Design Pattern Interview Questions

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1. What are the design principles in java [OO Design Principles]?

DRY (Don't repeat yourself) – avoids duplication in code

- Don't write duplicate code, instead use Abstraction to abstract common things in one place.
- If you have block of code in more than two place consider making it a separate method, or if you use a hard-coded value more than one time make them public final constant.
- Benefit of this Object oriented design principle is in maintenance.
- It's important not to abuse it, duplication is not for code, but for functionality.
- It means, if you used common code to validate OrderID and SSN it doesn't mean they are same or they will remain same in future.
- By using common code for two different functionality or thing you closely couple them forever and when your OrderID changes its format, your SSN validation code will break.
- So beware of such coupling and just don't combine anything which uses similar code but are not related.

Encapsulate What Changes – hides implementation details, helps in maintenance

- Only one thing is constant in software field and that is "Change", so encapsulate the code you expect or suspect to be changed in future.

- Benefit of this OOPS Design principle is that It's easy to test and maintain proper encapsulated code.
- If you are coding in Java then follow principle of making variable and methods private by default and increasing access step by step e.g. from private to protected and not public.
- Several of design pattern in Java uses Encapsulation, Factory design pattern is one example of Encapsulation which encapsulate object creation code and provides flexibility to introduce new product later with no impact on existing code.

Open Closed Design Principle - open for extension, closed for modification

- Classes, methods or functions should be Open for extension (new functionality) and Closed for modification.
- This is another beautiful SOLID design principle, which prevents some-one from changing already tried and tested code.
- Ideally if you are adding new functionality only than your code should be tested and that's the goal of Open Closed Design principle.
- By the way, Open Closed principle is "O" from SOLID acronym.

Single Responsibility Principle (SRP) - one class should do one thing and do it well

- Single Responsibility Principle is another SOLID design principle, and represent "S" on SOLID acronym.

- As per SRP, there should not be more than one reason for a class to change, or a class should always handle single functionality.
- If you put more than one functionality in one Class in Java it introduce coupling between two functionality and even if you change one functionality there is chance you broke coupled functionality, which require another round of testing to avoid any surprise on production environment.

Dependency Injection or Inversion principle - don't ask, let framework give to you

- Don't ask for dependency it will be provided to you by framework.
- This has been very well implemented in spring framework, beauty of this design principle is that any class which is injected by DI framework is easy to test with mock object and easier to maintain because object creation code is centralized in framework and client code is not littered with that.
- There are multiple ways to implemented Dependency injection like using byte code instrumentation which some AOP (Aspect Oriented programming) framework like AspectJ does or by using proxies just like used in spring.
- It represent "D" on SOLID acronym.

Favor Composition over Inheritance - Code reuse without cost of inflexibility

- Always favor composition over inheritance, if possible.
- Some of you may argue this, but I found that Composition is lot more flexible than Inheritance.

- Composition allows to change behavior of a class at run-time by setting property during run-time and by using Interfaces to compose a class we use polymorphism which provides flexibility of to replace with better implementation any time.

Liskov Substitution Principle (LSP) - Subtype must be substitutable for super type

- According to Liskov Substitution Principle, Subtypes must be substitutable for super type i.e. methods or functions which uses super class type must be able to work with object of sub class without any issue".
- LSP is closely related to Single responsibility principle and Interface Segregation Principle.
- If a class has more functionality than subclass might not support some of the functionality, and does violated LSP.
- In order to follow LSP SOLID design principle, derived class or sub class must enhance functionality, but not reduce them. LSP represent “L" on SOLID acronym.

Interface Segregation principle (ISP) - avoid monolithic interface, reduce pain on client side

- Interface Segregation Principle stats that, a client should not implement an interface, if it doesn't use that.

- This happens mostly when one interface contains more than one functionality, and client only need one functionality and not other.
- Interface design is tricky job because once you release your interface you cannot change it without breaking all implementation.
- Another benefit of this design principle in Java is, interface has disadvantage to implement all method before any class can use it so having single functionality means less method to implement.

Programming for Interface not implementation - helps in maintenance, improves flexibility

- Always program for interface and not for implementation this will lead to flexible code which can work with any new implementation of interface.
- So use interface type on variables, return types of method or argument type of methods in Java.

Delegation principle – don’t do all things by yourself, delegate it

- Don't do all stuff by yourself, delegate it to respective class.
- Classical example of delegation design principle is equals() and hashCode() method in Java.
- In order to compare two object for equality we ask class itself to do comparison instead of Client class doing that check.

