JAVA BACKEND DEVELOPMENT PROGRAM

Actuator, Logging, Spring AOP

OUTLINE

- Actuator
- Logging
- Spring AOP
  - AOP Concept
  - Proxy
  - AspectJ
  - Controller Advice

SPRING BOOT ACTUATOR

- What if we want to monitor our application when it is in production?
- Actuator — An actuator is a manufacturing term that refers to a mechanical device for moving or controlling something. Actuators can generate a large amount of motion from a small change
- Spring Boot Actuator
  - Spring Boot includes a number of additional features to help you monitor and manage your application when you push it to production
  - You can choose to manage and monitor your application by using HTTP endpoints.
  - Auditing, health, and metrics gathering can also be automatically applied to your application
  - Here we will explore the Spring Boot Actuator

SPRING BOOT ACTUATOR

- To get started, we just need to add the *spring-boot-actuator* dependency to our package manager

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

- Once added, we have a list of predefined endpoint (some commonly used are listed here):
    - */health* – summaries the health status of our application
    - */info* – returns general information. It might be custom data, build information or details about the latest commit
    - /beans – *displays a complete list of all the Spring beans in your application*
- By default, all Actuator endpoints are now placed under the */actuator* path
- Now only */health is* enabled by default. If we want all other endpoints, include following property:
    - *management.endpoints.web.exposure.include=*.*

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LOGGING

- When we are working on a large project, we will also hear something below
  - "This feature we deployed last week was working fine till yesterday now I have no idea why is it not working!"
- We can't be sure how customer will interact with our web application.
  - Even if we have a user friendly guidance, but some behaviors are really hard to expect
  - For example, when the user are calling the customer service to change a plan, and at the same time, he is trying to submit the same order online. It may lead to a failure transaction in our web application.The problem is that when production support team get a call regarding why that online was failed.
  - The only solution is that we have to go through our log to find out how many order are submitted during the same time.

LOGGING

- There are two commonly used Logging tools:
  - Log4j (version 2)

```java
public class HelloWorld {
    private static final Logger logger = LogManager.getLogger("HelloWorld");
    public static void main(String[] args) {
        logger.info("Hello, World!");
    }
}
```

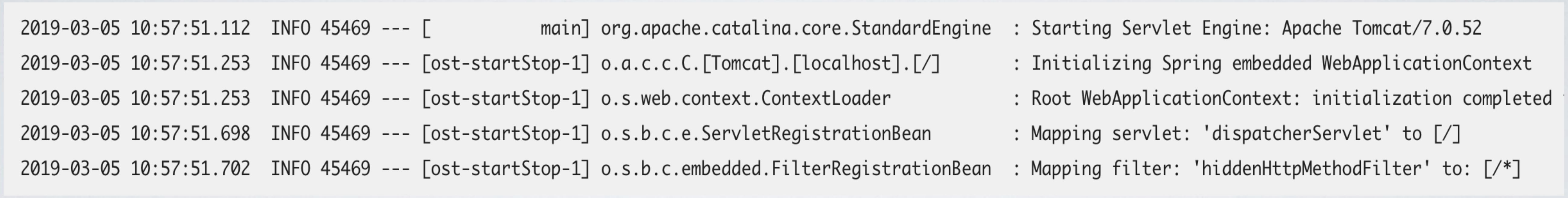
  - Logback (used by Spring Boot by default)

```java
@RestController
public class LoggingController {

    Logger logger = LoggerFactory.getLogger(LoggingController.class);

    @RequestMapping("/")
    public String index() {
        logger.trace("A TRACE Message");
        logger.debug("A DEBUG Message");
```

LOGGING



```
2019-03-05 10:57:51.112  INFO 45469 --- [           main] org.apache.catalina.core.StandardEngine  : Starting Servlet Engine: Apache Tomcat/7.0.52
2019-03-05 10:57:51.253  INFO 45469 --- [ost-startStop-1] o.a.c.c.C.[Tomcat].[localhost].[/]       : Initializing Spring embedded WebApplicationContext
2019-03-05 10:57:51.253  INFO 45469 --- [ost-startStop-1] o.s.web.context.ContextLoader            : Root WebApplicationContext: initialization completed
2019-03-05 10:57:51.698  INFO 45469 --- [ost-startStop-1] o.s.b.c.e.ServletRegistrationBean        : Mapping servlet: 'dispatcherServlet' to [/]
2019-03-05 10:57:51.702  INFO 45469 --- [ost-startStop-1] o.s.b.c.embedded.FilterRegistrationBean  : Mapping filter: 'hiddenHttpMethodFilter' to: [/*]
```

