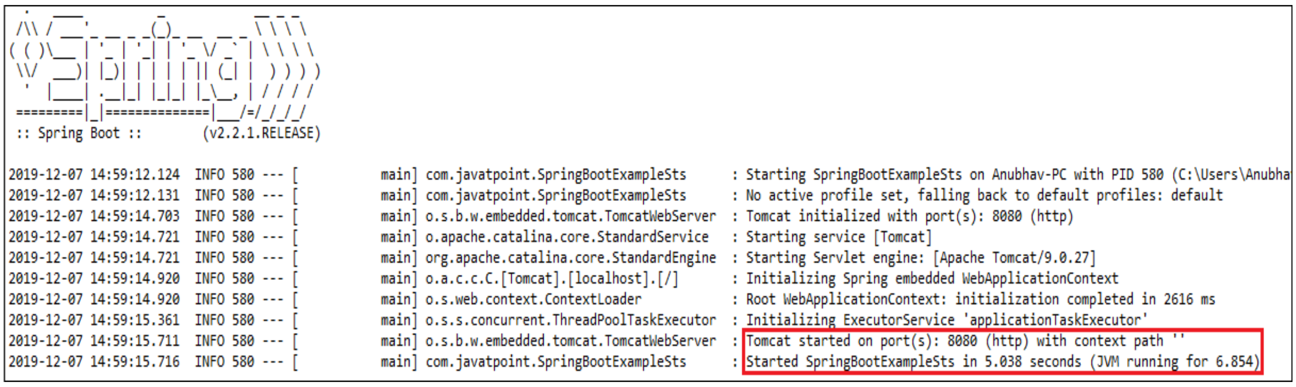
A single @SpringBootApplication annotation is used to enable the following annotations:

- **@EnableAutoConfiguration:** It enables the Spring Boot auto-configuration mechanism.
- **@ComponentScan:** It scans the package where the application is located.
- **@Configuration:** It allows us to register extra beans in the context or import additional configuration classes.

SpringBootApplicationSts.java

```java
package com.javatpoint;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
@SpringBootApplication
public class SpringBootExampleSts
{
public static void main(String[] args)
{
SpringApplication.run(SpringBootExampleSts.class, args);
}
}
```

Step: Run the file **SpringBootExampleSts.java**, as Java Application. It displays the following in the console.



```
  .   ____          _            __ _ _
 /\\ / ___'_ __ _ _(_)_ __  __ _ \ \ \ \
( ( )\___ | '_ | '_| | '_ \/ _` | \ \ \ \
 \\/  ___)| |_)| | | | | || (_| |  ) ) ) )
  '  |____| .__|_| |_|_| |_\__, | / / / /
 =========|_|==============|___/=/_/_/_/
 :: Spring Boot ::        (v2.2.1.RELEASE)

2019-12-07 14:59:12.124  INFO 580 --- [           main] com.javatpoint.SpringBootExampleSts      : Starting SpringBootExampleSts on Anubhav-PC with PID 580 (C:\Users\Anubha
2019-12-07 14:59:12.131  INFO 580 --- [           main] com.javatpoint.SpringBootExampleSts      : No active profile set, falling back to default profiles: default
2019-12-07 14:59:14.703  INFO 580 --- [           main] o.s.b.w.embedded.tomcat.TomcatWebServer  : Tomcat initialized with port(s): 8080 (http)
2019-12-07 14:59:14.721  INFO 580 --- [           main] o.apache.catalina.core.StandardService   : Starting service [Tomcat]
2019-12-07 14:59:14.721  INFO 580 --- [           main] org.apache.catalina.core.StandardEngine  : Starting Servlet engine: [Apache Tomcat/9.0.27]
2019-12-07 14:59:14.920  INFO 580 --- [           main] o.a.c.c.C.[Tomcat].[localhost].[/]       : Initializing Spring embedded WebApplicationContext
2019-12-07 14:59:14.920  INFO 580 --- [           main] o.s.web.context.ContextLoader            : Root WebApplicationContext: initialization completed in 2616 ms
2019-12-07 14:59:15.361  INFO 580 --- [           main] o.s.s.concurrent.ThreadPoolTaskExecutor  : Initializing ExecutorService 'applicationTaskExecutor'
2019-12-07 14:59:15.711  INFO 580 --- [           main] o.s.b.w.embedded.tomcat.TomcatWebServer  : Tomcat started on port(s): 8080 (http) with context path ''
2019-12-07 14:59:15.716  INFO 580 --- [           main] com.javatpoint.SpringBootExampleSts      : Started SpringBootExampleSts in 5.038 seconds (JVM running for 6.854)
```

The line **Started SpringBootExampleSts in 5.038 seconds (JVM running for 6.854)** in the console shows that the application is up and running.

Spring Boot Annotations

- Spring Boot Annotations is a form of metadata that provides data about a program.
- In other words, annotations are used to provide **supplemental** information about a program.
- It is not a part of the application that we develop.
- It does not have a direct effect on the operation of the code they annotate.
- It does not change the action of the compiled program.

In this section, we are going to discuss some important **Spring Boot Annotation** that we will use later in this tutorial.

Core Spring Framework Annotations

@Required:

- It applies to the **bean** setter method.
- It indicates that the annotated bean must be populated at configuration time with the required property, else it throws an exception **BeanInitilizationException**.

Example

```
public class Machine
{
private Integer cost;
@Required
public void setCost(Integer cost)
{
this.cost = cost;
}
public Integer getCost()
{
return cost;
}
}
```

@Autowired:

- Spring provides annotation-based auto-wiring by providing @Autowired annotation.
- It is used to autowire spring bean on setter methods, instance variable, and constructor.
- When we use @Autowired annotation, the spring container auto-wires the bean by matching data-type.

Example

```
@Component
public class Customer
{
private Person person;
@Autowired
public Customer(Person person)
{
this.person=person;
}
}
```

@Configuration:

- It is a class-level annotation. The class annotated with @Configuration used by Spring Containers as a source of bean definitions.

Example

```
@Configuration
public class Vehicle
{
@BeanVehicle engine()
{
return new Vehicle();
}
}
```

@ComponentScan:

- It is used when we want to scan a package for beans.
- It is used with the annotation @Configuration.
- We can also specify the base packages to scan for Spring Components

.

Example

```
@ComponentScan(basePackages = "com.javatpoint")
@Configuration
public class ScanComponent
{
// ...
}
```

@Bean:

- It is a method-level annotation. It is an alternative of XML <bean> tag.
- It tells the method to produce a bean to be managed by Spring Container

.

Example

```
@Bean
public BeanExample beanExample()
{
return new BeanExample ();
}
```

Spring Framework Stereotype Annotations

@Component:

- It is a class-level annotation.
- It is used to mark a Java class as a bean.
- A Java class annotated with **@Component** is found during the classpath.
- The Spring Framework pick it up and configure it in the application context as a **Spring Bean**

.

Example

```
@Component
public class Student
{
.......
}
```

@Controller:

- The @Controller is a class-level annotation.
- It is a specialization of **@Component**.
- It marks a class as a web request handler.
- It is often used to serve web pages.

- By default, it returns a string that indicates which route to redirect. It is mostly used with **@RequestMapping** annotation

.

Example

```
@Controller
@RequestMapping("books")
public class BooksController
{
@RequestMapping(value = "/{name}", method = RequestMethod.GET)
public Employee getBooksByName()
{
return booksTemplate;
}
}
```

@Service:

- It is also used at class level.
- It tells the Spring that class contains the **business logic**.

Example

```
package com.javatpoint;
@Service
public class TestService
{
public void service1()
{
//business code
}
}
```

@Repository:

- It is a class-level annotation.
- The repository is a **DAOs** (Data Access Object) that access the database directly.
- The repository does all the operations related to the database.

```
package com.javatpoint;
```

```
@Repository
public class TestRepository
{
public void delete()
{
//persistence code
}
}
```

Spring Boot Annotations

@EnableAutoConfiguration:

- It auto-configures the bean that is present in the classpath and configures it to run the methods.
- The use of this annotation is reduced in Spring Boot 1.2.0 release because developers provided an alternative of the annotation, i.e. **@SpringBootApplication**.

@SpringBootApplication:

- It is a combination of three annotations **@EnableAutoConfiguration, @ComponentScan,** and **@Configuration**.

Spring MVC and REST Annotations

@RequestMapping:

- It is used to map the **web requests**.
- It has many optional elements like **consumes, header, method, name, params, path, produces**, and **value**.
- We use it with the class as well as the method

.

Example

```
@Controller
public class BooksController
{
```

```
@RequestMapping("/computer-science/books")
public String getAllBooks(Model model)
{
//application code
return "bookList";
}
```

@GetMapping:

- It maps the **HTTP GET** requests on the specific handler method.
- It is used to create a web service endpoint that **fetches**
- It is used instead of using: **@RequestMapping(method = RequestMethod.GET)**

@PostMapping:

- It maps the **HTTP POST** requests on the specific handler method.
- It is used to create a web service endpoint that **creates** It is used instead of using: **@RequestMapping(method = RequestMethod.POST)**

@PutMapping:

- It maps the **HTTP PUT** requests on the specific handler method.
- It is used to create a web service endpoint that **creates** or **updates** It is used instead of using: **@RequestMapping(method = RequestMethod.PUT)**

@DeleteMapping:

- It maps the **HTTP DELETE** requests on the specific handler method.
- It is used to create a web service endpoint that **deletes** a resource.
- It is used instead of using: **@RequestMapping(method = RequestMethod.DELETE)**

@PatchMapping:

- It maps the **HTTP PATCH** requests on the specific handler method.
- It is used instead of using: **@RequestMapping(method = RequestMethod.PATCH)**

@RequestBody:

- It is used to **bind** HTTP request with an object in a method parameter.
- Internally it uses **HTTP MessageConverters** to convert the body of the request.

- When we annotate a method parameter with **@RequestBody,** the Spring framework binds the incoming HTTP request body to that parameter.

@ResponseBody:

- It binds the method return value to the response body.
- It tells the Spring Boot Framework to serialize a return an object into JSON and XML format

@PathVariable:

- It is used to extract the values from the URI.
- It is most suitable for the RESTful web service, where the URL contains a path variable.
- We can define multiple @PathVariable in a method.

@RequestParam:

- It is used to extract the query parameters form the URL.
- It is also known as a **query parameter**.
- It is most suitable for web applications.
- It can specify default values if the query parameter is not present in the URL.

@RequestHeader:

- It is used to get the details about the HTTP request headers.
- We use this annotation as a **method parameter**.
- The optional elements of the annotation are **name, required, value, defaultValue.**
- For each detail in the header, we should specify separate annotations. We can use it multiple time in a method

@RestController:

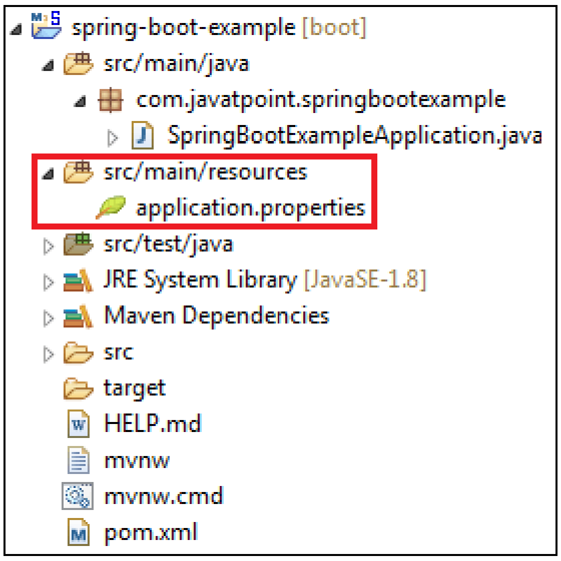
- It can be considered as a combination of **@Controller** and **@ResponseBody** annotations**.**
- The @RestController annotation is itself annotated with the @ResponseBody annotation.
- It eliminates the need for annotating each method with @ResponseBody.

@RequestAttribute:

- It binds a method parameter to request attribute.
- It provides convenient access to the request attributes from a controller method.
- With the help of @RequestAttribute annotation, we can access objects that are populated on the server-side.

Spring Boot Application Properties

- Spring Boot Framework comes with a built-in mechanism for application configuration using a file called **application.properties**.
- It is located inside the **src/main/resources** folder, as shown in the following figure.



```
spring-boot-example [boot]
  src/main/java
    com.javatpoint.springbootexample
      SpringBootExampleApplication.java
  src/main/resources
    application.properties
  src/test/java
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  HELP.md
  mvnw
  mvnw.cmd
  pom.xml
```

- Spring Boot provides various properties that can be configured in the **application.properties** file.
- The properties have default values.
- We can set a property(s) for the Spring Boot application. Spring Boot also allows us to define our own property if required.

