CS544 Enterprise Application Architecture

Lesson 2 – Spring Boot and AOP

Frameworks and Best Practices Used in Designing Large-Scale Software Systems

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SPRING BOOT

Spring boot

- Framework that makes it easy to configure and run spring applications
- Simple maven configuration
- Default/auto spring configuration
- Containerless deployment

Spring boot POM file

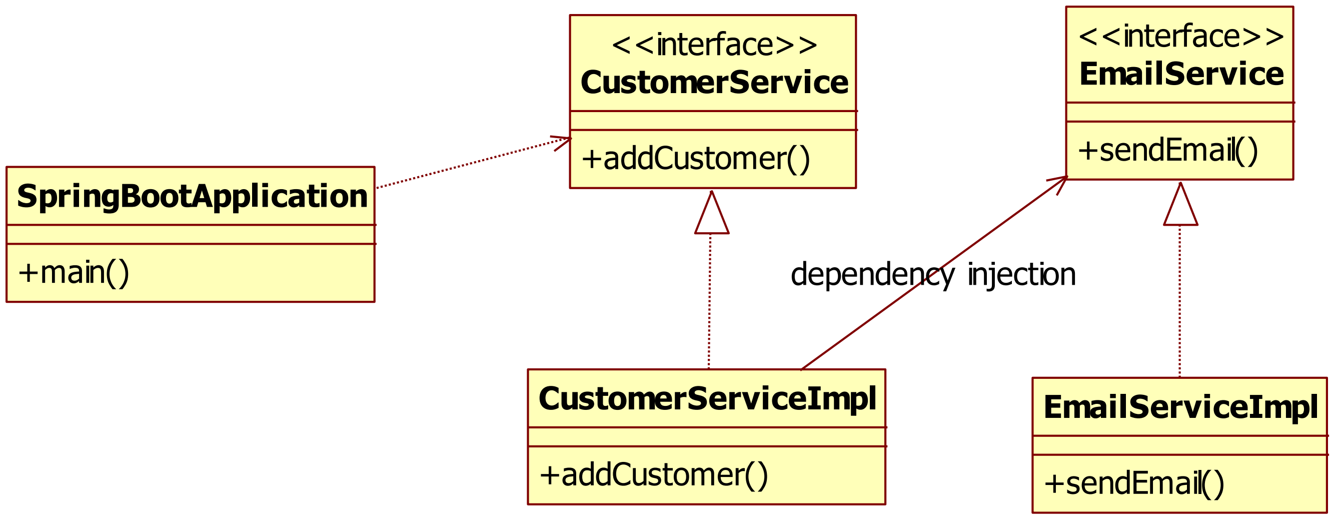
```xml
<parent>
  <groupId>org.springframework.boot</groupId>
  <artifactId>spring-boot-starter-parent</artifactId>
  <version>2.0.0.M6</version>
  <relativePath/> <!-- lookup parent from repository -->
</parent>


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

  <dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-test</artifactId>
    <scope>test</scope>
  </dependency>
</dependencies>

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

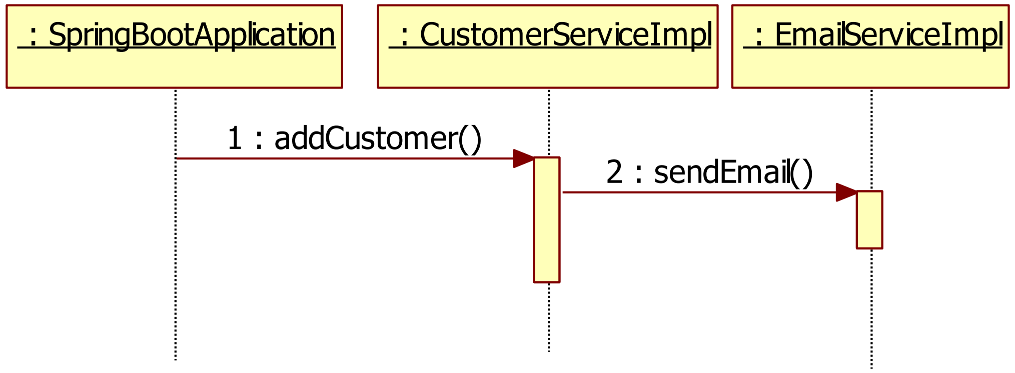
Inherit Spring Boot default dependencies and versions

Starter POM

Contains goals for packaging the application

Example application





Using annotations

```java
public interface EmailService {
  void sendEmail();
}
```

```java
@Service
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

```java
public interface CustomerService {
  void addCustomer();
}
```

```java
@Service
public class CustomerServiceImpl implements CustomerService{
  @Autowired
  private EmailService emailService;

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

Spring Boot option 1

Same as
@Configuration,
@ComponentScan
@EnableAutoConfiguration

```
@SpringBootApplication
public class SpringBootApplication {

  public static void main(String[] args) {
    ApplicationContext context = new
         AnnotationConfigApplicationContext(SpringBootApplication.class);
    CustomerService customerService =
    context.getBean("customerServiceImpl",CustomerService.class);
    customerService.addCustomer();
  }
}
```

Create an ApplicationContext based on the current configuration class

Spring Boot option 2

```
@SpringBootApplication
public class SpringBootApplication {

  public static void main(String[] args) {
    ApplicationContext context = new
         AnnotationConfigApplicationContext(AppConfig.class);
    CustomerService customerService =
    context.getBean("customerServiceImpl",CustomerService.class);
    customerService.addCustomer();
  }
}
```

Create an ApplicationContext based on an external configuration class

```
@Configuration
@ComponentScan("customers")
public class AppConfig {
}
```

Spring Boot option 3

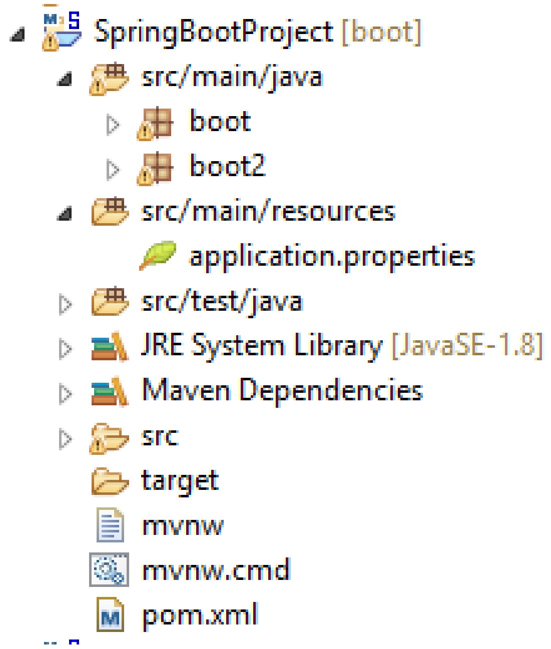
```java
@SpringBootApplication
public class SpringBootProjectApplication implements CommandLineRunner {
  @Autowired
  private CustomerService customerService;

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

  @Override
  public void run(String... args) throws Exception {
    customerService.addCustomer();
  }
}
```

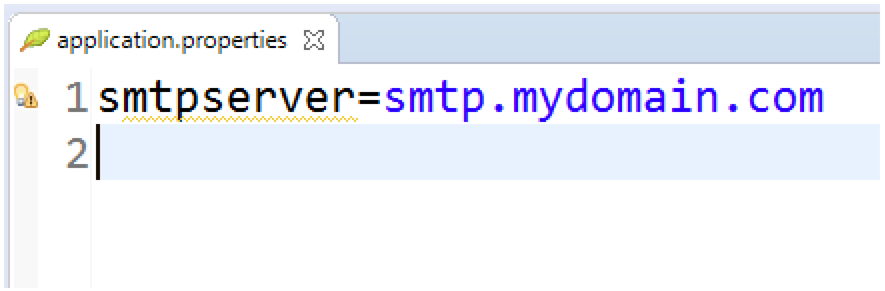
Implement the CommandLineRunner

Implement the run() method

Spring Boot configuration

- Spring Boot uses **application.properties** as the default configuration file





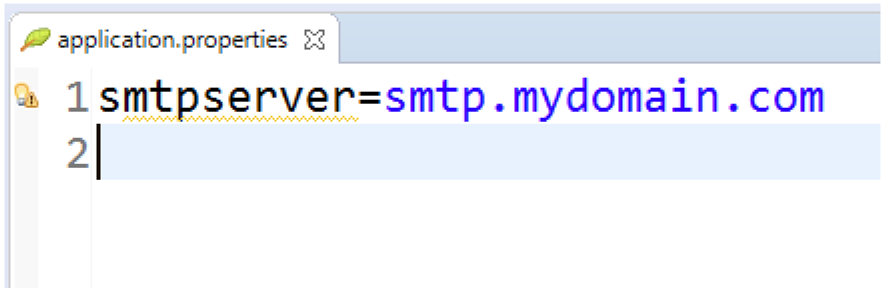
```
smtpserver=smtp.mydomain.com
```

application.properties

```
public interface EmailService {
  void sendEmail();
}
```

```
@Service
public class EmailServiceImpl implements EmailService{
  @Value(" ${smtpserver}")
  String smtpServer;

  public void sendEmail() {
    System.out.println("Sending email using smtp server "+smtpServer);
  }
}
```

Inject the value from the properties file



```
smtpserver=smtp.mydomain.com
```

Spring creates the context

```java
@SpringBootApplication
public class SpringBootProjectApplication implements CommandLineRunner {
  @Autowired
  private EmailService emailService;

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

  @Override
  public void run(String... args) throws Exception {
    emailService.sendEmail();
  }
}
```

Spring automatically reads application.properties

You create the context yourself

```
@SpringBootApplication
@PropertySource("classpath:application.properties")
public class SpringBootProjectApplication  {

  public static void main(String[] args) {
    ApplicationContext context = new
      AnnotationConfigApplicationContext(SpringBootProjectApplication.class);
    EmailService emailService = context.getBean("emailServiceImpl",
                                EmailService.class);
    emailService.sendEmail();
 }
}
```

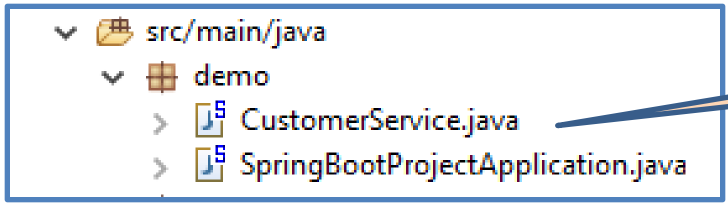
You need to define the application.properties file yourself

You create the context yourself

Spring component scanning

Spring will automatically scan all classes in the package 'demo' and all sub-packages of 'demo'

```
package demo;

@SpringBootApplication
public class SpringBootProjectApplication implements CommandLineRunner {
  @Autowired
  private CustomerService customerService;

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

  @Override
  public void run(String... args) throws Exception {
    customerService.addCustomer();
  }
}
```

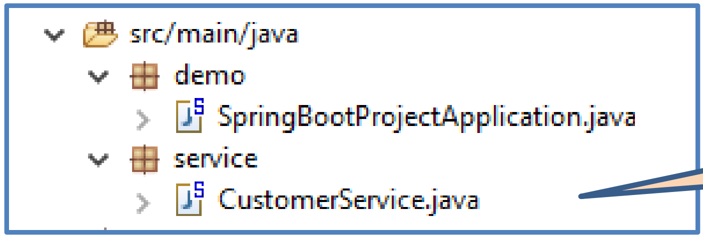


CustomerService is in the package 'demo'

@ComponentScan

```
package demo;

@SpringBootApplication
@ComponentScan(basePackages = {"service"})
public class SpringBootProjectApplication implements CommandLineRunner {
  @Autowired
  private CustomerService customerService;

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

  @Override
  public void run(String... args) throws Exception {
    customerService.addCustomer();
  }
}
```

Specify all packages that Spring will scan



```
src/main/java
  demo
    SpringBootProjectApplication.java
  service
    CustomerService.java
```

CustomerService is not in the package 'demo' or subpackage of 'demo'

@ComponentScan with filters

Also scan the classes that follow this reggex pattern

```
@ComponentScan(basePackages = "com.concretepage",
includeFilters = @Filter(type = FilterType.REGEX, pattern="com.concretepage.*.*Util"),
excludeFilters = @Filter(type = FilterType.ASSIGNABLE_TYPE, classes = IUserService.class))
```

Do not scan the IUserService class

- The available FilterType values are:
  - FilterType.ANNOTATION: Include or exclude those classes with a stereotype annotation
  - FilterType.ASPECTJ: Include or exclude classes using an AspectJ type pattern expression
  - FilterType.ASSIGNABLE_TYPE: Include or exclude classes that extend or implement this class or interface
  - FilterType.REGEX: Include or exclude classes using a regular expression
  - FilterType.CUSTOM: Include or exclude classes using a custom implementation of theorg.springframework.core.type.TypeFilter interface

Set the logging level in application.properties

```
logging.level.root=ERROR
logging.level.org.springframework=ERROR
```

DI example