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

LOGGING

- Logging Configuration
  - When a file in the classpath has one of the following names, Spring Boot will automatically load it over the default configuration:
    - logback-spring.xml
    - logback.xml
    - logback-spring.groovy
    - logback.groovy

LOGGING

- Logging Configuration
  - Appender — Appenders are responsible for delivering LogEvents to their destination
  - Layouts — An Appender uses a Layout to format a LogEvent into a form that meets the needs of whatever will be consuming the log event
  - Pattern — The goal of this class is to format a LogEvent and return the results
    - All pattern conversions can be found at: https://logging.apache.org/log4j/2.x/index.html
  - Logger — Loggers that are available in the application. Each logger can have multiple appenders.

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SPRING AOP

- How will you handle following scenarios:
  - For each Service and DAO layer method, your leader wants to know the execution time
  - For each request and response, your leader wants to know what is the request received and what is the response generated
  - If there is any exception thrown during the process of the request, how do you handle those exception?

SPRING AOP

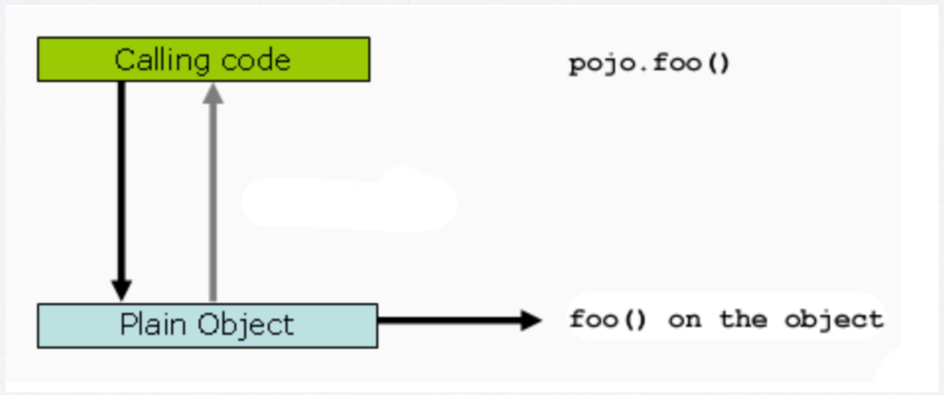
- AOP — Aspect-Oriented Programming
  - Aspect-oriented Programming (AOP) complements Object-oriented Programming (OOP) by providing another way of thinking about program structure
  - The key unit of modularity in OOP is the class, whereas in AOP the unit of modularity is the aspect
  - Aspects enable the modularization of concerns (such as audit log) that cut across multiple types and objects. (Such concerns are often termed "**crosscutting**" concerns in AOP literature.)

AOP PROXY

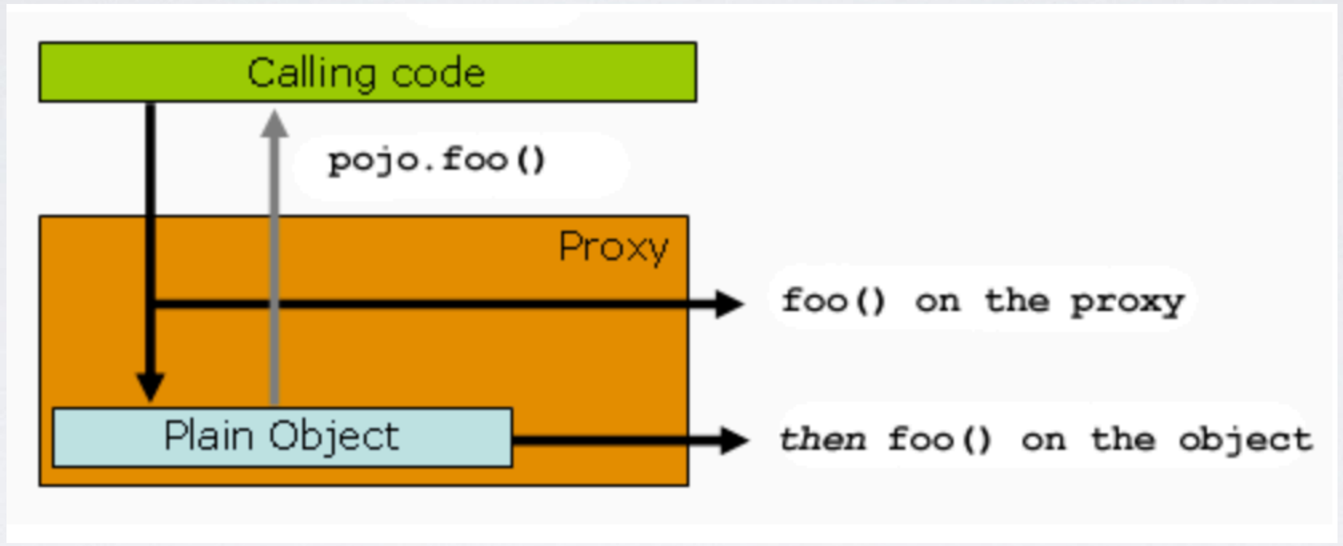
- Spring AOP is proxy-based
    - A proxy is a wrapper or agent object that is being called by the client to access the real serving object behind the scenes. Use of the proxy can simply be forwarding to the read object or can provide additional logic.

