CS 525 - ASD

Advanced Software Development

MS.CS Program

Department of Computer Science

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OF MANAGEMENT

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Lesson 13 Spring framework

L1: ASD Introduction
L2: Strategy, Template method
L3: Observer pattern
L4: Composite pattern, iterator pattern
L5: Command pattern
L6: State pattern
L7: Chain Of Responsibility pattern

Midterm

L8: Proxy, Adapter, Mediator
L9: Factory, Builder, Decorator, Singleton
L10: Framework design
L11: Framework implementation
L12: Framework example: Spring framework
L13: Framework example: Spring framework

Final

Crosscutting concern

- Check security for every service level method

```
public class CustomerService {

  public void getAllCustomers(){
    checkSecurity();
    ...
  }

  public void getCustomer(long customerNumber){
    checkSecurity();
    ...
  }

  public void addCustomer(long customerNumber, String firstName){
    checkSecurity();
    ...
  }

  public void removeCustomer(long customerNumber){
    checkSecurity();
    ...
  }
}
```

We have to call checkSecurity() for all methods of all service classes

Crosscutting concern

- Log every call to the database

```
public class AccountDAO {

  public void saveAccount(Account account){
    ...
    Logger.log("...");
  }

  public void updateAccount(Account account){
    ...
    Logger.log("...");
  }

  public void loadAccount(long accountNumber){
    ...
    Logger.log("...");
  }

  public void removeAccount(long accountNumber){
    ...
    Logger.log("...");
  }
}
```

We have to call Logger.log() for all methods of all DAO classes

Good programming practice principles

DRY: Don’t Repeat Yourself

- Write functionality at one place, and only at one place
- Avoid code scattering