The application.properties file allows us to run an application in a **different environment.** In short, we can use the application.properties file to:

- Configure the Spring Boot framework
- define our application custom configuration properties

Example of application.properties

```
1. #configuring application name
2. spring.application.name = demoApplication
3. #configuring port
4. server.port = 8081
```

Spring Boot Starters

Name	**Description**
spring-boot-starter-thymeleaf	It is used to build MVC web applications using Thymeleaf views.
spring-boot-starter-data-couchbase	It is used for the Couchbase document-oriented database and Spring Data Couchbase.
spring-boot-starter-artemis	It is used for JMS messaging using Apache Artemis.
spring-boot-starter-web-services	It is used for Spring Web Services.
spring-boot-starter-mail	It is used to support Java Mail and Spring Framework's email sending.
spring-boot-starter-data-redis	It is used for Redis key-value data store with Spring Data Redis and the Jedis client.
spring-boot-starter-web	It is used for building the web application, including RESTful applications using Spring MVC. It uses Tomcat as the default embedded container.
spring-boot-starter-data-gemfire	It is used to GemFire distributed data store and Spring Data GemFire.
spring-boot-starter-activemq	It is used in JMS messaging using Apache ActiveMQ.

spring-boot-starter-data-elasticsearch	It is used in Elasticsearch search and analytics engine and Spring Data Elasticsearch.
spring-boot-starter-integration	It is used for Spring Integration.
spring-boot-starter-test	It is used to test Spring Boot applications with libraries, including JUnit, Hamcrest, and Mockito.
spring-boot-starter-jdbc	It is used for JDBC with the Tomcat JDBC connection pool.
spring-boot-starter-mobile	It is used for building web applications using Spring Mobile.
spring-boot-starter-validation	It is used for Java Bean Validation with Hibernate Validator.
spring-boot-starter-hateoas	It is used to build a hypermedia-based RESTful web application with Spring MVC and Spring HATEOAS.
spring-boot-starter-jersey	It is used to build RESTful web applications using JAX-RS and Jersey. An alternative to spring-boot-starter-web.
spring-boot-starter-data-neo4j	It is used for the Neo4j graph database and Spring Data Neo4j.
spring-boot-starter-data-ldap	It is used for Spring Data LDAP.
spring-boot-starter-websocket	It is used for building the WebSocket applications. It uses Spring Framework's WebSocket support.
spring-boot-starter-aop	It is used for aspect-oriented programming with Spring AOP and AspectJ.
spring-boot-starter-amqp	It is used for Spring AMQP and Rabbit MQ.
spring-boot-starter-data-cassandra	It is used for Cassandra distributed database and Spring Data Cassandra.
spring-boot-starter-social-facebook	It is used for Spring Social Facebook.
spring-boot-starter-jta-atomikos	It is used for JTA transactions using Atomikos.

spring-boot-starter-security	It is used for Spring Security.
spring-boot-starter-mustache	It is used for building MVC web applications using Mustache views.
spring-boot-starter-data-jpa	It is used for Spring Data JPA with Hibernate.
spring-boot-starter	It is used for core starter, including auto-configuration support, logging, and YAML.
spring-boot-starter-groovy-templates	It is used for building MVC web applications using Groovy Template views.
spring-boot-starter-freemarker	It is used for building MVC web applications using FreeMarker views.
spring-boot-starter-batch	It is used for Spring Batch.
spring-boot-starter-social-linkedin	It is used for Spring Social LinkedIn.
spring-boot-starter-cache	It is used for Spring Framework's caching support.
spring-boot-starter-data-solr	It is used for the Apache Solr search platform with Spring Data Solr.
spring-boot-starter-data-mongodb	It is used for MongoDB document-oriented database and Spring Data MongoDB.
spring-boot-starter-jooq	It is used for jOOQ to access SQL databases. An alternative to spring-boot-starter-data-jpa or spring-boot-starter-jdbc.
spring-boot-starter-jta-narayana	It is used for Spring Boot Narayana JTA Starter.
spring-boot-starter-cloud-connectors	It is used for Spring Cloud Connectors that simplifies connecting to services in cloud platforms like Cloud Foundry and Heroku.
spring-boot-starter-jta-bitronix	It is used for JTA transactions using Bitronix.
spring-boot-starter-social-twitter	It is used for Spring Social Twitter.

spring-boot-starter-data-rest	It is used for exposing Spring Data repositories over REST using Spring Data REST.

Spring Boot Production Starters

Name	Description
spring-boot-starter-actuator	It is used for Spring Boot's Actuator that provides production-ready features to help you monitor and manage your application.
spring-boot-starter-remote-shell	It is used for the CRaSH remote shell to monitor and manage your application over SSH. Deprecated since 1.5.

Spring Boot Technical Starters

Name	Description
spring-boot-starter-undertow	It is used for Undertow as the embedded servlet container. An alternative to spring-boot-starter-tomcat.
spring-boot-starter-jetty	It is used for Jetty as the embedded servlet container. An alternative to spring-boot-starter-tomcat.
spring-boot-starter-logging	It is used for logging using Logback. Default logging starter.
spring-boot-starter-tomcat	It is used for Tomcat as the embedded servlet container. Default servlet container starter used by spring-boot-starter-web.
spring-boot-starter-log4j2	It is used for Log4j2 for logging. An alternative to spring-boot-starter-logging.

Spring Boot Hello World Example

In the section, we will create a **Maven** project for Hello Word Example. We need the following tools and technologies to develop the same.

- Spring Boot 2.2.2.RELEASE
- JavaSE 1.8
- Maven 3.3.9

- STS IDE

Step 1: Open Spring Initializr https://start.spring.io/

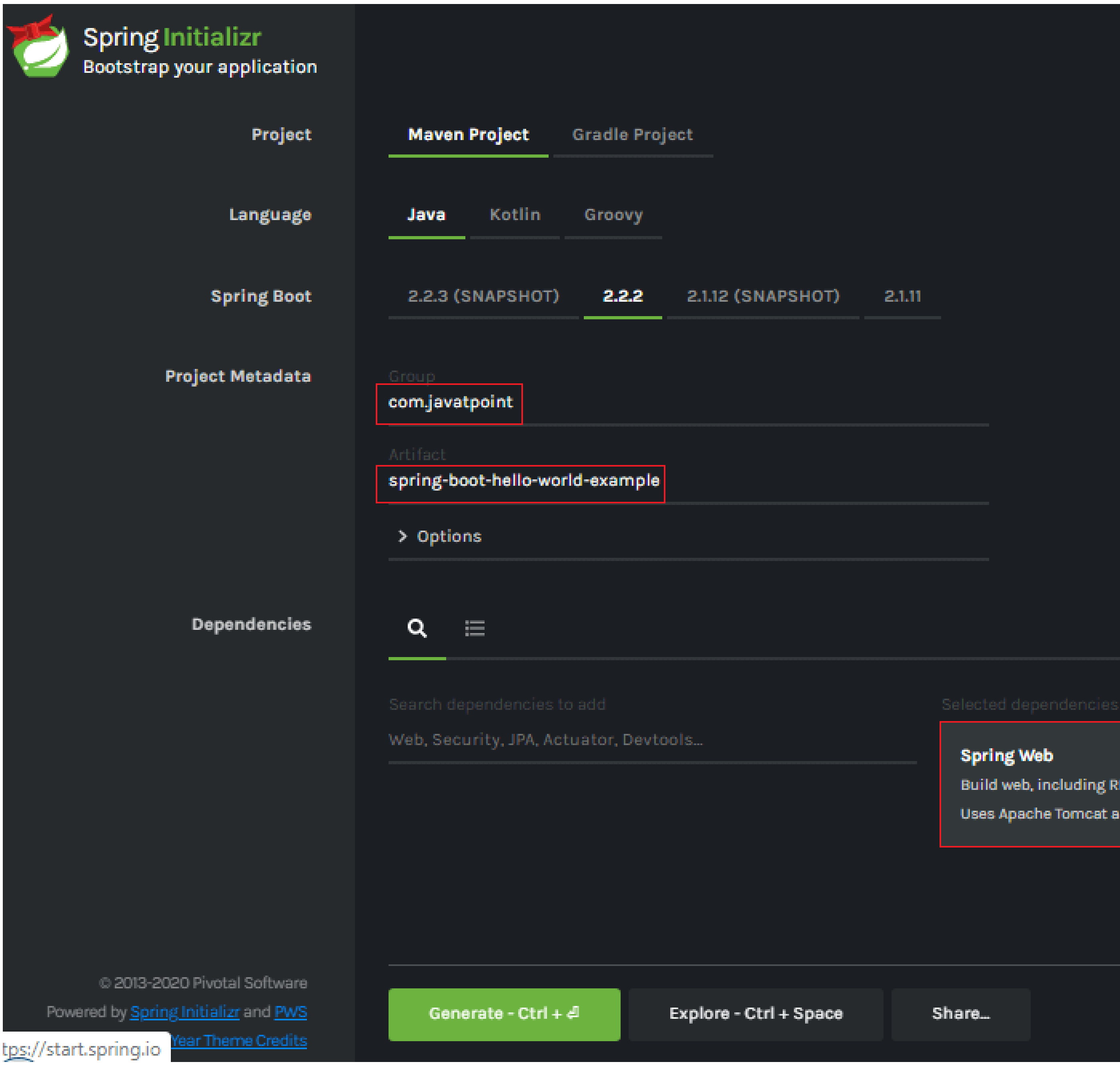
.

Step 2: Provide the **Group** name. We have provided **com.javatpoint.**

Step 3: Provide the **Artifact** Id. We have provided the **spring-boot-hello-world-example.**

Step 4: Add the dependency **Spring Web.**

Step 5: Click on the **Generate** button. When we click on the Generate button, it wraps all the specifications into a jar file and downloads it to our local system.

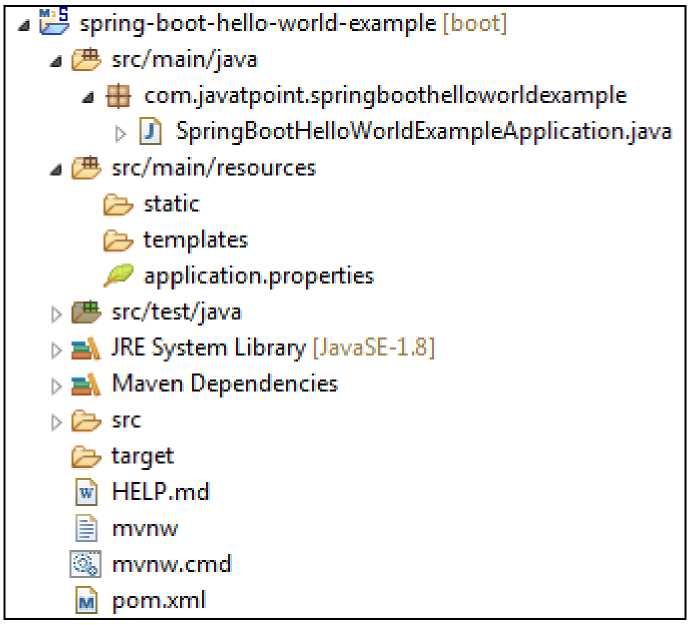


Step 6: Extract the RAR file.

Step 7: Import the project folder by using the following steps:

File -> Import -> Existing Maven Project -> Next -> Browse -> Select the Project Folder -> Finish

When the project imports successfully, it shows the following project directory in the Package Explorer section of the IDE.



```
spring-boot-hello-world-example [boot]
  src/main/java
    com.javatpoint.springboothelloworldexample
      SpringBootHelloWorldExampleApplication.java
  src/main/resources
    static
    templates
    application.properties
  src/test/java
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  HELP.md
  mvnw
  mvnw.cmd
  pom.xml
```

Step 8: Create a package with the name **com.javatpoint.controller** inside the folder **src/main/java.**

Step 9: Create a Controller class with the name **HelloWorldController.**

Step 10: Create a method named **hello()** that returns a String.

HelloWorldController.java

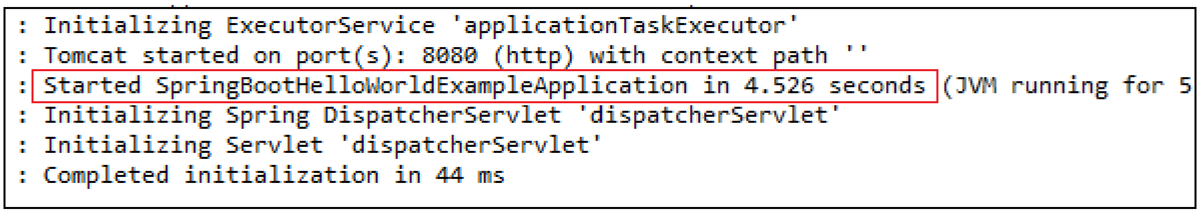
```java
package com.javatpoint.controller;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RestController;
@RestController
public class HelloWorldController
{
@RequestMapping("/")
public String hello()
{
return "Hello javaTpoint";
}
}
```

Step 11: Run the **SpringBootHelloWorldExampleApplication.java** file.

SpringBootHelloWorldExampleApplication.java

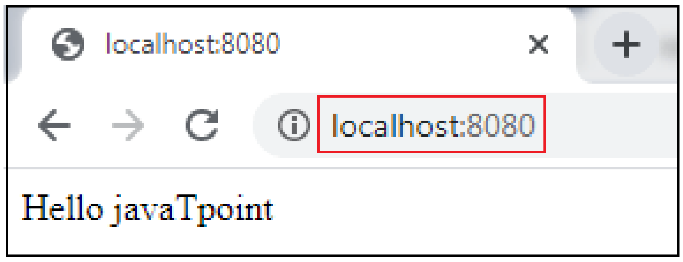
```java
package com.javatpoint;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
@SpringBootApplication
public class SpringBootHelloWorldExampleApplication
{
public static void main(String[] args)
{
SpringApplication.run(SpringBootHelloWorldExampleApplication.class, args);
}
}
```

When the application runs successfully, it shows a massage in the console, as shown in the following figure.



```
: Initializing ExecutorService 'applicationTaskExecutor'
: Tomcat started on port(s): 8080 (http) with context path ''
: Started SpringBootHelloWorldExampleApplication in 4.526 seconds (JVM running for 5
: Initializing Spring DispatcherServlet 'dispatcherServlet'
: Initializing Servlet 'dispatcherServlet'
: Completed initialization in 44 ms
```

Step 12: Open the browser and invoke the URL **https://localhost:8080**. It returns a String that we have specified in the Controller.



Hello javaTpoint

Spring Boot AOP

- The application is generally developed with multiple layers.
- A typical Java application has the following layers:

  - **Web Layer:** It exposes the **services** using the REST or web application.
  - **Business Layer:** It implements the **business logic** of an application.
  - **Data Layer:** It implements the **persistence logic** of the application.

The responsibility of each layer is different, but there are a few common aspects that apply to all layers are **Logging, Security, validation, caching,** etc. These common aspects are called **cross-cutting concerns.**

If we implement these concerns in each layer separately, the code becomes more difficult to maintain. To overcome this problem, **Aspect-Oriented Programming** (AOP) provides a solution to implement cross-cutting concerns.

- Implement the cross-cutting concern as an aspect.
- Define pointcuts to indicate where the aspect has to be applied.

It ensures that the cross-cutting concerns are defined in one cohesive code component.

AOP

AOP **(Aspect-Oriented Programming)** is a programming pattern that increases modularity by allowing the separation of the **cross-cutting concern**. These cross-cutting concerns are different from the main business logic. We can add additional behavior to existing code without modification of the code itself.

Spring's AOP framework helps us to implement these cross-cutting concerns.

Using AOP, we define common functionality in one place. We are free to define how and where this functionality is applied without modifying the class to which we are applying the new feature. The cross-cutting concern can now be modularized into special classes, called **aspect**.

There are **two** benefits of aspects:

- First, the logic for each concern is now in one place instead of scattered all over the codebase.
- Second, the business modules only contain code for their primary concern. The secondary concern has been moved to the **aspect**.

The aspects have the responsibility that is to be implemented, called **advice**. We can implement an aspect's functionality into a program at one or more join points.

Benefits of AOP

- It is implemented in pure Java.
- There is no requirement for a special compilation process.
- It supports only method execution Join points.
- Only run time weaving is available.
- Two types of AOP proxy is available: **JDK dynamic proxy** and **CGLIB proxy.**

Cross-cutting concern

The cross-cutting concern is a concern that we want to implement in multiple places in an application. It affects the entire application.

