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How to create a well designed Java application?

Posted on August 11, 2014 by Arulkumaran Kumaraswamipillai — No Comments ↓

A software application is built by coupling various classes, modules, and components. Without coupling, you can't build a software system. But, the software applications are always subject to changes and enhancements. So, you need to build your applications such a way that they can not only adapt to growing requirements, but also are easy to maintain and understand. 3 key aspects to achieve this are

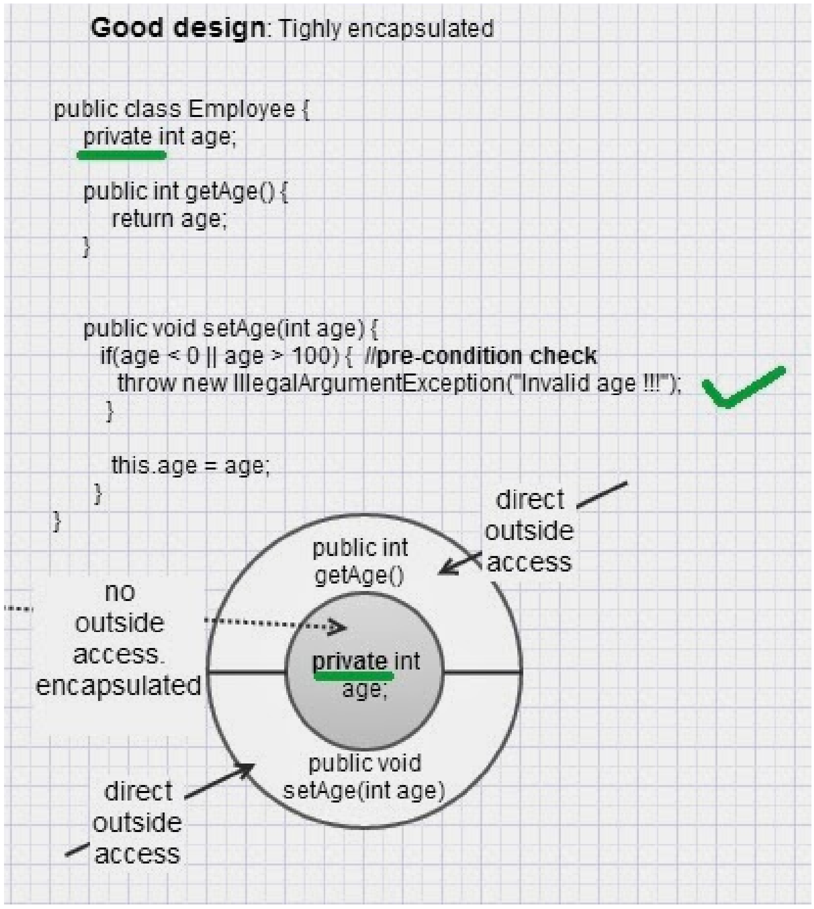
1. Tight **encapsulation**.
2. Loose (or low) **coupling**.
3. High **cohesion**.

The purpose of SOLID design principles and GoF (GangOfFour) design patterns is to achieve the above goal.

Q1. What is encapsulation?

A1. Encapsulation is about hiding the implementation details. This means

1) **Hiding data** by setting member variables with private access level and providing public methods with pre and post condition checks to access the member variables.


Good design: Tighly encapsulated
direct outside access
public int getAge()
no outside access. encapsulated
private int age;
public void setAge(int age)
direct outside access

```
public class Employee {
  private int age;

  public int getAge() {
    return age;
  }


  public void setAge(int age) {
   if(age < 0 || age > 100) {  //pre-condition check
     throw new IllegalArgumentException("Invalid age !!!");
   }

    this.age = age;
  }
}
```

Good design: Tightly Encapsulated

2) **Coding to an interface and not implementation**: Using a given class or module by its interface, and not needing to know any implementation details.

