



# spring

## AOP

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## About the Tutorial

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One of the key components of Spring Framework is the Aspect Oriented Programming (AOP) framework. Aspect Oriented Programming entails breaking down program logic into distinct parts called so-called concerns.

This tutorial will take you through simple and practical approaches while learning AOP framework provided by Spring.

## Audience

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This tutorial has been prepared for beginners to help them understand the basic to advanced concepts related to AOP framework of Spring.

## Prerequisites

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Before you start practicing various types of examples given in this tutorial, we assume that you are already aware about computer programs and computer programming languages.

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## Table of Contents

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About the Tutorial .....	i
Audience .....	i
Prerequisites .....	i
Copyright & Disclaimer .....	i
Table of Contents .....	ii
 <b>SPRING AOP BASICS .....</b>	 <b>1</b>
1. <b>Spring AOP – Overview .....</b>	<b>2</b>
2. <b>Spring AOP – Environment Setup .....</b>	<b>3</b>
3. <b>Spring AOP – Core Concepts .....</b>	<b>8</b>
4. <b>Spring AOP – Advice Types .....</b>	<b>9</b>
5. <b>Spring AOP – Implementations .....</b>	<b>10</b>
Declaring an Aspect .....	10
Declaring a PointCut .....	11
Declaring Advices .....	12
Declaring an Aspect .....	13
Declaring a PointCut .....	14
Declaring Advices .....	14
 <b>XML CONFIGURATION EXAMPLES .....</b>	 <b>16</b>
6. <b>Spring AOP – XML-Based Application .....</b>	<b>17</b>
Create a Project .....	17
Import Project in Eclipse .....	26
Run Project .....	26
7. <b>Spring AOP – XML-Based PointCut .....</b>	<b>28</b>
8. <b>Spring AOP – XML-Based Before Advice .....</b>	<b>33</b>
9. <b>Spring AOP – XML-Based After Advice .....</b>	<b>37</b>
10. <b>Spring AOP – XML-Based After Returning Advice .....</b>	<b>41</b>
11. <b>Spring AOP – XML-Based After-Throwing Advice .....</b>	<b>45</b>
12. <b>Spring AOP – XML-Based Around Advice .....</b>	<b>49</b>
 <b>ANNOTATION EXAMPLES .....</b>	 <b>53</b>
13. <b>Spring AOP – Annotation-Based Application .....</b>	<b>54</b>
14. <b>Spring AOP – Annotation-Based PointCut .....</b>	<b>58</b>

15.	Spring AOP – Annotation-Based Before Advice .....	62
16.	Spring AOP – Annotation-Based After Advice .....	66
17.	Spring AOP – Annotation-Based After-Returning Advice .....	70
18.	Spring AOP – Annotation-Based After Throwing Advice .....	74
19.	Spring AOP – Annotation-Based Around Advice .....	78
	SPRING AOP ADVANCED .....	83
20.	Spring AOP – Proxy.....	84
21.	Spring AOP – Custom Annotation .....	88

# Spring AOP Basics

# 1. Spring AOP – Overview

One of the key components of Spring Framework is the **Aspect Oriented Programming (AOP)** framework. Aspect Oriented Programming entails breaking down program logic into distinct parts called **so-called concerns**. The functions that span multiple points of an application are called **cross-cutting concerns**. These cross-cutting concerns are conceptually separate from the application's business logic. There are various common good examples of aspects such as logging, auditing, declarative transactions, security, caching, etc.

The key unit of modularity in OOP is the class, whereas in AOP the unit of modularity is the aspect. Dependency Injection helps you decouple your application objects from each other, while AOP helps you decouple cross-cutting concerns from the objects that they affect. AOP is like triggers in programming languages such as Perl, .NET, Java, and others.

Spring AOP module lets interceptors intercept an application. For example, when a method is executed, you can add extra functionality before or after the method execution.

## 2. Spring AOP – Environment Setup

This chapter takes you through the process of setting up Spring AOP on Windows and Linux based systems. Spring AOP can be easily installed and integrated with your current Java environment and MAVEN by following a few simple steps without any complex setup procedures. User administration is required while installation.

### System Requirements

JDK	Java SE 2 JDK 1.5 or above
Memory	1 GB RAM (recommended)
Disk Space	No minimum requirement
Operating System Version	Windows XP or above, Linux

Let us now look at the steps to install Spring AOP.

### Step 1: Verify your Java Installation

First of all, you need to have Java Software Development Kit (SDK) installed on your system. To verify this, execute any of the following two commands depending on the platform you are working on.

If the Java installation has been done properly, then it will display the current version and specification of your Java installation. A sample output is given in the following table.

Platform	Command	Sample Output
Windows	Open command console and type:  <b>\&gt;java -version</b>	Java version "1.7.0_60"  Java (TM) SE Run Time Environment (build 1.7.0_60-b19)  Java Hotspot (TM) 64-bit Server VM (build 24.60-b09,mixed mode)
Linux	Open command terminal and type:  <b>\$java -version</b>	java version "1.7.0_25"  Open JDK Runtime Environment (rhel-2.3.10.4.el6_4-x86_64)  Open JDK 64-Bit Server VM (build 23.7-b01, mixed mode)

We assume the readers of this tutorial have Java SDK version 1.7.0\_60 installed on their system.

In case you do not have Java SDK, download its current version from <http://www.oracle.com/technetwork/java/javase/downloads/index.html> and have it installed.

## Step 2: Set your Java Environment

Set the environment variable JAVA\_HOME to point to the base directory location where Java is installed on your machine. For example,

Platform	Description
Windows	Set JAVA_HOME to C:\ProgramFiles\java\jdk1.7.0_60
Linux	Export JAVA_HOME=/usr/local/java-current

Append the full path of Java compiler location to the System Path.

Platform	Description
Windows	Append the String "C:\Program Files\Java\jdk1.7.0_60\bin" to the end of the system variable PAT
Linux	Export PATH=\$PATH:\$JAVA_HOME/bin/

Execute the command **java -version** from the command prompt as explained above.

## Step 3: Download Maven Archive

Download Maven 3.3.3 from <http://maven.apache.org/download.cgi>

OS	Archive Name
Windows	apache-maven-3.3.3-bin.zip
Linux	apache-maven-3.3.3-bin.tar.gz
Mac	apache-maven-3.3.3-bin.tar.gz

## Step 4: Extract the Maven Archive

Extract the archive, to the directory you wish to install Maven 3.3.3. The subdirectory apache-maven-3.3.3 will be created from the archive.

OS	Location (can be different based on your installation)
Windows	C:\Program Files\Apache Software Foundation\apache-maven-3.3.3
Linux	/usr/local/apache-maven
Mac	/usr/local/apache-maven



## Step 5: Set Maven Environment Variables

Add M2\_HOME, M2, MAVEN\_OPTS to environment variables.

OS	Output
Windows	<p>Set the environment variables using system properties.</p> <pre>M2_HOME=C:\Program Files\Apache Software Foundation\apache-maven-3.3.3</pre> <pre>M2=%M2_HOME%\bin</pre> <pre>MAVEN_OPTS=-Xms256m -Xmx512m</pre>
Linux	<p>Open command terminal and set environment variables.</p> <pre>export M2_HOME=/usr/local/apache-maven/apache-maven-3.3.3</pre> <pre>export M2=\$M2_HOME/bin</pre> <pre>export MAVEN_OPTS=-Xms256m -Xmx512m</pre>
Mac	<p>Open command terminal and set environment variables.</p> <pre>export M2_HOME=/usr/local/apache-maven/apache-maven-3.3.3</pre> <pre>export M2=\$M2_HOME/bin</pre> <pre>export MAVEN_OPTS=-Xms256m -Xmx512m</pre>

## Step 6: Add Maven Bin Directory Location to System Path

Now append M2 variable to System Path.

OS	Output
Windows	Append the string ;%M2% to the end of the system variable, Path.
Linux	<pre>export PATH=\$M2:\$PATH</pre>
Mac	<pre>export PATH=\$M2:\$PATH</pre>

## Step 7: Verify Maven installation

Now open console, and execute the following **mvn** command.