AOP Terminology

- **Aspect:** An aspect is a module that encapsulates **advice** and **pointcuts** and provides **cross-cutting** An application can have any number of aspects. We can implement an aspect using regular class annotated with **@Aspect** annotation.
- **Pointcut:** A pointcut is an expression that selects one or more join points where advice is executed. We can define pointcuts using **expressions** or **patterns**. It uses different kinds of expressions that matched with the join points. In Spring Framework, **AspectJ** pointcut expression language is used.
- **Join point:** A join point is a point in the application where we apply an **AOP aspect**. Or it is a specific execution instance of an advice. In AOP, join point can be a **method execution, exception handling, changing object variable value**, etc.
- **Advice:** The advice is an action that we take either **before** or **after** the method execution. The action is a piece of code that invokes during the program execution. There are **five** types of advices in the Spring AOP framework: **before, after, after-returning, after-throwing,** and **around advice.** Advices are taken for a particular **join point.** We will discuss these advices further in this section.
- **Target object:** An object on which advices are applied, is called the **target object**. Target objects are always a **proxied** It means a subclass is created at run time in which the target method is overridden, and advices are included based on their configuration.

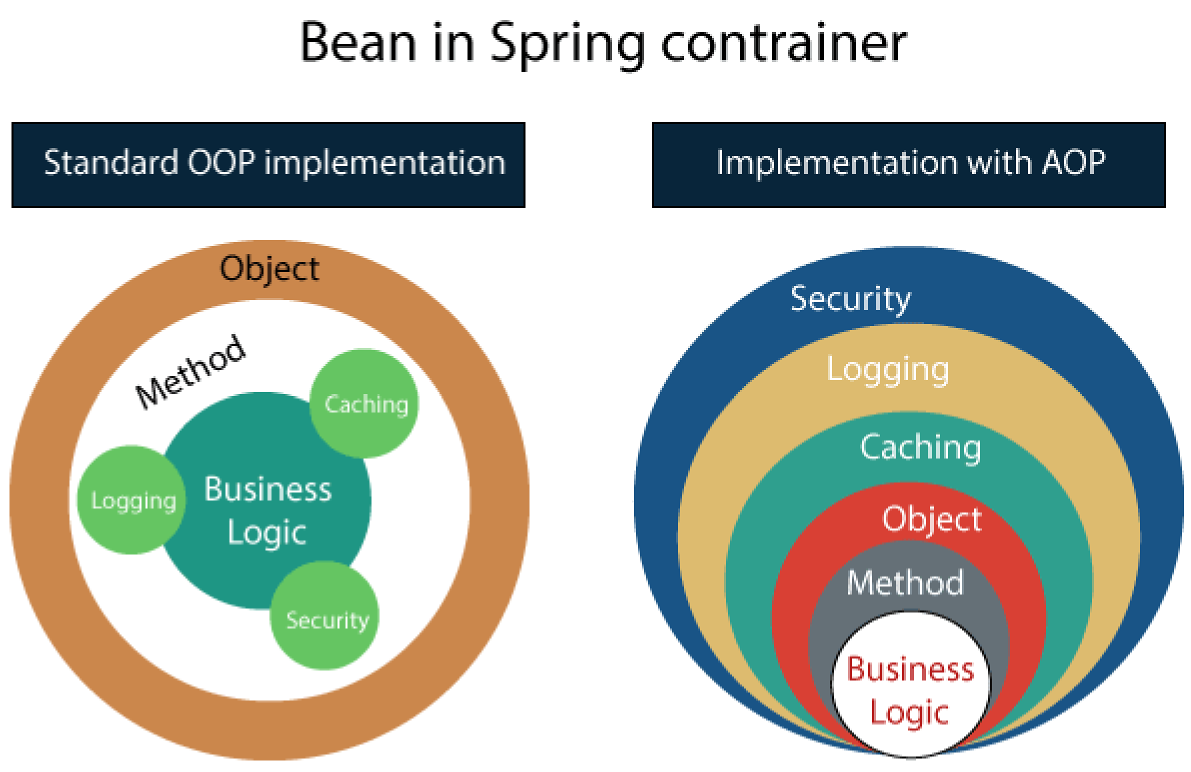
- **Weaving:** It is a process of **linking aspects** with other application types. We can perform weaving at **run time, load time,** and **compile time**.

Proxy: It is an object that is created after applying advice to a target object is called **proxy**. The Spring AOP implements the **JDK dynamic proxy** to create the proxy classes with target classes and advice invocations. These are called AOP proxy classes.

AOP vs. OOP

The differences between AOP and OOP are as follows:

AOP	OOP
Aspect: A code unit that encapsulates pointcuts, advices, and attributes.	**Class:** A code unit that encapsulates methods and attributes.
Pointcut: It defines the set of entry points in which advice is executed.	**Method signature:** It defines the entry points for the execution of method bodies.
Advice: It is an implementation of cross-cutting concerns.	**Method bodies:** It is an implementation of the business logic concerns.
Waver: It constructs code (source or object) with advice.	**Compiler: It converts source code to object code.**



Spring AOP vs. AspectJ

The differences between AOP and OOP are as follows:

Spring AOP	AspectJ
There is a need for a separate compilation process.	It requires the AspectJ compiler.
It supports only method execution pointcuts.	It supports all pointcuts.
It can be implemented on beans managed by Spring Container.	It can be implemented on all domain objects.
It supports only method level weaving.	It can wave fields, methods, constructors, static initializers, final class, etc.

Types of AOP Advices

There are five types of AOP advices are as follows:

- Before Advice
- After Advice
- Around Advice
- After Throwing
- After Returning

Before Advice:

- An advice that executes before a join point, is called before advice.
- We use **@Before** annotation to mark an advice as Before advice.

After Advice:

- An advice that executes after a join point, is called after advice.
- We use **@After** annotation to mark an advice as After advice.

Around Advice:

- An advice that executes before and after of a join point, is called around advice.

After Throwing Advice:

- An advice that executes when a join point throws an exception.

After Returning Advice:

- An advice that executes when a method executes successfully.

Before implementing the AOP in an application, we are required to add **Spring AOP** dependency in the pom.xml file.

Spring Boot Starter AOP

Spring Boot Starter AOP is a dependency that provides Spring AOP and AspectJ. Where AOP provides basic AOP capabilities while the AspectJ provides a complete AOP framework.

```xml
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-aop</artifactId>
<version>2.2.2.RELEASE</version>
</dependency>
```

In the next section, we will implement the different advices in the application.

Spring Boot AOP Before Advice

- Before advice is used in Aspect-Oriented Programming to achieve the cross-cutting.
- It is an advice type which ensures that an advice runs before the method execution.
- We use **@Before** annotation to implement the before advice.

Let's understand before advice through an example.

Spring Boot Before Advice Example

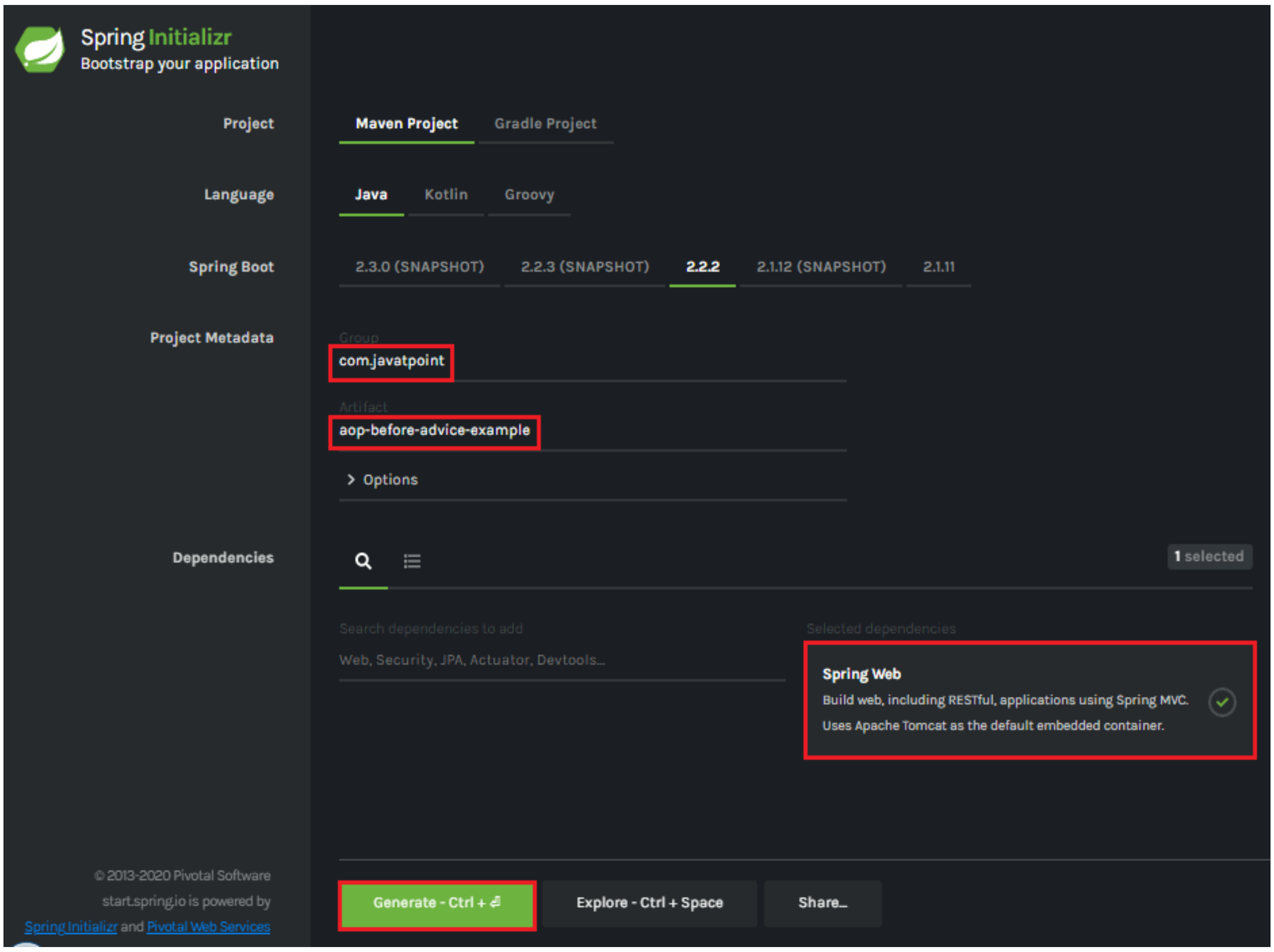
Step 1: Open Spring Initializr http://start.spring.io.

Step 2: Provide the **Group** name. We have provided the Group name **com.javatpoint.**

Step 3: Provide the **Artifact Id.** We have provided the Artifact Id **aop-before-advice-example.**

Step 4: Add the **Spring Web** dependency.

Step 5: Click on the **Generate** button. When we click on the Generate button, it wraps all the specifications in a **jar** file and downloads it to the local system.



Group: com.javatpoint

Artifact: aop-before-advice-example

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

Step 6: Extract the downloaded jar file.

Step 7: Import the folder by using the following steps:

File -> Import -> Existing Maven Projects -> Next -> Browse the Folder **aop-before-advice-example** -> Finish.

Step 8: Open the **pom.xml** file and add the following **AOP** dependency. It is a starter for aspect-oriented programming with **Spring AOP** and **AspectJ**.

```xml
<dependency>
<groupId>org.springframework.boot</groupId>
<artifactId>spring-boot-starter-aop</artifactId>
</dependency>
</dependencies>
```

pom.xml

```xml
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
<groupId>com.javatpoint</groupId>
<artifactId> aop-before-advice-example</artifactId>
<version>0.0.1-SNAPSHOT</version>
<packaging>jar</packaging>
<name>aop-before-advice-example</name>
    <description>Demo project for Spring Boot</description>
    <parent>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-starter-parent</artifactId>
        <version>2.2.2.RELEASE</version>
        <relativePath /> <!-- lookup parent from repository -->
    </parent>
    <properties>
        <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
        <project.reporting.outputEncoding>UTF-8</project.reporting.outputEncoding>
        <java.version>1.8</java.version>
    </properties>
```

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

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

Step 9: Open **AopBeforeAdviceExampleApplication.java** file and add an annotation **@EnableAspectJAutoProxy.**

```java
@EnableAspectJAutoProxy(proxyTargetClass=true)
```

It enables support for handling components marked with AspectJ's @Aspect annotation. It is used with @Configuration annotation. We can control the type of proxy by using the **proxyTargetClass** attribute. Its default value is **false**.

AopBeforeAdviceExampleApplication.java

```java
package com.javatpoint;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.EnableAspectJAutoProxy;
@SpringBootApplication
@EnableAspectJAutoProxy(proxyTargetClass=true)
public class AopBeforeAdviceExampleApplication
```

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

Step 10: Create a package with the name **com.javatpoint.model.**

Step 11: Create a model class under the package **com.javatpoint.model.** We have created a class with the name **Employee.** In the class, define the following:

- Define three variables **empId, firstName,** and **secondName** of type String.
- Generate **Getters and Setters.**
- Create a **default**

Employee.java

```java
package com.javatpoint.model;
public class Employee
{
private String empId;
private String firstName;
private String secondName;
//default constructor
public Employee()
{
}
public String getEmpId()
{
return empId;
}
public void setEmpId(String empId)
{
this.empId = empId;
}
public String getFirstName()
{
```

```java
return firstName;
}
public void setFirstName(String firstName)
{
this.firstName = firstName;
}
public String getSecondName()
{
return secondName;
}
public void setSecondName(String secondName)
{
this.secondName = secondName;
}
}
```

Step 12: Create a package with the name **com.javatpoint.controller.**

Step 13: Create a controller class under the package **com.javatpoint.controller.** We have created a class with the name **EmployeeController.**

In the controller class, we have defined the two mappings one for adding an employee and the other for removing an employee.

EmployeeController.java

```java
package com.javatpoint.controller;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;
import com.javatpoint.model.Employee;
import com.javatpoint.service.EmployeeService;
@RestController
public class EmployeeController
{
@Autowired
private EmployeeService employeeService;
@RequestMapping(value = "/add/employee", method = RequestMethod.GET)
public com.javatpoint.model.Employee addEmployee(@RequestParam("empId") String empId, @RequestParam("firstName") String firstName, @RequestParam("secondName") String secondName)
{
return employeeService.createEmployee(empId, firstName, secondName);
}
@RequestMapping(value = "/remove/employee", method = RequestMethod.GET)
public String removeEmployee( @RequestParam("empId") String empId)
{
employeeService.deleteEmployee(empId);
return "Employee removed";
}
}
```

Step 14: Create a package with the name **com.javatpoint.service.**

Step 15: Create a Service class under the package **com.javatpoint.service.** We have created a class with the name **EmployeeService.**

In the Service class, we have defined two methods **createEmployee** and **deleteEmployee.**

EmployeeService.java

```
package com.javatpoint.service;
import org.springframework.stereotype.Service;
import com.javatpoint.model.Employee;
@Service
public class EmployeeService
{
public Employee createEmployee( String empId, String fname, String sname)
{
Employee emp = new Employee();
emp.setEmpId(empId);
emp.setFirstName(fname);
emp.setSecondName(sname);
return emp;
}
public void deleteEmployee(String empId)
{
}
}
```

Step 16: Create a package with the name **com.javatpoint.aspect.**

Step 17: Create an aspect class under the package **com.javatpoint.aspect.** We have created a class with the name **EmployeeServiceAspect.**

In the aspect class, we have defined the before advice logic.