AOP PROXY

- If you invoke a method on an object reference, the method is invoked directly on that object reference, as the following image and listing show:



AOP PROXY



- The key thing to understand here is that the client code inside the main(..) method of the Main class has a reference to the proxy.

- This means that method calls on that object reference are calls on the proxy.

- As a result, the proxy can delegate to all of the interceptors (advice) that are relevant to that particular method call.

AOP PROXY

- How does it work
    - We have a service bean that invokes a call to the saveCustomer( ) method on a DAO
    - We want to have some logging (a cross cutting concern) occur when a call to any save method occurs on a DAO
    - Spring detects our need to call on a logging aspect through your AOP configuration or annotations.
        - When it does, it builds a proxy (called CustomerDaoProxy for example sake here) around the "target" object – in this case the DAO
    - Now, on a call to a save method in the DAO, the proxy intercepts the call and routes it appropriately to the appropriate advice method in the aspect class

SPRING AOP

- Spring provide two ways to configure the AOP
  - AspectJ Supported AOP — Annotation
  - Schema-based AOP — XML (won’t cover here)

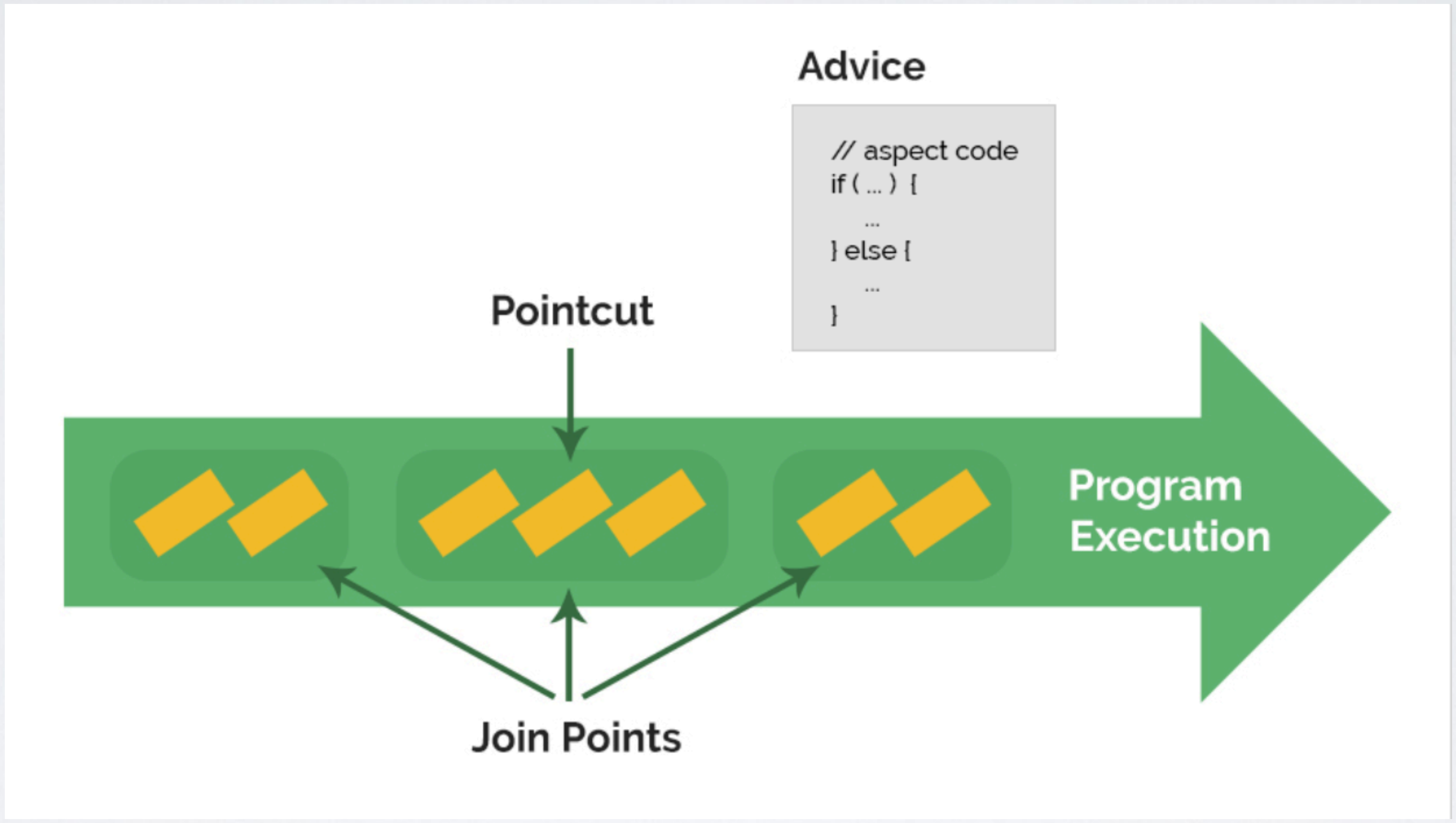
ASPECTJ

