



Object Oriented principles and design.

I am in pain.

The information contained in this document might not be fully correct.
If any wrongful information is found please contact me at
samuel.hammersberg@gmail.com and I will correct it.
Proof read by Emmie Berger.

Solid: **S**ingle Responsibility Principle (SRP):

A class should only have a single responsibility, and only one reason to change.

Open-Closed Principle (OCP):

Objects should be open to extension but closed for modification.

Liskov Substitution Principle (LSP):

Every subclass or derived class should be able to substitute for their base or super class.

Interface Segregation Principle (ISP):

A client should never be forced to implement an interface that it doesn't use, nor should clients be forced to depend on methods they do not use. Many client-specific interfaces are better than one general-purpose interface.

Dependency Inversion Principle (DIP):

One should depend on abstractions, rather than on concrete implementations.

Other: **S**eperation of Concern (SoC):

Concerns of the software should be split up into individual parts. One should not write their software as one giant block, but instead split the code into smaller more distinctive parts.

Command-Query Separation Principle (CQSP):

A method should either return data or modify data(void in most cases), but not both.

Something that breaks this principle is for example the `pop()` method, that exists for lists in many languages, because it both modifies the list by removing the last index and then it returns that data. This is one of many exceptions to the rule.

High Cohesion, Low Coupling (HCLC):

Low Coupling: Modules and classes should be as independent from each other as possible.

High Cohesion: Related code should be close together. For example all methods in a module should be related to the modules distinct task.

Composition over Inheritance (CoI):

Classes should preferably contain other classes that implement needed behavior rather than inheriting behavior.

Law of Demeter (LoD):

To avoid loose coupling, classes should only talk to their immediate "friends".

For example: instead of writing `a.b.c.d()` one should do `a.tellBtoTellCtoDoD()`, as one should avoid relying on other classes implementation. This also ties into information hiding, as in for example if something doesn't need to be `public` it shouldn't be `public`. Package- or class-private should always be preferred.

Defensive Programming (DP):

Software and libraries should be written as if the user **will** use it wrongly. For example, if data should only gettable instead of settable, a getter method should be implemented and the data should be hidden.

Design Patterns

BEWARE NONE OF THESE TEXTS ABOUT PATTERNS HAVE BEEN PROOF READ, AND MIGHT CONTAIN INCORRECT INFORMATION!

Template Method

This pattern suggests that you break down your algorithms into smaller steps, and each step is its own method. These may either be abstract or inheritable, but the idea is that the client supply their own subclasses with their own implementations of the steps.

Bridge

The bridge pattern is a design pattern used in software engineering that is meant to "decouple an abstraction from its implementation so that the two can vary independently". The bridge uses encapsulation, aggregation, and can use inheritance to separate responsibilities into different classes.

Strategy

This suggests that algorithms should be able to be selected during runtime. Instead of implementing a single algorithm directly, an algorithms should be able to be selected during runtime.

State

This allows objects to change their behavior when its internal state changes. This could be seen as an implementation of the Strategy Pattern.

Decorator

Decorator pattern allows for objects to implement behavior dynamically without affecting other objects of the same class. This can be useful for the Single Responsibility Principle as it allows for objects to have dynamic different areas of concerns, without the need for subtyping.

Adapter

This is used to wrap an interface of another class to be used as another interface. It's used to make existing classes work with each other without modifying their source code.

Factory (Method)

The factory method pattern is a creation pattern that uses factory methods to deal with the problem of creating objects without having to specify the exact class of the object that will be created. This is done by creating objects by calling a factory method—either specified in an interface and implemented by child classes, or implemented in a base class and optionally overridden by derived classes—rather than by calling a constructor.

Singleton

This restricts a class to only be created once. This is used to coordinate actions across the whole program easily. Could be considered a "Global State". Often criticized however as it leads to a lot of tight coupling with the Singleton.

Iterator

In object-oriented programming, the iterator pattern is a design pattern in which an iterator is used to traverse a container and access the container's elements. The iterator pattern decouples algorithms from containers; in some cases, algorithms are necessarily container-specific and thus cannot be decoupled. For example, an object that sorts a list no matter the type of list used.

Composite

This is a structural pattern where a group of objects are treated in a similar way as a single object. This is often represented as a tree structure.

Module

This design pattern is used to wrap a set of function, variables and classes in a module, similarly to packages in Java.

Facade

A facade is an object that serves as a front-facing interface used to mask more complex underlying code. An implementation of the Aggregate pattern.

Model-View-Controller

Model

The central component of the pattern. It is the application's dynamic data structure, independent of the user interface. It directly manages the data, logic and rules of the application.

View

Any representation of information such as a chart, diagram or table. Multiple views of the same information are possible, such as a bar chart for management and a tabular view for accountants.

Controller

Accepts input and converts it to commands for the model or view.

Observer

The observer pattern is a software design pattern in which an object, named the subject, maintains a list of its dependents, called observers, and notifies them automatically of any state changes, usually by calling one of their methods.

Design Patterns (VG)

Entity

If we have data stored on disk, using xml for example, we may want to implement an Entity class which provides an interface for accessing and manipulating the data while hiding the underlying storage parts.

"A design pattern for logically representing data and decoupling the persistence of data from the application view of that data."

Aggregate

Taking a cluster or group of entities and behaviors and treating them as one cohesive unit. The cluster has one aggregate root or primary entity, that has the child objects and working with them all to implement required behavior.