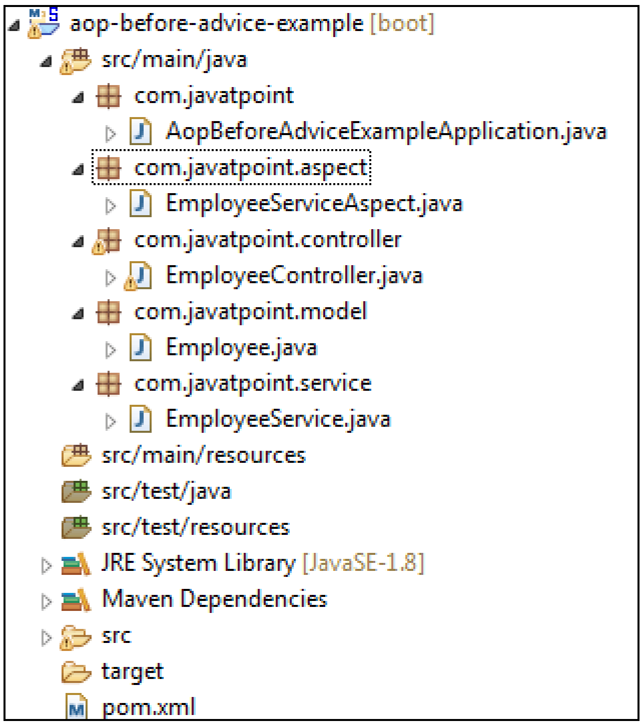
EmployeeServiceAspect.java

```java
package com.javatpoint.aspect;
import org.aspectj.lang.JoinPoint;
import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Before;
import org.springframework.stereotype.Component;
@Aspect
@Component
public class EmployeeServiceAspect
{
@Before(value = "execution(* com.javatpoint.service.EmployeeService.*(..)) and args(empId, fname, sname)")
public void beforeAdvice(JoinPoint joinPoint, String empId, String fname, String sname) {
System.out.println("Before method:" + joinPoint.getSignature());
System.out.println("Creating Employee with first name - " + fname + ", second name - " + sname + " and id - " + empId);
}
}
```

In the above class:

- **execution(expression):** The expression is a method on which advice is to be applied.
- **@Before:** It marks a function as an advice to be executed before method that covered by PointCut.

After creating all the modules, the project directory looks like the following:

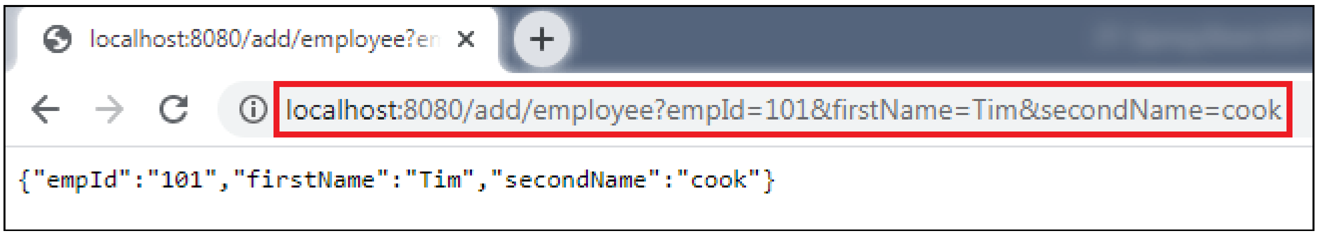

```
aop-before-advice-example [boot]
  src/main/java
    com.javatpoint
      AopBeforeAdviceExampleApplication.java
    com.javatpoint.aspect
      EmployeeServiceAspect.java
    com.javatpoint.controller
      EmployeeController.java
    com.javatpoint.model
      Employee.java
    com.javatpoint.service
      EmployeeService.java
  src/main/resources
  src/test/java
  src/test/resources
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  pom.xml
```

We have set-up all the modules. Now we will run the application.

Step 18: Open the e**AopBeforeAdviceExampleApplication.java** file and run it as Java Application.

Step 19: Open the browser and invoke the following URL : *http://localhost:8080/add/employee?empId={id}&firstName={fname}&secondName={sname}*

In the above URL, **/add/employee** is the mapping that we have created in the Controller class. We have used two separators **(?)** and **(&)** for separating two values.

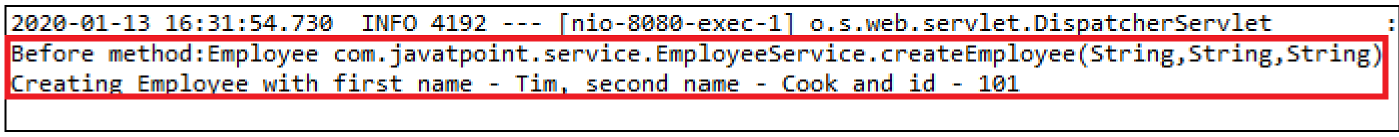


```
localhost:8080/add/employee?empId=101&firstName=Tim&secondName=cook
```

```
{"empId":"101","firstName":"Tim","secondName":"cook"}
```

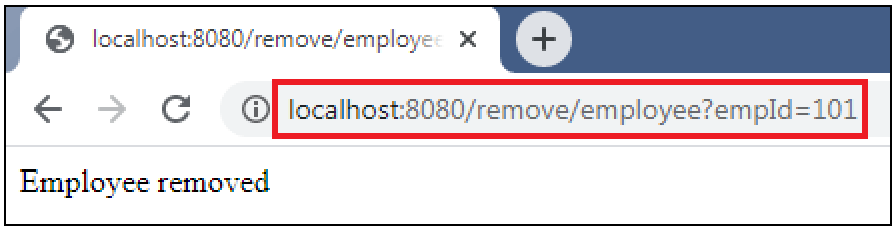
In the above output, we have assigned **emId 101, firstName=Tim,** and **secondName=cook.**

Let's have a look at the console. We see that before invoking the **createEmployee**() method of **EmployeeService** class, the method **beforeAdvice()** of **EmployeeServiceAspect** class invokes, as shown below.



```
2020-01-13 16:31:54.730  INFO 4192 --- [nio-8080-exec-1] o.s.web.servlet.DispatcherServlet        :
Before method:Employee com.javatpoint.service.EmployeeService.createEmployee(String,String,String)
Creating Employee with first name - Tim, second name - Cook and id - 101
```

Similarly, we can also remove an employee by invoking the URL http://localhost:8080/remove/employee?empId=101. It returns a message **Employee removed**, as shown in the following figure.



localhost:8080/remove/employee?empId=101

```
Employee removed
```

In this section, we have learned the working of before advice. In the next section, we will learn the working of after advice and implement it in an apllication.

Spring Boot AOP After Advice

After advice is used in Aspect-Oriented Programming to achieve the cross-cutting. It is an advice type which ensures that an advice runs after the method execution. We use **@After** annotation to implement the after advice.

Let's understand after advice through an example.

Spring Boot After Advice Example

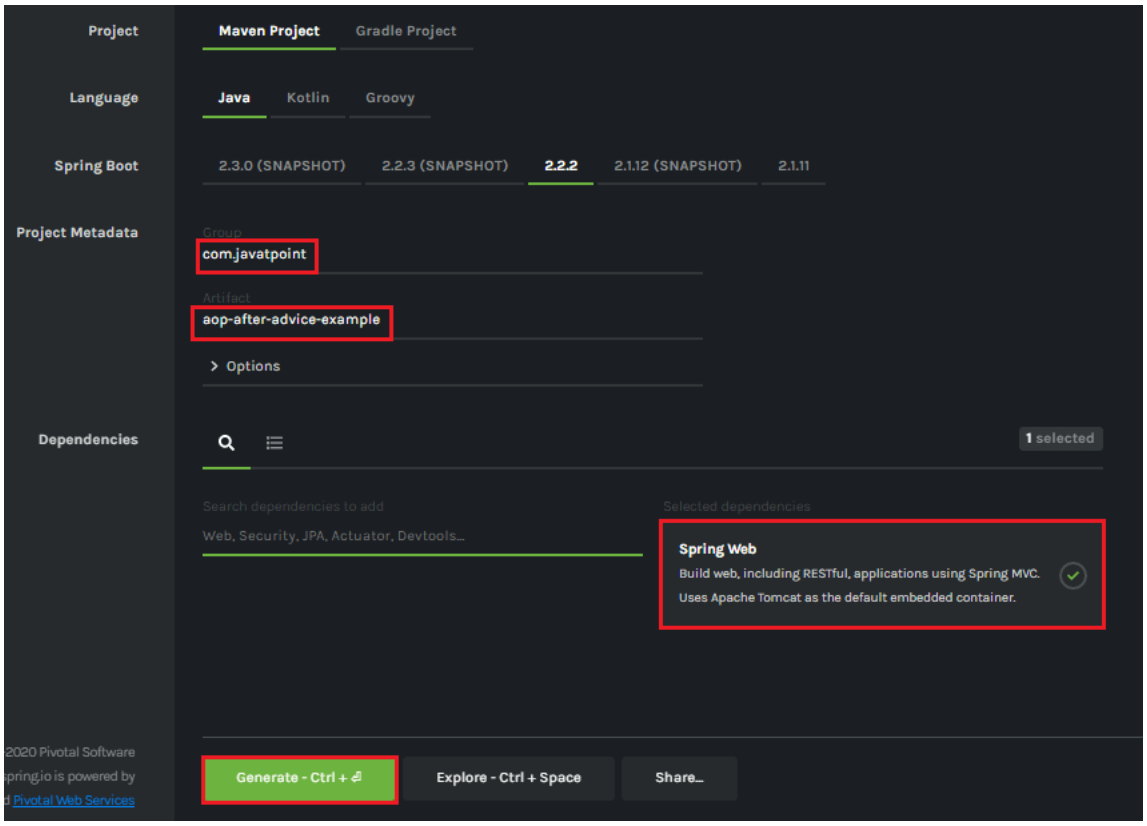
Step 1: Open Spring Initializr http://start.spring.io.

Step 2: Provide the **Group** name. We have provided the Group name **com.javatpoint.**

Step 3: Provide the **Artifact Id.** We have provided the Artifact Id **aop-after-advice-example.**

Step 4: Add the **Spring Web** dependency.

Step 5: Click on the **Generate** button. When we click on the Generate button, it wraps all the specifications in a **jar** file and downloads it to the local system.


Project: Maven Project [✓] | Gradle Project

Language: Java [✓] | Kotlin | Groovy

Spring Boot: 2.3.0 (SNAPSHOT) | 2.2.3 (SNAPSHOT) | 2.2.2 [✓] | 2.1.12 (SNAPSHOT) | 2.1.11

Project Metadata
Group: com.javatpoint
Artifact: aop-after-advice-example

Dependencies: 1 selected
Selected dependencies:
Spring Web
Build web, including RESTful, applications using Spring MVC. Uses Apache Tomcat as the default embedded container.

Step 6: Extract the downloaded jar file.

Step 7: Import the folder by using the following steps:

File -> Import -> Existing Maven Projects -> Next -> Browse the Folder **aop-after-advice-example** -> Finish.

Step 8: Open the **pom.xml** file and add the following **AOP** dependency. It is a starter for aspect-oriented programming with **Spring AOP** and **AspectJ**.

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

pom.xml

```
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
<modelVersion>4.0.0</modelVersion>
```

```xml
<groupId>com.javatpoint</groupId>
<artifactId> aop-after-advice-example</artifactId>
<version>0.0.1-SNAPSHOT</version>
<packaging>jar</packaging>
<name>aop-after-advice-example</name>
  <description>Demo project for Spring Boot</description>
  <parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>2.2.2.RELEASE</version>
    <relativePath /> <!-- lookup parent from repository -->
  </parent>
  <properties>
    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    <project.reporting.outputEncoding>UTF-
8</project.reporting.outputEncoding>
    <java.version>1.8</java.version>
  </properties>
  <dependencies>
    <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
  <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-aop</artifactId>
    </dependency>
  </dependencies>

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

```
</project>
```

Step 9: Open **AopAfterAdviceExampleApplication.java** file and add an annotation **@EnableAspectJAutoProxy.**

```
@EnableAspectJAutoProxy(proxyTargetClass=true)
```

It enables support for handling components marked with AspectJ's **@Aspect** annotation. It is used with @Configuration annotation. We can control the type of proxy by using the **proxyTargetClass** attribute. Its default value is **false**.

AopAfterAdviceExampleApplication.java

```
package com.javatpoint;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.EnableAspectJAutoProxy;
@SpringBootApplication
@EnableAspectJAutoProxy(proxyTargetClass=true)
public class AopAfterAdviceExampleApplication
{
public static void main(String[] args) {
SpringApplication.run(AopAfterAdviceExampleApplication.class, args);
}
}
```

Step 10: Create a package with the name **com.javatpoint.model.**

Step 11: Create a model class under the package **com.javatpoint.model.** We have created a class with the name **Employee.** In the class, define the following:

- Define three variables **empId, firstName,** and **secondName** of type String.
- Generate **Getters and Setters.**
- Create a **default**

Employee.java

```
package com.javatpoint.model;
public class Employee
{
private String empId;
private String firstName;
private String secondName;
//default constructor
public Employee()
{
}
public String getEmpId()
{
return empId;
}
public void setEmpId(String empId)
{
this.empId = empId;
}
public String getFirstName()
{
return firstName;
}
public void setFirstName(String firstName)
{
this.firstName = firstName;
}
public String getSecondName()
{
return secondName;
}
public void setSecondName(String secondName)
{
this.secondName = secondName;
}
}
```

Step 12: Create a package with the name **com.javatpoint.controller.**

Step 13: Create a controller class under the package **com.javatpoint.controller.** We have created a class with the name **EmployeeController.**

In the controller class, we have defined the two mappings one for adding an employee and the other for removing an employee.

EmployeeController.java