SoC: Separation of Concern

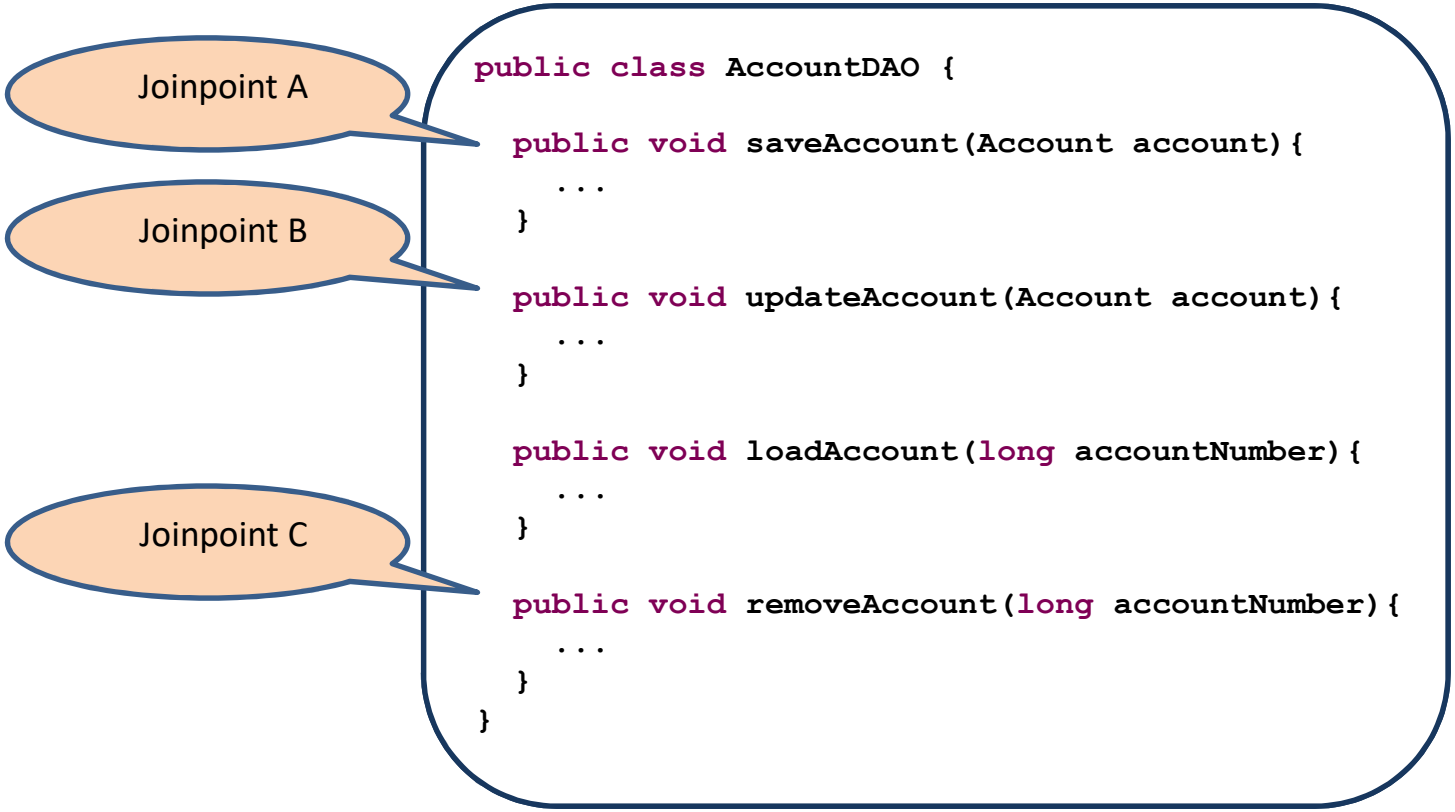
- Avoid code tangling

AOP concepts

- Joinpoint
- Pointcut
- Aspect
- Advice
- Weaving

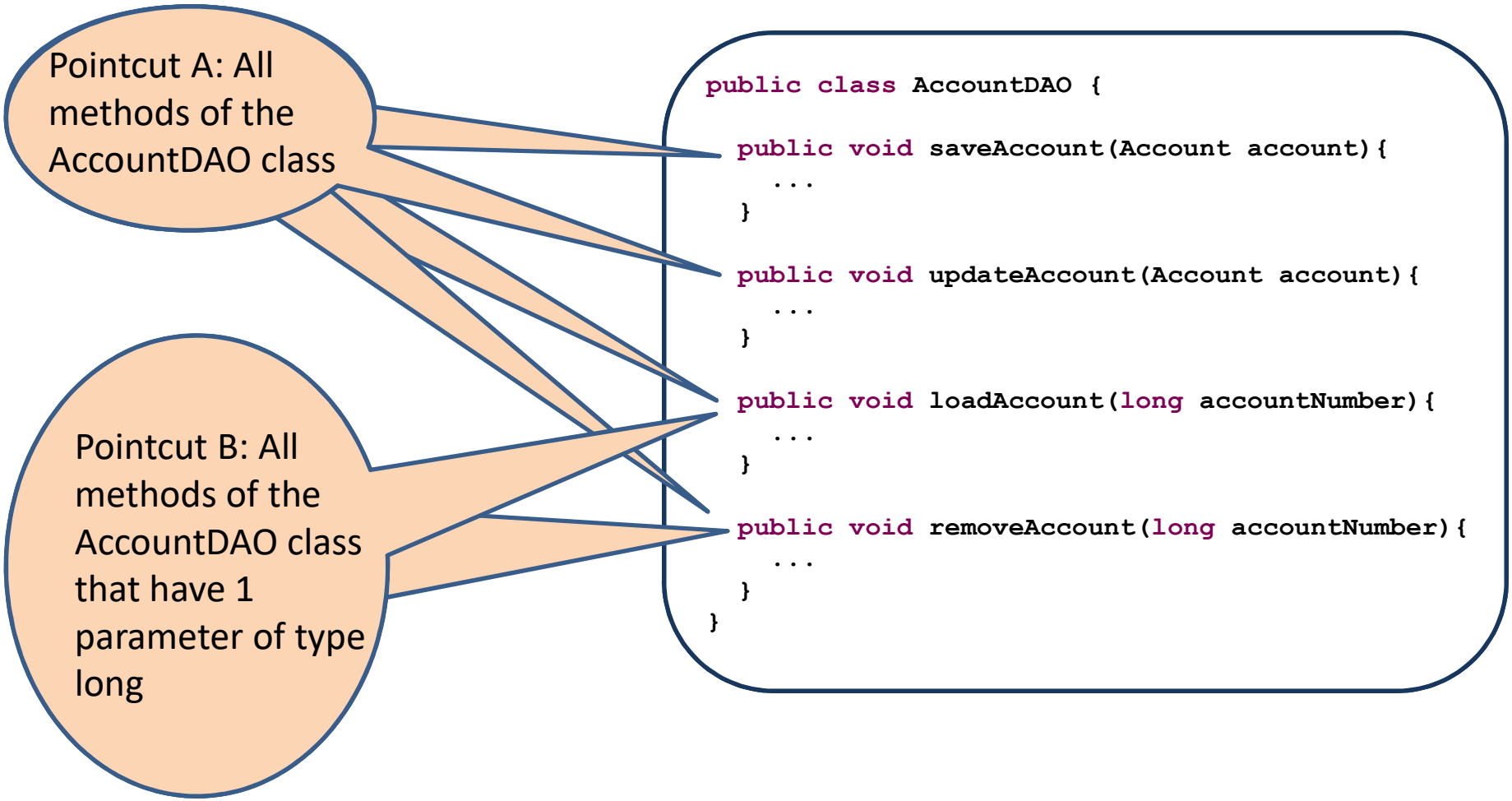
AOP concept: Joinpoint

- A specific method



AOP concept: Pointcut

- A collection of 1 or more joinpoints



AOP concept: Advice

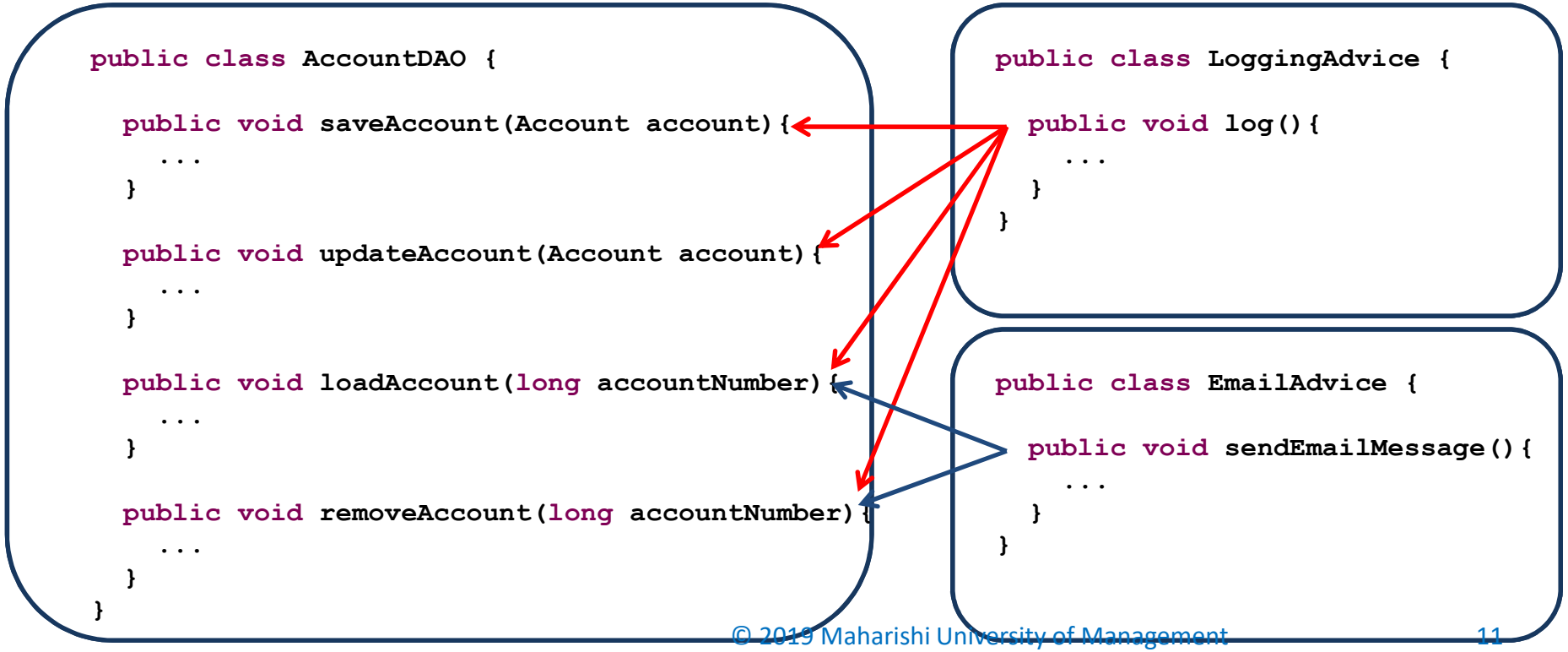
- The implementation of the crosscutting concern what do you wanna do?

```
public class LoggingAdvice {

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