Badly Encapsulated: Directly dependent on *ProductServiceImpl*

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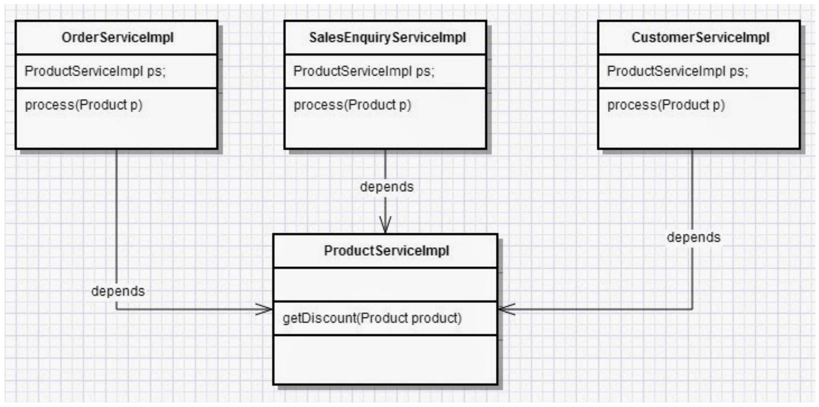
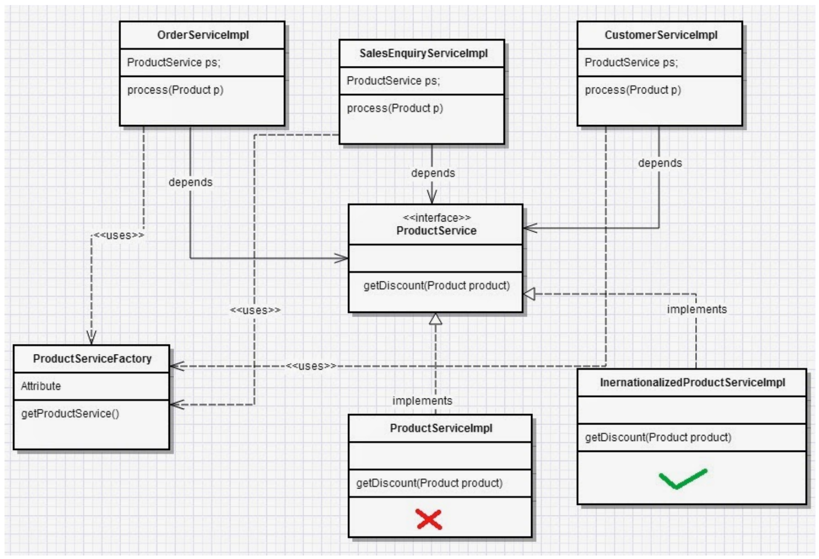


Loosely Encapsulated

Tightly Encapsulated: Dependent on the interface ProductService. The implementation can change from *ProductServiceImpl* to InternationalizedProductServiceImpl without the callers or clients *OrderServiceImpl*, *SalesEnquiryServiceImpl*, and *CustomerServiceImpl* needing to know about the implementation details.



Tightly Encapsulated

SOLID Principle: LSP (Liskov substitution principle), DIP (Dependency inversion principle), and SRP (Single Responsibility Principle) strive to create tight encapsulation.

Q2. Does tight encapsulation promote loose coupling?
A2. Yes, poor encapsulation can allow tight coupling as it will be possible to access non-encapsulated variables directly

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from another class, making it dependent on the implementation of the class that contains those variables. It is also possible to have poor encapsulation with loose coupling. So, encapsulation and coupling are different concepts, but poor encapsulation makes it possible to create tight coupling.

Q3. What is coupling?
A3. Coupling in software development is defined as the degree to which a module, class, or other construct, is tied directly to others. You can reduce coupling by defining intermediate components (e.g. a factory class or an IoC container like Spring) and interfaces between two pieces of a system. Favoring composition over inheritance can also reduce coupling.

Let’s write some code for the above UML diagram to demonstrated loose coupling with GoF factory design pattern.

Step 1: Define the interfaces for the above diagram

```

public interface OrderService {
    abstract void process(Product p);
}

```

```

import java.math.BigDecimal;

public interface ProductService {
    abstract BigDecimal getDiscount(Product p);
}

```

Step 2: Define the implementation class for ProductService

```

public class ProductServiceImpl implements Produ

  @Override
  public BigDecimal getDiscount(Product p) {
     //logic goes here
     return null;
```

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```
   }

}

```

Step 3: Factory eliminate need to bind application specific classes into the code. The code only deals with the ProductService interface , and can therefore work with any user-defined concrete implementations like ProductServiceImpl or InternationalizedProductServiceImpl.

```

public final class ProductServiceFactory {

   private ProductServiceFactory(){}

   public static ProductService getProductServic
      ProductService ps = new ProductServiceImpl
      return ps;
   }
}

```

Step 4: The caller or client class who is loosely coupled to ProductService via the ProductServiceFactory.