```
package com.javatpoint.controller;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestMethod;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;
import com.javatpoint.model.Employee;
import com.javatpoint.service.EmployeeService;
@RestController
public class EmployeeController
{
@Autowired
private EmployeeService employeeService;
@RequestMapping(value = "/add/employee", method = RequestMethod.GET)
public com.javatpoint.model.Employee addEmployee(@RequestParam("empId") String empId, @RequestParam("firstName") String firstName, @RequestParam("secondName") String secondName)
{
return employeeService.createEmployee(empId, firstName, secondName);
}
@RequestMapping(value = "/remove/employee", method = RequestMethod.GET)
public String removeEmployee( @RequestParam("empId") String empId)
{
employeeService.deleteEmployee(empId);
return "Employee removed";
}
}
```

Step 14: Create a package with the name **com.javatpoint.service.**

Step 15: Create a Service class under the package **com.javatpoint.service.** We have created a class with the name **EmployeeService.**

In the Service class, we have defined two methods **createEmployee** and **deleteEmployee.**

EmployeeService.java

```
package com.javatpoint.service;
```

```java
import org.springframework.stereotype.Service;
import com.javatpoint.model.Employee;
@Service
public class EmployeeService
{
public Employee createEmployee( String empId, String fname, String sname)
{
Employee emp = new Employee();
emp.setEmpId(empId);
emp.setFirstName(fname);
emp.setSecondName(sname);
return emp;
}
public void deleteEmployee(String empId)
{
}
}
```

Step 16: Create a package with the name **com.javatpoint.aspect.**

Step 17: Create an aspect class under the package **com.javatpoint.aspect.** We have created a class with the name **EmployeeServiceAspect.**

In the aspect class, we have defined the after-advice logic.

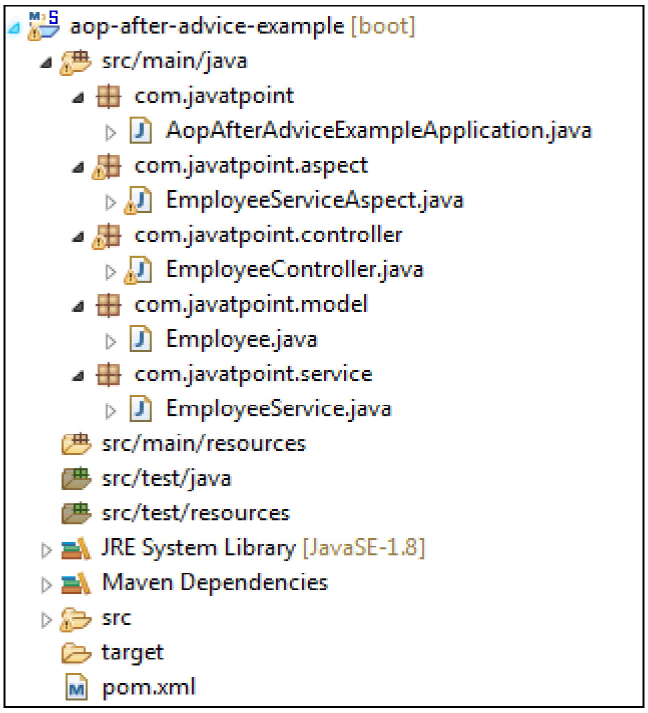
EmployeeServiceAspect.java

```java
package com.javatpoint.aspect;
import org.aspectj.lang.JoinPoint;
import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.After;
import org.springframework.stereotype.Component;
@Aspect
@Component
public class EmployeeServiceAspect
{
@After(value = "execution(* com.javatpoint.service.EmployeeService.*(..)) and args(
empId, fname, sname)")
public void afterAdvice(JoinPoint joinPoint, String empId, String fname, String sname ) {
System.out.println("After method:" + joinPoint.getSignature());
System.out.println("Creating Employee with first name - " + fname + ", second name - " + sname + " and id - " + empId);
}
}
```

In the above class:

- **execution(expression):** The expression is a method on which advice is to be applied.
- **@After:** The method annotated with **@After** executes after all the methods that matched with the pointcut expression.

After creating all the modules, the project directory looks like the following:



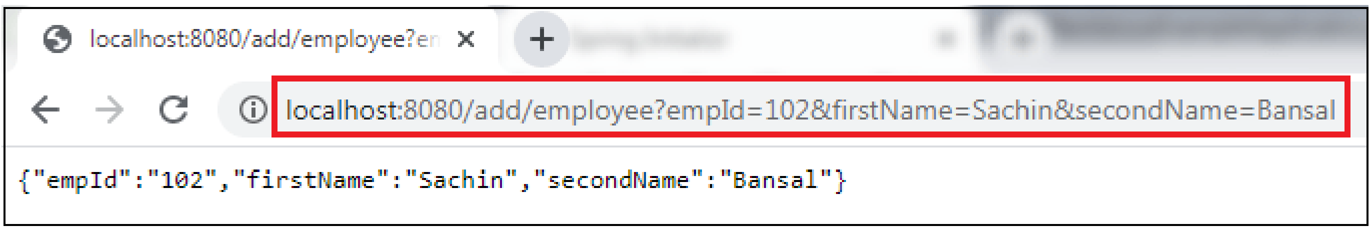
```
aop-after-advice-example [boot]
  src/main/java
    com.javatpoint
      AopAfterAdviceExampleApplication.java
    com.javatpoint.aspect
      EmployeeServiceAspect.java
    com.javatpoint.controller
      EmployeeController.java
    com.javatpoint.model
      Employee.java
    com.javatpoint.service
      EmployeeService.java
  src/main/resources
  src/test/java
  src/test/resources
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  pom.xml
```

We have set-up all the modules. Now we will run the application.

Step 18: Open the **AopAfterAdviceExampleApplication.java** file and run it as Java Application.

Step 19: Open the browser and invoke the following URL : *http://localhost:8080/add/employee?empId={id}&firstName={fname}&secondName={sname}*

In the above URL, **/add/employee** is the mapping that we have created in the Controller class. We have used two separators **(?)** and **(&)** for separating two values.

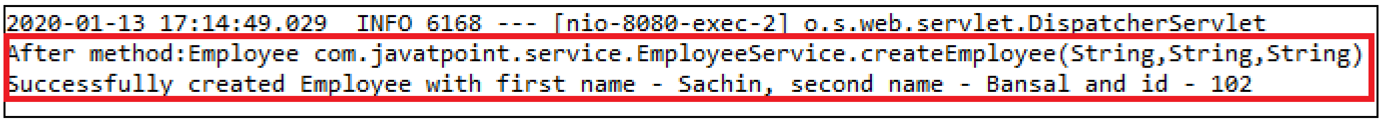


localhost:8080/add/employee?empId=102&firstName=Sachin&secondName=Bansal

```
{"empId":"102","firstName":"Sachin","secondName":"Bansal"}
```

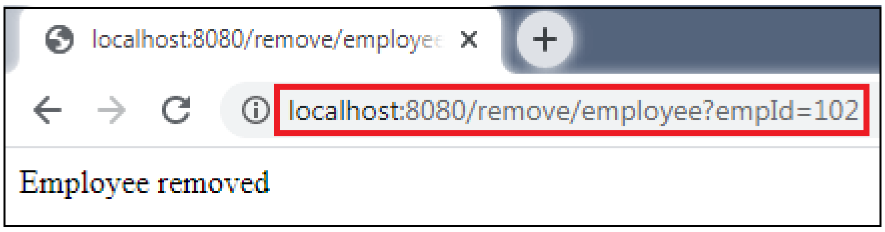
In the above output, we have assigned **emId 102, firstName=Sachin,** and **secondName=Bansal.**

Let's have a look at the console. We see that after invoking the **createEmployee**() method of **EmployeeService** class, the method **afterAdvice()** of **EmployeeServiceAspect** class invokes, as shown below.