OS	Task	Command
Windows	Open Command Console	c:\> mvn --version
Linux	Open Command Terminal	\$ mvn --version
Mac	Open Terminal	machine:< joseph\$ mvn --version

Finally, verify the output of the above commands, which should be something as follows:

OS	Output
Windows	<p>Apache Maven 3.3.3 (7994120775791599e205a5524ec3e0dfe41d4a06; 2015-04-22T17:27:37+05:30)</p> <p>Maven home: C:\Program Files\Apache Software Foundation\apache-maven-3.3.3</p> <p>Java version: 1.7.0_75, vendor: Oracle Corporation</p> <p>Java home: C:\Program Files\Java\jdk1.7.0_75\jre</p> <p>Default locale: en_US, platform encoding: Cp1252</p>
Linux	<p>Apache Maven 3.3.3 (7994120775791599e205a5524ec3e0dfe41d4a06; 2015-04-22T17:27:37+05:30)</p> <p>Maven home: /usr/local/apache-maven/apache-maven-3.3.3</p> <p>Java version: 1.7.0_75, vendor: Oracle Corporation</p> <p>Java home: /usr/local/java-current/jdk1.7.0_75/jre</p>
Mac	<p>Apache Maven 3.3.3 (7994120775791599e205a5524ec3e0dfe41d4a06; 2015-04-22T17:27:37+05:30)</p> <p>Maven home: /usr/local/apache-maven/apache-maven-3.3.3</p> <p>Java version: 1.7.0_75, vendor: Oracle Corporation</p> <p>Java home: /Library/Java/Home/jdk1.7.0_75/jre</p>

## Step 8: Set Up Eclipse IDE

All the examples in this tutorial have been written using Eclipse IDE. So I would suggest you should have the latest version of Eclipse installed on your machine.

To install Eclipse IDE, download the latest Eclipse binaries from <http://www.eclipse.org/downloads/>. Once you download the installation, unpack the binary distribution into a convenient location. For example, in C:\eclipse on Windows, or /usr/local/eclipse on Linux/Unix and finally set PATH variable appropriately.

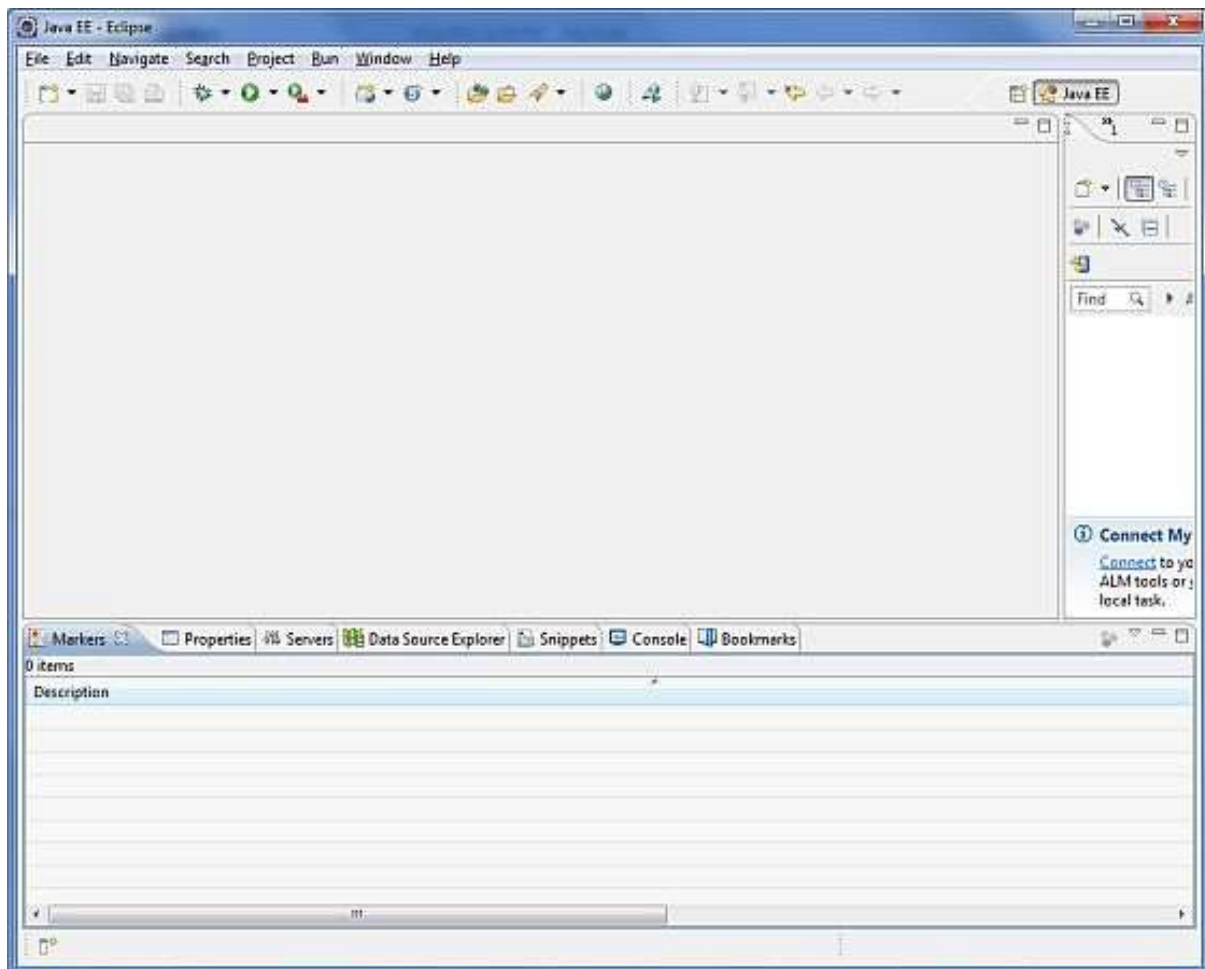
Eclipse can be started by executing the following commands on Windows machine, or you can double-click on eclipse.exe

```
%C:\eclipse\eclipse.exe
```

Eclipse can be started by executing the following commands on Unix (Solaris, Linux, etc.) machine:

```
$/usr/local/eclipse/eclipse
```

After a successful startup, if everything is fine then it should display the following result.



Once you are done with this last step, you are ready to proceed for your first AOP example, which you will see in the next chapter.

### 3. Spring AOP – Core Concepts

Before we start working with AOP, let us become familiar with the AOP concepts and terminologies. These terms are not specific to Spring, rather they are related to AOP.

Terms	Description
Aspect	A module which has a set of APIs providing cross-cutting requirements. For example, a logging module would be called AOP aspect for logging. An application can have any number of aspects depending on the requirement.
Join point	This represents a point in your application where you can plug-in AOP aspect. You can also say, it is the actual place in the application where an action will be taken using Spring AOP framework.
Advice	This is the actual action to be taken either before or after the method execution. This is the actual piece of code that is invoked during program execution by Spring AOP framework.
Pointcut	This is a set of one or more join points where an advice should be executed. You can specify pointcuts using expressions or patterns as we will see in our AOP examples.
Introduction	An introduction allows you to add new methods or attributes to existing classes.
Target object	The object being advised by one or more aspects. This object will always be a proxied object. Also referred to as the advised object.
Weaving	Weaving is the process of linking aspects with other application types or objects to create an advised object. This can be done at compile time, load time, or at runtime.

## 4. Spring AOP – Advice Types

Spring aspects can work with five kinds of advice mentioned in the following table.

Advice	Description
before	Run advice before the method execution.
after	Run advice after the method execution, regardless of its outcome.
after-returning	Run advice after the method execution, only if the method completes successfully.
after-throwing	Run advice after the method execution, only if the method exits by throwing an exception.
around	Run advice before and after the advised method is invoked.

## 5. Spring AOP – Implementations

Spring supports the **@AspectJ annotation style** approach and the **schema-based** approach to implement custom aspects.

### XML Schema Based

Aspects are implemented using regular classes along with XML based configuration.

To use the AOP namespace tags described in this section, you need to import the spring-AOP schema, described as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
http://www.springframework.org/schema/aop
http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <!-- bean definition & AOP specific configuration -->
</beans>
```

### Declaring an Aspect

An **aspect** is declared using the **<aop:aspect>** element, and the backing bean is referenced using the **ref** attribute as follows.