- @AspectJ refers to a style of declaring aspects as regular Java classes annotated with annotations
- Spring interprets the same annotations as AspectJ 5, using a library supplied by AspectJ for pointcut parsing and matching
- The AOP runtime is still pure Spring AOP, though, and there is no dependency on the AspectJ compiler or weaver

AOP CONCEPT

- Aspect — A modularization of a concern that cuts across multiple classes
    - Logging / Performance monitoring is a good example of a **crosscutting concern** in enterprise Java applications
- Join point — A point during the execution of a program, such as the execution of a method or the handling of an exception
- Advice — Action taken by an aspect at a particular join point. Different types of advice include "around", "before" and "after" advice
- Pointcut — A predicate that matches join points.
- Target object — An object being advised by one or more aspects
- AOP proxy — An object created by the AOP framework in order to implement the aspect contracts

AOP CONCEPT



- Instead of directly calling the advice logic inside our business logic, we can define different Join Points by using Pointcut, so that the advice logic will be executed automatically

@ASPECT

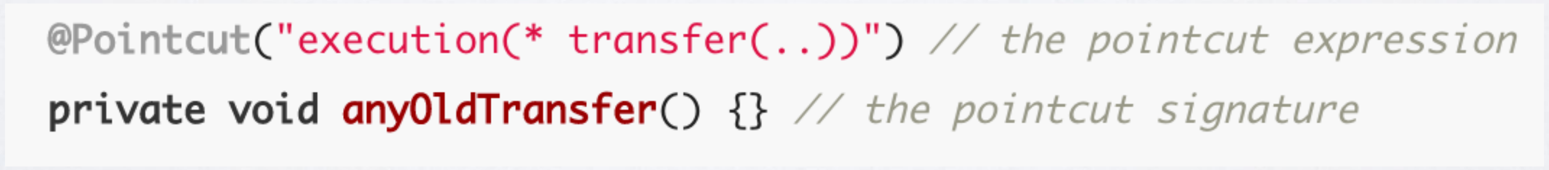
- @Aspect — Aspects can have methods and fields, the same as any other class. They can also contain pointcut, advice