```
2020-01-13 17:14:49.029  INFO 6168 --- [nio-8080-exec-2] o.s.web.servlet.DispatcherServlet
After method:Employee com.javatpoint.service.EmployeeService.createEmployee(String,String,String)
Successfully created Employee with first name - Sachin, second name - Bansal and id - 102
```

Similarly, we can also remove an employee by invoking the URL http://localhost:8080/remove/employee?empId=102. It returns a message **Employee removed**, as shown in the following figure.



localhost:8080/remove/employee?empId=102

Employee removed

In this section, we have learned the working of after advice. In the next section, we will learn the working of around advice.

Spring Boot JPA

What is JPA?

Spring Boot JPA is a Java specification for managing **relational** data in Java applications. It allows us to access and persist data between Java object/ class and relational database. JPA follows **Object-Relation Mapping** (ORM). It is a set of interfaces. It also provides a runtime **EntityManager** API for processing queries and transactions on the objects against the database. It uses a platform-independent object-oriented query language JPQL (Java Persistent Query Language).

In the context of persistence, it covers three areas:

- The Java Persistence API
- **Object-Relational** metadata
- The API itself, defined in the **persistence** package

JPA is not a framework. It defines a concept that can be implemented by any framework.

Why should we use JPA?

JPA is simpler, cleaner, and less labor-intensive than JDBC, SQL, and hand-written mapping. JPA is suitable for non-performance oriented complex applications. The main advantage of JPA over JDBC is that, in JPA, data is represented by objects and classes while in JDBC data is represented by tables and records. It uses POJO to represent persistent data that simplifies database programming. There are some other advantages of JPA:

- JPA avoids writing DDL in a database-specific dialect of SQL. Instead of this, it allows mapping in XML or using Java annotations.
- JPA allows us to avoid writing DML in the database-specific dialect of SQL.
- JPA allows us to save and load Java objects and graphs without any DML language at all.
- When we need to perform queries JPQL, it allows us to express the queries in terms of Java entities rather than the (native) SQL table and columns.

JPA Features

There are following features of JPA:

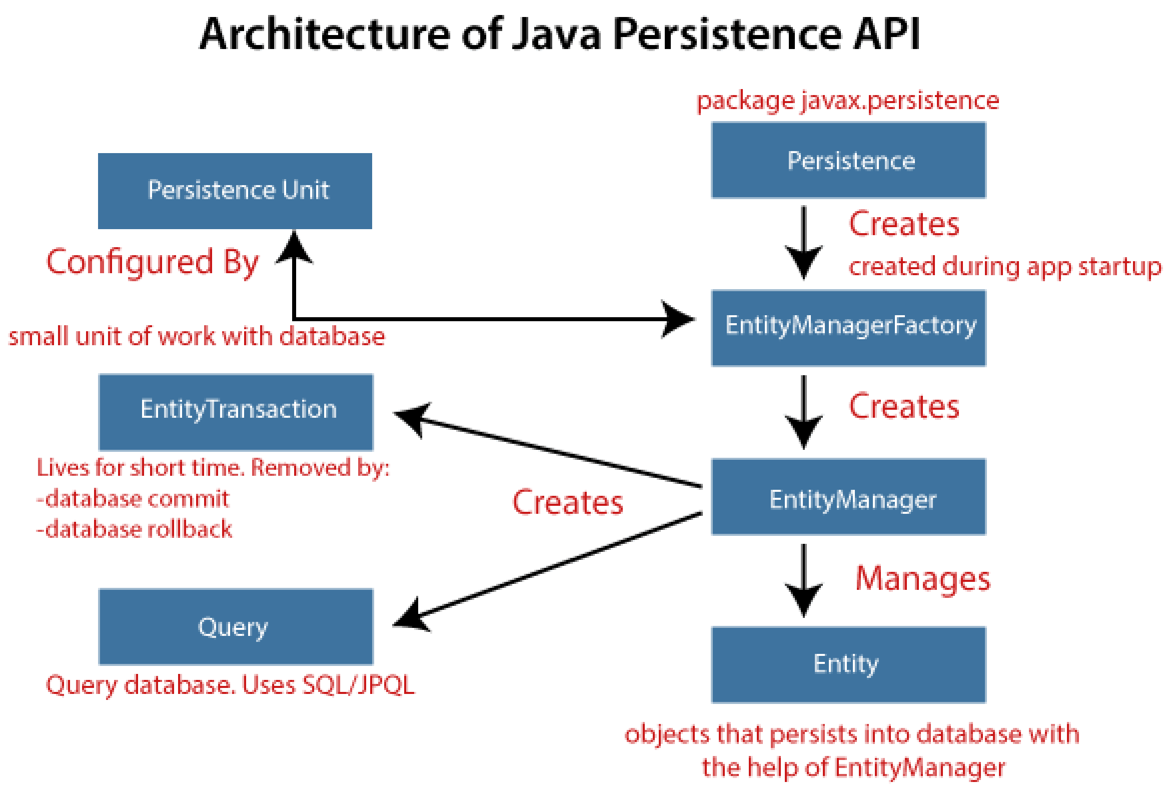
- It is a powerful repository and custom **object-mapping abstraction.**
- It supports for **cross-store persistence**. It means an entity can be partially stored in MySQL and Neo4j (Graph Database Management System).
- It dynamically generates queries from queries methods name.
- The domain base classes provide basic properties.
- It supports transparent auditing.
- Possibility to integrate custom repository code.
- It is easy to integrate with Spring Framework with the custom namespace.

JPA Architecture

JPA is a source to store business entities as relational entities. It shows how to define a POJO as an entity and how to manage entities with relation.

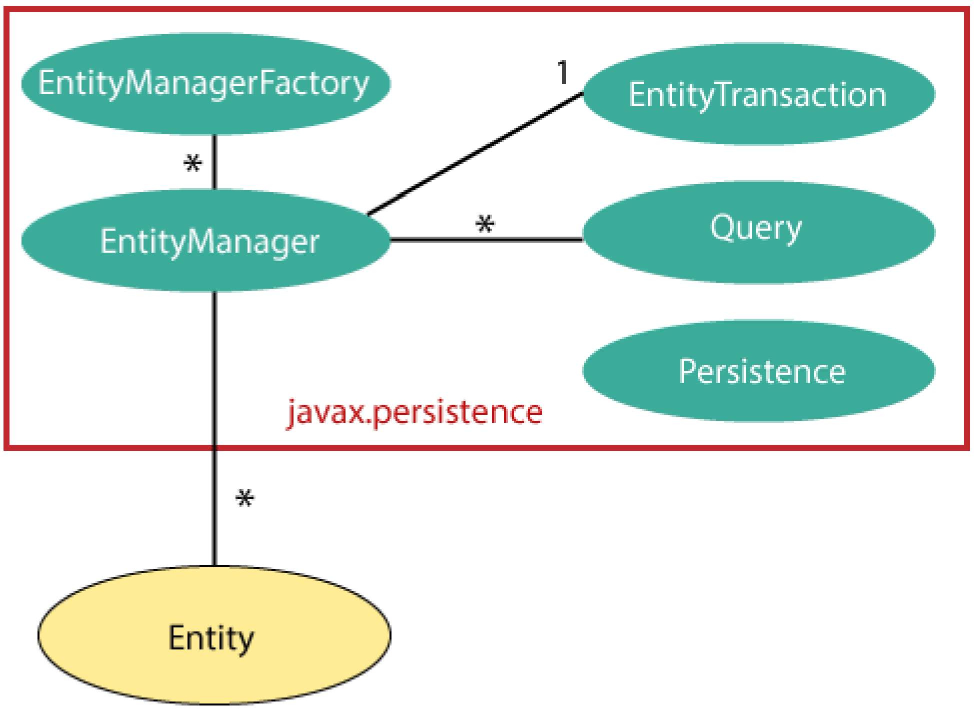
The following figure describes the class-level architecture of JPA that describes the core classes and interfaces of JPA that is defined in the **javax persistence** package. The JPA architecture contains the following units:

- **Persistence:** It is a class that contains static methods to obtain an EntityManagerFactory instance.
- **EntityManagerFactory:** It is a factory class of EntityManager. It creates and manages multiple instances of EntityManager.
- **EntityManager:** It is an interface. It controls the persistence operations on objects. It works for the Query instance.
- **Entity:** The entities are the persistence objects stores as a record in the database.
- **Persistence Unit:** It defines a set of all entity classes. In an application, EntityManager instances manage it. The set of entity classes represents the data contained within a single data store.
- **EntityTransaction:** It has a **one-to-one** relationship with the EntityManager class. For each EntityManager, operations are maintained by EntityTransaction class.
- **Query:** It is an interface that is implemented by each JPA vendor to obtain relation objects that meet the criteria.


Architecture of Java Persistence API
package javax.persistence
Persistence
Creates
created during app startup
Persistence Unit
Configured By
small unit of work with database
EntityManagerFactory
Creates
EntityTransaction
Lives for short time. Removed by:
-database commit
-database rollback
Creates
EntityManager
Manages
Query
Query database. Uses SQL/JPQL
Entity
objects that persists into database with the help of EntityManager

JPA Class Relationships

The classes and interfaces that we have discussed above maintain a relationship. The following figure shows the relationship between classes and interfaces.



JPA Class Relationship

- The relationship between EntityManager and EntiyTransaction is **one-to-one**. There is an EntityTransaction instance for each EntityManager operation.
- The relationship between EntityManageFactory and EntiyManager is **one-to-many**. It is a factory class to EntityManager instance.
- The relationship between EntityManager and Query is **one-to-many**. We can execute any number of queries by using an instance of EntityManager class.
- The relationship between EntityManager and Entity is **one-to-many**. An EntityManager instance can manage multiple Entities.

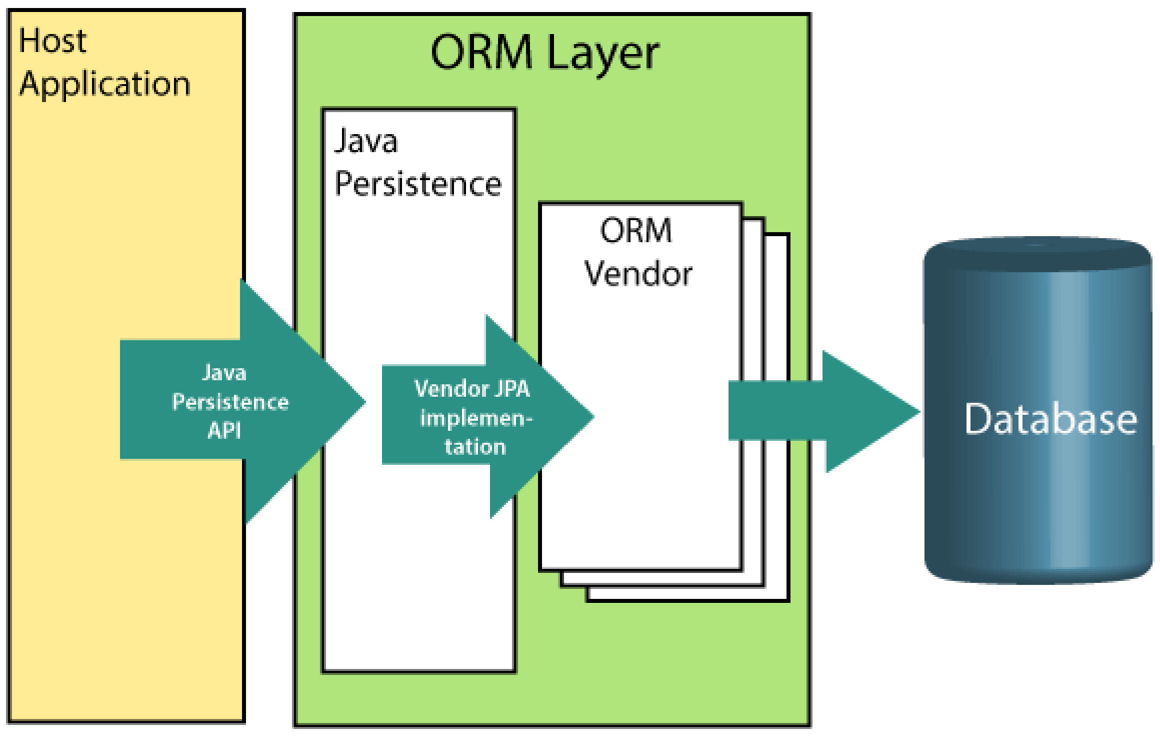
JPA Implementations

JPA is an open-source API. There is various enterprises vendor such as Eclipse, RedHat, Oracle, etc. that provides new products by adding the JPA in them. There are some popular JPA implementations frameworks such as **Hibernate, EclipseLink, DataNucleus,** etc. It is also known as **Object-Relation Mapping** (ORM) tool.

Object-Relation Mapping (ORM)

In ORM, the mapping of Java objects to database tables, and vice-versa is called **Object-Relational Mapping.** The ORM mapping works as a bridge between a **relational database** (tables and records) and **Java application** (classes and objects).

In the following figure, the ORM layer is an adapter layer. It adapts the language of object graphs to the language of SQL and relation tables.



The ORM layer exists between the application and the database. It converts the Java classes and objects so that they can be stored and managed in a relational database. By default, the name that persists become the name of the table, and fields become columns. Once an application sets-up, each table row corresponds to an object.

Spring Boot CRUD Operations

What is the CRUD operation?

The **CRUD** stands for **Create, Read/Retrieve, Update,** and **Delete**. These are the four basic functions of the persistence storage.

The CRUD operation can be defined as user interface conventions that allow view, search, and modify information through computer-based forms and reports. CRUD is data-oriented and the standardized use of **HTTP action verbs**. HTTP has a few important verbs.

- **POST:** Creates a new resource
- **GET:** Reads a resource
- **PUT:** Updates an existing resource
- **DELETE:** Deletes a resource

Within a database, each of these operations maps directly to a series of commands. However, their relationship with a RESTful API is slightly more complex.

Standard CRUD Operation

- **CREATE Operation:** It performs the INSERT statement to create a new record.
- **READ Operation:** It reads table records based on the input parameter.
- **UPDATE Operation:** It executes an update statement on the table. It is based on the input parameter.
- **DELETE Operation:** It deletes a specified row in the table. It is also based on the input parameter.

How CRUD Operations Works

CRUD operations are at the foundation of the most dynamic websites. Therefore, we should differentiate **CRUD** from the **HTTP action verbs**.

Suppose, if we want to **create** a new record, we should use HTTP action verb **POST**. To **update** a record, we should use the **PUT** verb. Similarly, if we want to **delete** a record, we should use the **DELETE** verb. Through CRUD operations, users and administrators have the right to retrieve, create, edit, and delete records online.

We have many options for executing CRUD operations. One of the most efficient choices is to create a set of stored procedures in SQL to execute operations.

The CRUD operations refer to all major functions that are implemented in relational database applications. Each letter of the CRUD can map to a SQL statement and HTTP methods.

Operation	SQL	HTTP verbs	RESTful Web Service
Create	INSERT	PUT/POST	POST
Read	SELECT	GET	GET
Update	UPDATE	PUT/POST/PATCH	PUT
Delete	DELETE	DELETE	DELETE

Spring Boot CrudRepository

- Spring Boot provides an interface called **CrudRepository** that contains methods for CRUD operations.
- It is defined in the package **org.springframework.data.repository**.
- It extends the Spring Data **Repository** interface.
- It provides generic Crud operation on a repository.

- If we want to use CrudRepository in an application, we have to create an interface and extend the **CrudRepository**.

Syntax

```
public interface CrudRepository<T,ID> extends Repository<T,ID>
```

where,

- **T** is the domain type that repository manages.
- **ID** is the type of the id of the entity that repository manages.

For example:

```
public interface StudentRepository extends CrudRepository<Student, Integer>
{
}
```

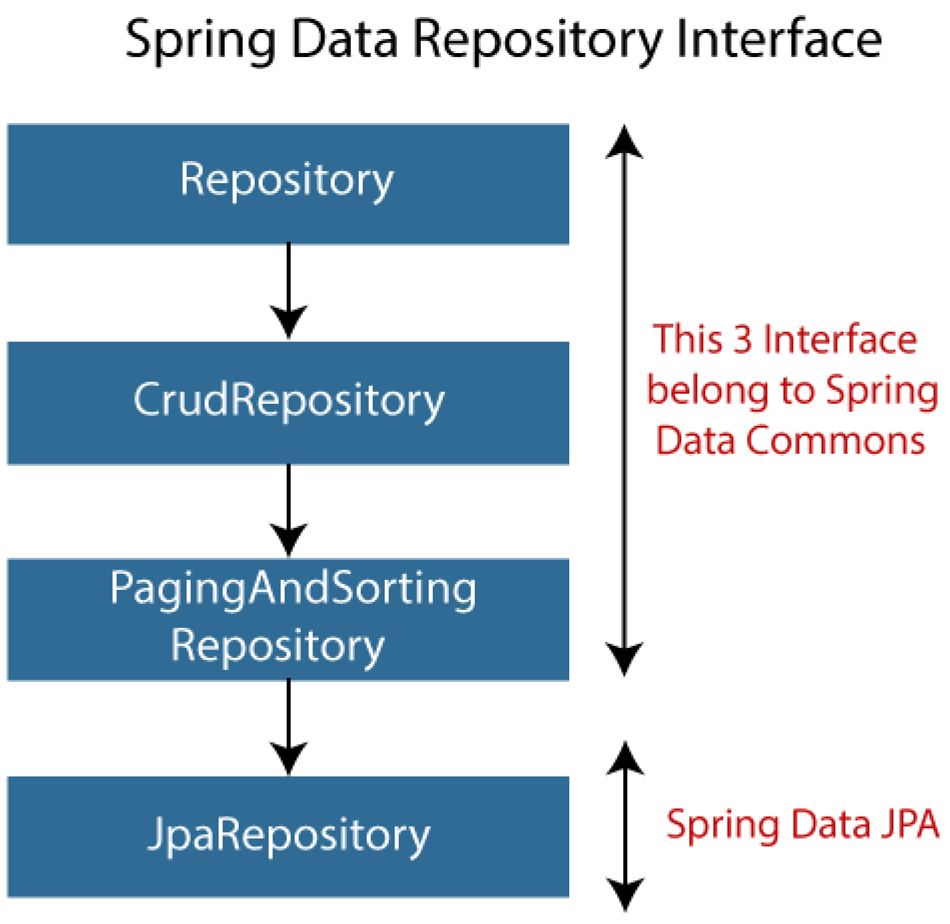
In the above example, we have created an interface named **StudentRepository** that extends CrudRepository. Where **Student** is the repository to manage, and **Integer** is the type of Id that is defined in the Student repository.

Spring Boot JpaRepository

JpaRepository provides JPA related methods such as flushing, persistence context, and deletes a record in a batch. It is defined in the package **org.springframework.data.jpa.repository.** JpaRepository extends both **CrudRepository** and **PagingAndSortingRepository.**

For example:

```
public interface BookDAO extends JpaRepository
{
}
```


Spring Data Repository Interface
Repository
CrudRepository
PagingAndSorting Repository
JpaRepository
This 3 Interface belong to Spring Data Commons
Spring Data JPA

Why should we use these interfaces?

- The interfaces allow Spring to find the repository interface and create proxy objects for that.
- It provides methods that allow us to perform some common operations. We can also define custom methods as well.

CrudRepository vs. JpaRepository

CrudRepository	JpaRepository
CrudRepository does not provide any method for pagination and sorting.	JpaRepository extends PagingAndSortingRepository. It provides all the methods for implementing the pagination.
It works as a **marker** interface.	JpaRepository extends both **CrudRepository** and **PagingAndSortingRepository**.

It provides CRUD function only. For example **findById(), findAll(),** etc.	It provides some extra methods along with the method of PagingAndSortingRepository and CrudRepository. For example, **flush(), deleteInBatch().**
It is used when we do not need the functions provided by JpaRepository and PagingAndSortingRepository.	It is used when we want to implement pagination and sorting functionality in an application.

Spring Boot CRUD Operation Example

Let's set up a Spring Boot application and perform CRUD operation.

Step 1: Open Spring Initializr http://start.spring.io.

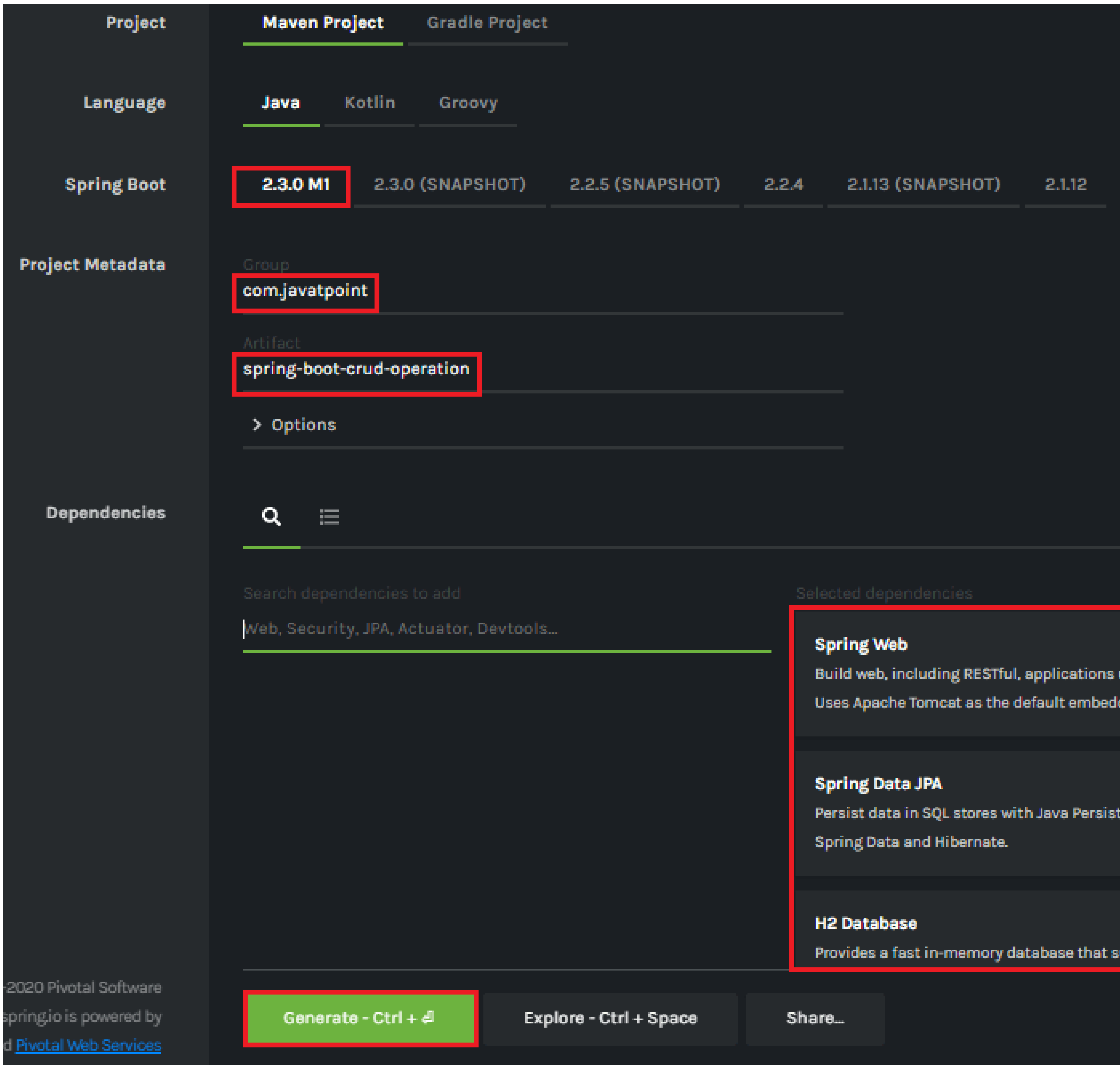
Step 2: Select the Spring Boot version **2.3.0.M1.**

Step 2: Provide the **Group** name. We have provided **com.javatpoint.**

Step 3: Provide the **Artifact** Id. We have provided **spring-boot-crud-operation.**

Step 5: Add the dependencies **Spring Web, Spring Data JPA,** and **H2 Database.**

Step 6: Click on the **Generate** button. When we click on the Generate button, it wraps the specifications in a **Jar** file and downloads it to the local system.


Project: Maven Project [✓] / Gradle Project

Language: Java [✓] / Kotlin / Groovy

Spring Boot: 2.3.0 M1 [✓] / 2.3.0 (SNAPSHOT) / 2.2.5 (SNAPSHOT) / 2.2.4 / 2.1.13 (SNAPSHOT) / 2.1.12

Project Metadata

Group: com.javatpoint

Artifact: spring-boot-crud-operation

> Options

Dependencies

Search dependencies to add: Web, Security, JPA, Actuator, Devtools...

Selected dependencies

Spring Web
Build web, including RESTful, applications
Uses Apache Tomcat as the default embedd

Spring Data JPA
Persist data in SQL stores with Java Persist
Spring Data and Hibernate.

H2 Database
Provides a fast in-memory database that s

Step 7: Extract the Jar file and paste it into the STS workspace.

Step 8: Import the project folder into STS.

File -> Import -> Existing Maven Projects -> Browse -> Select the folder spring-boot-crud-operation -> Finish

It takes some time to import.

Step 9: Create a package with the name **com.javatpoint.model** in the folder **src/main/java.**

Step 10: Create a model class in the package **com.javatpoint.model.** We have created a model class with the name **Books.** In the Books class, we have done the following:

- Define four variable **bookid, bookname, author,** and
- Generate Getters and Setters.
  Right-click on the file -> Source -> Generate Getters and Setters.
- Mark the class as an **Entity** by using the annotation **@Entity.**
- Mark the class as **Table** name by using the annotation **@Table.**
- Define each variable as **Column** by using the annotation **@Column.**

Books.java

```java
package com.javatpoint.model;
import javax.persistence.Column;
import javax.persistence.Entity;
import javax.persistence.Id;
import javax.persistence.Table;
//mark class as an Entity
@Entity
//defining class name as Table name
@Table
public class Books
{
//Defining book id as primary key
@Id
@Column
private int bookid;
@Column
private String bookname;
@Column
private String author;
@Column
private int price;
public int getBookid()
{
return bookid;
}
public void setBookid(int bookid)
{
this.bookid = bookid;
}
public String getBookname()
{
return bookname;
}
public void setBookname(String bookname)
{
this.bookname = bookname;
}
public String getAuthor()
{
return author;
}
public void setAuthor(String author)
{
this.author = author;
}
public int getPrice()
{
return price;
}
public void setPrice(int price)
{
this.price = price;
}
}
```

Step 11: Create a package with the name **com.javatpoint.controller** in the folder **src/main/java.**

Step 12: Create a Controller class in the package **com.javatpoint.controller.** We have created a controller class with the name **BooksController.** In the BooksController class, we have done the following:

- Mark the class as **RestController** by using the annotation **@RestController.**

- Autowire the **BooksService** class by using the annotation **@Autowired**.
- Define the following methods:
  - **getAllBooks():** It returns a List of all Books.
  - **getBooks():** It returns a book detail that we have specified in the path variable. We have passed bookid as an argument by using the annotation @PathVariable. The annotation indicates that a method parameter should be bound to a URI template variable.
  - **deleteBook():** It deletes a specific book that we have specified in the path variable.
  - **saveBook():** It saves the book detail. The annotation @RequestBody indicates that a method parameter should be bound to the body of the web request.
  - **update():** The method updates a record. We must specify the record in the body, which we want to update. To achieve the same, we have used the annotation @RequestBody.

BooksController.java

```java
package com.javatpoint.controller;
import java.util.List;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.web.bind.annotation.DeleteMapping;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.PutMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RestController;
import com.javatpoint.model.Books;
import com.javatpoint.service.BooksService;
//mark class as Controller
@RestController
public class BooksController
{
//autowire the BooksService class
@Autowired
BooksService booksService;
//creating a get mapping that retrieves all the books detail from the database
@GetMapping("/book")
private List<Books> getAllBooks()
{
return booksService.getAllBooks();
}
//creating a get mapping that retrieves the detail of a specific book
@GetMapping("/book/{bookid}")
private Books getBooks(@PathVariable("bookid") int bookid)
{
return booksService.getBooksById(bookid);
}
//creating a delete mapping that deletes a specified book
@DeleteMapping("/book/{bookid}")
private void deleteBook(@PathVariable("bookid") int bookid)
{
booksService.delete(bookid);
}
//creating post mapping that post the book detail in the database
@PostMapping("/books")
private int saveBook(@RequestBody Books books)
{
booksService.saveOrUpdate(books);
return books.getBookid();
}
//creating put mapping that updates the book detail
@PutMapping("/books")
private Books update(@RequestBody Books books)
{
booksService.saveOrUpdate(books);
return books;
}
}
```

Step 13: Create a package with the name **com.javatpoint.service** in the folder **src/main/java.**

Step 14: Create a **Service** class. We have created a service class with the name **BooksService** in the package **com.javatpoint.service.**

BooksService.java

```java
package com.javatpoint.service;
import java.util.ArrayList;
import java.util.List;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Service;
import com.javatpoint.model.Books;
import com.javatpoint.repository.BooksRepository;
//defining the business logic
@Service
public class BooksService
{
@Autowired
BooksRepository booksRepository;
//getting all books record by using the method findaAll() of CrudRepository
public List<Books> getAllBooks()
{
List<Books> books = new ArrayList<Books>();
booksRepository.findAll().forEach(books1 -> books.add(books1));
return books;
}
//getting a specific record by using the method findById() of CrudRepository
public Books getBooksById(int id)
{
return booksRepository.findById(id).get();
}
//saving a specific record by using the method save() of CrudRepository
public void saveOrUpdate(Books books)
{
booksRepository.save(books);
}
//deleting a specific record by using the method deleteById() of CrudRepository
public void delete(int id)
{
booksRepository.deleteById(id);
}
//updating a record
public void update(Books books, int bookid)
{
booksRepository.save(books);
}
}
```

Step 15: Create a package with the name **com.javatpoint.repository** in the folder **src/main/java.**

Step 16: Create a **Repository** interface. We have created a repository interface with the name **BooksRepository** in the package **com.javatpoint.repository.** It extends the **Crud Repository** interface.

BooksRepository.java

```java
package com.javatpoint.repository;

import org.springframework.data.repository.CrudRepository;
import com.javatpoint.model.Books;
//repository that extends CrudRepository
public interface BooksRepository extends CrudRepository<Books, Integer>
{
}
```

Now we will configure the datasource **URL, driver class name, username,** and **password,** in the **application.properties** file.

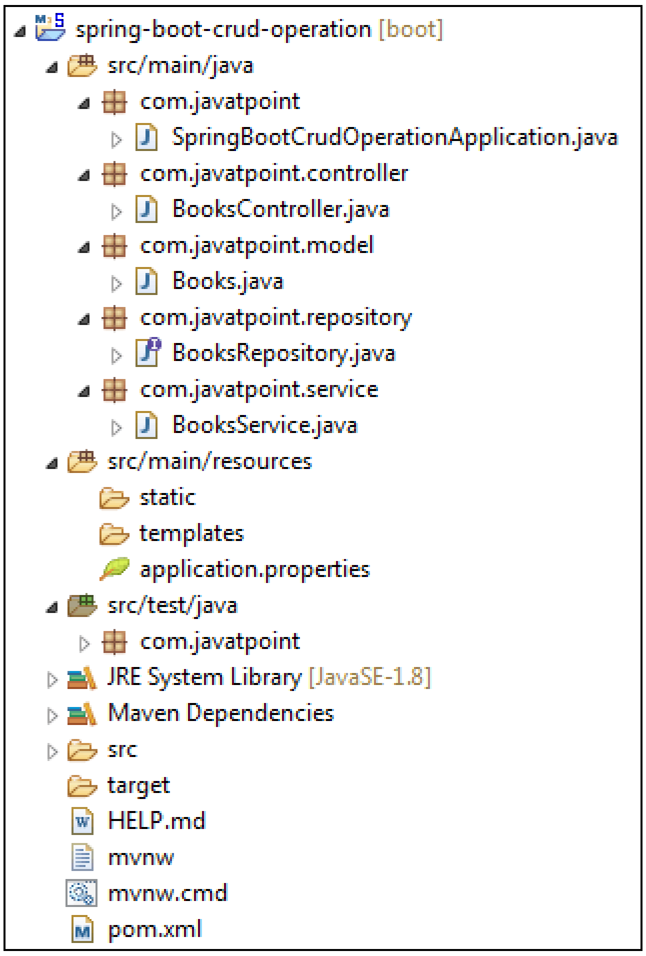
Step 17: Open the **application.properties** file and configure the following properties.

application.properties

```properties
spring.datasource.url=jdbc:h2:mem:books_data
spring.datasource.driverClassName=org.h2.Driver
spring.datasource.username=sa
spring.datasource.password=
spring.jpa.database-platform=org.hibernate.dialect.H2Dialect
#enabling the H2 console
spring.h2.console.enabled=true
```

Note: Do not forget to enable the H2 console.

After creating all the classes and packages, the project directory looks like the following.



```
spring-boot-crud-operation [boot]
  src/main/java
    com.javatpoint
      SpringBootCrudOperationApplication.java
    com.javatpoint.controller
      BooksController.java
    com.javatpoint.model
      Books.java
    com.javatpoint.repository
      BooksRepository.java
    com.javatpoint.service
      BooksService.java
  src/main/resources
    static
    templates
    application.properties
  src/test/java
    com.javatpoint
  JRE System Library [JavaSE-1.8]
  Maven Dependencies
  src
  target
  HELP.md
  mvnw
  mvnw.cmd
  pom.xml
```

Now we will run the application.

Step 18: Open **SpringBootCrudOperationApplication.java** file and run it as Java Application.

SpringBootCrudOperationApplication.java

```java
package com.javatpoint;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
@SpringBootApplication
public class SpringBootCrudOperationApplication
{
public static void main(String[] args)
{
SpringApplication.run(SpringBootCrudOperationApplication.class, args);
}
}
```

Note: In the next steps we will use rest client Postman. So, ensure that the Postman application is already installed in your system.

Step 19: Open the **Postman** and do the following:

- Select the **POST**
- Invoke the URL http://localhost:8080/books.
- Select the **Body**
- Select he Content-Type **JSON (application/json).**
- Insert the data. We have inserted the following data in the Body:

```
{
    "bookid": "5433",
    "bookname": "Core and Advance Java",
    "author": "R. Nageswara Rao",
    "price": "800"
}
```

- Click on the **Send**

When the request is successfully executed, it shows the **Status:200 OK**. It means the record has been successfully inserted in the database.

Similarly, we have inserted the following data.