```
<aop:config>
    <aop:aspect id="myAspect" ref="aBean">
        ...
    </aop:aspect>
</aop:config>

<bean id="aBean" class="...">
    ...
</bean>
```

Here "aBean" will be configured and dependency injected just like any other Spring bean as you have seen in the previous chapters.

## Declaring a PointCut

A **PointCut** helps in determining the join points (i.e. methods) of interest to be executed with different advices. While working with XML Schema based configuration, PointCut will be defined as follows:

```
<aop:config>
  <aop:aspect id="myAspect" ref="aBean">

    <aop:pointcut id="businessService"
      expression="execution(* com.xyz.myapp.service.*(..))"/>
    ...
  </aop:aspect>
</aop:config>

<bean id="aBean" class="...">
  ...
</bean>
```

The following example defines a pointcut named 'businessService' that will match the execution of getName() method available in Student class under the package com.tutorialspoint.

```
<aop:config>
  <aop:aspect id="myAspect" ref="aBean">

    <aop:pointcut id="businessService"
      expression="execution(* com.tutorialspoint.Student.getName(..))"/>
    ...
  </aop:aspect>
</aop:config>

<bean id="aBean" class="...">
  ...
</bean>
```

## Declaring Advices

You can declare any of the five advices inside an `<aop:aspect>` using the `<aop:{ADVICE NAME}>` element as follows.

```
<aop:config>
  <aop:aspect id="myAspect" ref="aBean">
    <aop:pointcut id="businessService"
      expression="execution(* com.xyz.myapp.service.*(..))"/>

    <!-- a before advice definition -->
    <aop:before pointcut-ref="businessService"
      method="doRequiredTask"/>

    <!-- an after advice definition -->
    <aop:after pointcut-ref="businessService"
      method="doRequiredTask"/>

    <!-- an after-returning advice definition -->
    <!--The doRequiredTask method must have parameter named retVal -->
    <aop:after-returning pointcut-ref="businessService"
      returning="retVal"
      method="doRequiredTask"/>

    <!-- an after-throwing advice definition -->
    <!--The doRequiredTask method must have parameter named ex -->
    <aop:after-throwing pointcut-ref="businessService"
      throwing="ex"
      method="doRequiredTask"/>

    <!-- an around advice definition -->
    <aop:around pointcut-ref="businessService"
      method="doRequiredTask"/>

    ...
  </aop:aspect>
</aop:config>
```



```
<bean id="aBean" class="...">
...
</bean>
```

You can use same **doRequiredTask** or different methods for different advices. These methods will be defined as a part of aspect module.

### @AspectJ based

@AspectJ refers to a style of declaring aspects as regular Java classes annotated with Java 5 annotations. @AspectJ refers to a style of declaring aspects as regular Java classes annotated with Java 5 annotations. The @AspectJ support is enabled by including the following element inside your XML Schema-based configuration file.

```
<aop:aspectj-autoproxy/>
```

## Declaring an Aspect

Aspects classes are like any other normal bean and may have methods and fields just like any other class, except that they will be annotated with @Aspect as follows.

```
package org.xyz;

import org.aspectj.lang.annotation.Aspect;

@Aspect
public class AspectModule {

}
```

They will be configured in XML like any other bean as follows.

```
<bean id="myAspect" class="org.xyz.AspectModule">
    <!-- configure properties of aspect here as normal -->
</bean>
```

## Declaring a PointCut

A PointCut helps in determining the join points (i.e. methods) of interest to be executed with different advices. While working with @AspectJ based configuration, PointCut declaration has two parts:

- A PointCut expression that determines exactly which method executions we are interested in.
- A PointCut signature comprising a name and any number of parameters. The actual body of the method is irrelevant and in fact should be empty.

The following example defines a pointcut named 'businessService' that will match the execution of every method available in the classes under the package com.xyz.myapp.service.

```
import org.aspectj.lang.annotation.Pointcut;

@Pointcut("execution(* com.xyz.myapp.service.*(..))") // expression
private void businessService() {} // signature
```

The following example defines a PointCut named 'getname' that will match the execution of getName() method available in Student class under the package com.tutorialspoint.

```
import org.aspectj.lang.annotation.Pointcut;

@Pointcut("execution(* com.tutorialspoint.Student.getName(..))")
private void getname() {}
```

## Declaring Advices

You can declare any of the five advices using @{ADVICE-NAME} annotations as given below. This assumes that you already have defined a PointCut signature method businessService().

```
@Before("businessService()")
public void doBeforeTask(){
    ...
}

@After("businessService()")
public void doAfterTask(){
    ...
}
```

```
@AfterReturning(pointcut = "businessService()", returning="retVal")
public void doAfterReturnningTask(Object retVal){
    // you can intercept retVal here.
    ...
}

@AfterThrowing(pointcut = "businessService()", throwing="ex")
public void doAfterThrowingTask(Exception ex){
    // you can intercept thrown exception here.
    ...
}

@Around("businessService()")
public void doAroundTask(){
    ...
}
```

You can define PointCut inline for any of the advices. Following is an example to define inline PointCut for before advice.

```
@Before("execution(* com.xyz.myapp.service.*.*(..))")
public void doBeforeTask(){
    ...
}
```

# XML Configuration Examples

## 6. Spring AOP – XML-Based Application

In this chapter, we will write actual AOP applications using Spring AOP Framework. Before you start writing your first example using Spring-WS framework, you have to make sure that you have set up your Spring AOP environment properly as explained in [Spring Web Services - Environment Setup](#) chapter.

Now, proceed to write a simple console-based Spring AOP Application, which will demonstrate AOP concepts.

### Create a Project

**Step 1:** Open a command console, go the C:\MVN directory and execute the following **mvn** command.

```
C:\MVN>mvn archetype:generate -DgroupId=com.tutorialspoint -DartifactId=Student
-DarchetypeArtifactId=maven-archetype-quickstart -DinteractiveMode=false
```

Maven will start processing and will create the complete Java application project structure.

```
[INFO] Scanning for projects...
[INFO]
[INFO] -----
[INFO] Building Maven Stub Project (No POM) 1
[INFO] -----
[INFO]
[INFO] >>> maven-archetype-plugin:2.4:generate (default-cli) > generate-sources
@ standalone-pom >>>
[INFO]
[INFO] <<< maven-archetype-plugin:2.4:generate (default-cli) < generate-sources
@ standalone-pom <<<
[INFO]
[INFO] --- maven-archetype-plugin:2.4:generate (default-cli) @ standalone-pom ---

[INFO] Generating project in Batch mode
Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/archetypes/maven-archetype-quickstart/1.0/maven-archetype-quickstart-1.0.jar
Downloaded: https://repo.maven.apache.org/maven2/org/apache/maven/archetypes/maven-archetype-quickstart/1.0/maven-archetype-quickstart-1.0.jar (5 KB at 1.1 KB/sec)
```

```

Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/archetypes/maven-
archetype-quickstart/1.0/maven-archetype-quickstart-1.0.pom

Downloaded:
https://repo.maven.apache.org/maven2/org/apache/maven/archetypes/maven-
archetype-quickstart/1.0/maven-archetype-quickstart-1.0.pom (703 B at 1.2
KB/sec)

[INFO] -----
[INFO] Using following parameters for creating project from Old (1.x)
Archetype:
    maven-archetype-quickstart:1.0
[INFO] -----
[INFO] Parameter: groupId, Value: com.tutorialspoint
[INFO] Parameter: packageName, Value: com.tutorialspoint
[INFO] Parameter: package, Value: com.tutorialspoint
[INFO] Parameter: artifactId, Value: Student
[INFO] Parameter: basedir, Value: C:\MVN
[INFO] Parameter: version, Value: 1.0-SNAPSHOT
[INFO] project created from Old (1.x) Archetype in dir: C:\MVN\Student
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 01:17 min
[INFO] Finished at: 2017-02-19T21:11:14+05:30
[INFO] Final Memory: 15M/114M
[INFO] -----

```

**Step 2:** Go to C:/MVN directory. You'll see a Java application project created, named student (as specified in artifactId). Update the POM.xml to include Spring-AOP dependencies. Add MainApp.java, Student.java, and Logging.java files.

## 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/maven-v4_0_0.xsd">
    <modelVersion>4.0.0</modelVersion>
    <groupId>com.tutorialspoint</groupId>
    <artifactId>Student</artifactId>