- Benefit of this design principle is no duplication of code and pretty easy to modify behavior.

2. Builder Design Pattern in Java?

- Builder pattern is a creational design pattern it means its solves problem related to object creation.
- Constructors in Java are used to create object and can take parameters required to create object.
- Problem starts when an Object can be created with lot of parameters, some of them may be mandatory and others may be optional.
- Consider a class which is used to create Cake, now you need number of item like egg, milk, flour to create cake. Many of them are mandatory and some of them are optional like cherry, fruits etc.
- If we are going to have overloaded constructor for different kind of cake then there will be many constructor and even worst they will accept many parameter.
- Problems:
    - Too many constructors to maintain.
    - error prone because many fields has same type e.g. sugar and and butter are in cups so instead of 2 cup sugar if you pass 2 cup butter, your compiler will not complain but will get a buttery cake with almost no sugar with high cost of wasting butter.

- You can partially solve this problem by creating Cake and then adding ingredients but that will impose another problem of leaving Object on inconsistent state during building, ideally cake should not be available until it's created.
- Both of these problem can be solved by using Builder design pattern in Java.
- Builder design pattern not only improves readability but also reduces chance of error by adding ingredients explicitly and making object available once fully constructed.

Example

- Make a static nested class called Builder inside the class whose object will be build by Builder. In this example it's Cake.
- Builder class will have exactly same set of fields as original class.
- Builder class will expose method for adding ingredients e.g. sugar() in this example. each method will return same Builder object. Builder will be enriched with each method call.
- Builder.build() method will copy all builder field values into actual class and return object of Item class.
- Item class (class for which we are creating Builder) should have private constructor to create its object from build() method and prevent outsider to access its constructor.

```
public class BuilderPatternExample {
    public static void main(String args[]) {
        //Creating object using Builder pattern in java
        Cake whiteCake
= new Cake.Builder().sugar(1).butter(0.5).  eggs(2).vanila(2).flour(1.5). bakingpowder
(0.75).milk(0.5).build();d

        //Cake is ready to eat :)
        System.out.println(whiteCake);
    }
}
class Cake {
    private final double sugar;   //cup
    private final double butter;  //cup
    private final int eggs;
    private final int vanila;     //spoon
    private final double flour;   //cup
    private final double bakingpowder; //spoon
    private final double milk;  //cup
    private final int cherry;

    public static class Builder {

        private double sugar;   //cup
        private double butter;  //cup
        private int eggs;
        private int vanila;     //spoon
        private double flour;   //cup
        private double bakingpowder; //spoon
        private double milk;  //cup
        private int cherry;

        //builder methods for setting property
        public Builder sugar(double cup){this.sugar = cup; return this; }
        public Builder butter(double cup){this.butter = cup; return this; }
        public Builder eggs(int number){this.eggs = number; return this; }
        public Builder vanila(int spoon){this.vanila = spoon; return this; }
        public Builder flour(double cup){this.flour = cup; return this; }
        public Builder bakingpowder(double spoon){this.sugar = spoon; return this; }
        public Builder milk(double cup){this.milk = cup; return this; }
        public Builder cherry(int number){this.cherry = number; return this; }

        //return fully build object
        public Cake build() {
            return new Cake(this);
        }
    }

    //private constructor to enforce object creation through builder
    private Cake(Builder builder) {
        this.sugar = builder.sugar;
        this.butter = builder.butter;
        this.eggs = builder.eggs;
        this.vanila = builder.vanila;
```

```
        this.flour = builder.flour;
        this.bakingpowder = builder.bakingpowder;
        this.milk = builder.milk;
        this.cherry = builder.cherry;
    }


    @Override
    public String toString() {
        return "Cake{" + "sugar=" + sugar + ", butter=" + butter + ", eggs=" + eggs
+ ", vanila=" + vanila + ", flour=" + flour + ", bakingpowder=" + bakingpowder + ",
milk=" + milk + ", cherry=" + cherry + '}';
    }
}
```

Output:

```
Cake{sugar=0.75, butter=0.5, eggs=2, vanila=2, flour=1.5, bakingpowder=0.0, milk=0.5,
cherry=0}
```

Advantages:

- More maintainable if number of fields required to create object is more than 4 or 5.
- Less error-prone as user will know what they are passing because of explicit method call.
- More robust as only fully constructed object will be available to client.

Disadvantages:

- Verbose and code duplication as Builder needs to copy all fields from Original or Item class.