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

@Aspect
public class NotVeryUsefulAspect {

}
```

- We can register aspect classes as regular beans in your Spring XML configuration or autodetect them through classpath scanning — the same as any other Spring-managed bean.
- In Spring AOP, it is not possible to have aspects themselves be the target of advice of other aspects. The @Aspect annotation excludes a class from auto-proxying.
- However, note that the @Aspect annotation is not sufficient for autodetection in the classpath.
  - For that purpose, you need to add a separate @Component annotation

@POINTCUT

- Pointcuts determine join points of interest and thus enable us to control when advice executes
  - Spring AOP only supports method execution join points for Spring beans, so you can think of a pointcut as matching the execution of methods on Spring beans.
- A pointcut declaration has two parts
  - A signature comprising a name and any parameters
    - A pointcut signature is provided by a regular method definition (the method serving as the pointcut signature must have a void return type)
  - A pointcut expression that determines exactly which method executions we are interested in
    - The pointcut expression is indicated by using the @Pointcut annotation



```java
@Pointcut("execution(* transfer(..))") // the pointcut expression
private void anyOldTransfer() {} // the pointcut signature
```

@POINTCUT

- Pointcut Designators (PCD) (must understand)
  - *execution* — For matching method execution join points. This is the primary pointcut designator to use when working with Spring AOP.
  - *within* — Limits matching to join points within certain types (the execution of a method declared within a matching type when using Spring AOP).
  - *bean* — Limit the matching of join points to a particular named Spring bean or to a set of named Spring beans (when using wildcards) (Spring AOP Only)

@POINTCUT

- Pointcut Designators (PCD) (For your reference)
  - *this* — Limits matching to join points (the execution of methods when using Spring AOP) where the bean reference (Spring AOP proxy) is an instance of the given type.
  - *target* — Limits matching to join points (the execution of methods when using Spring AOP) where the target object (application object being proxied) is an instance of the given type.
  - *args* — Limits matching to join points (the execution of methods when using Spring AOP) where the arguments are instances of the given types.

@POINTCUT

- Pointcut Designators (PCD) (For your reference)
  - *@target* — Limits matching to join points (the execution of methods when using Spring AOP) where the class of the executing object has an annotation of the given type.
  - *@args* — Limits matching to join points (the execution of methods when using Spring AOP) where the runtime type of the actual arguments passed have annotations of the given types.
  - *@within* — Limits matching to join points within types that have the given annotation (the execution of methods declared in types with the given annotation when using Spring AOP).
  - *@annotation* — Limits matching to join points where the subject of the join point (the method being executed in Spring AOP) has the given annotation.

@POINTCUT

- The format of an execution expression follows:

```
execution(modifiers-pattern? ret-type-pattern declaring-type-pattern?name-pattern(param-pattern)
            throws-pattern?)
```

- All parts **except** the returning type pattern (ret-type-pattern in the preceding snippet), the name pattern, and the parameters pattern are optional.
- The returning type pattern determines what the return type of the method must be in order for a join point to be matched
- * — It matches any string
- .. — It matches zero or more string
- () — It matches to a method take no parameter

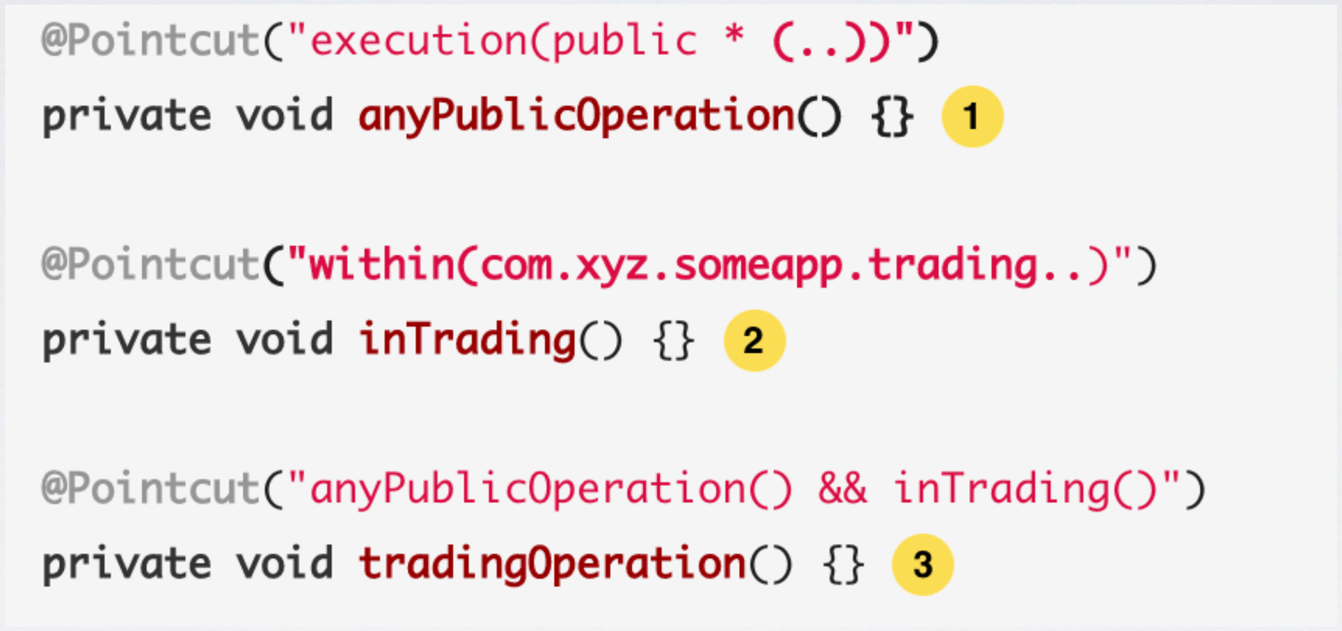
@POINTCUT

`execution(public * *(..))`	The execution of any public method
`execution(* set*(..))`	The execution of any method with a name that begins with set
`execution(* com.xyz.service.AccountService.*(..))`	The execution of any method defined by the AccountService interface
`execution(* com.xyz.service.*.*(..))`	The execution of any method defined in the service package
`execution(* com.xyz.service..*.*(..))`	The execution of any method defined in the service package or one of its sub-packages
`within(com.xyz.service.*)`	Any join point within the service package
`within(com.xyz.service..*)`	Any join point within the service package or one of its sub-packages

@POINTCUT

`this(com.xyz.service.AccountService)`	Any join point where the proxy implements the AccountService interface
`target(com.xyz.service.AccountService)`	Any join point where the target object implements the AccountService interface
`args(java.io.Serializable)`	Any join point that takes a single parameter and where the argument passed at runtime is Serializable
`@target(org.springframework.transaction.annotation.Transactional)`	Any join point where the target object has a @Transactional annotation
`@within(org.springframework.transaction.annotation.Transactional)`	Any join point where the declared type of the target object has an @Transactional annotation
`@annotation(org.springframework.transaction.annotation.Transactional)`	Any join point where the executing method has an @Transactional annotation:
`bean(tradeService)`	Any join point on a Spring bean named 'tradeService'

@POINTCUT

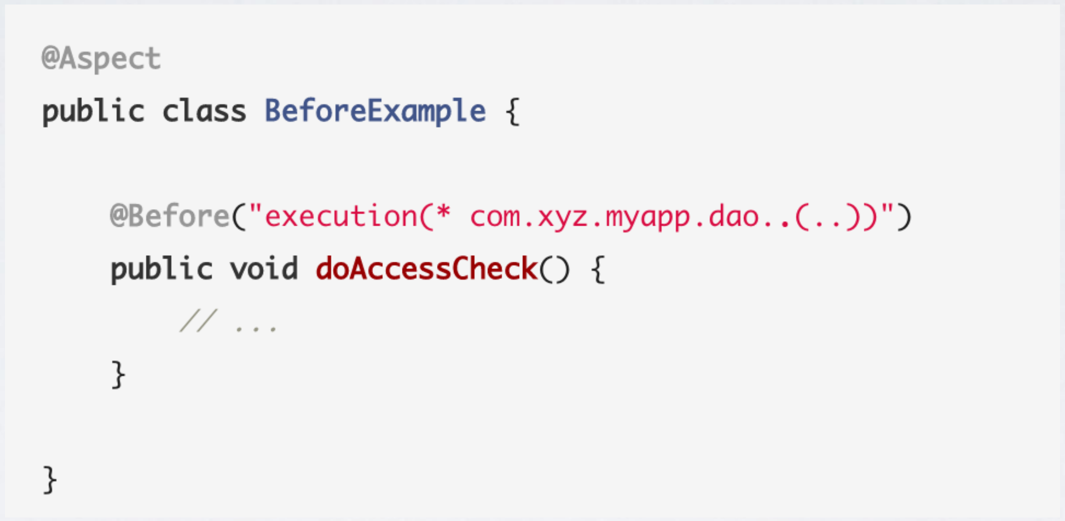