```

```

<packaging>jar</packaging>
<version>1.0-SNAPSHOT</version>
<name>Student</name>
<url>http://maven.apache.org</url>
<dependencies>
  <dependency>
    <groupId>junit</groupId>
    <artifactId>junit</artifactId>
    <version>3.8.1</version>
    <scope>test</scope>
  </dependency>
  <dependency>
    <groupId>org.springframework</groupId>
    <artifactId>spring-aop</artifactId>
    <version>4.1.0.RELEASE</version>
  </dependency>
  <dependency>
    <groupId>org.springframework</groupId>
    <artifactId>spring-context</artifactId>
    <version>4.1.4.RELEASE</version>
  </dependency>
  <dependency>
    <groupId>org.aspectj</groupId>
    <artifactId>aspectjweaver</artifactId>
    <version>1.6.8</version>
  </dependency>
</dependencies>
</project>
package com.tutorialspoint;

public class Logging {

  /**
   * This is the method which I would like to execute
   * before a selected method execution.
   */

```

```

public void beforeAdvice(){
    System.out.println("Going to setup student profile.");
}

/**
 * This is the method which I would like to execute
 * after a selected method execution.
 */
public void afterAdvice(){
    System.out.println("Student profile has been setup.");
}

/**
 * This is the method which I would like to execute
 * when any method returns.
 */
public void afterReturningAdvice(Object retVal){
    System.out.println("Returning:" + retVal.toString() );
}

/**
 * This is the method which I would like to execute
 * if there is an exception raised.
 */
public void AfterThrowingAdvice(IllegalArgumentException ex){
    System.out.println("There has been an exception: " + ex.toString());
}
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

```



```

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
    }
}

```

```

        student.getAge();

        student.printThrowException();
    }
}

```

**Step 3:** Add the configuration file **Beans.xml** under **src > main > resources** folder.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
http://www.springframework.org/schema/aop
http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">
            <aop:pointcut id="selectAll"
                expression="execution(* com.tutorialspoint.*.*(..))"/>
            <aop:before pointcut-ref="selectAll" method="beforeAdvice"/>
            <aop:after pointcut-ref="selectAll" method="afterAdvice"/>
            <aop:after-returning pointcut-ref="selectAll"
                returning="retVal"
                method="afterReturningAdvice"/>
            <aop:after-throwing pointcut-ref="selectAll"
                throwing="ex"
                method="AfterThrowingAdvice"/>
        </aop:aspect>
    </aop:config>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

```

```
<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

**Step 4:** Open the command console, go the C:\MVN directory and execute the following **mvn** command.

```
C:\MVN>Student> mvn package
```

Maven will start processing and downloading the required libraries.

```
[INFO] Scanning for projects...
[INFO]
[INFO] -----
[INFO] Building Student 1.0-SNAPSHOT
[INFO] -----

Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-jar-
plugin/2.4/maven-jar-plugin-2.4.pom
Downloaded:
https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-
jar-plugin/2.4/maven-jar-plugin-2.4.pom (6 KB at 2.2 KB/sec)

Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-jar-
plugin/2.4/maven-jar-plugin-2.4.jar
Downloaded:
https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-
jar-plugin/2.4/maven-jar-plugin-2.4.jar (34 KB at 31.6 KB/sec)

Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
aop/4.1.0.RELEASE/spring-aop-4.1.0.RELEASE.pom
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
aop/4.1.0.RELEASE/spring-aop-4.1.0.RELEASE.pom (3 KB at 3.7 KB/sec)

Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
beans/4.1.0.RELEASE/spring-beans-4.1.0.RELEASE.pom
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
beans/4.1.0.RELEASE/spring-beans-4.1.0.RELEASE.pom (3 KB at 4.1 KB/sec)

Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
core/4.1.0.RELEASE/spring-core-4.1.0.RELEASE.pom
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
core/4.1.0.RELEASE/spring-core-4.1.0.RELEASE.pom (3 KB at 4.0 KB/sec)
```

```

Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
aop/4.1.0.RELEASE/spring-aop-4.1.0.RELEASE.jar
Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
core/4.1.0.RELEASE/spring-core-4.1.0.RELEASE.jar
Downloading: https://repo.maven.apache.org/maven2/org/springframework/spring-
beans/4.1.0.RELEASE/spring-beans-4.1.0.RELEASE.jar
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
aop/4.1.0.RELEASE/spring-aop-4.1.0.RELEASE.jar (351 KB at 43.9 KB/sec)
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
beans/4.1.0.RELEASE/spring-beans-4.1.0.RELEASE.jar (685 KB at 37.5 KB/sec)
Downloaded: https://repo.maven.apache.org/maven2/org/springframework/spring-
core/4.1.0.RELEASE/spring-core-4.1.0.RELEASE.jar (982 KB at 47.1 KB/sec)
[INFO]
[INFO] --- maven-resources-plugin:2.6:resources (default-resources) @ Student -
[WARNING] Using platform encoding (Cp1252 actually) to copy filtered resources,
i.e. build is platform dependent!
[INFO] skip non existing resourceDirectory C:\MVN\Student\src\main\resources
[INFO]
[INFO] --- maven-compiler-plugin:3.1:compile (default-compile) @ Student ---
[INFO] Changes detected - recompiling the module!
[WARNING] File encoding has not been set, using platform encoding Cp1252, i.e.
build is platform dependent!
[INFO] Compiling 1 source file to C:\MVN\Student\target\classes
[INFO]
[INFO] --- maven-resources-plugin:2.6:testResources (default-testResources) @ Student --
[WARNING] Using platform encoding (Cp1252 actually) to copy filtered resources,
i.e. build is platform dependent!
[INFO] skip non existing resourceDirectory C:\MVN\Student\src\test\resources
[INFO]
[INFO] --- maven-compiler-plugin:3.1:testCompile (default-testCompile) @ Student
---
[INFO] Changes detected - recompiling the module!
[WARNING] File encoding has not been set, using platform encoding Cp1252, i.e.
build is platform dependent!
[INFO] Compiling 1 source file to C:\MVN\Student\target\test-classes
[INFO]
[INFO] --- maven-surefire-plugin:2.12.4:test (default-test) @ Student ---
[INFO] Surefire report directory: C:\MVN\Student\target\surefire-reports

```

```

Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/surefire/sure
fire-junit3/2.12.4/surefire-junit3-2.12.4.pom
Downloaded:
https://repo.maven.apache.org/maven2/org/apache/maven/surefire/suref
ire-junit3/2.12.4/surefire-junit3-2.12.4.pom (2 KB at 1.3 KB/sec)
Downloading:
https://repo.maven.apache.org/maven2/org/apache/maven/surefire/surefire-
junit3/2.12.4/surefire-junit3-2.12.4.jar
Downloaded:
https://repo.maven.apache.org/maven2/org/apache/maven/surefire/surefire-
junit3/2.12.4/surefire-junit3-2.12.4.jar (26 KB at 27.7 KB/sec)
-----
T E S T S
-----
Running com.tutorialspoint.AppTest
Tests run: 1, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.002 sec

Results :

Tests run: 1, Failures: 0, Errors: 0, Skipped: 0

[INFO]
[INFO] --- maven-jar-plugin:2.4:jar (default-jar) @ Student ---
Downloading: https://repo.maven.apache.org/maven2/classworlds/classworlds/1.1-
alpha-2/classworlds-1.1-alpha-2.jar
Downloaded: https://repo.maven.apache.org/maven2/classworlds/classworlds/1.1-
alpha-2/classworlds-1.1-alpha-2.jar (37 KB at 35.8 KB/sec)
[INFO] Building jar: C:\MVN\Student\target\Student-1.0-SNAPSHOT.jar
[INFO] -----
[INFO] BUILD SUCCESS
[INFO] -----
[INFO] Total time: 38.441 s
[INFO] Finished at: 2017-02-19T21:18:59+05:30
[INFO] Final Memory: 18M/109M
[INFO] -----