```

import java.math.BigDecimal;

public class OrderServiceImpl implements OrderSe

   ProductService ps;

   @Override
   public void process(Product p) {
     ps = ProductServiceFactory.getProductServic
     BigDecimal discount = ps.getDiscount(p);
     //logic
   }

}


```

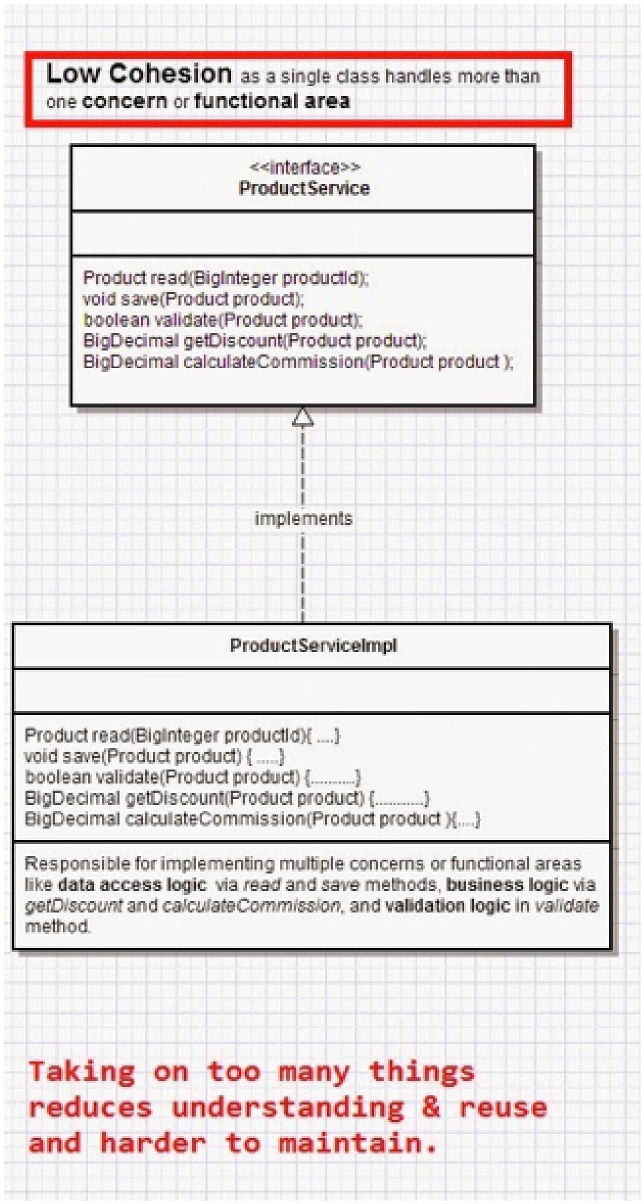
So, if you want to change over from ProductServiceImpl to InternationalizedProductServiceImpl, all you have to do is make a change in the ProductServiceFactory class. An alternative approach to using a factory is to use an IoC container like Spring instead of a factory class to loosely wire the dependencies via dependency injection at run time.

Q4. How do you create loose coupling?
A4. By abstracting many of the implementation needs into various interfaces and introducing the concepts of OCP and DIP, you can create a system that has very low coupling.

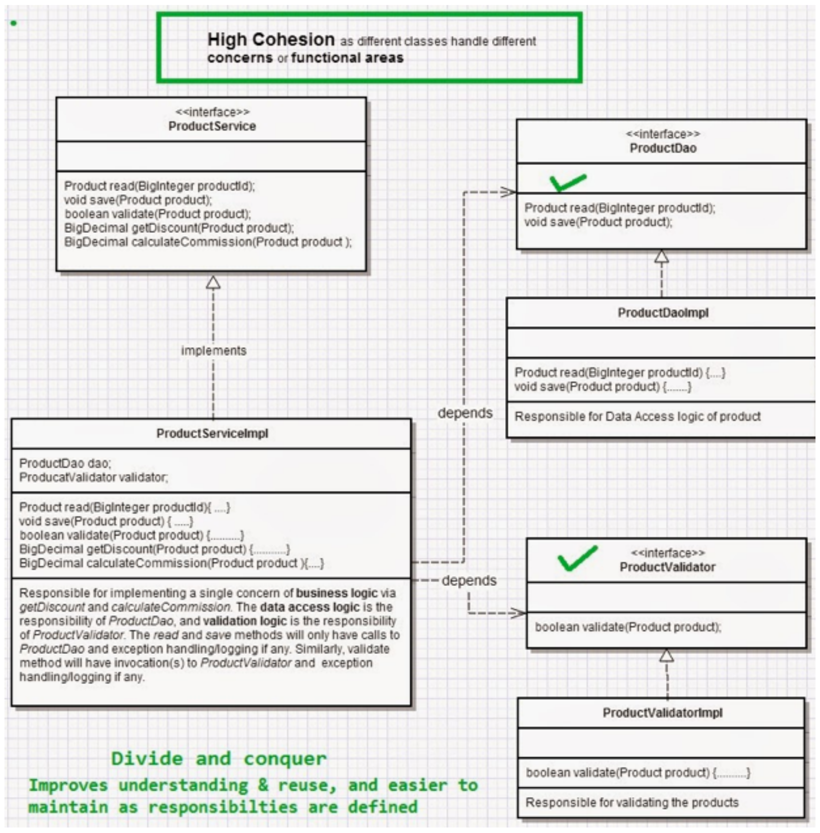
1. Open/Closed Principle (OCP) from the SOLID OO principles promotes loose coupling
2. Favor composition over inheritance for loose coupling
3. Dependency Inversion Principle for loose coupling
4. Event Driven Programming loosely couples producer and consumer

Q5. What is cohesion?
A5. Cohesion is the extent to which two or more parts of a system are related and how they work together to create something more valuable than the individual parts. You don't want a single class to perform all the functions (or concerns) like being a domain object, data access object, validator, and a service class with business logic. To create a more cohesive system from the higher and lower level perspectives, you need to break out the various needs into separate classes.

Coupling happens in between classes or modules, whereas cohesion happens within a class.


Low Cohesion as a single class handles more than one concern or functional area
<<interface>>
ProductService
Product read(BigInteger productId);
void save(Product product);
boolean validate(Product product);
BigDecimal getDiscount(Product product);
BigDecimal calculateCommission(Product product);
implements
ProductServiceImpl
Product read(BigInteger productId){ ....}
void save(Product product) { .....}
boolean validate(Product product) {..........}
BigDecimal getDiscount(Product product) {...........}
BigDecimal calculateCommission(Product product){....}