```java
@Service
public class GreetingService {
  @Autowired
  private Greeting greeting;

  public String getTheGreeting() {
    return greeting.getGreeting();
  }
}
```

Spring does not know which class to inject

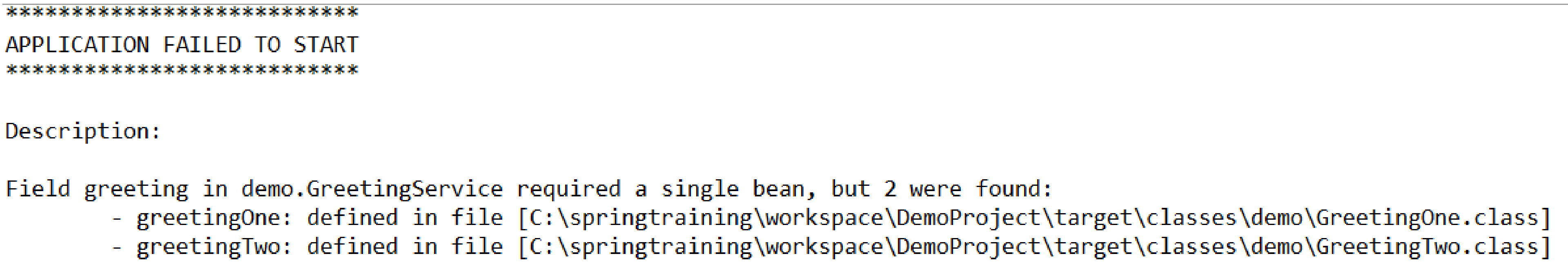
```java
public interface Greeting {
  String getGreeting();
}
```

```java
@Component
public class GreetingOne implements Greeting{

  public String getGreeting() {
    return "Hello World";
  }
}
```

```java
@Component
public class GreetingTwo implements Greeting{

  public String getGreeting() {
    return "Hi World";
  }
}
```

DI example

```java
@SpringBootApplication
public class DemoProjectApplication implements CommandLineRunner {

  @Autowired
  private GreetingService greetingService;

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

  @Override
  public void run(String... args) throws Exception {
    System.out.println(greetingService.getTheGreeting());
  }
}
```



```
***************************
APPLICATION FAILED TO START
***************************

Description:

Field greeting in demo.GreetingService required a single bean, but 2 were found:
	- greetingOne: defined in file [C:\springtraining\workspace\DemoProject\target\classes\demo\GreetingOne.class]
	- greetingTwo: defined in file [C:\springtraining\workspace\DemoProject\target\classes\demo\GreetingTwo.class]
```

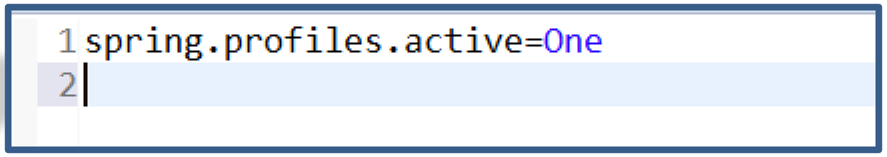
Solution 1: use qualifier

```java
@Service
public class GreetingService {
  @Autowired
  @Qualifier(value="greetingOne")
  private Greeting greeting;

  public String getTheGreeting() {
    return greeting.getGreeting();
  }
}
```

Solution 2: use profiles

```java
@Service
public class GreetingService {
  @Autowired
  private Greeting greeting;

  public String getTheGreeting() {
    return greeting.getGreeting();
  }
}
```

Set the active profile in application.properties



```
spring.profiles.active=One
```

```java
@Component
@Profile("One")
public class GreetingOne implements Greeting{
  public String getGreeting() {
    return "Hello World";
  }
}
```

Define a profile