```

## Import Project in Eclipse

---

**Step 1:** Open Eclipse.

**Step 2:** Select File -> Import -> option.

**Step 3:** Select Maven Projects Option. Click the Next Button.

**Step 4:** Select Project location, where Student project was created using Maven.

**Step 5:** Click Finish Button.

## Run Project

---

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```

Going to setup student profile.
Name : Zara
Student profile has been setup.
Returning:Zara
Going to setup student profile.
Age : 11
Student profile has been setup.
Returning:11
Going to setup student profile.
Exception raised
Student profile has been setup.
There has been an exception: java.lang.IllegalArgumentException
Exception in thread "main" java.lang.IllegalArgumentException
    at com.tutorialspoint.Student.printThrowException(Student.java:25)
    at
com.tutorialspoint.Student$$FastClassBySpringCGLIB$$7dc55815.invoke(<generated>)
    at org.springframework.cglib.proxy.MethodProxy.invoke(MethodProxy.java:204)
    at
org.springframework.aop.framework.CglibAopProxy$CglibMethodInvocation.invokeJoinpoint(CglibAopProxy.java:717)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:157)
    at
org.springframework.aop.framework.adapter.MethodBeforeAdviceInterceptor.invoke(MethodBeforeAdviceInterceptor.java:52)

```

```
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(Reflective
MethodInvocation.java:179)
    at
org.springframework.aop.aspectj.AspectJAfterAdvice.invoke(AspectJAfterAdvice.java:43)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(Reflective
MethodInvocation.java:179)
    at
org.springframework.aop.framework.adapter.AfterReturningAdviceInterceptor.invoke
(AfterReturningAdviceInterceptor.java:52)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(Reflective
MethodInvocation.java:179)
    at
org.springframework.aop.aspectj.AspectJAfterThrowingAdvice.invoke(AspectJAfterT
hrowingAdvice.java:58)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(Reflective
MethodInvocation.java:179)
    at
org.springframework.aop.interceptor.ExposeInvocationInterceptor.invoke(ExposeIn
vocationInterceptor.java:92)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(Reflective
MethodInvocation.java:179)
    at
org.springframework.aop.framework.CglibAopProxy$DynamicAdvisedInterceptor.inter
cept(CglibAopProxy.java:653)
    at
com.tutorialspoint.Student$$EnhancerBySpringCGLIB$$56a970f2.printThrowException
(<generated>)
    at com.tutorialspoint.MainApp.main(MainApp.java:16)
```

## 7. Spring AOP – XML-Based PointCut

### JoinPoint

A JoinPoint represents a point in your application where you can plug-in AOP aspect. You can also say, it is the actual place in the application where an action will be taken using Spring AOP framework. Consider the following examples:

- All methods classes contained in a package(s).
- A particular methods of a class.

### PointCut

PointCut is a set of one or more JoinPoints where an advice should be executed. You can specify PointCuts using expressions or patterns as we will see in our AOP examples. In Spring, PointCut helps to use specific JoinPoints to apply the advice. Consider the following examples:

- `expression="execution(* com.tutorialspoint.*.*(..))"`
- `expression="execution(* com.tutorialspoint.Student.getName(..))"`

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="adviceClass">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
  </aop:aspect>
</aop:config>
```

Where,

- **adviceClass** - ref of the class containing advice methods
- **pointcut-id** - id of the PointCut
- **execution( expression )** - expression covering methods on which advice is to be applied.

To understand the above-mentioned concepts related to JoinPoint and PointCut, let us write an example which will implement few of the PointCuts. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.



Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

public class Logging {

    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
}
```

```

    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
        student.getAge();
    }
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

```

```

<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="selectAll"
      expression="execution(* com.tutorialspoint.*.*(..))"/>
    <aop:before pointcut-ref="selectAll" method="beforeAdvice"/>
  </aop:aspect>
</aop:config>

<!-- Definition for student bean -->
<bean id="student" class="com.tutorialspoint.Student">
  <property name="name" value="Zara" />
  <property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>
</beans>

```

Once you are done with creating the source and bean configuration files, run the application. If everything is fine with your application, it will print the following message.

```

Going to setup student profile.
Name : Zara
Going to setup student profile.
Age : 11

```

The above-defined `<aop:pointcut>` selects all the methods defined under the package `com.tutorialspoint`. Let us suppose, you want to execute your advice before or after a particular method, you can define your PointCut to narrow down your execution by replacing stars (\*) in PointCut definition with actual class and method names. Following is a modified XML configuration file to show the concept.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:aop="http://www.springframework.org/schema/aop"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
    http://www.springframework.org/schema/aop
    http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

```

```
<aop:config>
<aop:aspect id="log" ref="logging">
  <aop:pointcut id="selectAll"
    expression="execution(* com.tutorialspoint.Student.getName(..))"/>
  <aop:before pointcut-ref="selectAll" method="beforeAdvice"/>
</aop:aspect>
</aop:config>

<!-- Definition for student bean -->
<bean id="student" class="com.tutorialspoint.Student">
  <property name="name" value="Zara" />
  <property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.
Name : Zara
Age : 11
```

## 8. Spring AOP – XML-Based Before Advice

**Before** is an advice type which ensures that an advice runs before the method execution. Following is the syntax of before advice.

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
    <aop:before pointcut-ref="pointcut-id" method="methodName"/>
  </aop:aspect>
</aop:config>
```

Where,

- **pointcut-id** - id of the PointCut.
- **methodName** - Method name of the function to be called before a called function.

To understand the above-mentioned concepts related to Before Advice, let us write an example, which will implement Before Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

public class Logging {

    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    public void beforeAdvice(){
```

```
        System.out.println("Going to setup student profile.");  
    }  
}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;  
  
public class Student {  
    private Integer age;  
    private String name;  
  
    public void setAge(Integer age) {  
        this.age = age;  
    }  
    public Integer getAge() {  
        System.out.println("Age : " + age );  
        return age;  
    }  
  
    public void setName(String name) {  
        this.name = name;  
    }  
    public String getName() {  
        System.out.println("Name : " + name );  
        return name;  
    }  
  
    public void printThrowException(){  
        System.out.println("Exception raised");  
        throw new IllegalArgumentException();  
    }  
}
```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
        student.getAge();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">
            <aop:pointcut id="selectAll"
                expression="execution(* com.tutorialspoint.Student.getName(..))"/>
            <aop:before pointcut-ref="selectAll" method="beforeAdvice"/>
        </aop:aspect>
    </aop:config>
```

```
<!-- Definition for student bean -->
<bean id="student" class="com.tutorialspoint.Student">
    <property name="name" value="Zara" />
    <property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.
Name : Zara
Age : 11
```



## 9. Spring AOP – XML-Based After Advice

After is an advice type which ensures that an advice runs after the method execution. Following is the syntax of after advice.

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
    <aop:after pointcut-ref="pointcut-id" method="methodName"/>
  </aop:aspect>
</aop:config>
```

Where,

- **pointcut-id** - id of the pointcut
- **methodName** - method name of the function to be called after a called function

To understand the above-mentioned concepts related to After Advice, let us write an example which will implement After Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

public class Logging {

    /**
     * This is the method which I would like to execute
     * after a selected method execution.
     */
    public void afterAdvice(){
```

```
        System.out.println("Student profile setup complete.");  
    }  
}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;  
  
public class Student {  
    private Integer age;  
    private String name;  
  
    public void setAge(Integer age) {  
        this.age = age;  
    }  
    public Integer getAge() {  
        System.out.println("Age : " + age );  
        return age;  
    }  
  
    public void setName(String name) {  
        this.name = name;  
    }  
    public String getName() {  
        System.out.println("Name : " + name );  
        return name;  
    }  
  
    public void printThrowException(){  
        System.out.println("Exception raised");  
        throw new IllegalArgumentException();  
    }  
}
```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
        student.getAge();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">
            <aop:pointcut id="selectAll"
                expression="execution(* com.tutorialspoint.Student.getAge(..))"/>
            <aop:after pointcut-ref="selectAll" method="afterAdvice"/>
        </aop:aspect>
    </aop:config>
```

```
<!-- Definition for student bean -->  
<bean id="student" class="com.tutorialspoint.Student">  
    <property name="name" value="Zara" />  
    <property name="age" value="11"/>  
</bean>  
  
<!-- Definition for logging aspect -->  
<bean id="logging" class="com.tutorialspoint.Logging"/>  
  
</beans>
```

## Run Project

Once you are done creating source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, this will print the following message.

```
Name : Zara  
Age : 11  
Student profile setup complete.
```

## 10. Spring AOP – XML-Based After Returning Advice

**After** is an advice type which ensures that an advice runs after the method execution only if the method completes successfully. Following is the syntax of after advice.