```
public class EmailAdvice {

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

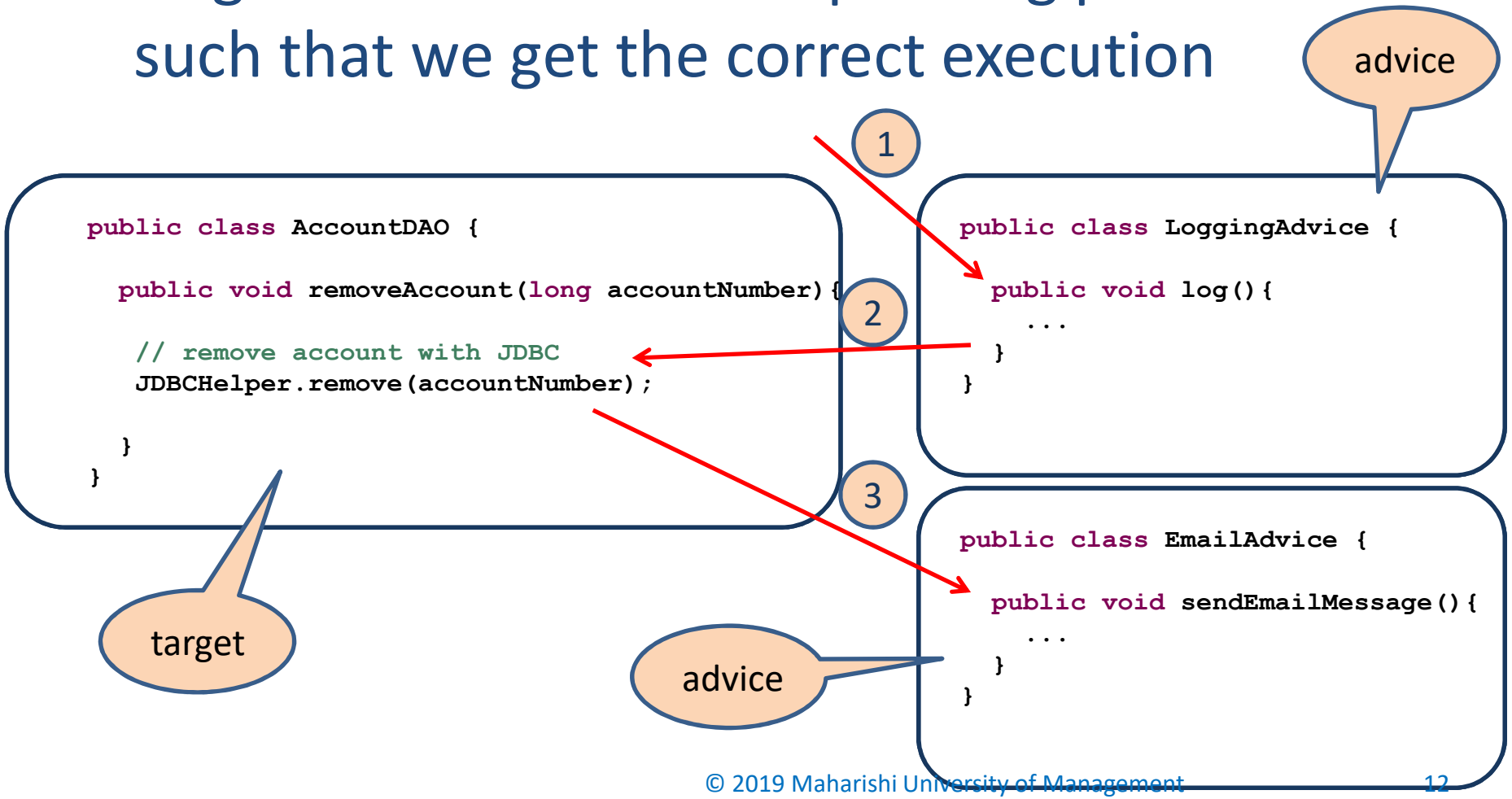
AOP concept: Aspect

- What crosscutting concern do I execute (=advice) at which locations in the code (=pointcut)
  - Aspect A: call the log() method of LoggingAdvice before every method call of AccountDAO
  - Aspect B: call the sendEmailMessage() method of EmailAdvice after every method call of AccountDAO that has one parameter of type long



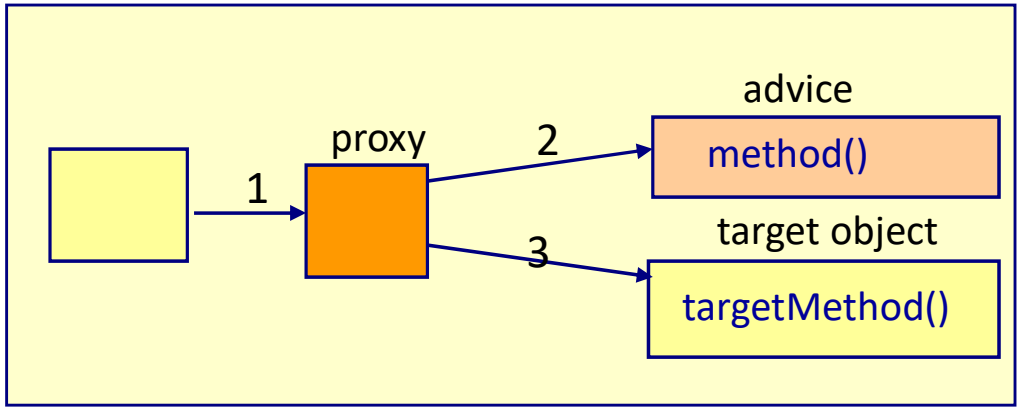
AOP concept: Weaving

- Weave the advice code together with the target code at the corresponding pointcuts such that we get the correct execution



Weaving

- Spring creates a dynamic proxy that weaves the advice and the target method together