```java
@Component
@Profile("Two")
public class GreetingTwo implements Greeting{
  public String getGreeting() {
    return "Hi World";
  }
}
```

Define a profile

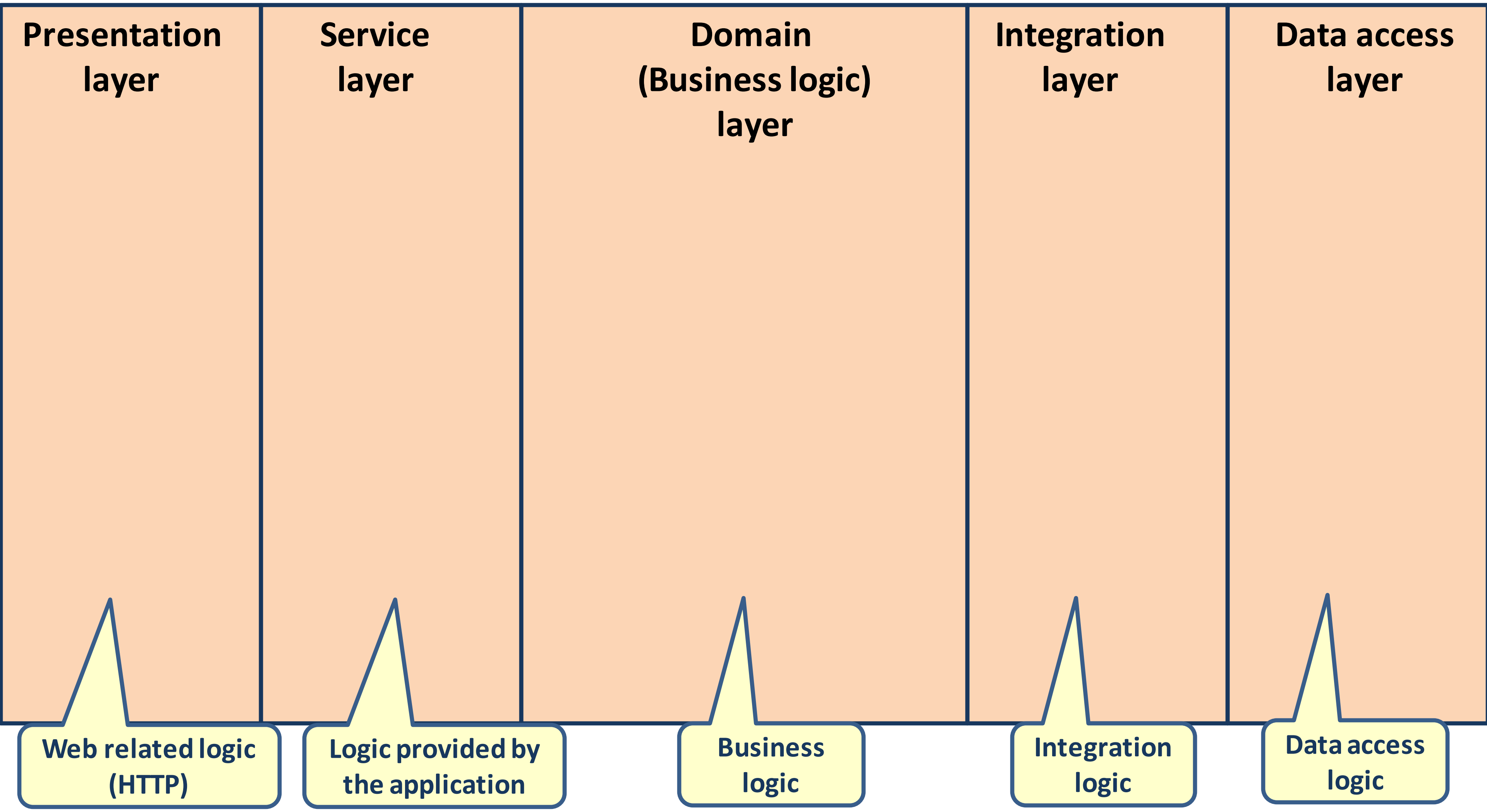
Main point

- Spring boot makes writing enterprise applications simpler by using convention over configuration.

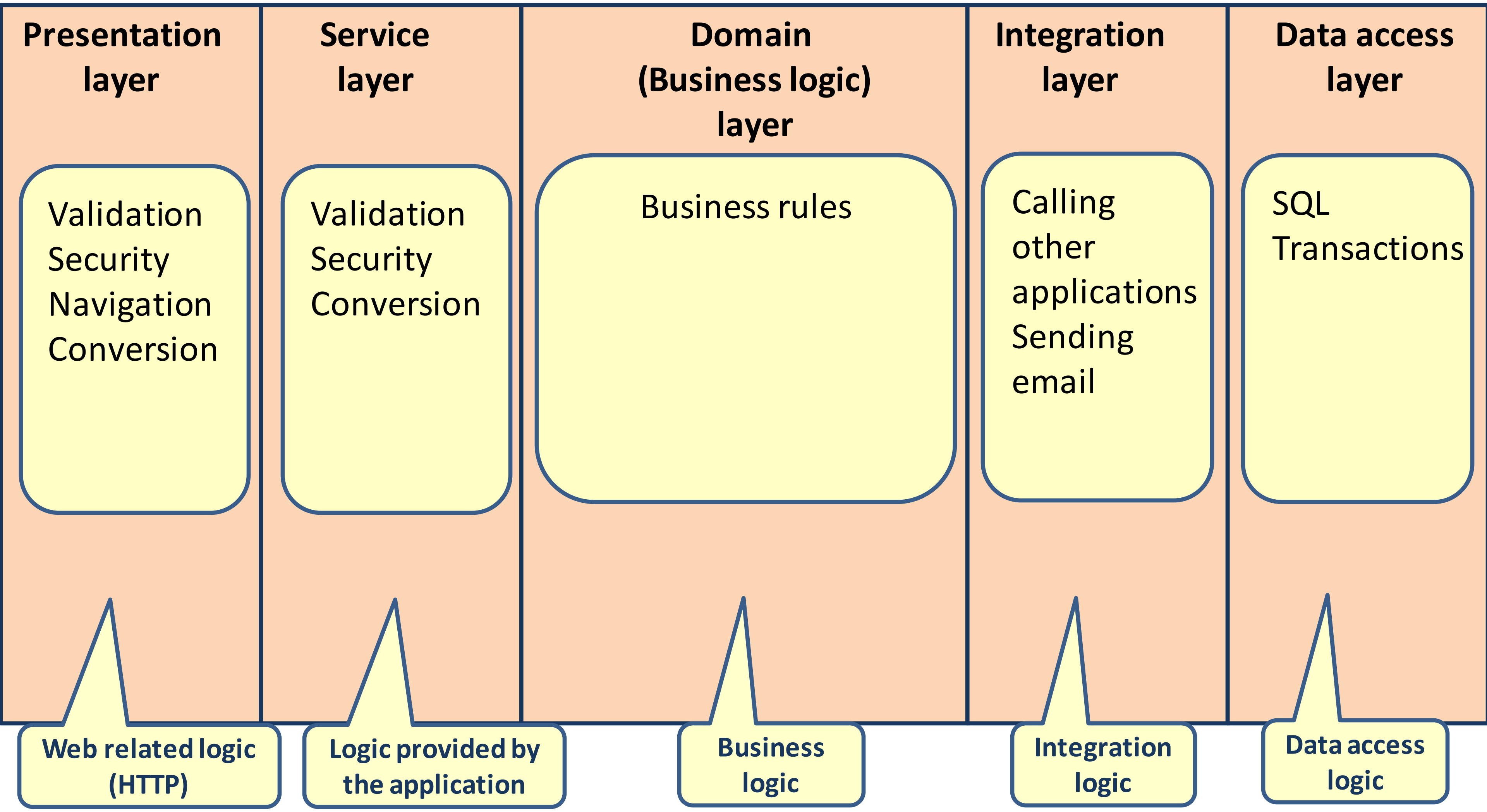
  Science of Consciousness: One gains full support of Nature when one operates from the level of the Unified Field, the source of all creation.

LAYERS OF AN ENTERPRISE APPLICATION

Application layers

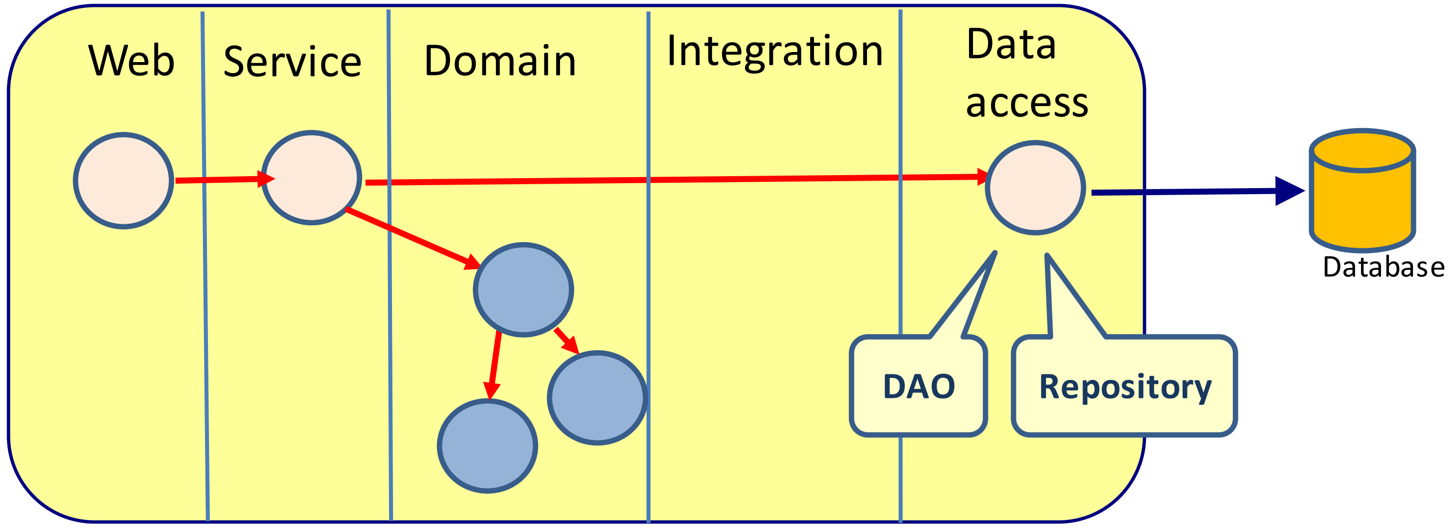


Application layers



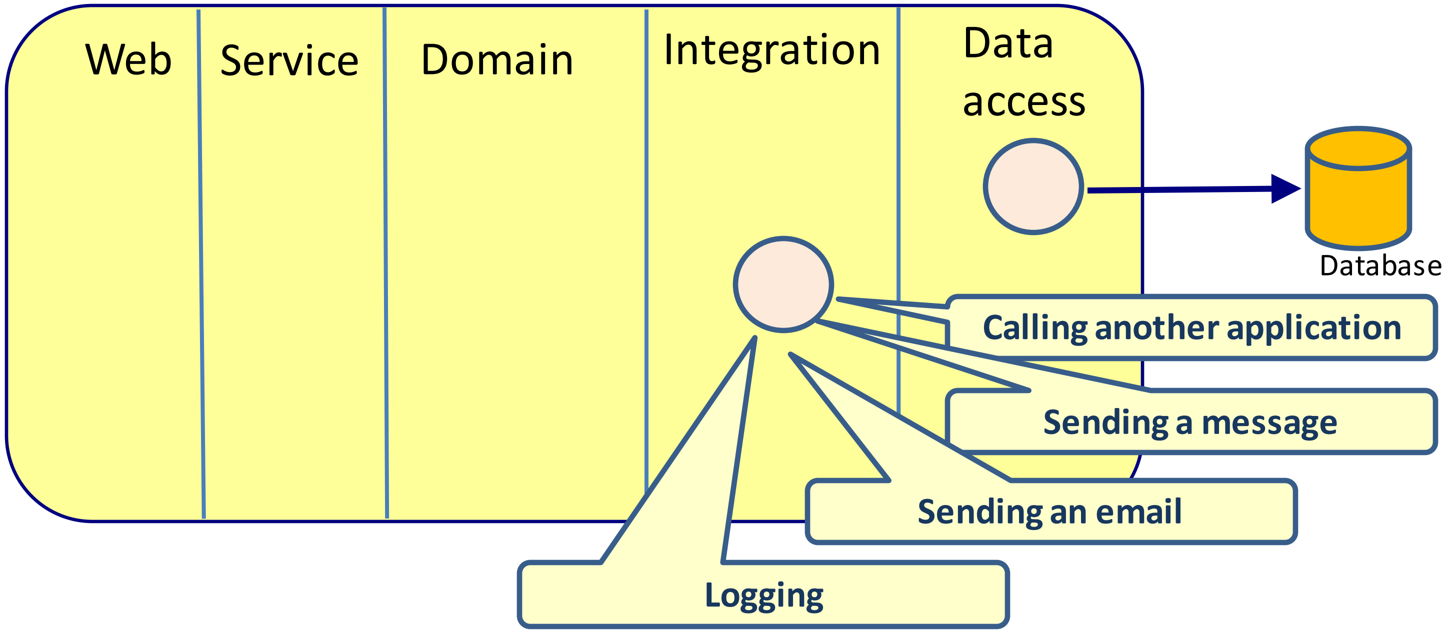
Data Access Object (DAO)/Repository

- Object that knows how to access the database
- Contains all database related logic
- Also called repository



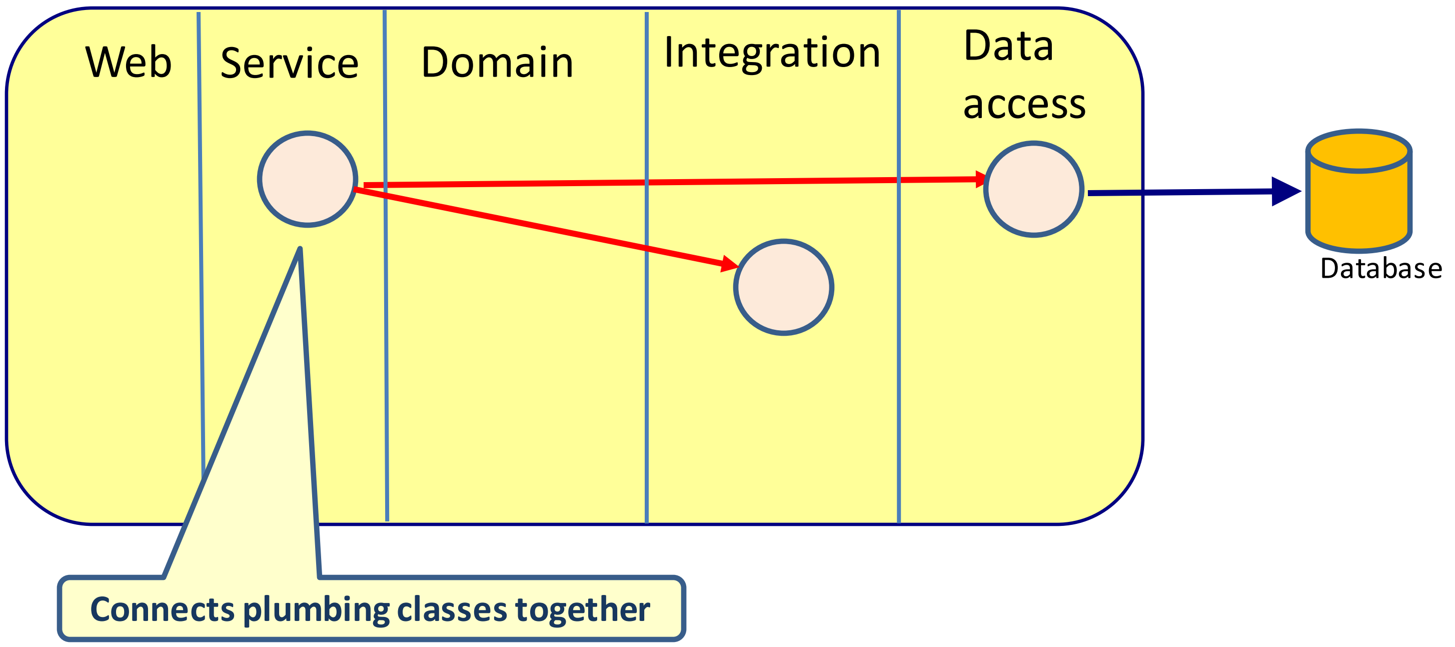
Technical plumbing classes