```
{
    "bookid": "0982",
    "bookname": "Programming with Java",
    "author": "E. Balagurusamy",
    "price": "350"
}
{
    "bookid": "6321",
    "bookname": "Data Structures and Algorithms in Java",
    "author": "Robert Lafore",
    "price": "590"
}
{
    "bookid": "5433",
    "bookname": "Effective Java",
```

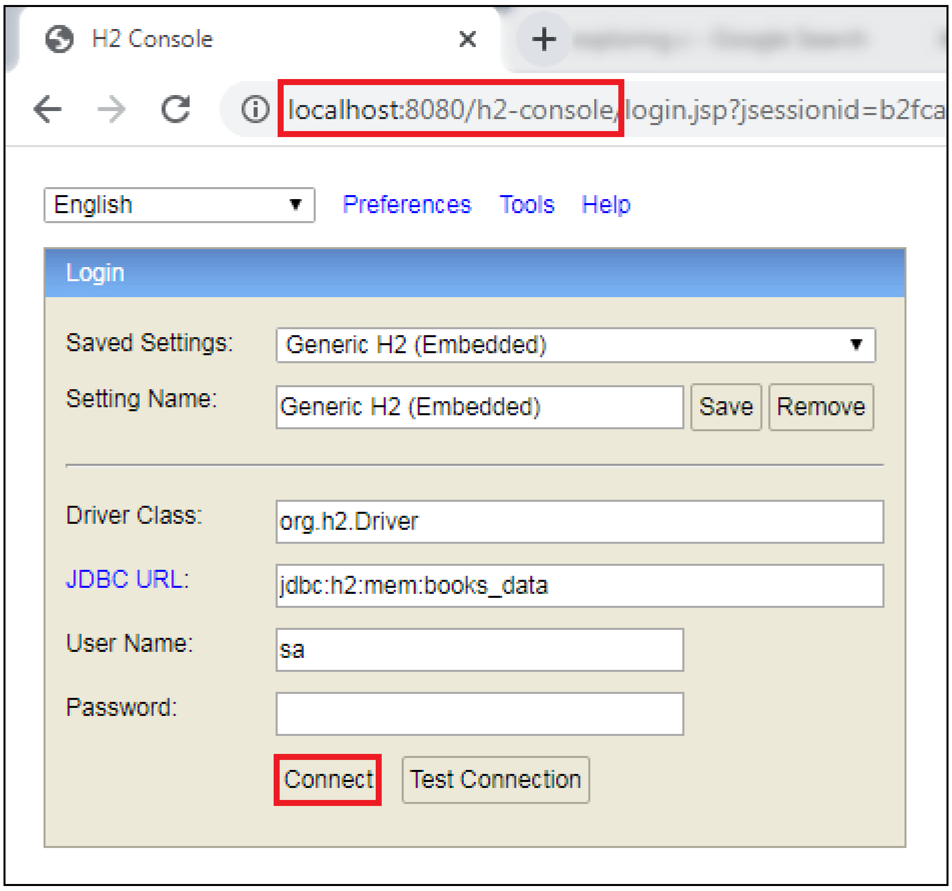
16. "author": "Joshua Bloch",

17. "price": "670"

18. }

Let's access the H2 console to see the data.

Step 20: Open the browser and invoke the URL http://localhost:8080/h2-console. Click on the **Connect** button, as shown below.



H2 Console

localhost:8080/h2-console/login.jsp?jsessionid=b2fca

English | Preferences | Tools | Help

Login

Saved Settings: Generic H2 (Embedded)

Setting Name: Generic H2 (Embedded) | Save | Remove

Driver Class: org.h2.Driver

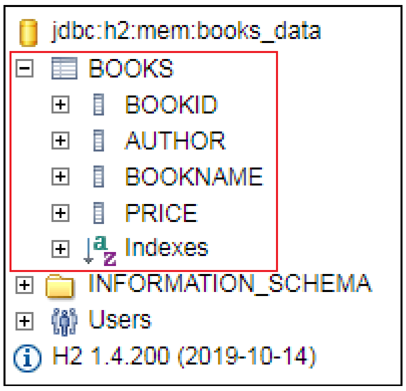
JDBC URL: jdbc:h2:mem:books_data

User Name: sa

Password:

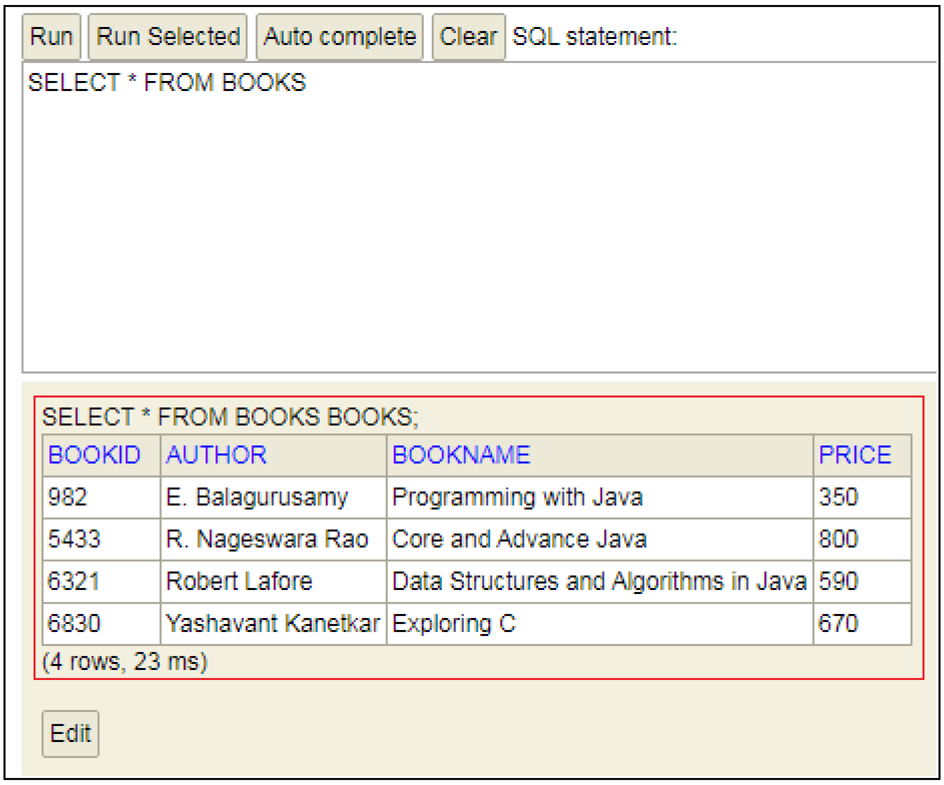
Connect | Test Connection

After clicking on the **Connect** button, we see the **Books** table in the database, as shown below.



```
jdbc:h2:mem:books_data
⊟ BOOKS
    ⊞ BOOKID
    ⊞ AUTHOR
    ⊞ BOOKNAME
    ⊞ PRICE
    ⊞ Indexes
⊞ INFORMATION_SCHEMA
⊞ Users
H2 1.4.200 (2019-10-14)
```

Step 21: Click on the **Books** table and then click on the **Run** button. The table shows the data that we have inserted in the body.



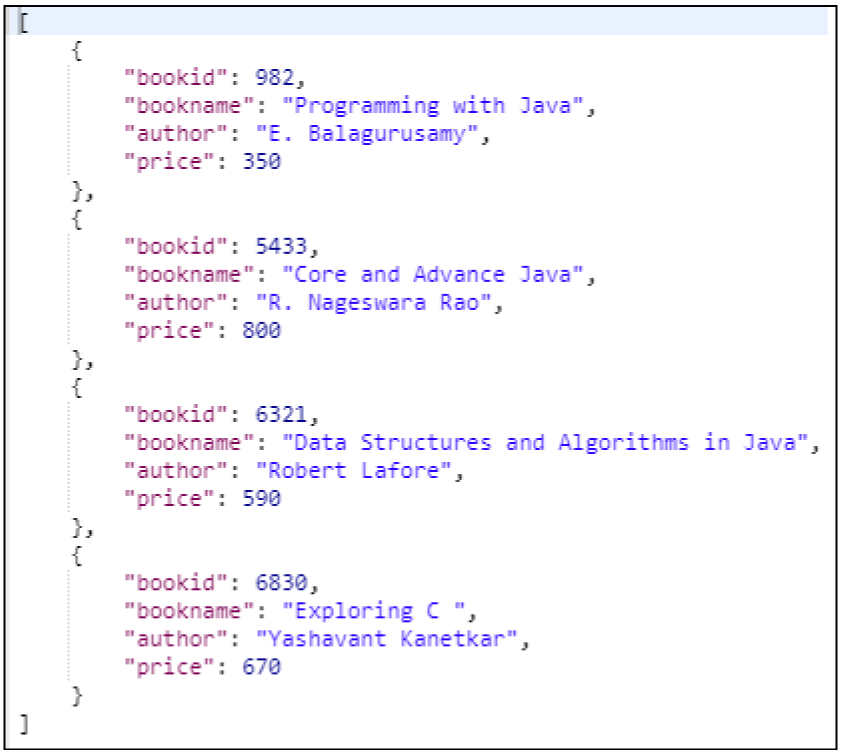
```
SELECT * FROM BOOKS
```

SELECT * FROM BOOKS BOOKS;

BOOKID	AUTHOR	BOOKNAME	PRICE
982	E. Balagurusamy	Programming with Java	350
5433	R. Nageswara Rao	Core and Advance Java	800
6321	Robert Lafore	Data Structures and Algorithms in Java	590
6830	Yashavant Kanetkar	Exploring C	670

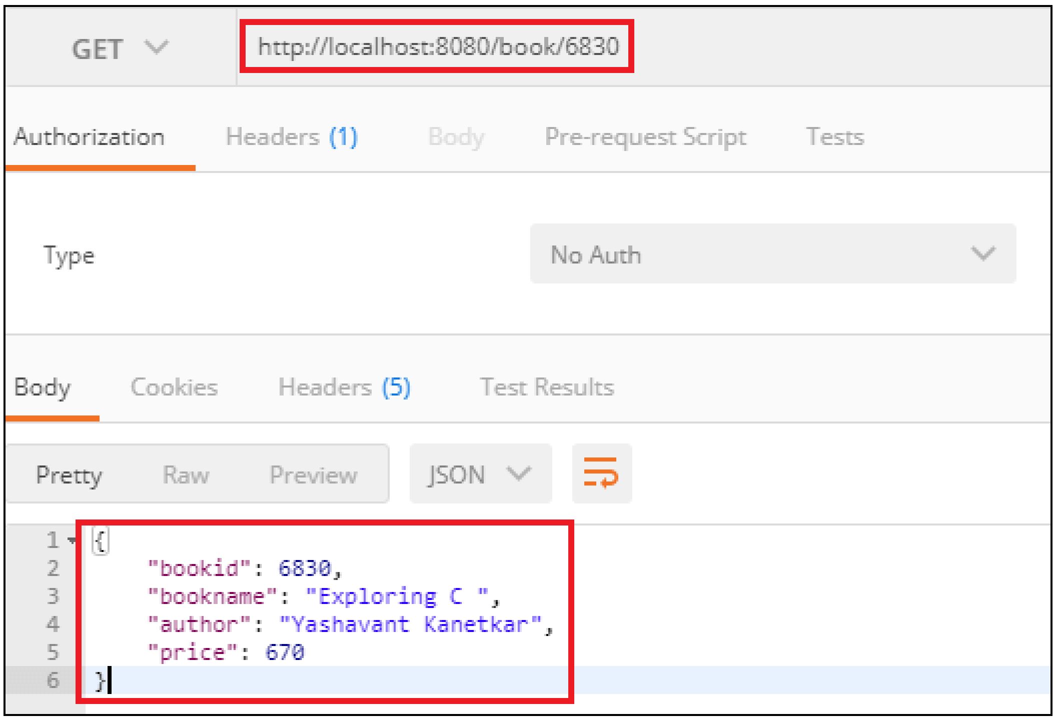
(4 rows, 23 ms)

Step 22: Open the **Postman** and send a **GET** request with the URL http://localhost:8080/books. It returns the data that we have inserted in the database.



```
[
    {
        "bookid": 982,
        "bookname": "Programming with Java",
        "author": "E. Balagurusamy",
        "price": 350
    },
    {
        "bookid": 5433,
        "bookname": "Core and Advance Java",
        "author": "R. Nageswara Rao",
        "price": 800
    },
    {
        "bookid": 6321,
        "bookname": "Data Structures and Algorithms in Java",
        "author": "Robert Lafore",
        "price": 590
    },
    {
        "bookid": 6830,
        "bookname": "Exploring C ",
        "author": "Yashavant Kanetkar",
        "price": 670
    }
]
```

Let's send a **GET** request with the URL http://localhost:8080/book/{bookid}. We have specified the **bookid 6830**. It returns the detail of the book whose id is 6830.



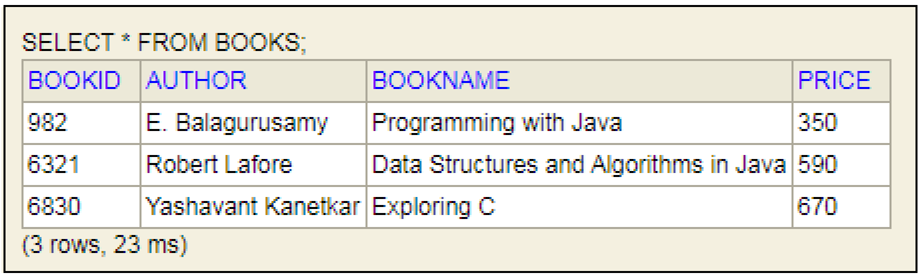
http://localhost:8080/book/6830

Type: No Auth

```
{
    "bookid": 6830,
    "bookname": "Exploring C ",
    "author": "Yashavant Kanetkar",
    "price": 670
}
```

Similarly, we can also send a **DELETE** request to delete a record. Suppose we want to delete a book record whose id is **5433**.

Select the **DELETE** method and invoke the URL http://localhost:8080/book/5433. Again, execute the **Select** query in the H2 console. We see that the book whose id is **5433** has been deleted from the database



SELECT * FROM BOOKS;

BOOKID	AUTHOR	BOOKNAME	PRICE
982	E. Balagurusamy	Programming with Java	350
6321	Robert Lafore	Data Structures and Algorithms in Java	590
6830	Yashavant Kanetkar	Exploring C	670

(3 rows, 23 ms)

Similarly, we can also update a record by sending a **PUT** request. Let's update the price of the book whose id is **6321**.

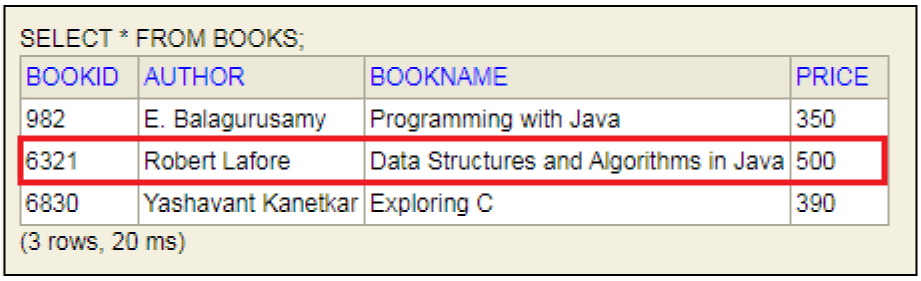
- Select the **PUT**
- In the request body, paste the record which you want to update and make the changes. In our case, we want to update the record of the book whose id is 6321. In the following record, we have changed the price of the book.

1. {

```
2.     "bookid": "6321",
3.     "bookname": "Data Structures and Algorithms in Java",
4.     "author": "Robert Lafore",
5.     "price": "500"
6.  }
```

- Click on the **Send**

Now, move to the H2 console and see the changes have reflected or not. We see that the price of the book has been changed, as shown below.



SELECT * FROM BOOKS;

BOOKID	AUTHOR	BOOKNAME	PRICE
982	E. Balagurusamy	Programming with Java	350
6321	Robert Lafore	Data Structures and Algorithms in Java	500
6830	Yashavant Kanetkar	Exploring C	390

(3 rows, 20 ms)