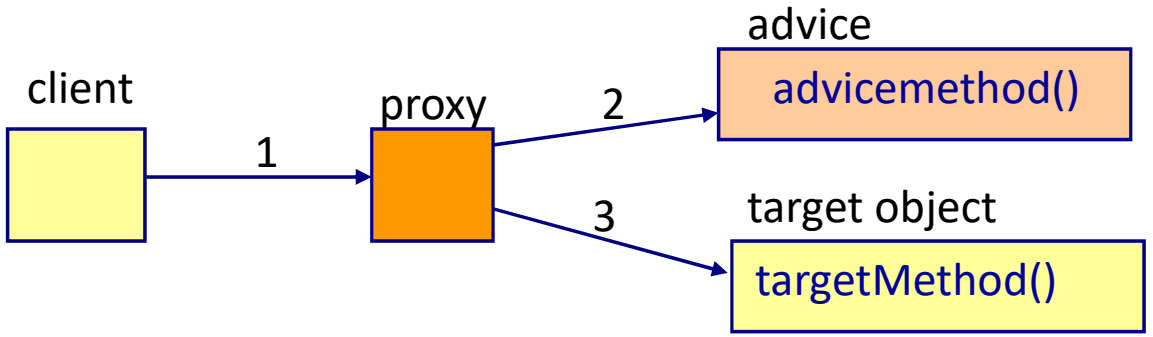


Advice types

- Before
- After returning
- After throwing
- After
- Around

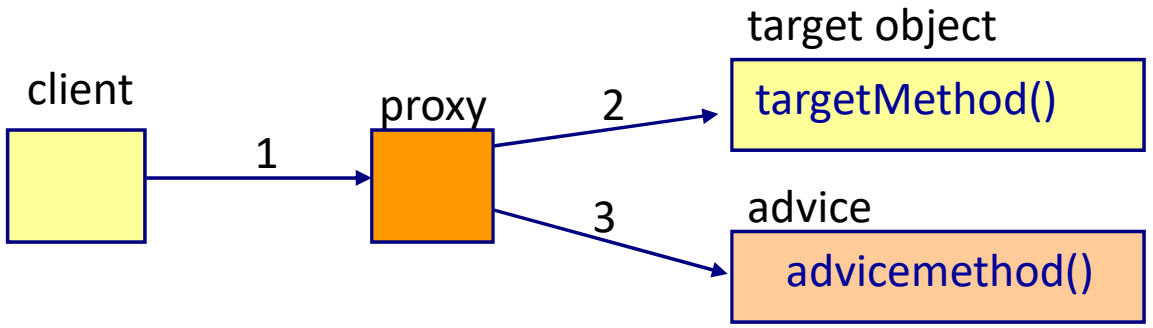
Before advice

- First call the advice method and then the business logic method



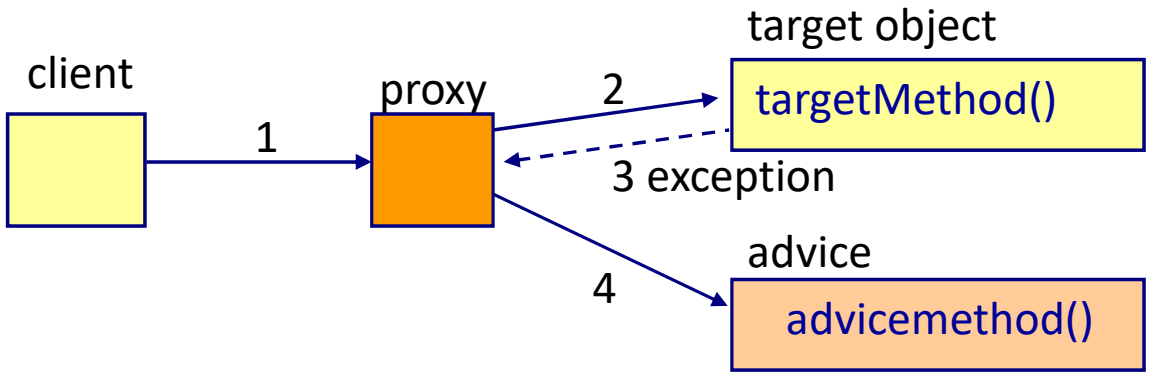
After returning advice

- First call the business logic method and when this business logic method returns normally without an exception, then call the advice method



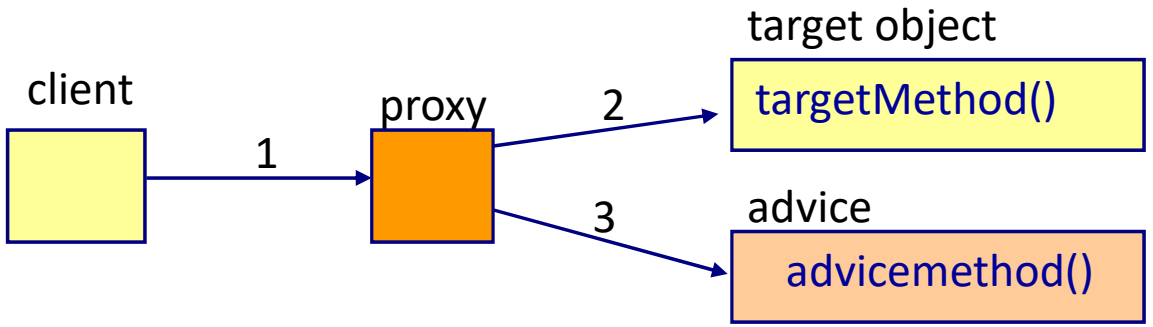
After throwing advice

- First call the business logic method and when this business logic method throws an exception, then call the advice method