```
@Pointcut("execution(public * (..))")
private void anyPublicOperation() {} 1

@Pointcut("within(com.xyz.someapp.trading..)")
private void inTrading() {} 2

@Pointcut("anyPublicOperation() && inTrading()")
private void tradingOperation() {} 3
```

- *anyPublicOperation* matches if a method execution join point represents the execution of any public method.
- *inTrading* matches if a method execution is in the trading module.
- *tradingOperation* matches if a method execution represents any public method in the trading module.

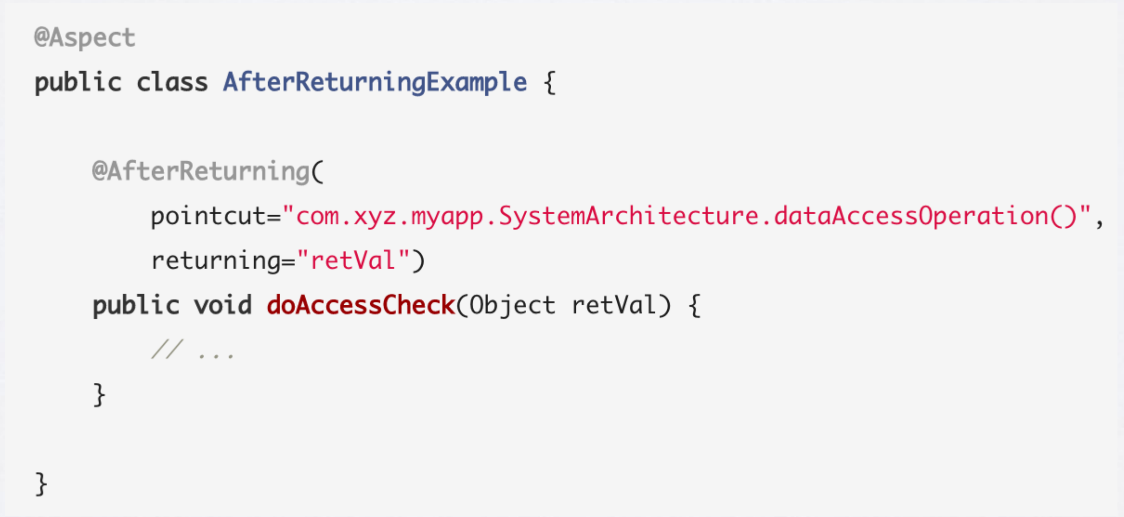
ADVICE

- Before advice (Advice that executes before a join point)



```
@Aspect
public class BeforeExample {

    @Before("execution(* com.xyz.myapp.dao..(..))")
    public void doAccessCheck() {
        // ...
    }

}
```

- After Returning advice (Advice to be executed after a join point completes normally)



```
@Aspect
public class AfterReturningExample {

    @AfterReturning(
        pointcut="com.xyz.myapp.SystemArchitecture.dataAccessOperation()",
        returning="retVal")
    public void doAccessCheck(Object retVal) {
        // ...
    }