- Single responsibility



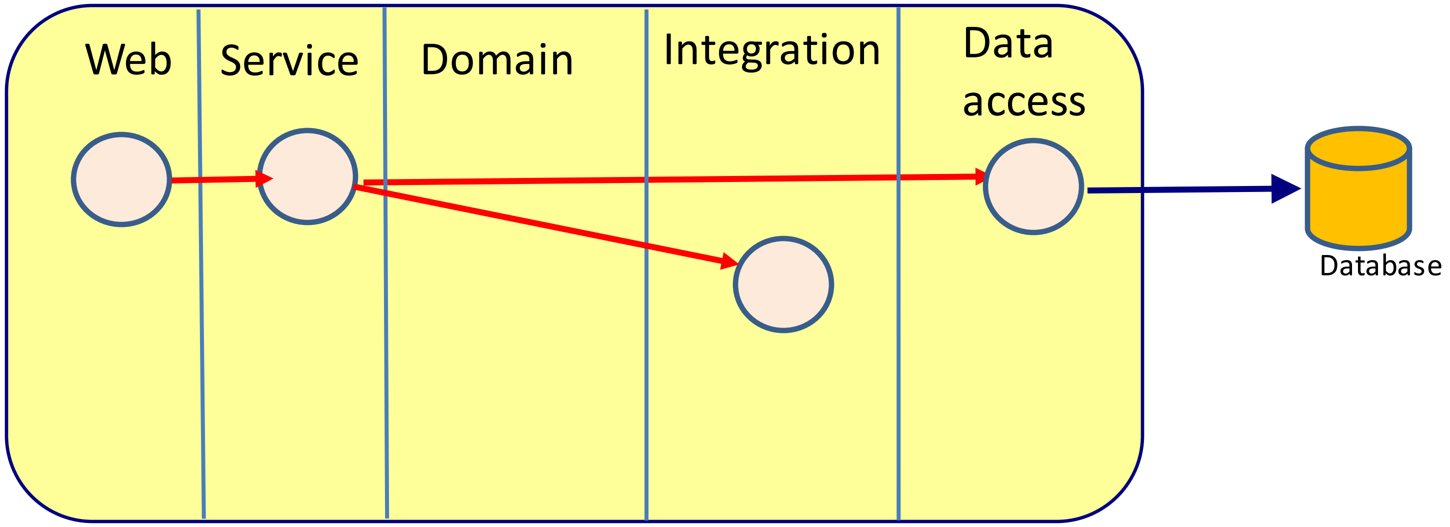
Service classes

- Reception
- Façade



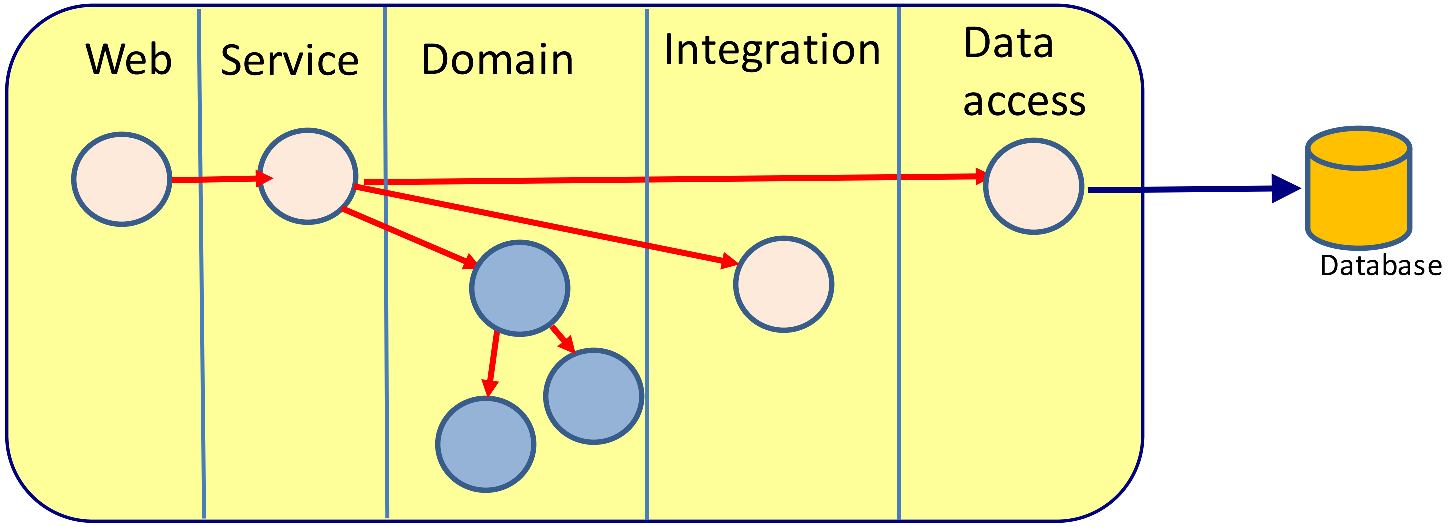
Controller classes

- HTTP controller
  - Receives the HTTP request

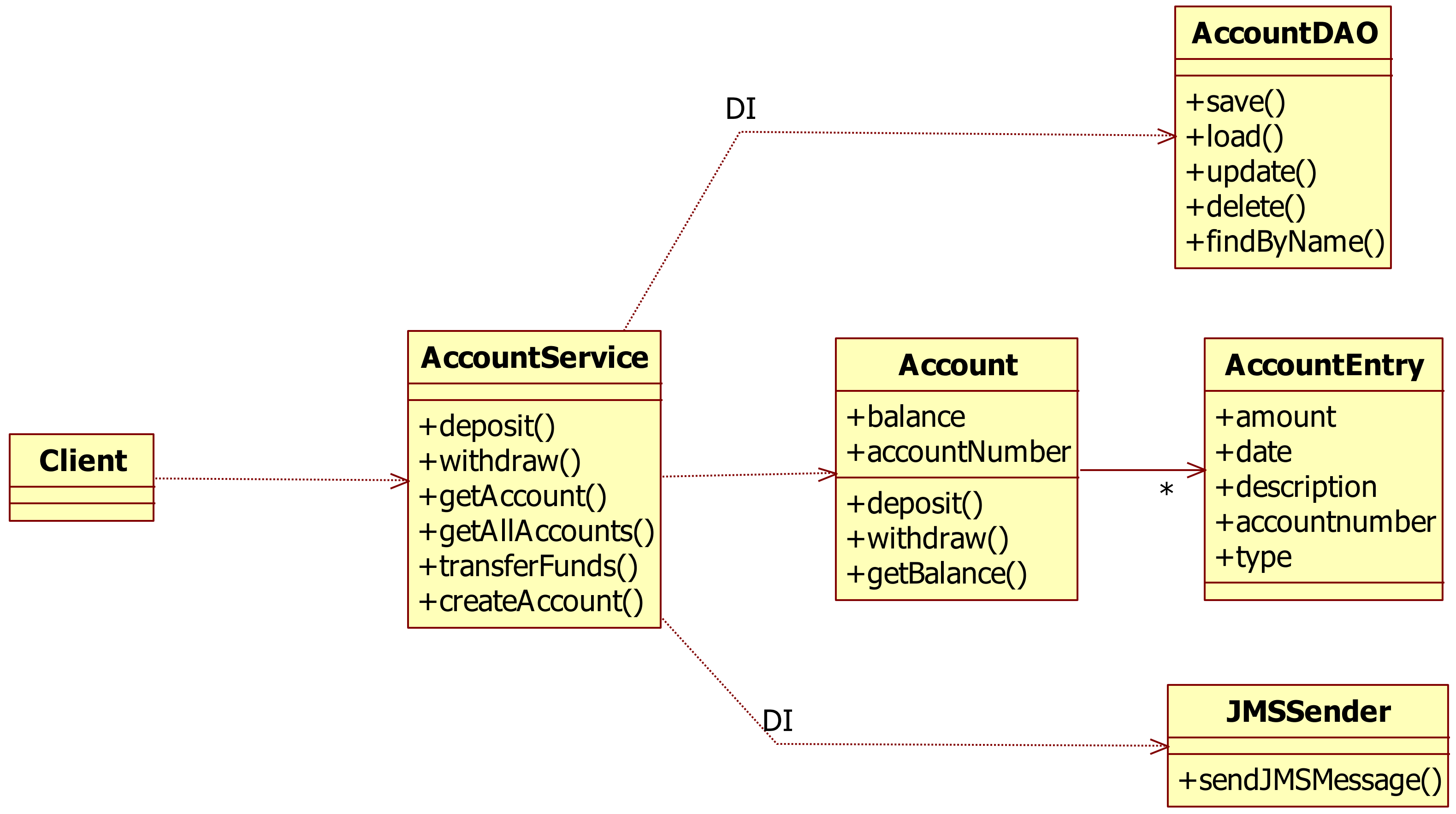


Domain classes

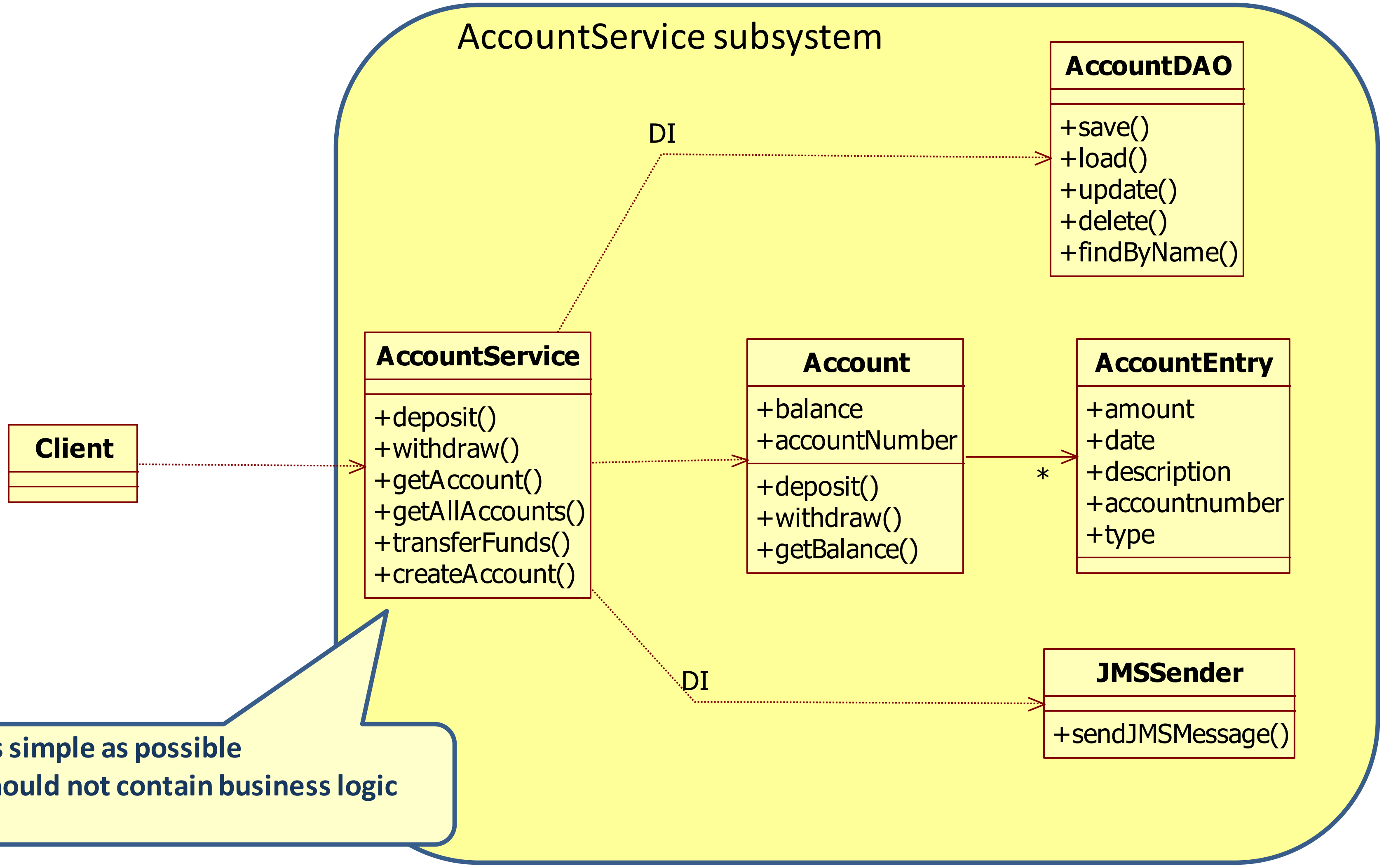
- Implement the business logic
  - Contains no technical code



Service Object

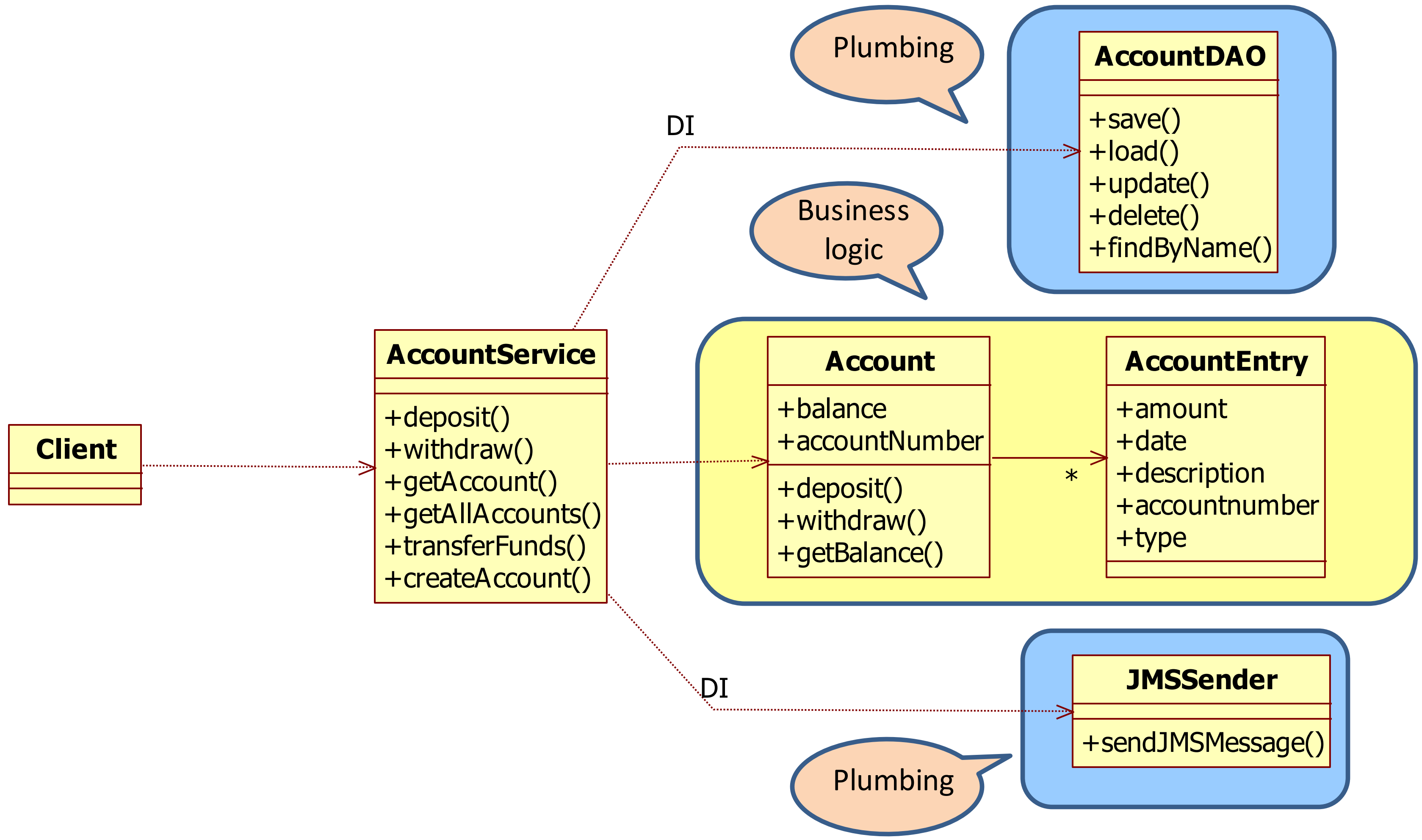


Entry of a complex subsystem

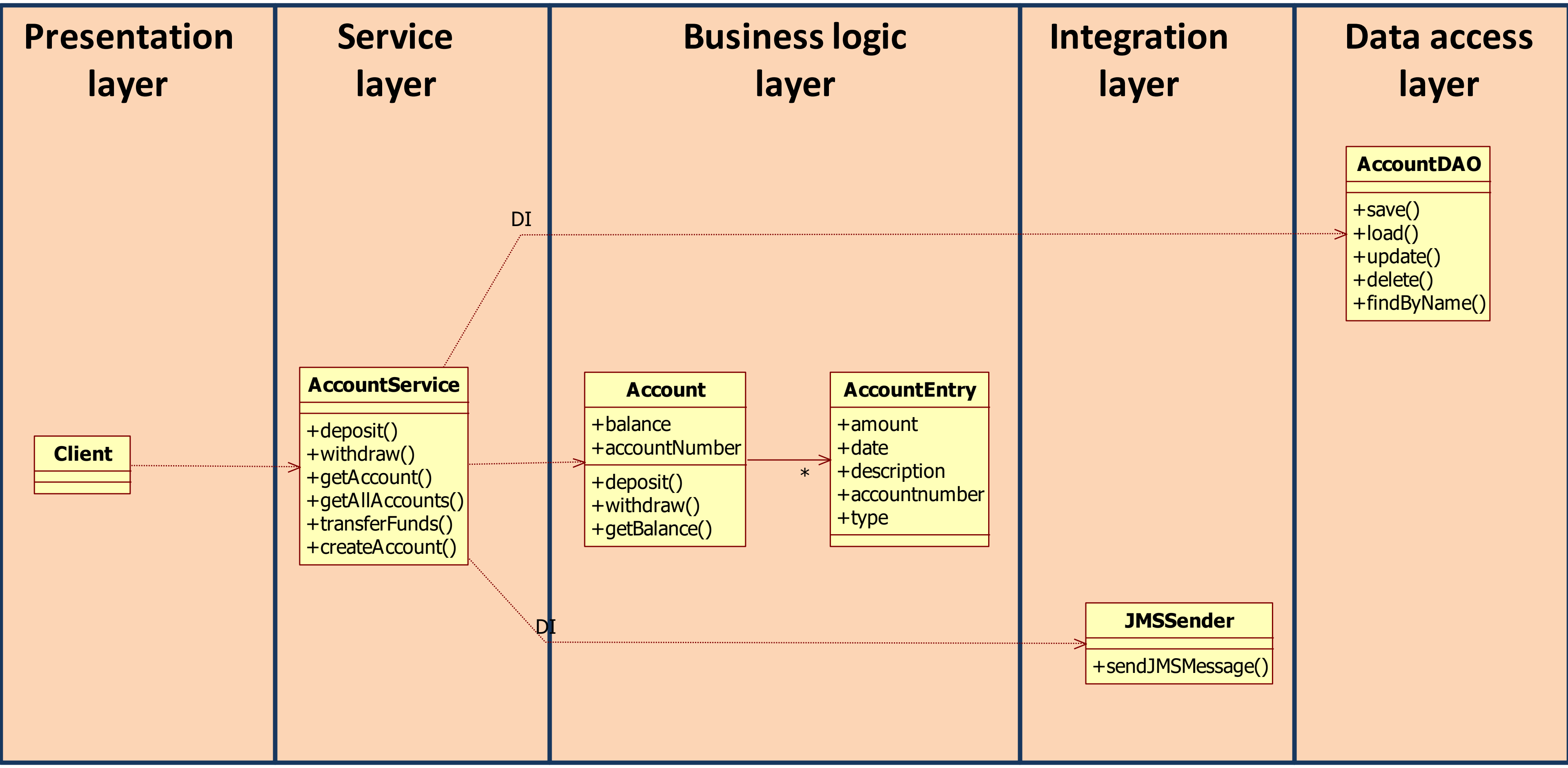


- As simple as possible
- Should not contain business logic

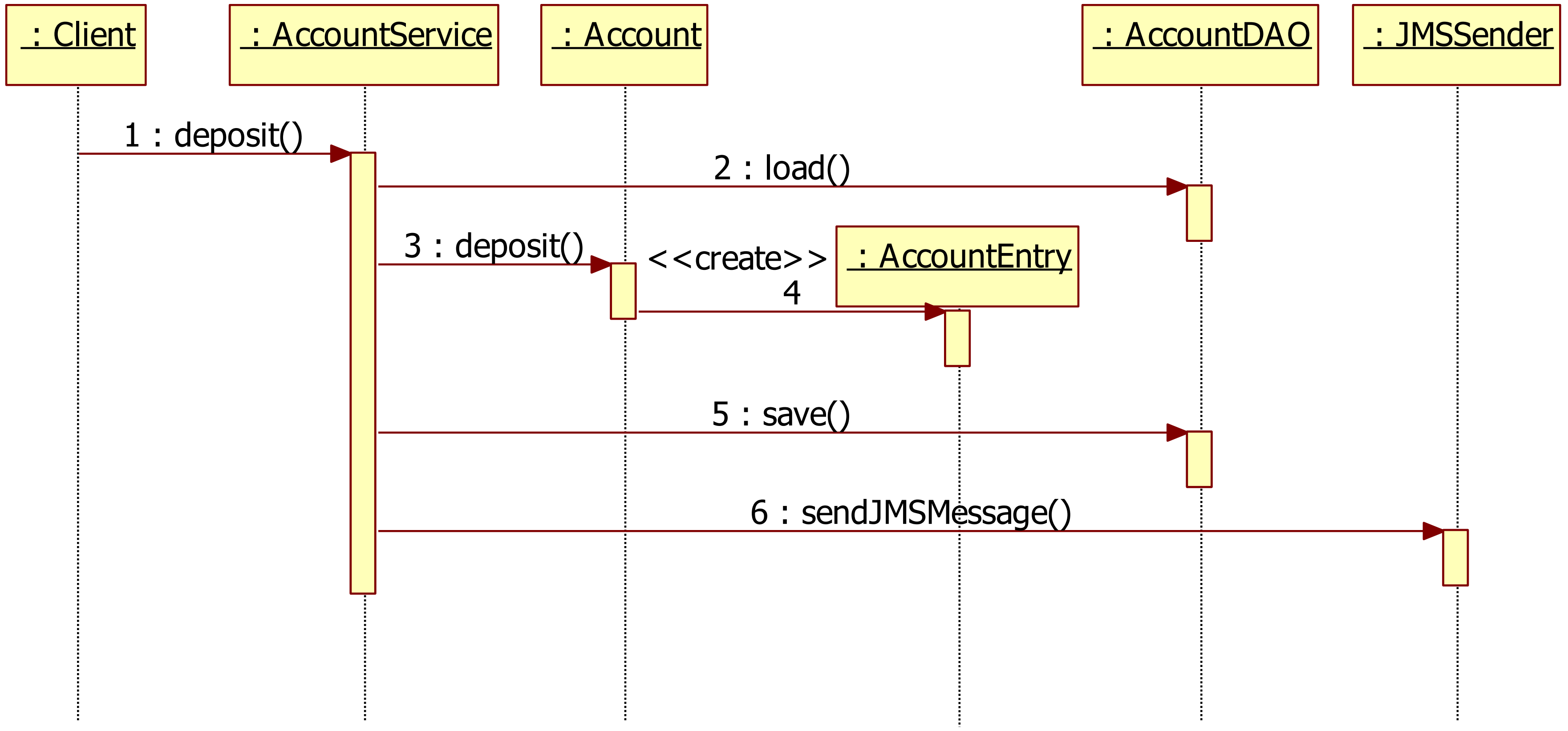
Separation of concern



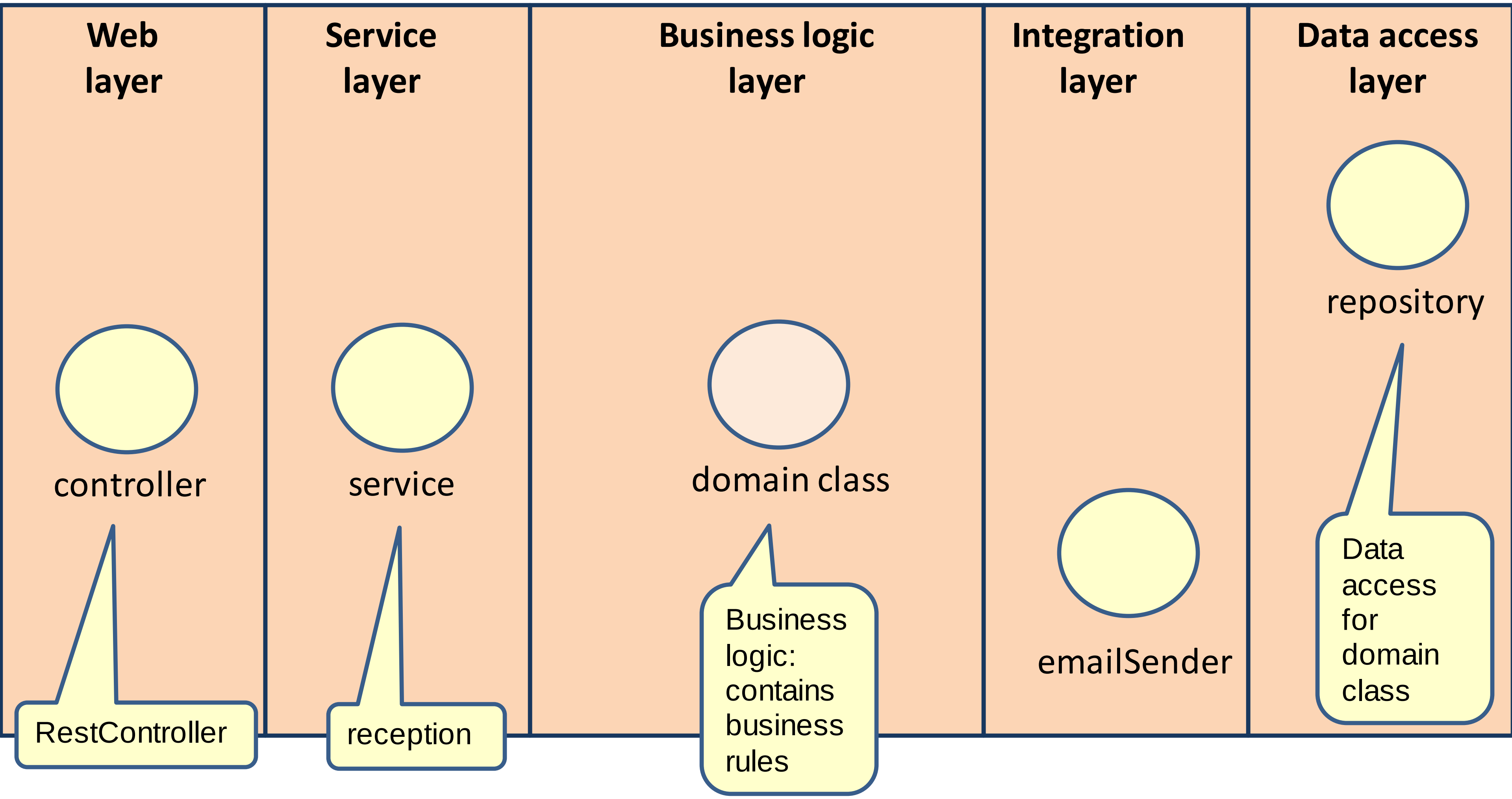
Application layers



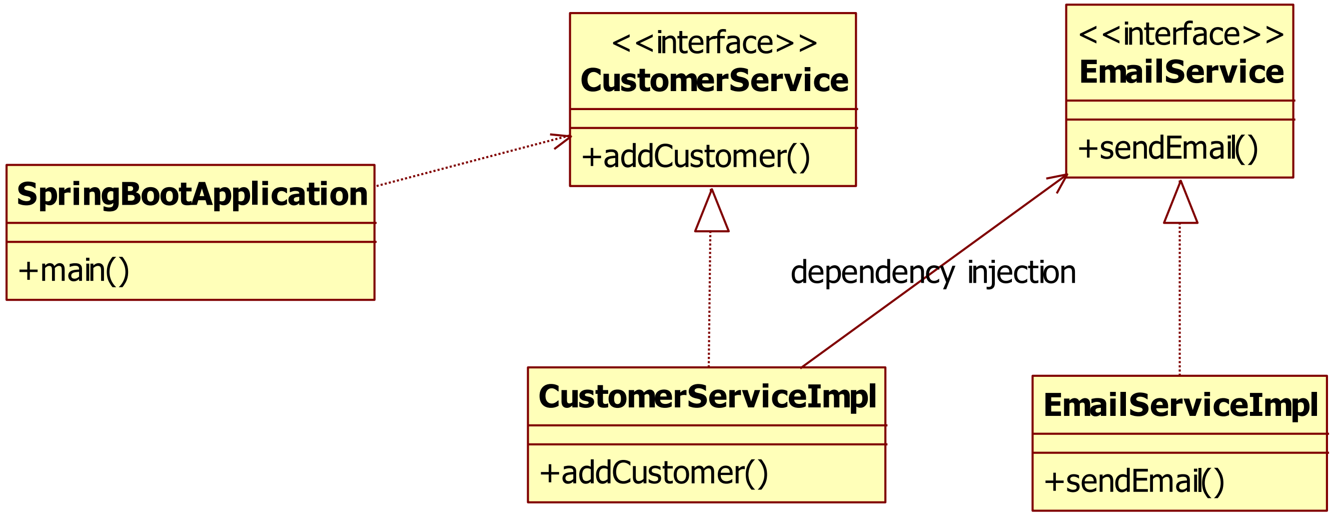
Service object

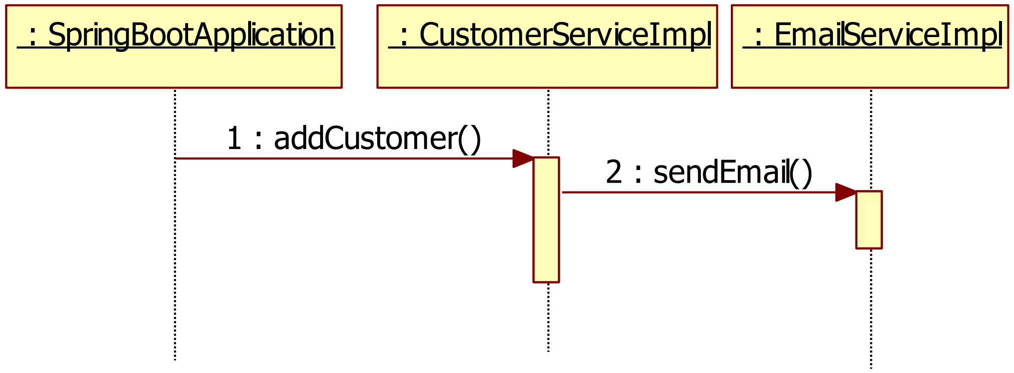


Layered architecture



Dependency injection





Dependency injection: Setter injection