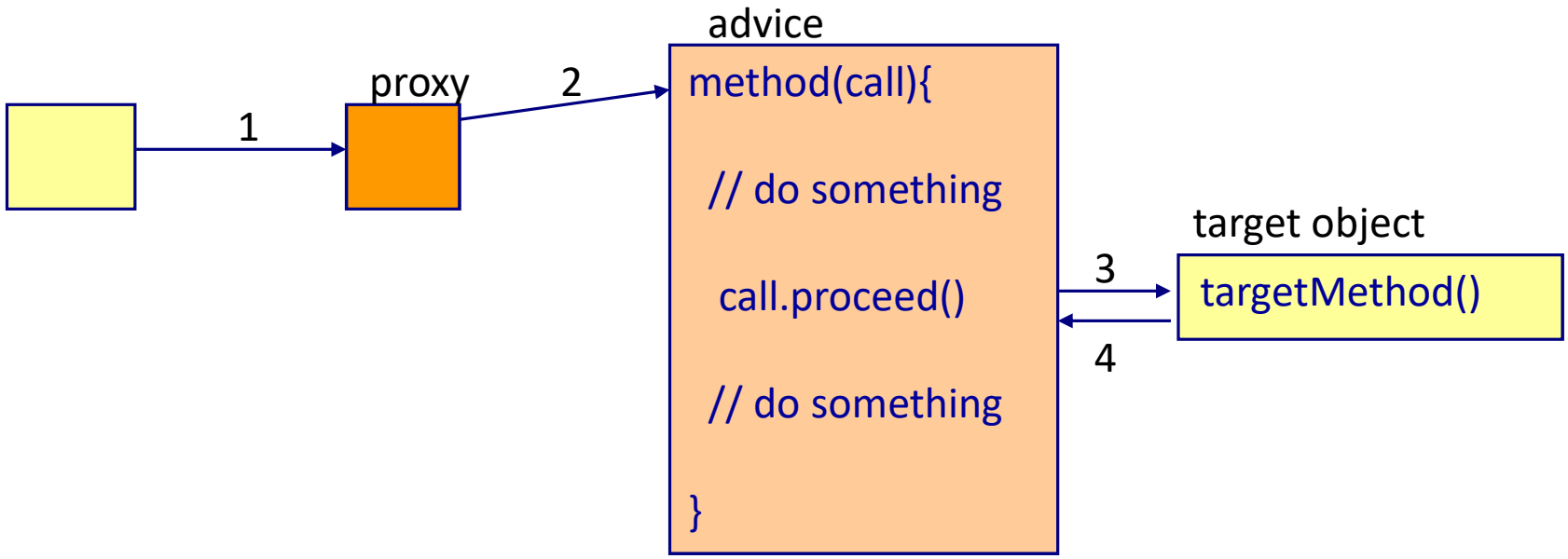
After advice

- First call the business logic method and then call the advice method (independent of how the business logic method returned: normally or with exception)



Around advice

- First call the advice method. The advice method calls the business logic method, and when the business logic method returns, we get back to the advice method



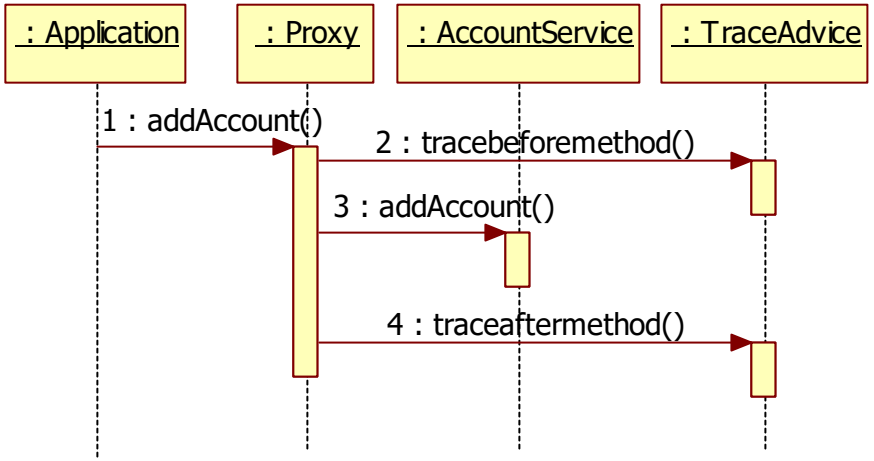
AOP with Spring Boot

```
public class AccountService implements IAccountService{
  Collection<Account> accountList = new ArrayList();

  public void addAccount(String accountNumber, Customer customer){
    Account account = new Account(accountNumber, customer);
    accountList.add(account);
    System.out.println("in execution of method addAccount");
  }
}
```

@Configuration

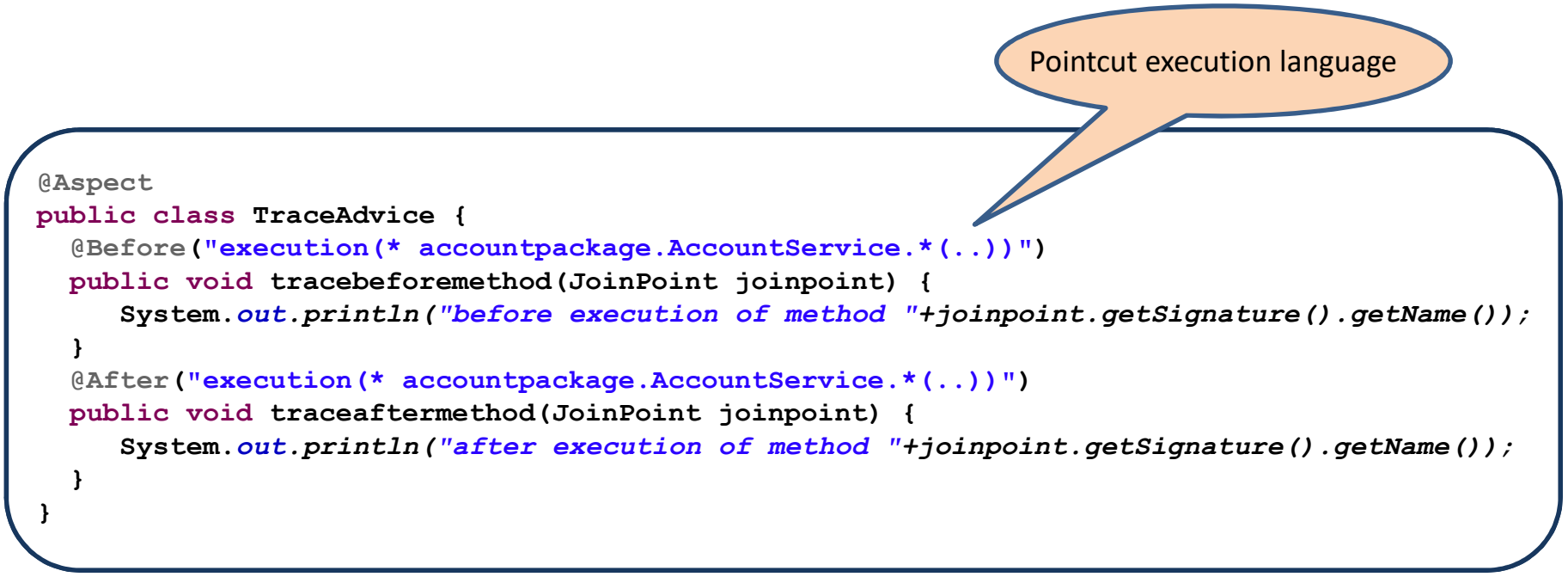
```
@Aspect
@Configuration
public class TraceAdvice {
  @Before("execution(* accountpackage.AccountService.*(..))")
  public void tracebeforemethod(JoinPoint joinpoint) {
     System.out.println("before execution of method "+joinpoint.getSignature().getName());
  }
  @After("execution(* accountpackage.AccountService.*(..))")
  public void traceaftermethod(JoinPoint joinpoint) {
     System.out.println("after execution of method "+joinpoint.getSignature().getName());
  }
}
```

AOP with Spring Boot




```
@Aspect
@Configuration
public class TraceAdvice {
  @Before("execution(* accountpackage.AccountService.*(..))")
  public void tracebeforemethod(JoinPoint joinpoint) {
     System.out.println("before execution of method "+joinpoint.getSignature().getName());
  }
  @After("execution(* accountpackage.AccountService.*(..))")
  public void traceaftermethod(JoinPoint joinpoint) {
     System.out.println("after execution of method "+joinpoint.getSignature().getName());
  }
}
```