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
    <aop:after-returning pointcut-ref="pointcut-id" returning="retVal"
method="methodName"/>
  </aop:aspect>
</aop:config>
```

Where,

- **pointcut-id** - ID of the PointCut.
- **methodName** - Method name of the function to be called after a called function returns successfully.

To understand the above-mentioned concepts related to After Returning Advice, let us write an example which will implement After Returning advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

public class Logging {

    /**
     * This is the method which I would like to execute
     * when any method returns.
     */
}
```

```

    */
    public void afterReturningAdvice(Object retVal){
        System.out.println("Returning:" + retVal.toString() );
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }

    public Integer getAge() {
        System.out.println("Age : " + age );
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
        return age;
    }

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

    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
        student.getAge();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">
            <aop:pointcut id="selectAll"
                expression="execution(* com.tutorialspoint.*.*(..))"/>
            <aop:after-returning pointcut-ref="selectAll"
                method="afterReturningAdvice" returning="retVal"/>
        </aop:aspect>
    </aop:config>
```

```
<!-- Definition for student bean -->
<bean id="student" class="com.tutorialspoint.Student">
    <property name="name" value="Zara" />
    <property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Name : Zara
Returning:Name
Age : 11
Exception raised
```



## 11. Spring AOP – XML-Based After-Throwing Advice

**After-throwing** is an advice type which ensures that an advice runs after the method execution, only if the method exits by throwing an exception. Following is the syntax of after-throwing advice.

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
    <aop:after-throwing pointcut-ref="pointcut-id" throwing="ex"
method="methodName"/>
  </aop:aspect>
</aop:config>
```

Where,

- **pointcut-id** - id of the PointCut.
- **ex** - Exception to be thrown.
- **methodName** - Method name of the function to be called, when a called function throws an exception and exits.

To understand the above-mentioned concepts related to After Throwing Advice, let us write an example which will implement After Throwing Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

public class Logging {
    /**
     * This is the method which I would like to execute
     * if there is an exception raised.
```

```

    */
    public void afterThrowingAdvice(IllegalArgumentException ex){
        System.out.println("There has been an exception: " + ex.toString());
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");
        Student student = (Student) context.getBean("student");
        student.printThrowException();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">
            <aop:pointcut id="selectAll"
                expression="execution(* com.tutorialspoint.*.*(..))"/>
            <aop:after-throwing pointcut-ref="selectAll" throwing="ex"
                method="afterThrowingAdvice"/>
        </aop:aspect>
    </aop:config>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
    </bean>
</beans>
```

```

        <property name="age" value="11"/>
    </bean>
    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>
</beans>

```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```

Exception raised
There has been an exception: java.lang.IllegalArgumentException
Exception in thread "main" java.lang.IllegalArgumentException
    at com.tutorialspoint.Student.printThrowException(Student.java:25)
    at
com.tutorialspoint.Student$$FastClassBySpringCGLIB$$7dc55815.invoke(<generated>)
    at org.springframework.cglib.proxy.MethodProxy.invoke(MethodProxy.java:204)
    at
org.springframework.aop.framework.CglibAopProxy$CglibMethodInvocation.invokeJoinpoint(CglibAopProxy.java:717)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:157)
    at
org.springframework.aop.aspectj.AspectJAfterThrowingAdvice.invoke(AspectJAfterThrowingAdvice.java:58)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:179)
    at
org.springframework.aop.interceptor.ExposeInvocationInterceptor.invoke(ExposeInvocationInterceptor.java:92)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:179)
    at
org.springframework.aop.framework.CglibAopProxy$DynamicAdvisedInterceptor.intercept(CglibAopProxy.java:653)
    at
com.tutorialspoint.Student$$EnhancerBySpringCGLIB$$8514cd8.printThrowException(<generated>)
    at com.tutorialspoint.MainApp.main(MainApp.java:15)

```

## 12. Spring AOP – XML-Based Around Advice

**Around** is an advice type which ensures that an advice runs before and after the method execution. Following is the syntax of around advice.

### Syntax

```
<aop:config>
  <aop:aspect id="log" ref="logging">
    <aop:pointcut id="pointcut-id" expression="execution( expression )"/>
    <aop:around pointcut-ref="pointcut-id" method="methodName"/>
  </aop:aspect>
</aop:config>
```

Where,

- **pointcut-id** - ID of the PointCut.
- **methodName** - Method name of the function to be called before a called function.

To understand the above-mentioned concepts related to Around Advice, let us write an example which will implement Around Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;
import org.aspectj.lang.ProceedingJoinPoint;

public class Logging {
    /**
     * This is the method which I would like to execute
     * around a selected method execution.
     */
    public String aroundAdvice(ProceedingJoinPoint jp) throws Throwable{
```

```

        System.out.println("Around advice");
        Object[] args=jp.getArgs();
        if(args.length>0){
            System.out.print("Arguments passed: " );
            for (int i = 0; i < args.length; i++) {
                System.out.print("arg "+(i+1)+" : "+args[i]);
            }
        }

        Object result=jp.proceed(args);
        System.out.println("Returning " + result);
        return result.toString();
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
}

```

```

    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");
        student.getName();
    }
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:config>
        <aop:aspect id="log" ref="logging">

```

```
<aop:pointcut id="selectName"
expression="execution(* com.tutorialspoint.Student.getName(..))"/>
<aop:around pointcut-ref="selectName" method="aroundAdvice"/>
</aop:aspect>
</aop:config>

<!-- Definition for student bean -->
<bean id="student" class="com.tutorialspoint.Student">
  <property name="name" value="Zara" />
  <property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Around advice
Name : Zara
Returning Zara
```



## Annotation Examples

## 13. Spring AOP – Annotation-Based Application

Let us write an example which will implement advice using Annotation based configuration. For this, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Before;
import org.aspectj.lang.annotation.Pointcut;

@Aspect
public class Logging {
    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.*.*(..))")
    private void selectAll(){}
    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    @Before("selectAll()")
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}
```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
```

```

    ApplicationContext context =
        new ClassPathXmlApplicationContext("Beans.xml");

    Student student = (Student) context.getBean("student");

    student.getName();
    student.getAge();
}
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>

```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.  
Name : Zara  
Going to setup student profile.  
Age : 11
```

# 14. Spring AOP – Annotation-Based PointCut

## JoinPoint

A JoinPoint represents a point in your application where you can plug-in AOP aspect. You can also say, it is the actual place in the application where an action will be taken using Spring AOP framework. Consider the following examples:

- All methods classes contained in a package(s).
- A particular methods of a class.

## PointCut

PointCut is a set of one or more JoinPoints where an advice should be executed. You can specify PointCuts using expressions or patterns as we will see in our AOP examples. In Spring, PointCut helps to use specific JoinPoints to apply the advice. Consider the following examples:

- `@Pointcut("execution(* com.tutorialspoint.*(..))")`
- `@Pointcut("execution(* com.tutorialspoint.Student.getName(..))")`

## Syntax

```
@Aspect
public class Logging {
    @Pointcut("execution(* com.tutorialspoint.*(..))")
    private void selectAll(){}
}
```

Where,

- **@Aspect** - Mark a class as a class containing advice methods.
- **@Pointcut** - Mark a function as a PointCut
- **execution( expression )** - Expression covering methods on which advice is to be applied.

To understand the above-mentioned concepts related to JoinPoint and PointCut, let us write an example which will implement few of the PointCuts. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Pointcut;
import org.aspectj.lang.annotation.Before;

@Aspect
public class Logging {

    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.*.*(..))")
    private void selectAll(){}

    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    @Before("selectAll()")
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
```

```

        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");
        Student student = (Student) context.getBean("student");
        student.getName();
        student.getAge();
    }
}