```java
@Service
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

  @Autowired
  public void setEmailService(EmailService emailService) {
    this.emailService = emailService;
  }


  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

Setter injection

```java
@Service
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

Dependency injection: Constructor injection

```java
@Service
public class CustomerServiceImpl implements CustomerService {

  private EmailService emailService;

  @Autowired
  public CustomerService(EmailService emailService) {
    this.emailService = emailService;
  }


  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

Customer injection

```java
@Service
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

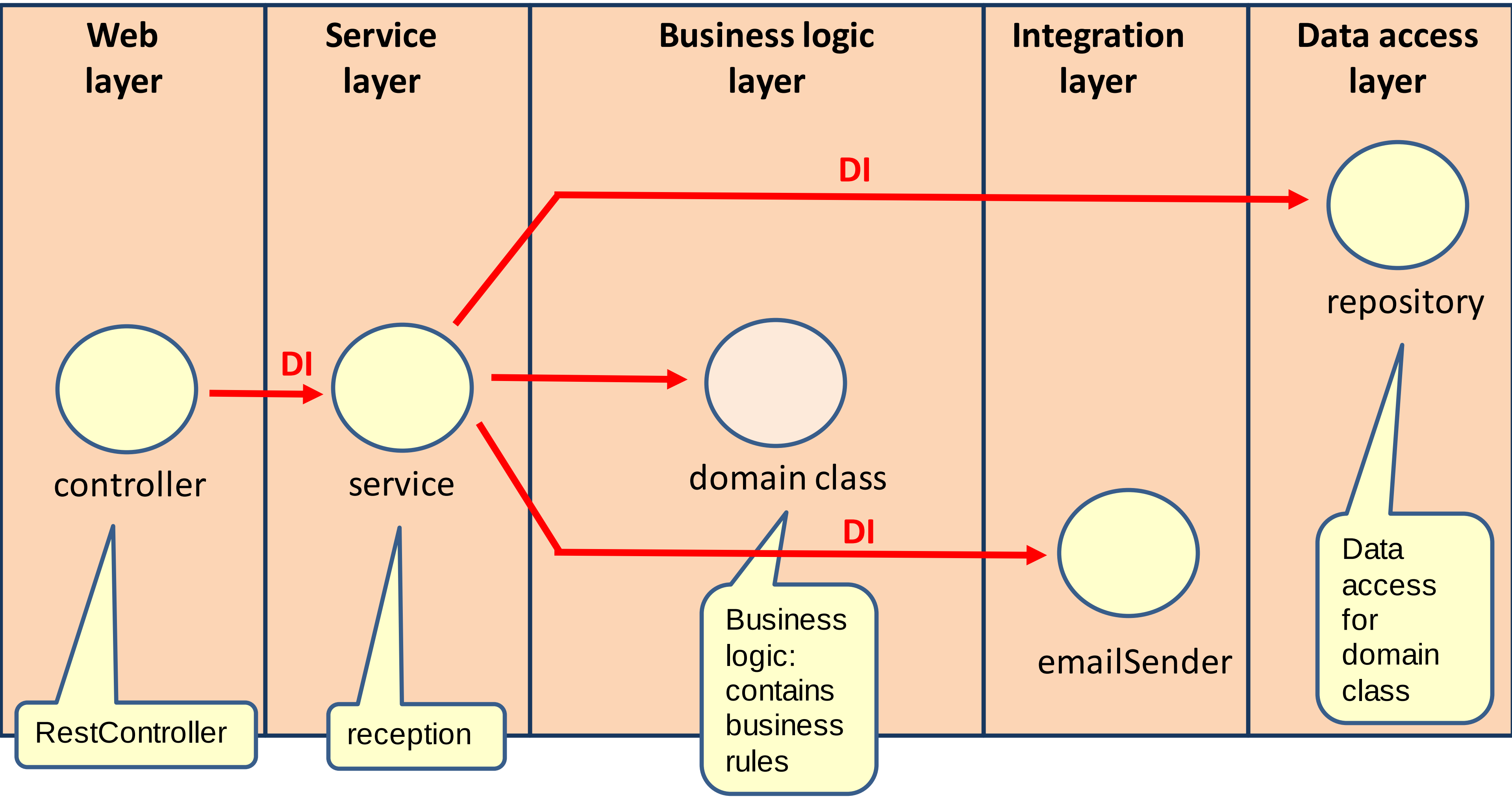
Dependency injection: Field injection