Pointcut execution language



Pointcut execution language

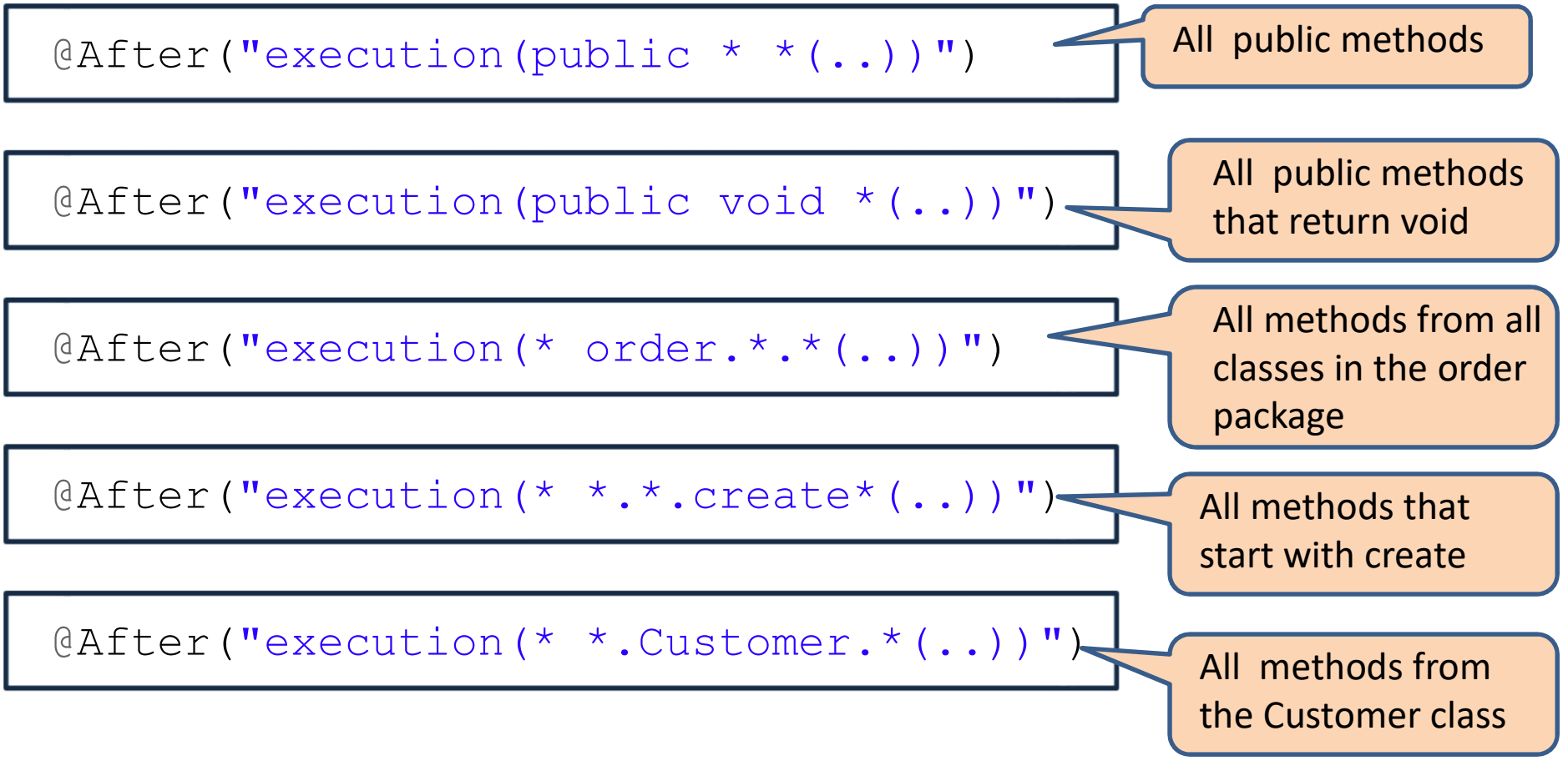
```
@Before("execution(public * *.*.*(..))")
```

Visibility:
- Possibilities:
  - private
  - public
  - Protected
- **Optional**
- **Cannot** be *

Return type:
- The return type of the corresponding method(s)
- Not optional
- Can be *

package.class.method(args):
- Name of the package can also be *
- Name of the class can also be *
- Name of the method can also be *
- Arguments can be ..
- Not optional
- Can also be *.*(..)
- Can also be *(..)

Pointcut execution language examples



Pointcut execution language examples

```
@After("execution(* order.Customer.*(..))")
```

All methods from the Customer class in the order package

```
@After("execution(* order.Customer.getPayment(..))")
```

The getPayment () method from the Customer class in the order package

```
@After("execution(* order.Customer.getPayment(int))")
```

The getPayment () method with a parameter of type int from the Customer class in the order package

```
@After("execution(* *.*.*(long,String))")
```

All methods from all classes that have 2 parameters, the first of type long, and the second of type String

Around example

```
@Around("execution(* *.*.*(..))")
public Object profile (ProceedingJoinPoint call) throws Throwable{
StopWatch clock = new StopWatch("");
clock.start(call.toShortString());

Object object= call.proceed();

clock.stop();
System.out.println(clock.prettyPrint());
return object;
}
```

Create and start a stopwatch

Call the business logic method

Stop the stopwatch and print result

```
StopWatch '': running time (millis) = 1
-----------------------------------------
ms     %     Task name
-----------------------------------------
00001  100%  execution(addAccount)
```

Getting the return value

- Works only for @AfterReturning

```
public class Customer {
  private String name;

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

getName() returns a String

```
@Aspect
public class TraceAdvice {
  @AfterReturning(pointcut="execution(* mypackage.Customer.getName(..))",returning="retValue")
  public void tracemethod(JoinPoint joinpoint, String retValue) {
    System.out.println("method ="+joinpoint.getSignature().getName()
    System.out.println("return value ="+retValue);
  }
}
```

The pointcut expression

Add 'returning' parameter

Add parameter to the advice method. The name of the parameter must be the same as the name of the returning parameter of the @AfterReturning annotation

Getting the return value

```
public class Customer {
private int age;

  public int getAge() {
    return age;
  }
  public void setAge(int age) {
    this.age = age;
  }
}
```

getAge() returns an integer

Add 'returning' parameter