Chain-of-Responsibility

The Chain-of-Responsibility pattern consists of a source of command objects and a series of processing objects. Each processing objects contains logic that defines the types of command objects that it can handle, and the rest are passed to the next processor in the chain. There should also be a mechanism for adding new processing objects to the end of the chain.

Concepts

Class and object

"The class is the template used to create objects." It can also contain its own static methods and fields.

Static and dynamic type

Static typed languages are those in which type checking is done at compile-time, whereas dynamic typed languages are those in which type checking is done at run-time. Left side is static, and dynamic is right side.

Encapsulation

Encapsulation means wrapping data together as a single unit. Specifically data should also be hidden and getters should be supplied.

Specification and Implementation inheritance

Implementing an interface or abstract class or inheriting code from classes/abstract classes.

Static method and instance method

Static methods are methods that can be used without an instance, while an instance method requires an instance of it's class to be executed.

Variables and attributes

Attributes are instance variables, meaning they are defined for each object of the class. Variables (more precisely local variables) stores values in a method and only can be accessed in the method.

Abstract class and interface

An interface is a form of specification inheritance that specifies what methods a class needs to have. Similarly an abstract class can do this while also having methods and attributes that are inherited. An abstract class can be used as a static but not dynamic type when creating objects.

Dynamic Binding

Also called late binding, and this is done when you are overriding inherited public methods as the method used is decided during runtime.

The opposite of this is static binding which is done with static, private and final methods as they cannot be overridden.

Primitive and referencetypes

Primitive types are types such as booleans, integers and floats, and they are stored on the stack.

Reference types are types such as Classes, which are stored on the heap, and when these are passed around you are actually passing around copies of the reference to the object in question.

Alias

Alias is when two variables point to the same object. (They have a copy of the same reference.)

```
A a = new A(); A b = a;
```

Super and subclass

When inheriting or implementing another class/interface onto a class, the implementation is a super class and the class implementing said class/interface is the subclass.

Overloading and overriding

Overloading means having multiple methods (or constructors) with the same name, but with different arguments.

Overriding means replacing an inherited method or constructor with a new implementation (or even using the old one in the new one), also known as dynamic or late binding.

Constructor

A specialized method used for initialization of new Objects of a Class.

Initialization

This means assigning a value to an attribute or variable, used in constructors for example.

Mechanisms and techniques

Mutability and immutability

Values that can be modified are mutable while values that cannot be modified are called immutable.

Refactoring

Altering internal code without changing its external behavior.

Defensive Copying

To ensure immutability, getter methods should return a copy instead of a reference the value in question.

Immutable Adapters

An implementation of the adapter pattern, where an interface is created to only expose immutable and safe methods of the underlying class.

Design by contract

This is a design philosophy where a methods specifications are seen as a contract between the client and the method.

"If you promise to give me two positive integers, I promise to give you their biggest common divisor."

- Precondition(Förvilkor): Things that must be fulfilled for the method to be called.

- Postcondition(Eftervilkor): If the precondition is not fulfilled there is no guarantee on the return.

Otherwise the return should be able to be guaranteed.

- Invariant: Something that is always true no matter the circumstances, for example that a divider cannot be zero.

Method Cascading

Calling multiple methods on the same object. For example:

`a.b().c();` instead of `a.b();a.c();`

Mutate-by-copy

Instead of mutating an object's state it should be copied with the new state.

Lambdas and function interfaces

Short-form replacement for anonymous classes for interfaces with single methods:

```
interface k { int p(double g); }
```

```
List<k> l = new List<>();
```

```
l.push((double g) -> return (int)g);
```

Exceptions

An error that is thrown whenever something that should not happen happens.

These should be handled using try catches (varies between languages).

Typically used for handling indata from users.

Polymorphism and code reuse

Polymorphism

Polymorphism is the provision of a single interface to entities of different types or the use of a single symbol to represent multiple different types.

Subtype-polymorphism

Being able to replace an object of a superclass with an object of its subclass.

```
functionThatTakesA(new BThatInheritsA())
```

Parametric polymorphism

The use of generics, ie `T extends A`.

Ad hoc-polymorphism

Different types should be able to give definitions of the same symbol/name without knowing of each other.

(See operator overloading in C# and type classes in Haskell)

Something like this:

```
<T implements +> T add(T x, T y) = x + y;
```

This is however not possible in Java.

Co-,contra-, and invariant

Covariant: `? extends T`

Contravariant: `? super T`

Invariant: `T` (No sub or supertypes)

Delegation

Delegation means handing over responsibilities for a task to another class or method.

Inheritance

Inheritance means that a subclass inherits (non-private) methods, attributes etc from the superclass.

Type constructor and type parameter

```
class Box<T>{}: The T here is a type parameter.
```

Type constructor is a `~_(_)/~`.

Type argument and Wildcards

```
Box<Integer> b = new Box<>();: The Integer is in this case a type argument.
```

Wildcards are used for creating generic declarations and method calls but not for defining generic type, for example: `List<? extends A>` but not

```
class A<? extends B>!
```

Upper and lower bounds

Upper bound wildcard means `? extends Type` and lower bound means `? super Type`.

Get-Put principle

Use `List<? super T>` to only be able to put data in the list and `List<? extends T>` to be able to get data out of the list.