Responsible for implementing multiple concerns or functional areas like data access logic via read and save methods, business logic via getDiscount and calculateCommission, and validation logic in validate method.
Taking on too many things reduces understanding & reuse and harder to maintain.

Low cohesion as a single class does many things


High Cohesion as different classes handle different concerns or functional areas
<<interface>>
ProductService
Product read(BigInteger productId);
void save(Product product);
boolean validate(Product product);
BigDecimal getDiscount(Product product);
BigDecimal calculateCommission(Product product);
implements
ProductServiceImpl
ProductDao dao;
ProducatValidator validator;
Product read(BigInteger productId){ ....}
void save(Product product) { .....}
boolean validate(Product product) {..........}
BigDecimal getDiscount(Product product) {...........}
BigDecimal calculateCommission(Product product){....}
depends
depends
<<interface>>
ProductDao
Product read(BigInteger productId);
void save(Product product);
ProductDaoImpl
Product read(BigInteger productId) {....}
void save(Product product) {.......}
Responsible for Data Access logic of product
<<interface>>
ProductValidator
boolean validate(Product product);
ProductValidatorImpl
boolean validate(Product product) {.........}
Responsible for validating the products
Divide and conquer
Improves understanding & reuse, and easier to maintain as responsibilties are defined

Responsible for implementing a single concern of **business logic** via *getDiscount* and *calculateCommission*. The **data access logic** is the responsibility of *ProductDao*, and **validation logic** is the responsibility of *ProductValidator*. The *read* and *save* methods will only have calls to *ProductDao* and exception handling/logging if any. Similarly, validate method will have invocation(s) to *ProductValidator* and exception handling/logging if any.

High Cohesion as each class focus on one thing

Q6. How do you create high cohesion?
A6. You can get higher cohesion with a combination of low coupling and SRP (Single Responsibility Principle from SOLID), which allows you to stack a lot of small pieces (e,g. Service, DAO, Validator, etc) together like puzzles to create something larger and more complex.
So, think, tight encapsulation, loose (low) coupling, and high cohesion.

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