When to use Builder Design pattern in Java

- Builder Design pattern is a creational pattern and should be used when number of parameter required in constructor is more than manageable usually 4 or at most 5.
- Don't confuse with Builder and Factory pattern there is an obvious difference between Builder and Factory pattern, as Factory can be used to create different implementation of same interface but Builder is tied up with its Container class and only returns object of Outer class.

3. Factory Design Pattern in Java?

- Factory design pattern in Java one of the core design pattern which is used heavily not only in JDK but also in various Open Source framework such as Spring, Struts and Apache along with decorator design pattern in Java.
- Factory Design pattern is based on Encapsulation object oriented concept.
- Factory method is used to create different object from factory often refereed as Item and it encapsulate the creation code.
- So instead of having object creation code on client side we encapsulate inside Factory method in Java
- Factory design pattern is used to create objects or Class in Java and it provides loose coupling and high cohesion.

- Factory pattern encapsulate object creation logic which makes it easy to change it later when you change how object gets created or you can even introduce new object with just change in one class.
- In GOF pattern list Factory pattern is listed as Creation design pattern.
- Factory should be an interface and clients first either creates factory or get factory which later used to create objects.

Example of static factory method in JDK

- valueOf() method which returns object created by factory equivalent to value of parameter passed.
- getInstance() method which creates instance of Singleton class.
- newInstance() method which is used to create and return new instance from factory method every time called.
- getType() and newType() equivalent of getInstance() and newInstance() factory method but used when factory method resides in separate class.

Problem which is solved by Factory method Pattern in Java

- Some time our application or framework will not know that what kind of object it has to create at run-time it knows only the interface or abstract class and as we know we cannot create object of interface or abstract class so main problem is frame work knows when it has to create but don't know what kind of object.
- Whenever we create object using new() we violate principle of programming for interface rather than implementation which eventually result in inflexible code and difficult to change in maintenance. By using Factory design pattern in Java we get rid of this problem.

- Another problem we can face is class needs to contain objects of other classes or class hierarchies within it; this can be very easily achieved by just using the new keyword and the class constructor. The problem with this approach is that it is a very hard coded approach to create objects as this creates dependency between the two classes.
- So factory pattern solve this problem very easily by model an interface for creating an object which at creation time can let its subclasses decide which class to instantiate, Factory Pattern promotes loose coupling by eliminating the need to bind application-specific classes into the code. The factory methods are typically implemented as virtual methods, so this pattern is also referred to as the “Virtual Constructor”. These methods create the objects of the products or target classes.

Example

- Let’s see an example of how factory pattern is implemented in Code. We have requirement to create multiple currency e.g. INR, SGD, USD and code should be extensible to accommodate new Currency as well. Here we have made Currency as interface and all currency would be concrete implementation of Currency interface. Factory Class will create Currency based upon country and return concrete implementation which will be stored in interface type. This makes code dynamic and extensible.

```
interface Currency {

	String getSymbol();

}

// Concrete Rupee Class code

class Rupee implements Currency {

	@Override

	public String getSymbol() {

		return "Rs";
```

```
	}
}


// Concrete SGD class Code
class SGDDollar implements Currency {
	@Override
	public String getSymbol() {
		return "SGD";
	}
}


// Concrete US Dollar code
class USDollar implements Currency {
	@Override
	public String getSymbol() {
		return "USD";
	}
}
```

```
// Factroy Class code
class CurrencyFactory {


	public static Currency createCurrency (String country) {
	if (country. equalsIgnoreCase ("India")){
		return new Rupee();
	}else if(country. equalsIgnoreCase ("Singapore")){
		return new SGDDollar();
	}else if(country. equalsIgnoreCase ("US")){
		return new USDollar();
	 }
```

```
        throw new IllegalArgumentException("No such currency");
        }
}


// Factory client code
public class Factory {
        public static void main(String args[]) {
                String country = args[0];
                Currency rupee = CurrencyFactory.createCurrency(country);
                System.out.println(rupee.getSymbol());
        }
}
```

Advantages

- Factory method design pattern decouples the calling class from the target class, which result in less coupled and highly cohesive code?
- Factory pattern in Java enables the subclasses to provide extended version of an object, because creating an object inside factory is more flexible than creating an object directly in the client. Since client is working on interface level any time you can enhance the implementation and return from Factory.
- Another benefit of using Factory design pattern in Java is that it encourages consistency in Code since every time object is created using Factory rather than using different constructor at different client side.
- Code written using Factory design pattern in Java is also easy to debug and troubleshoot because you have a centralized method for object creation and every client is getting object from same place.