```
@Service
public class CustomerServiceImpl implements CustomerService {
  @Autowired
  private EmailService emailService;

  public void addCustomer() {
    emailService.sendEmail();
  }
}
```

Field injection

```
@Service
public class EmailServiceImpl implements EmailService{
  public void sendEmail() {
    System.out.println("Sending email");
  }
}
```

Layered architecture

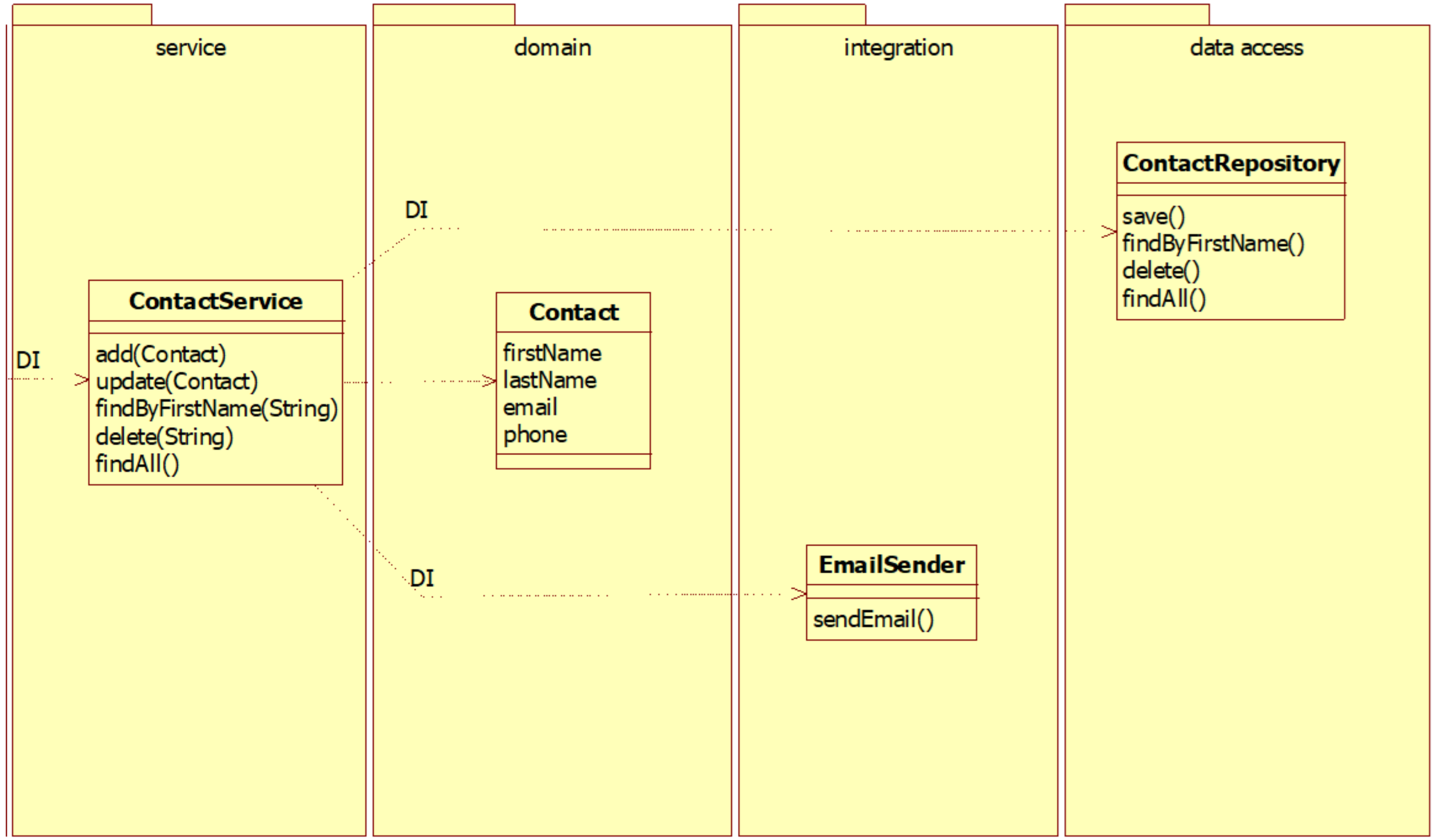


Main point

- An enterprise back-end system is typically divided in different layers.

  Science of Consciousness: Life is found in layers.

Spring Boot example



Repository

@Repository

```java
@Repository
public class ContactRepository {
   private Map<String, Contact> contacts = new HashMap<String, Contact>();

   public void save(Contact contact){
      contacts.put(contact.getFirstName(),contact);
   }

   public Contact findByFirstName(String firstName){
      return contacts.get(firstName);
   }

   public void delete(String firstName){
      contacts.remove(firstName);
   }

   public Collection<Contact> findAll(){
      return contacts.values();
   }
}
```

EmailSender

@Component

```
@Component
public class EmailSender {
   public void sendEmail (String message, String emailAddress){
      System.out.println("Send email message '"+ message+"' to"+emailAddress);
   }
}
```

Service

@Service

@Autowired

```
@Service
public class ContactService {
   @Autowired
   ContactRepository contactRepository;
   @Autowired
   EmailSender emailSender;

   public void add(Contact contact){
      contactRepository.save(contact);
      emailSender.sendEmail(contact.getEmail(), "Welcome");
   }

   public void update(Contact contact){
      contactRepository.save(contact);
   }

   public Contact findByFirstName(String firstName){
      return contactRepository.findByFirstName(firstName);
   }

   public void delete(String firstName){
      Contact contact = contactRepository.findByFirstName(firstName);
      emailSender.sendEmail(contact.getEmail(), "Good By");
      contactRepository.delete(firstName);
   }

   public Collection<Contact> findAll(){
      return contactRepository.findAll();
   }
}
```

Application

```
@SpringBootApplication
public class SpringBootMVCApplication implements CommandLineRunner {
  @Autowired
  private ContactService contactService;

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

  @Override
  public void run(String... args) throws Exception {
    contactService.add(new Contact("Frank","Brown","fbrown@gmail.com","4723459800"));
    System.out.println(contactService.findByFirstName("Frank"));
  }
}
```

ASPECT-ORIENTED PROGRAMMING

BASICS OF AOP

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

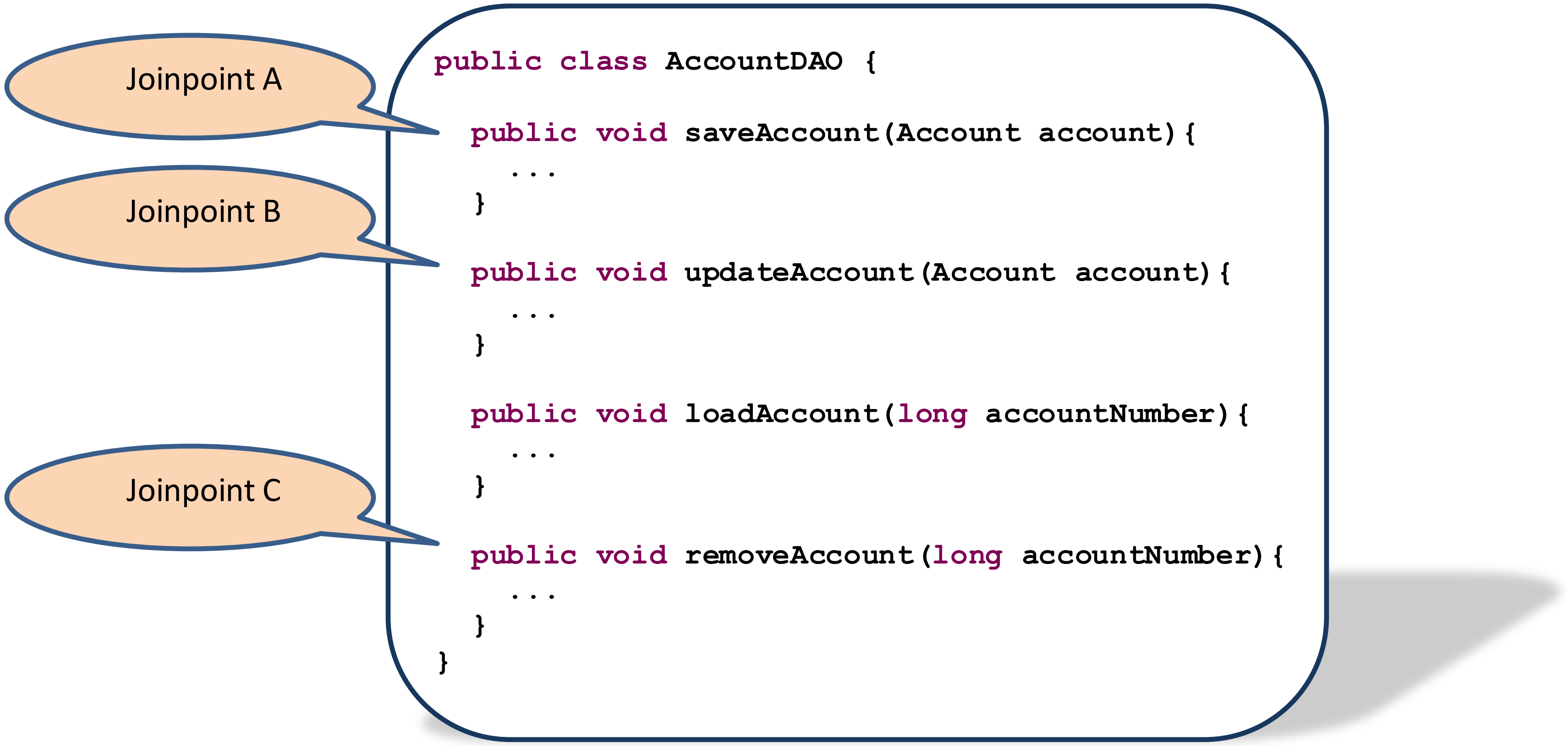
- Separate business logic from (technical) plumbing code
- Avoid code tangling

AOP concepts

- Joinpoint
- Pointcut
- Aspect
- Advice
- Weaving

AOP concept: Joinpoint

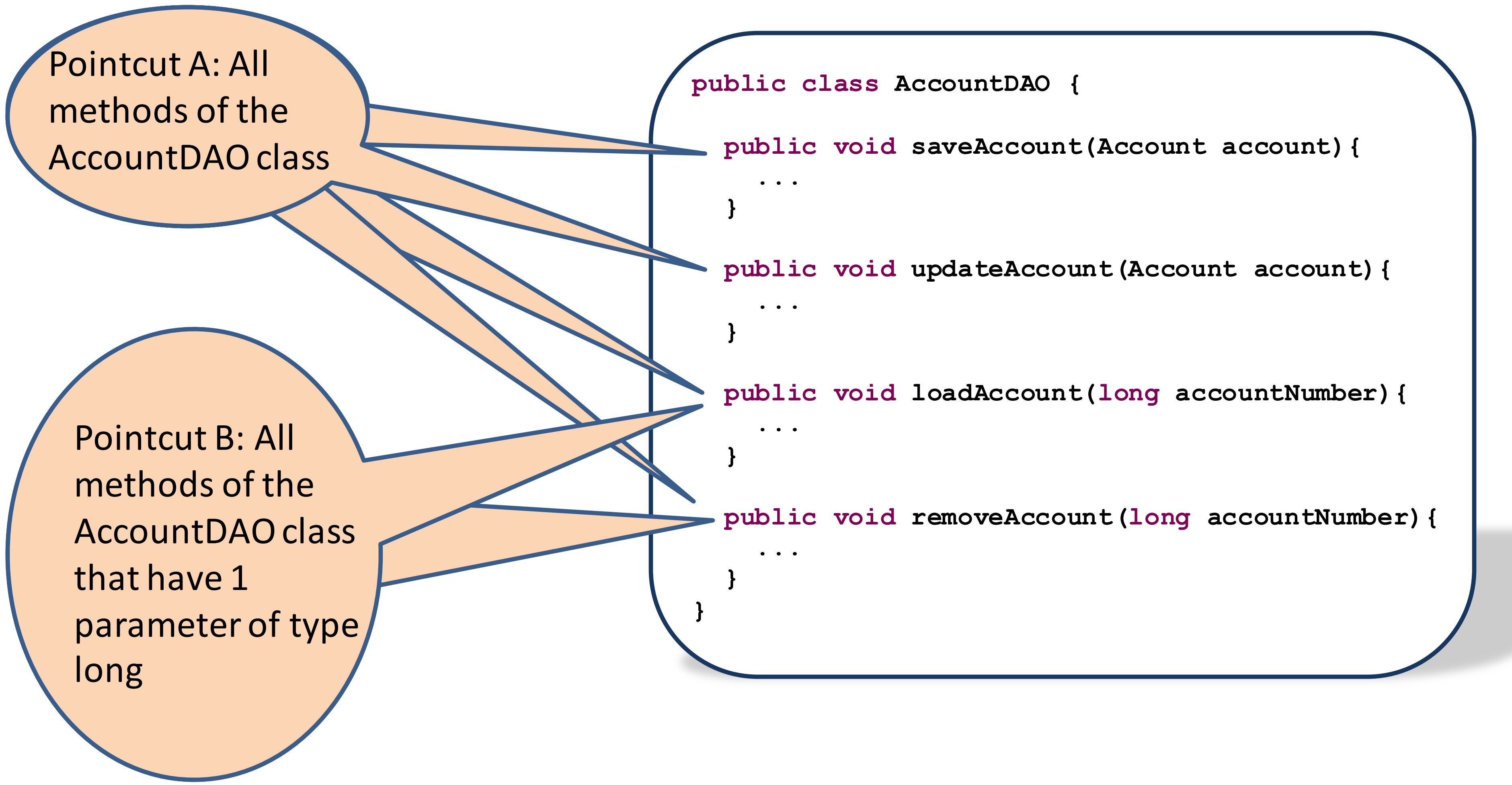
- A specific point in the code