```



Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
http://www.springframework.org/schema/aop
http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>
</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.
Name : Zara
Going to setup student profile.
Age : 11
```

The above-defined @Pointcut uses an expression to select all the methods defined under the package com.tutorialspoint. @Before advice uses the above-defined PointCut as a parameter. Effectively beforeAdvice() method will be called before every method covered by above PointCut.

## 15. Spring AOP – Annotation-Based Before Advice

@Before is an advice type which ensures that an advice runs before the method execution. Following is the syntax of @Before advice.

### Syntax

```
@Pointcut("execution(* com.tutorialspoint.Student.getName(..))")
private void selectGetName(){}

@Before("selectGetName()")
public void beforeAdvice(){
    System.out.println("Going to setup student profile.");
}
```

Where,

- **@Pointcut** - Mark a function as a PointCut
- **execution( expression )** - Expression covering methods on which advice is to be applied.
- **@Before** - Mark a function as an advice to be executed before method(s) covered by PointCut.

To understand the above-mentioned concepts related to @Before Advice, let us write an example, which will implement @Before Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Pointcut;
import org.aspectj.lang.annotation.Before;
@Aspect
```

```

public class Logging {

    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.Student.getName(..))")
    private void selectGetName(){}

    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    @Before("selectGetName()")
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

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

```

```
}  
public String getName() {  
    System.out.println("Name : " + name );  
    return name;  
}  
  
public void printThrowException(){  
    System.out.println("Exception raised");  
    throw new IllegalArgumentException();  
}  
}
```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;  
  
import org.springframework.context.ApplicationContext;  
import org.springframework.context.support.ClassPathXmlApplicationContext;  
  
public class MainApp {  
    public static void main(String[] args) {  
        ApplicationContext context =  
            new ClassPathXmlApplicationContext("Beans.xml");  
  
        Student student = (Student) context.getBean("student");  
  
        student.getName();  
        student.getAge();  
    }  
}
```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
http://www.springframework.org/schema/aop
http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>

```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```

Going to setup student profile.
Name : Zara
Age : 11

```

The above-defined @Pointcut uses an expression to select method getName() defined in class(es) under the package com.tutorialspoint. @Before advice uses the above-defined PointCut as a parameter. Effectively beforeAdvice() method will be called before every method covered by the above PointCut.

## 16. Spring AOP – Annotation-Based After Advice

**@After** is an advice type which ensures that an advice runs after the method execution. Following is the syntax of @After advice.

### Syntax

```
@Pointcut("execution(* com.tutorialspoint.Student.getAge(..))")
private void selectGetName(){}

@After("selectGetAge()")
public void afterAdvice(){
    System.out.println("Student profile setup completed.");
}
```

Where,

- **@Pointcut** - Mark a function as a PointCut
- **execution( expression )** - Expression covering methods on which advice is to be applied.
- **@After** - mark a function as an advice to be executed before method(s) covered by pointcut.

To understand the above-mentioned concepts related to @After Advice, let us write an example, which will implement @After Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Pointcut;
import org.aspectj.lang.annotation.After;
```

```

@Aspect
public class Logging {

    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.Student.getAge(..))")
    private void selectGetAge(){}

    /**
     * This is the method which I would like to execute
     * after a selected method execution.
     */
    @After("selectGetAge()")
    public void afterAdvice(){
        System.out.println("Student profile setup completed.");
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }

    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }
}

```

```

    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }

    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        student.getName();
        student.getAge();
    }
}

```



Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:aop="http://www.springframework.org/schema/aop"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
http://www.springframework.org/schema/aop
http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Name : Zara
Age : 11
Student profile setup completed.
```

The above-defined @Pointcut uses an expression to select method getAge() defined in class(es) under the package com.tutorialspoint. @After advice uses the above-defined PointCut as a parameter. Effectively afterAdvice() method will be called before every method covered by the above PointCut.

# 17. Spring AOP – Annotation-Based After-Returning Advice

**@AfterReturning** is an advice type, which ensures that an advice runs after the method executes successfully. Following is the syntax of @AfterReturning advice.

## Syntax

```
@AfterReturning(pointcut="execution(* com.tutorialspoint.Student.*(..))",
returning="retVal")
public void afterReturningAdvice(JoinPoint jp, Object retVal){
    System.out.println("Method Signature: " + jp.getSignature());
    System.out.println("Returning:" + retVal.toString() );
}
```

Where,

- **@AfterReturning** - Mark a function as an advice to be executed before method(s) covered by PointCut, if the method returns successfully.
- **pointcut** - Provides an expression to select a function.
- **execution( expression )** - Expression covering methods on which advice is to be applied.
- **returning** - Name of the variable to be returned.

To understand the above-mentioned concepts related to @AfterReturning Advice, let us write an example, which will implement @AfterReturning Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.JoinPoint;
import org.aspectj.lang.annotation.AfterReturning;
@Aspect
```

```

public class Logging {

    /**
     * This is the method which I would like to execute
     * after a selected method execution.
     */
    @AfterReturning(pointcut="execution(* com.tutorialspoint.Student.*(..))",
returning="retVal")
    public void afterReturningAdvice(JoinPoint jp, Object retVal){
        System.out.println("Method Signature: " + jp.getSignature());
        System.out.println("Returning:" + retVal.toString() );
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }
    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
    public void printThrowException(){

```

```

        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");
        student.getAge();
    }
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
    
```

```
<property name="age" value="11"/>
</bean>

<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Age : 11
Method Signature: Integer com.tutorialspoint.Student.getAge()
Returning 11
```

## 18. Spring AOP – Annotation-Based After Throwing Advice

**@AfterThrowing** is an advice type which ensures that an advice runs if the method throws an exception. Following is the syntax of @AfterThrowing advice.

### Syntax

```
@AfterThrowing(pointcut="execution(* com.tutorialspoint.Student.*(..))",
throwing= "error")
public void afterThrowingAdvice(JoinPoint jp, Throwable error){
    System.out.println("Method Signature: " + jp.getSignature());
    System.out.println("Exception: "+error);
}
```

Where,

- **@AfterThrowing** - Mark a function as an advice to be executed before method(s) covered by PointCut, if the method throws an exception.
- **pointcut** - Provides an expression to select a function.
- **execution( expression )** - Expression covering methods on which advice is to be applied.
- **throwing** - Name of the exception to be returned.

To understand the above-mentioned concepts related to @AfterThrowing Advice, let us write an example, which will implement @AfterThrowing Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.JoinPoint;
import org.aspectj.lang.annotation.AfterThrowing;
@Aspect
```

```

public class Logging {

    /**
     * This is the method which I would like to execute
     * after a selected method execution throws exception.
     */
    @AfterThrowing(pointcut="execution(* com.tutorialspoint.Student.*(..))",
    throwing= "error")
    public void afterThrowingAdvice(JoinPoint jp, Throwable error){
        System.out.println("Method Signature: " + jp.getSignature());
        System.out.println("Exception: "+error);
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }
    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
    public void printThrowException(){

```

```

        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}

```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");
        Student student = (Student) context.getBean("student");
        student.printThrowException();
    }
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>
    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

```



```
<!-- Definition for logging aspect -->
<bean id="logging" class="com.tutorialspoint.Logging"/>
</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Exception raised
Method Signature: void com.tutorialspoint.Student.printThrowException()
Exception: java.lang.IllegalArgumentException
Exception in thread "main" java.lang.IllegalArgumentException
    at com.tutorialspoint.Student.printThrowException(Student.java:25)
    at com.tutorialspoint.Student$$FastClassBySpringCGLIB$$7dc55815.invoke(<generated>)
    at org.springframework.cglib.proxy.MethodProxy.invoke(MethodProxy.java:204)
    at
org.springframework.aop.framework.CglibAopProxy$CglibMethodInvocation.invokeJoinpoint(CglibAopProxy.java:717)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:157)
    at
org.springframework.aop.aspectj.AspectJAfterThrowingAdvice.invoke(AspectJAfterThrowingAdvice.java:58)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:179)
    at
org.springframework.aop.interceptor.ExposeInvocationInterceptor.invoke(ExposeInvocationInterceptor.java:92)
    at
org.springframework.aop.framework.ReflectiveMethodInvocation.proceed(ReflectiveMethodInvocation.java:179)
    at
org.springframework.aop.framework.CglibAopProxy$DynamicAdvisedInterceptor.intercept(CglibAopProxy.java:653)
    at
com.tutorialspoint.Student$$EnhancerBySpringCGLIB$$99b0a988.printThrowException(<generated>)
    at com.tutorialspoint.MainApp.main(MainApp.java:13)
```

## 19. Spring AOP – Annotation-Based Around Advice

**@Around** is an advice type, which ensures that an advice can run before and after the method execution. Following is the syntax of @Around advice.