```
@Aspect
public class TraceAdvice {
  @AfterReturning(pointcut="execution(* mypackage.Customer.getAge(..))",returning="retValue")
  public void tracemethod(JoinPoint joinpoint, int retValue) {
    System.out.println("method ="+joinpoint.getSignature().getName());
    System.out.println("return value ="+retValue);
  }
}
```

retValue is an int

Getting the exception

- Works only for @AfterThrowing

```
public class Customer {
  public void myMethod() throws MyException{
    throw new MyException("myexception");
  }
}
```

```
public class MyException extends Exception{
  private String message;

  public MyException(String message){
    this.message=message;
  }
  public String getMessage(){
    return message;
  }
}
```

Add 'throwing' parameter

```
@Aspect
public class TraceAdvice {
  @AfterThrowing(pointcut="execution(* mypackage.Customer.myMethod(..))",throwing="exception")
  public void tracemethod(JoinPoint joinpoint, MyException exception) {
     System.out.println("method ="+joinpoint.getSignature().getName());
     System.out.println("exception message ="+exception.getMessage());
  }
}
```

Add parameter to the advice method

Get parameters

```
public class Customer {
  private String name;

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

```
@Aspect
public class TraceAdvice {
  @After("execution(* mypackage.Customer.setName(..)) && args(name)")
  public void tracemethod(JoinPoint joinpoint, String name) {
     System.out.println("method ="+joinpoint.getSignature().getName());
     System.out.println("parameter name ="+name);
  }
}
```

Add 'args' parameter

Add parameter(s) to the advice method

Get parameters

```
public class Customer {
  private String name;
  private int age;

  public void setNameAndAge(String name, int age){
    this.name = name;
    this.age = age;
   }
 }
```

2 parameters

```
@Aspect
public class TraceAdvice {
  @Before("execution(* mypackage.Customer.setNameAndAge(..)) && args(name,age)")
  public void tracemethod(JoinPoint joinpoint, String name, int age) {
     System.out.println("method ="+joinpoint.getSignature().getName());
     System.out.println("parameter name ="+name);
     System.out.println("parameter age ="+age);
  }
}
```

Add name and age to the args parameter

Add 2 parameters to the advice method

Get parameters from the Joinpoint

```
public class Customer {
  private String name;

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

Get the arguments from the joinpoint

Take the first argument

```
@Aspect
public class TraceAdvice {
 @After("execution(* mypackage.Customer.setName(..))")
  public void tracemethodA(JoinPoint joinpoint) {
  Object[] args = joinpoint.getArgs();
  String name = (String)args[0];
  System.out.println("method ="+joinpoint.getSignature().getName());
  System.out.println("parameter name ="+name);
  }
}
```

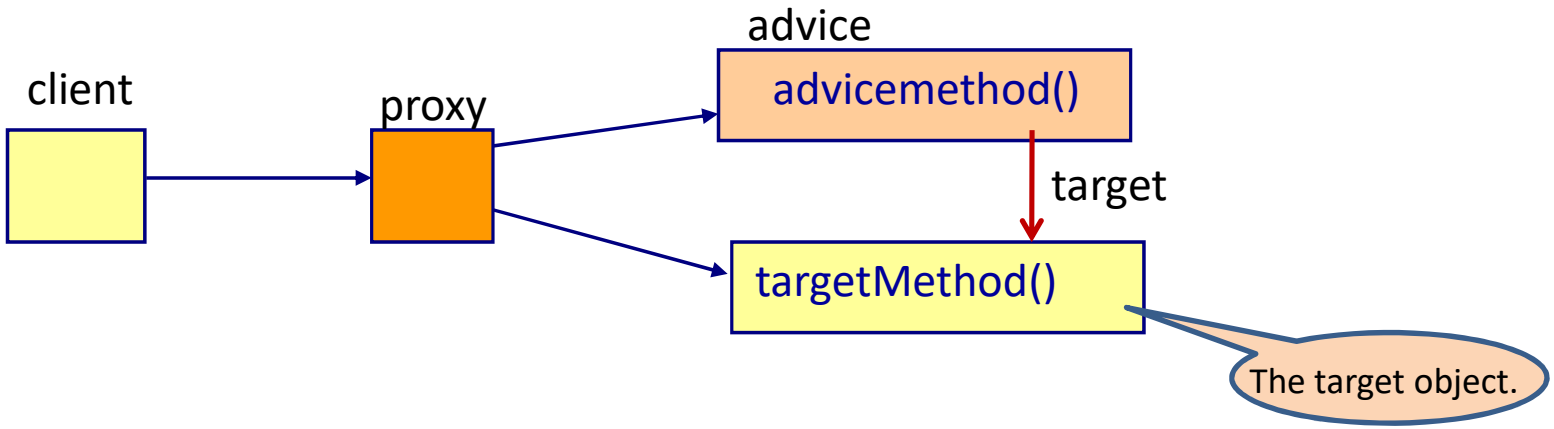
Get multiple parameters from the Joinpoint

```
public class Customer {
  private String name;
  private int age;

  public void setNameAndAge(String name, int age){
    this.name = name;
    this.age = age;
   }
 }
```

2 parameters