```java
public class AccountDAO {

  public void saveAccount(Account account){
    ...
  }

  public void updateAccount(Account account){
    ...
  }

  public void loadAccount(long accountNumber){
    ...
  }

  public void removeAccount(long accountNumber){
    ...
  }
}
```

AOP concept: Pointcut

- A collection of 1 or more joinpoints


Pointcut A: All methods of the AccountDAO class
Pointcut B: All methods of the AccountDAO class that have 1 parameter of type long

```
public class AccountDAO {

  public void saveAccount(Account account){
     ...
  }

  public void updateAccount(Account account){
     ...
  }

  public void loadAccount(long accountNumber){
     ...
  }

  public void removeAccount(long accountNumber){
     ...
  }
}
```

AOP concept: Advice

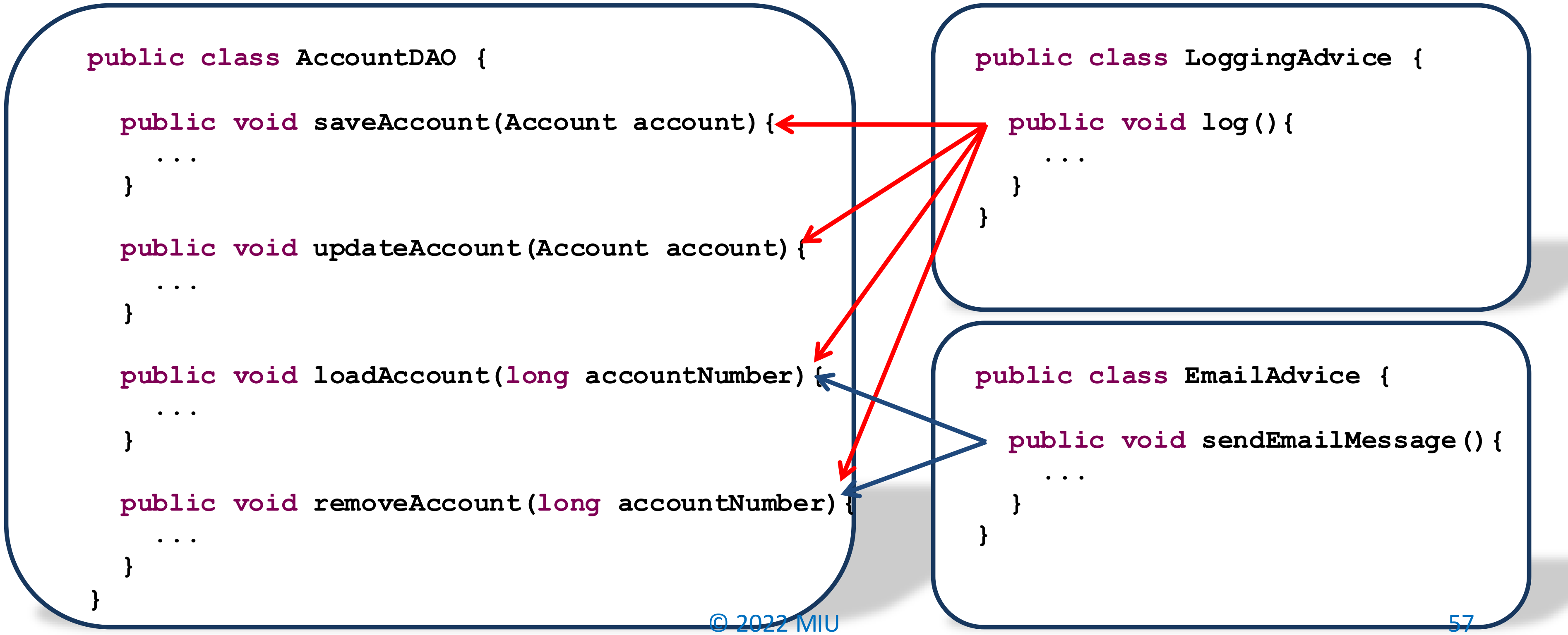
- The implementation of the crosscutting concern

```
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



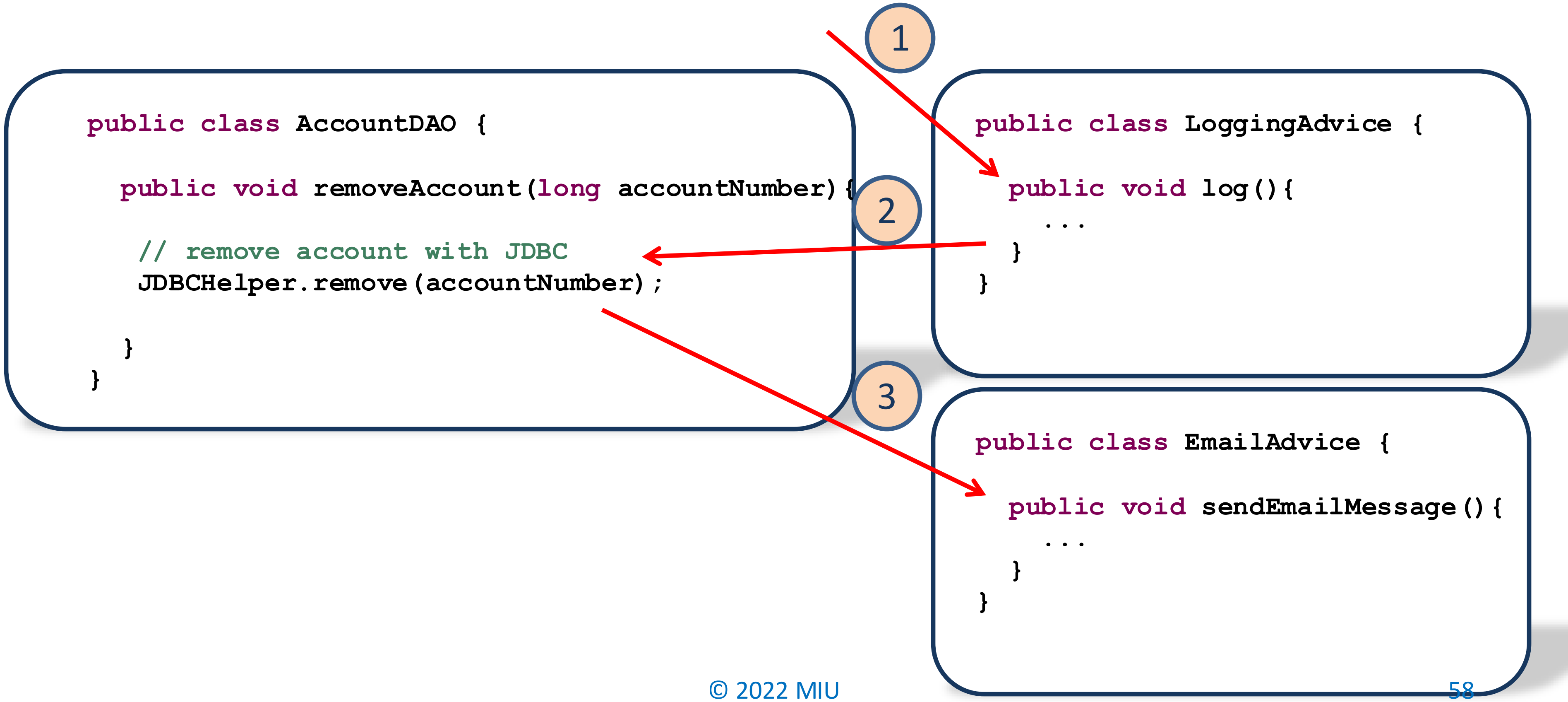
```
public class AccountDAO {

  public void saveAccount(Account account){
    ...
  }

  public void updateAccount(Account account){
    ...
  }

  public void loadAccount(long accountNumber){
    ...
  }

  public void removeAccount(long accountNumber){
    ...
  }
}
```

```
public class LoggingAdvice {

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

```
public class EmailAdvice {

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

AOP concept: Weaving

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



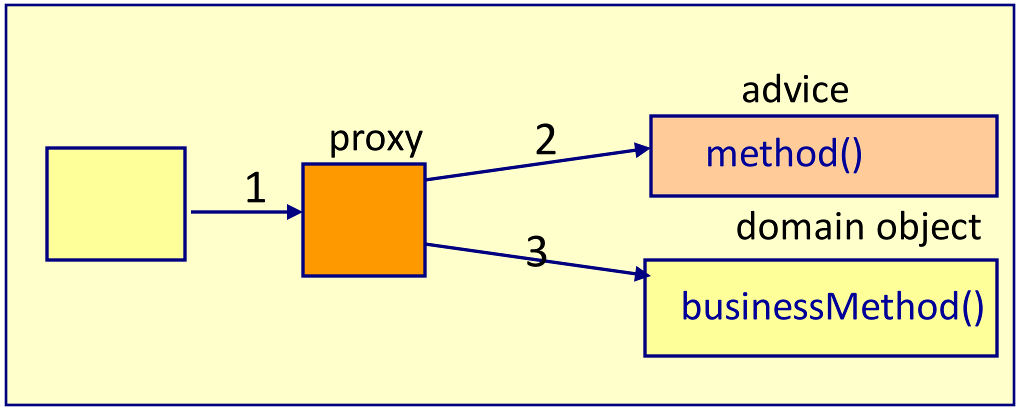
```
public class AccountDAO {

  public void removeAccount(long accountNumber){

   // remove account with JDBC
   JDBCHelper.remove(accountNumber);

  }
}
```

```
public class LoggingAdvice {

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

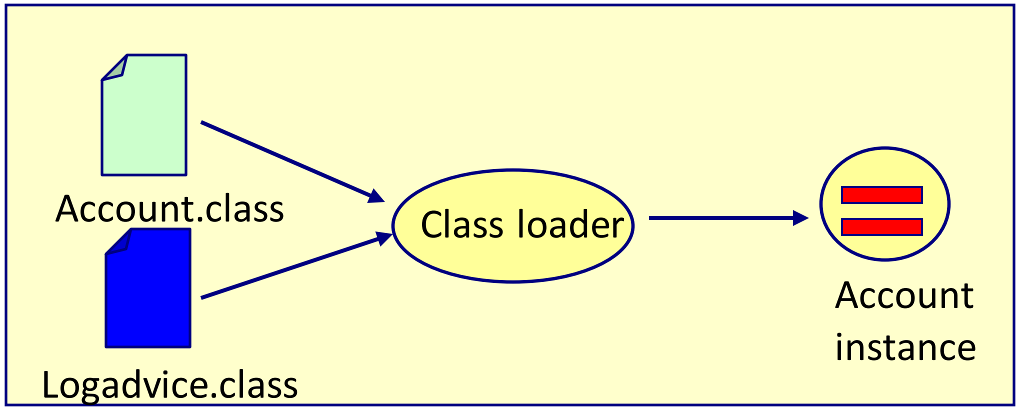
```
public class EmailAdvice {