}
```

ADVICE

- After Throwing advice (Advice to be executed if a method exits by throwing an exception)

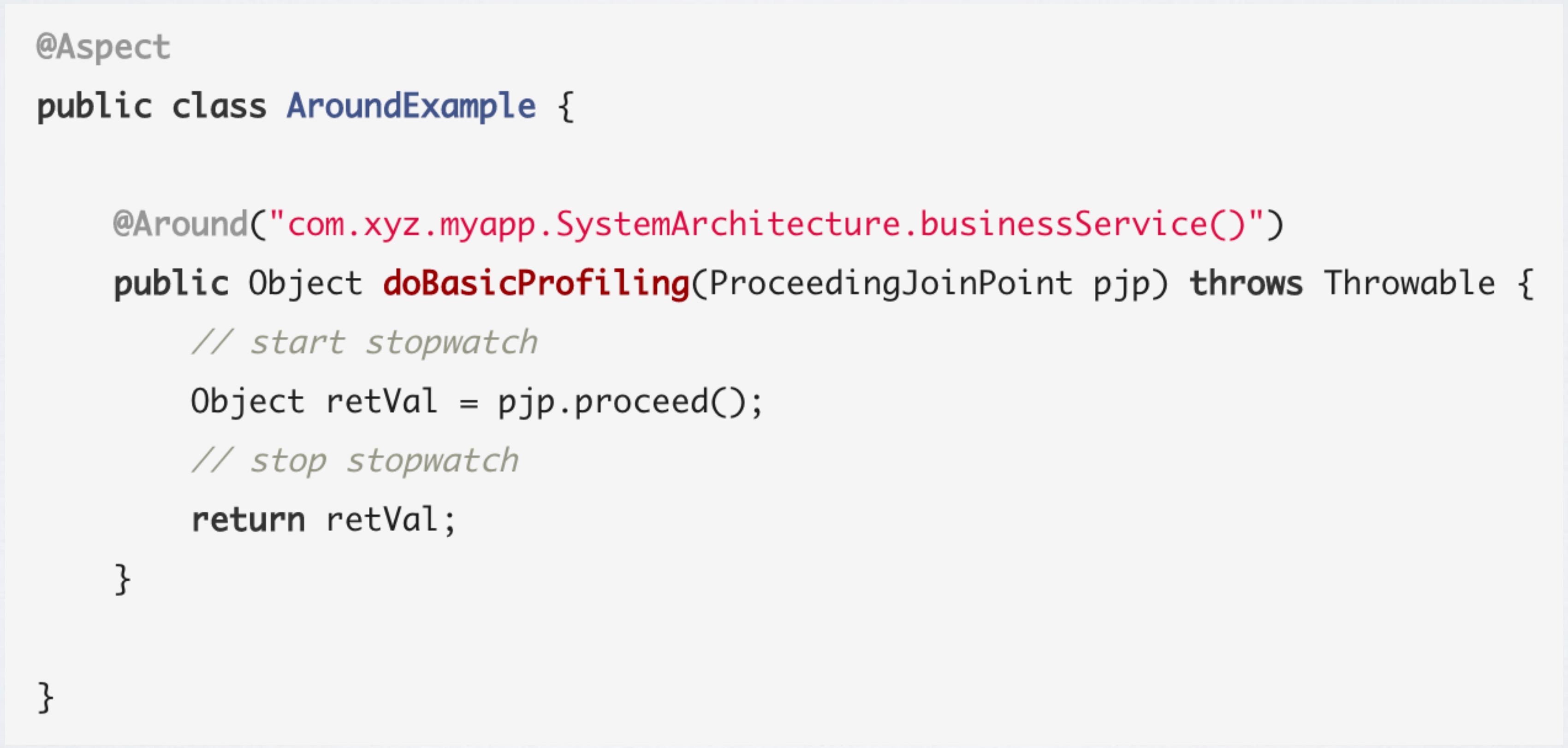
```
@Aspect
public class AfterThrowingExample {

    @AfterThrowing(
        pointcut="com.xyz.myapp.SystemArchitecture.dataAccessOperation()",
        throwing="ex")
    public void doRecoveryActions(DataAccessException ex) {
        // ...
    }

}
```

- After Advice (Advice to be executed regardless of the means by which a join point exits (normal or exceptional return))

```
@Aspect
public class AfterFinallyExample {

    @After("com.xyz.myapp.SystemArchitecture.dataAccessOperation()")
    public void doReleaseLock() {
        // ...
    }

}
```

ADVICE

- Around advice
  - It has the opportunity to do work both before and after the method executes and to determine when, how, and even if the method actually gets to execute at all.



```java
@Aspect
public class AroundExample {

    @Around("com.xyz.myapp.SystemArchitecture.businessService()")
    public Object doBasicProfiling(ProceedingJoinPoint pjp) throws Throwable {
        // start stopwatch
        Object retVal = pjp.proceed();
        // stop stopwatch
        return retVal;
    }

}
```

CONTROLLER ADVICE

- The@*ControllerAdvice* annotation allows us to consolidate our multiple, scattered @*ExceptionHandler*s from before into a single, global error handling component
- It gives us:
  - Full control over the body of the response as well as the status code
  - Mapping of several exceptions to the same method, to be handled together, and
  - It makes good use of the newer RESTful ResposeEntity response
- The order of the @*ExceptionHandlers* matters — once it matches to one exception, it will not continue to check following handlers.

ANY QUESTIONS?