### Syntax

```
@Pointcut("execution(* com.tutorialspoint.Student.getAge(..))")
private void selectGetName(){}

@Around("selectGetName()")
public void aroundAdvice(ProceedingJoinPoint proceedingJoinPoint){
    System.out.println("Around advice");
    Object[] args=jp.getArgs();
    if(args.length>0){
        System.out.print("Arguments passed: " );
        for (int i = 0; i < args.length; i++) {
            System.out.print("arg "+(i+1)+"": "+args[i]);
        }
    }

    Object result=jp.proceed(args);
    System.out.println("Returning " + result);
    return result.toString();
}
```

Where,

- **@Pointcut** - Mark a function as a PointCut.
- **execution( expression )** - Expression covering methods on which advice is to be applied.
- **@Around** - Mark a function as an advice to be executed before method(s) covered by PointCut.

To understand the above-mentioned concepts related to @Around Advice, let us write an example which will implement @Around Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Pointcut;
import org.aspectj.lang.annotation.Around;
import org.aspectj.lang.ProceedingJoinPoint;

@Aspect
public class Logging {

    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.Student.getAge(..))")
    private void selectGetAge(){}

    /**
     * This is the method which I would like to execute
     * around a selected method execution.
     */
    @Around("selectGetAge()")
    public void aroundAdvice(ProceedingJoinPoint proceedingJoinPoint) throws
    Throwable{
        System.out.println("Around advice");
        Object[] args=proceedingJoinPoint.getArgs();
        if(args.length>0){
            System.out.print("Arguments passed: " );

```

```

        for (int i = 0; i < args.length; i++) {
            System.out.print("arg " + (i + 1) + ": " + args[i]);
        }
    }
    Object result = proceedingJoinPoint.proceed(args);
    System.out.println("Returning " + result);
}
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }
    public void setName(String name) {
        this.name = name;
    }
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}
}

```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");
        student.getAge();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>
    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>
    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>
</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Around advice
```

```
Age : 11
```

```
Returning 11
```

# Spring AOP Advanced

## 20. Spring AOP – Proxy

So far, we've declared aspects using **<aop:config>** or **<aop:aspectj-autoproxy>**. We can create a proxy programmatically as well as invoke the aspects programmatically using the proxy object.

### Syntax

```
//Create object to be proxied
Student student = new Student();
//Create the Proxy Factory
AspectJProxyFactory proxyFactory = new AspectJProxyFactory(student);
//Add Aspect class to the factory
proxyFactory.addAspect(Logging.class);
//Get the proxy object
Student proxyStudent = proxyFactory.getProxy();
//Invoke the proxied method.
proxyStudent.getAge();
```

Where,

- **AspectJProxyFactory** - Factory class to create a proxy object.
- **Logging.class** - Class of the Aspect containing advices.
- **Student** - Business class to be advised.

To understand the above-mentioned concepts related to proxy, let us write an example, which will implement proxy. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><u>Spring AOP - Application</u></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
```



```

import org.aspectj.lang.annotation.Pointcut;
import org.aspectj.lang.annotation.Before;

@Aspect
public class Logging {

    /** Following is the definition for a pointcut to select
     *  all the methods available. So advice will be called
     *  for all the methods.
     */
    @Pointcut("execution(* com.tutorialspoint.Student.getAge(..))")
    private void selectGetAge(){}

    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    @Before("selectGetAge()")
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}

```

Following is the content of the **Student.java** file.

```

package com.tutorialspoint;

public class Student {
    private Integer age;

    public void setAge(Integer age) {
        this.age = age;
    }

    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }
}

```

Following is the content of the **MainApp.java** file.

```
package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;
import org.springframework.aop.aspectj.annotation.AspectJProxyFactory;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");

        //Create the Proxy Factory
        AspectJProxyFactory proxyFactory = new AspectJProxyFactory(student);

        //Add Aspect class to the factory
        proxyFactory.addAspect(Logging.class);

        //Get the proxy object
        Student proxyStudent = proxyFactory.getProxy();

        //Invoke the proxied method.
        proxyStudent.getAge();
    }
}
```

Following is the configuration file **Beans.xml**.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop"
```

```
    http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>

</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.
Age : 11
```

## 21. Spring AOP – Custom Annotation

As per PointCut expressions, it may be the case that they get applied to some other beans for which advice is not intended. For example, consider the following expression.

```
execution(* com.tutorialspoint.*.getAge(..))
```

A new spring bean is added with getAge() method and the advice will start getting applied to it although it may not be intended. To achieve this, we can create a custom annotation and annotate the methods on which the advice is to be applied.

```
@Before("@annotation(com.tutorialspoint.Loggable)")
```

To understand the above-mentioned concepts related to @Before Advice, let us write an example which will implement @Before Advice. To write our example with few advices, let us have a working Eclipse IDE in place and use the following steps to create a Spring application.

Step	Description
1	Update the project <i>Student</i> created under chapter <b><i>Spring AOP - Application</i></b> .
2	Update the bean configuration and run the application as explained below.

Following is the content of **Logging.java** file. This is actually a sample of aspect module, which defines the methods to be called at various points.

```
package com.tutorialspoint;

import org.aspectj.lang.annotation.Aspect;
import org.aspectj.lang.annotation.Before;

@Aspect
public class Logging {
    /**
     * This is the method which I would like to execute
     * before a selected method execution.
     */
    @Before("@annotation(com.tutorialspoint.Loggable)")
    public void beforeAdvice(){
        System.out.println("Going to setup student profile.");
    }
}
```

Following is the content of the **Loggable.java** file.

```
package com.tutorialspoint;

public @interface Loggable {

}
```

Following is the content of the **Student.java** file.

```
package com.tutorialspoint;

public class Student {
    private Integer age;
    private String name;

    public void setAge(Integer age) {
        this.age = age;
    }
    public Integer getAge() {
        System.out.println("Age : " + age );
        return age;
    }

    public void setName(String name) {
        this.name = name;
    }
    @Loggable
    public String getName() {
        System.out.println("Name : " + name );
        return name;
    }
    public void printThrowException(){
        System.out.println("Exception raised");
        throw new IllegalArgumentException();
    }
}
```

Following is the content of the **MainApp.java** file.

```

package com.tutorialspoint;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class MainApp {
    public static void main(String[] args) {
        ApplicationContext context =
            new ClassPathXmlApplicationContext("Beans.xml");

        Student student = (Student) context.getBean("student");
        student.getName();
        student.getAge();
    }
}

```

Following is the configuration file **Beans.xml**.

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:aop="http://www.springframework.org/schema/aop"
    xsi:schemaLocation="http://www.springframework.org/schema/beans
        http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
        http://www.springframework.org/schema/aop
        http://www.springframework.org/schema/aop/spring-aop-3.0.xsd ">

    <aop:aspectj-autoproxy/>

    <!-- Definition for student bean -->
    <bean id="student" class="com.tutorialspoint.Student">
        <property name="name" value="Zara" />
        <property name="age" value="11"/>
    </bean>

    <!-- Definition for logging aspect -->
    <bean id="logging" class="com.tutorialspoint.Logging"/>

```

```
</beans>
```

## Run Project

Once you are done creating the source and configuration files, run your application. Right-click on MainApp.java in your application and use **run as Java Application** command. If everything is fine with your application, it will print the following message.

```
Going to setup student profile.
```

```
Name : Zara
```

```
Age : 11
```