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

Weaving

Proxy-based weaving



Load time weaving

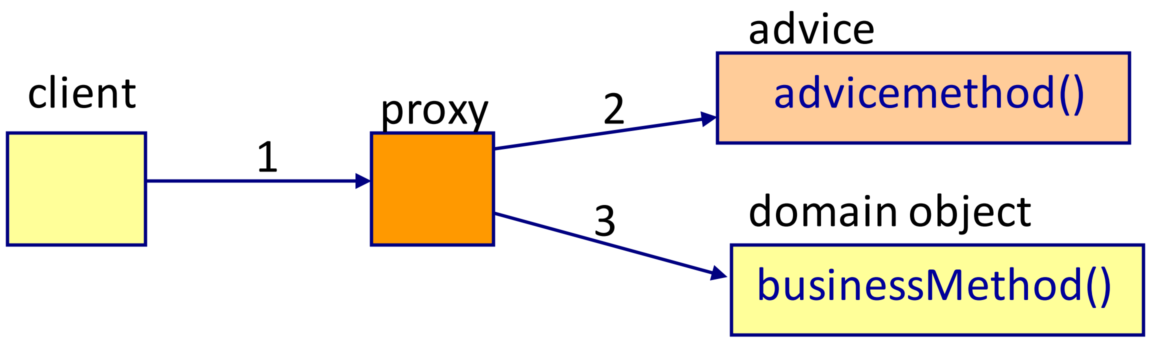


Advice types

- Before
- After returning
- After throwing
- After (finally)
- Around

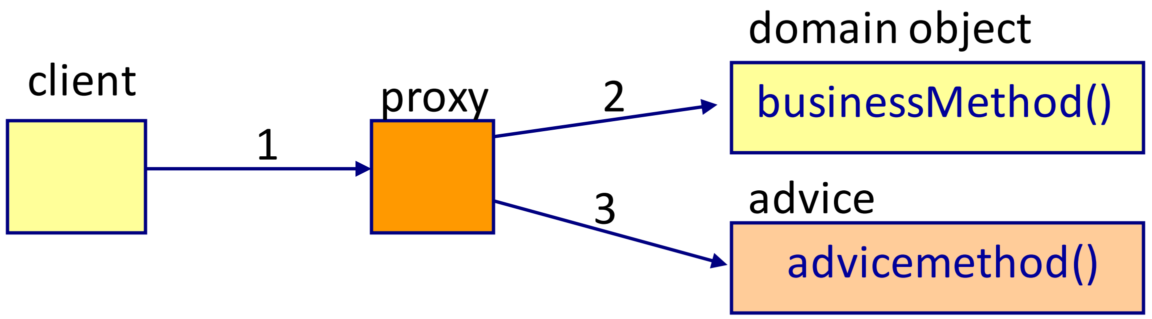
Before advice

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



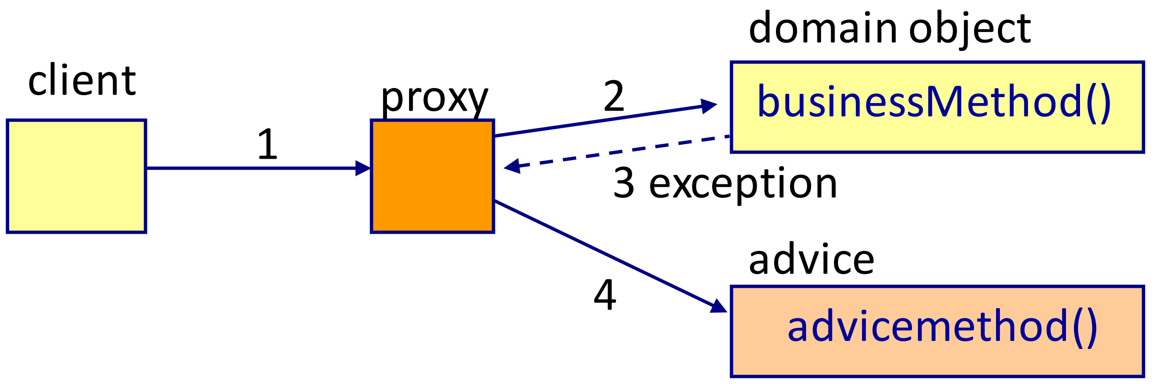
After returning advice

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



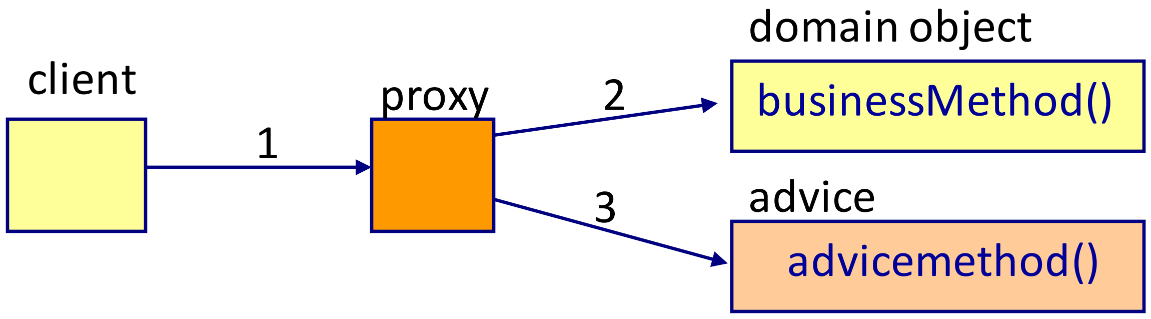
After throwing advice

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



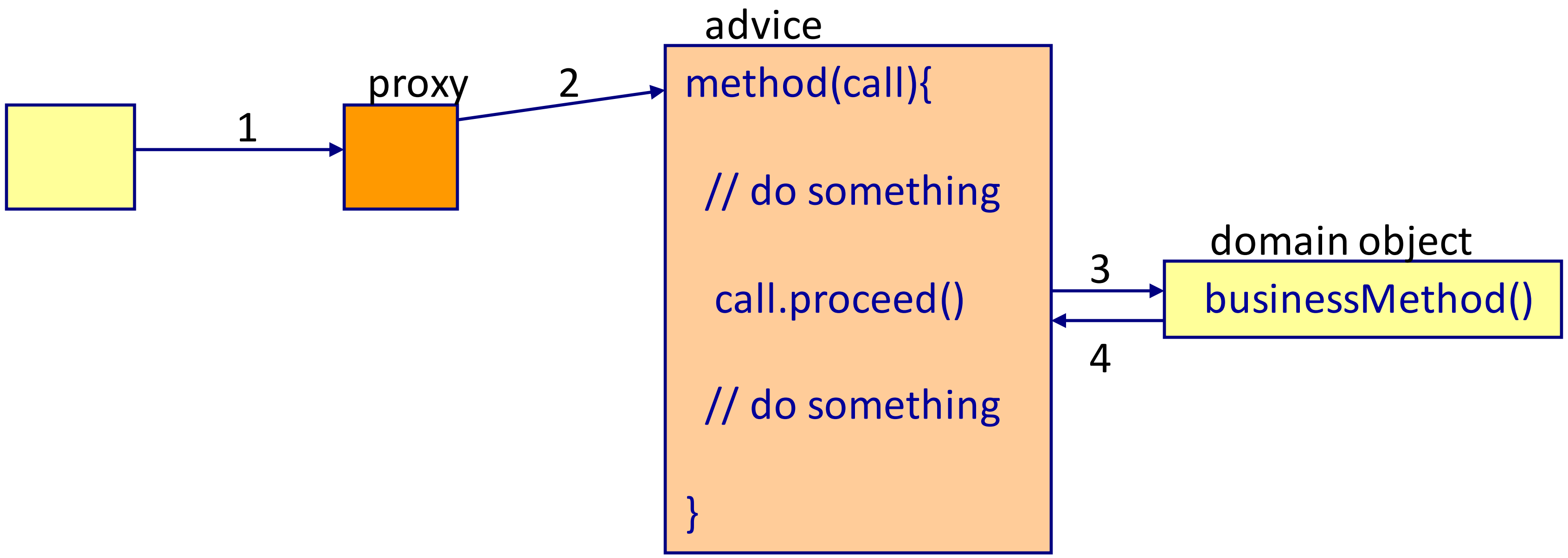
After advice

- 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



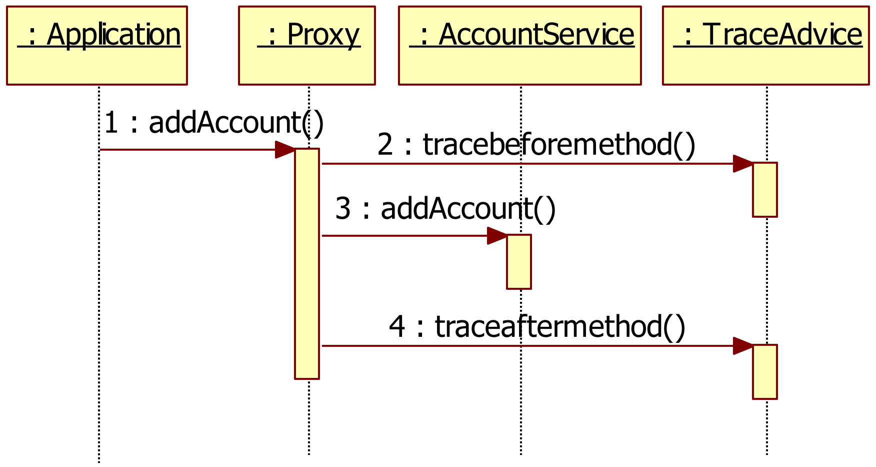
AOP with Spring Boot

```java
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

```java
@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

```
@Aspect
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

- `@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

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

All public methods

```
@After("execution(public void *(..))")
```

All public methods that return void

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

All methods from all classes in the order package

```
@After("execution(* *.*.create*(..))")
```

All methods that start with create

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

All methods from the Customer class

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

```java
@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

```java
public class Customer {
  private String name;

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

getName() returns a String

The pointcut expression

Add 'returning' parameter

```java
@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);
  }
}
```

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;
  }
}
```

```
@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 the arguments from the joinpoint

Take the first argument

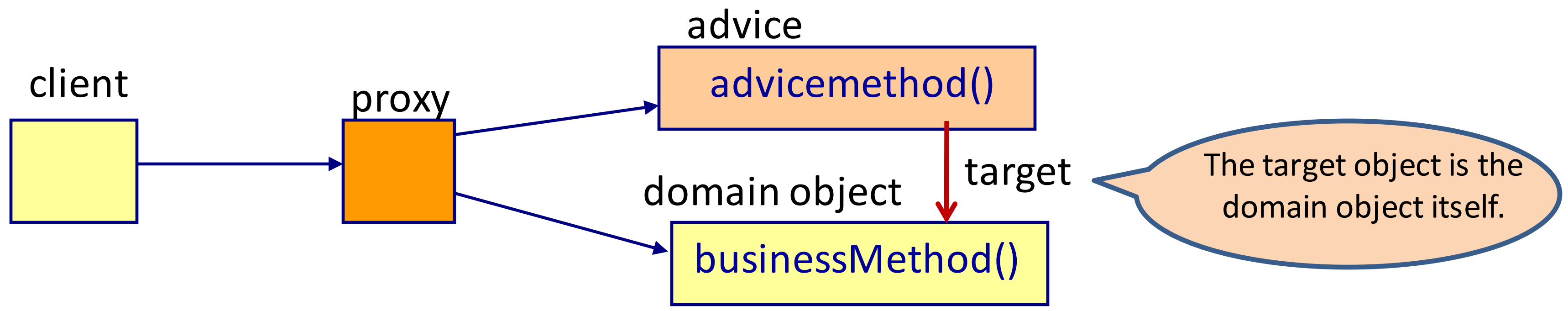
Get multiple parameters from the Joinpoint

```
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



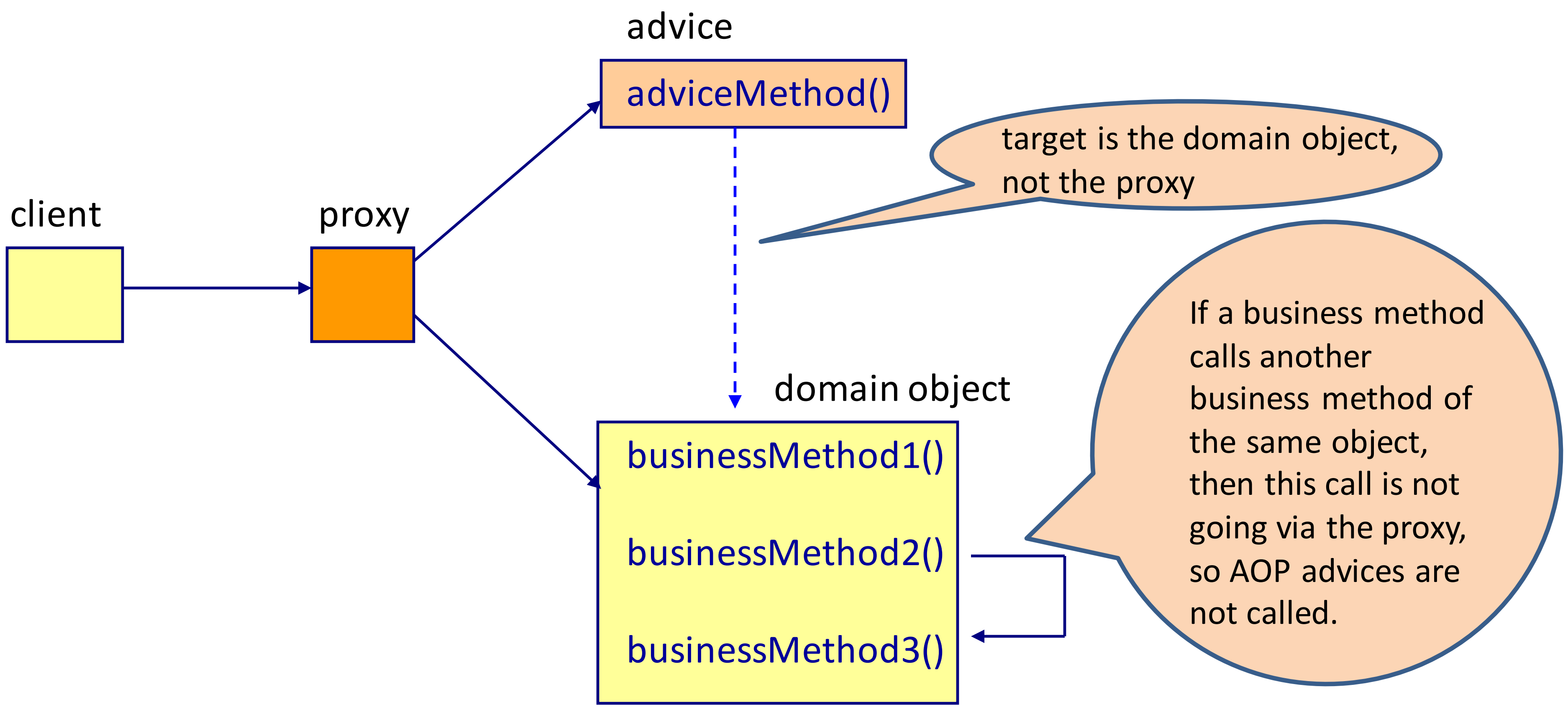
Get the target class

```
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



advice
adviceMethod()
client
proxy
domain object
businessMethod1()
businessMethod2()
businessMethod3()
target is the domain object, not the proxy
If a business method calls another business method of the same object, then this call is not going via the proxy, so AOP advices are not called.

Advantages of AOP

- No code tangling
  - Clean separation of business logic and plumbing code
- No code scattering

Disadvantages of AOP

- You don't have a clear overview of which code runs when
- 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

Be careful with AOP: always use unit testing and integration testing with AOP

Main point

- Aspect Oriented Programming lets us program additional logic in one place, and then declaratively apply that logic to many places. *Science of Consciousness*: We create harmony (single implementation), in diversity (applied to many places).

Connecting the parts of knowledge with the wholeness of knowledge

1. Layering is a powerful technique to separate different aspects of a system
2. The service class is the connection point between the different layers

3. **Transcendental consciousness** is the source of all intelligence of creation.
4. **Wholeness moving within itself:** In unity consciousness, one experiences that everything is just an expression of one'sown Self.