```
@Aspect
public class TraceAdvice {
  @Before("execution(* mypackage.Customer.setNameAndAge(..))")
  public void tracemethod(JoinPoint joinpoint ) {
     Object[] args = joinpoint.getArgs();
     String name = (String)args[0];
     int age = (Integer)args[1];
     System.out.println("method ="+joinpoint.getSignature().getName());
     System.out.println("parameter name ="+name);
     System.out.println("parameter age ="+age);
  }
}
```

The target class



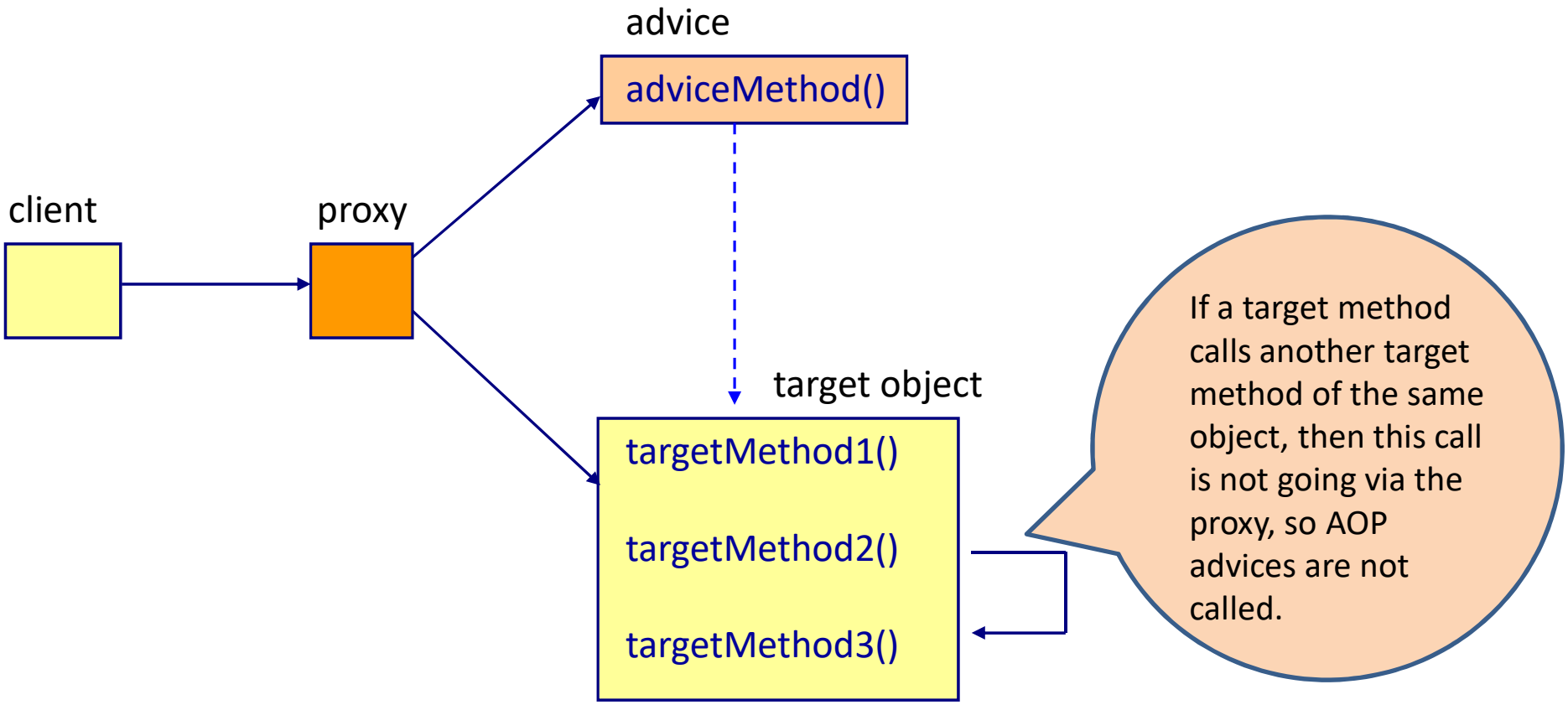
Get the target class

```
public class Customer {
  private String name;
  private int age;

  public int getAge() {
    return age;
  }
  public void setAge(int age) {
    this.age = age;
  }
  public String getName() {
    return name;
  }
  public void setName(String name) {
    this.name = name;
  }
}
```

Get the target object from the joinpoint

```
@Aspect
public class TraceAdvice {
 @After("execution(* mypackage.Customer.setName(..))")
  public void tracemethod(JoinPoint joinpoint) {
    Customer customer = (Customer)joinpoint.getTarget();
    System.out.println("method ="+joinpoint.getSignature().getName());
    System.out.println("customer age ="+customer.getAge());
  }
}
```

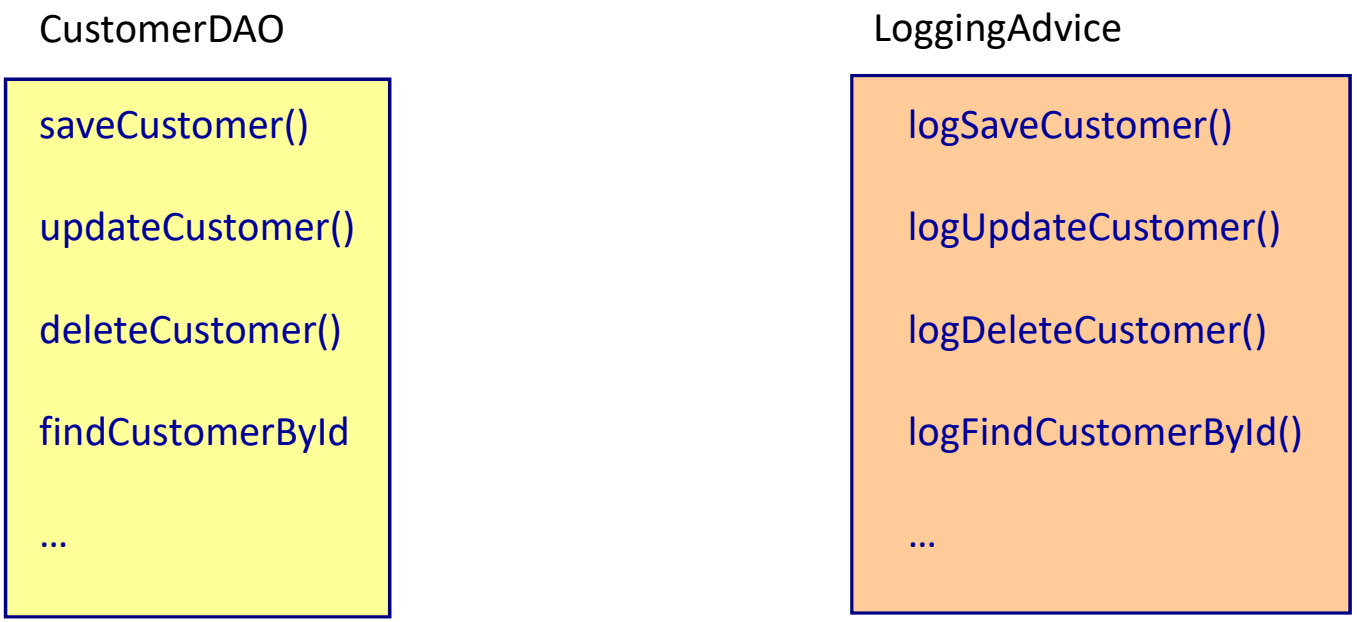
Disadvantage of a proxy



Advantages of AOP

- No code tangling
- No code scattering

Crosscutting concern needs to be generic



Disadvantages of AOP

- You don’t have a clear overview of which code runs when
- AOP works only for generic logic that is always the same
- A pointcut expression is a string that is parsed at runtime
  - No compile time checking of the pointcut expression
- You make mistakes easily
- Problems with proxy-based AOP

Main point

- With Spring AOP we separate the logic at design time and we weave it together at runtime using a proxy.
- In the relative world everything seems to be separated while in reality everything is connected at its source, the unified field of pure consciousness.