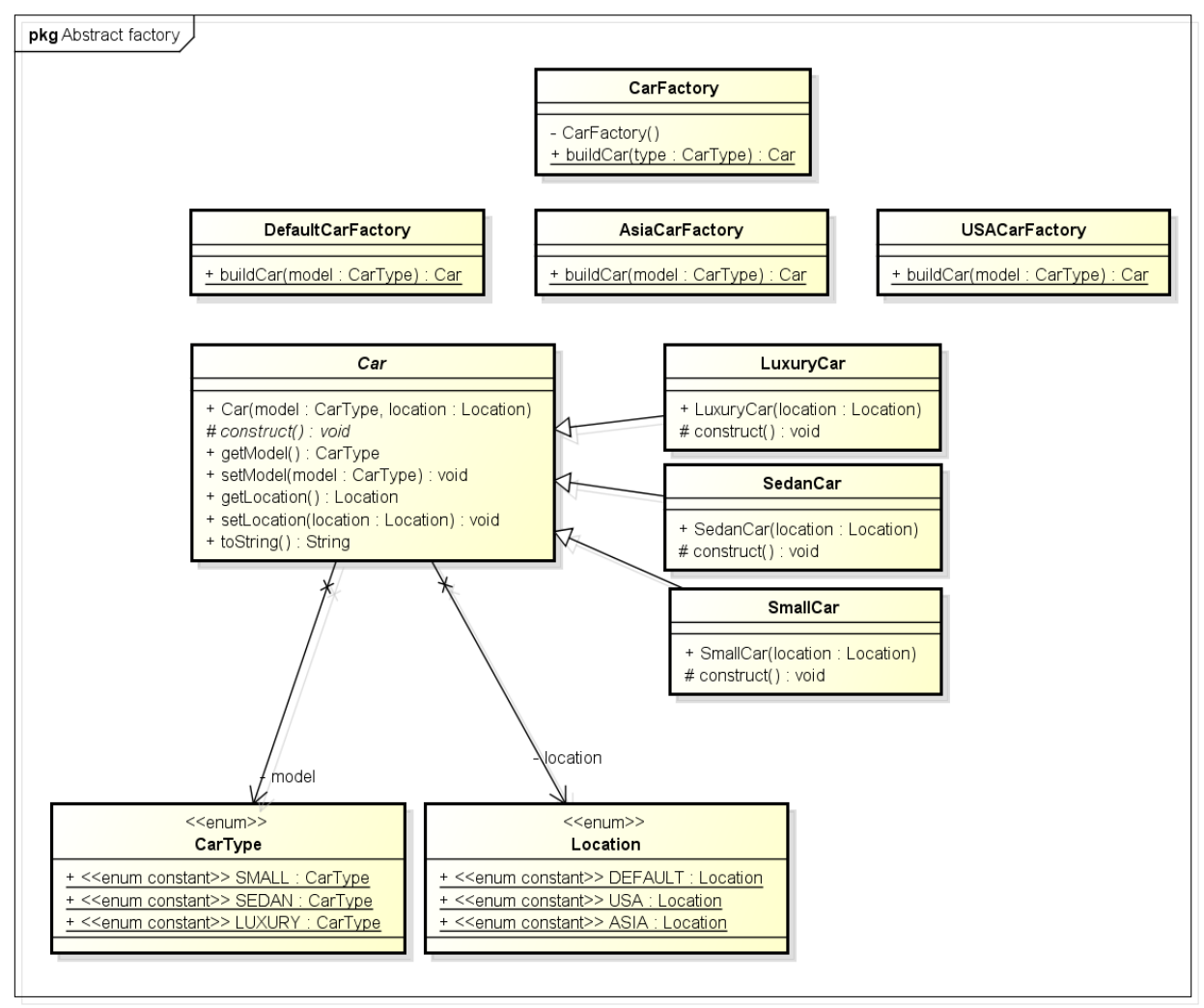
- Static factory method used in factory design pattern enforces use of Interface than implementation which itself a good practice. for example:
- Map synchronizedMap = Collections.synchronizedMap(new HashMap());
- Since static factory method have return type as Interface, it allows you to replace implementation with better performance version in newer release.
- Another advantage of static factory method pattern is that they can cache frequently used object and eliminate duplicate object creation. Boolean.valueOf() method is good example which caches true and false boolean value.
- Factory method pattern is also recommended by Joshua Bloch in Effective Java.
- Factory method pattern offers alternative way of creating object.
- Factory pattern can also be used to hide information related to creation of object.

4. Abstract Factory Design Pattern in Java?

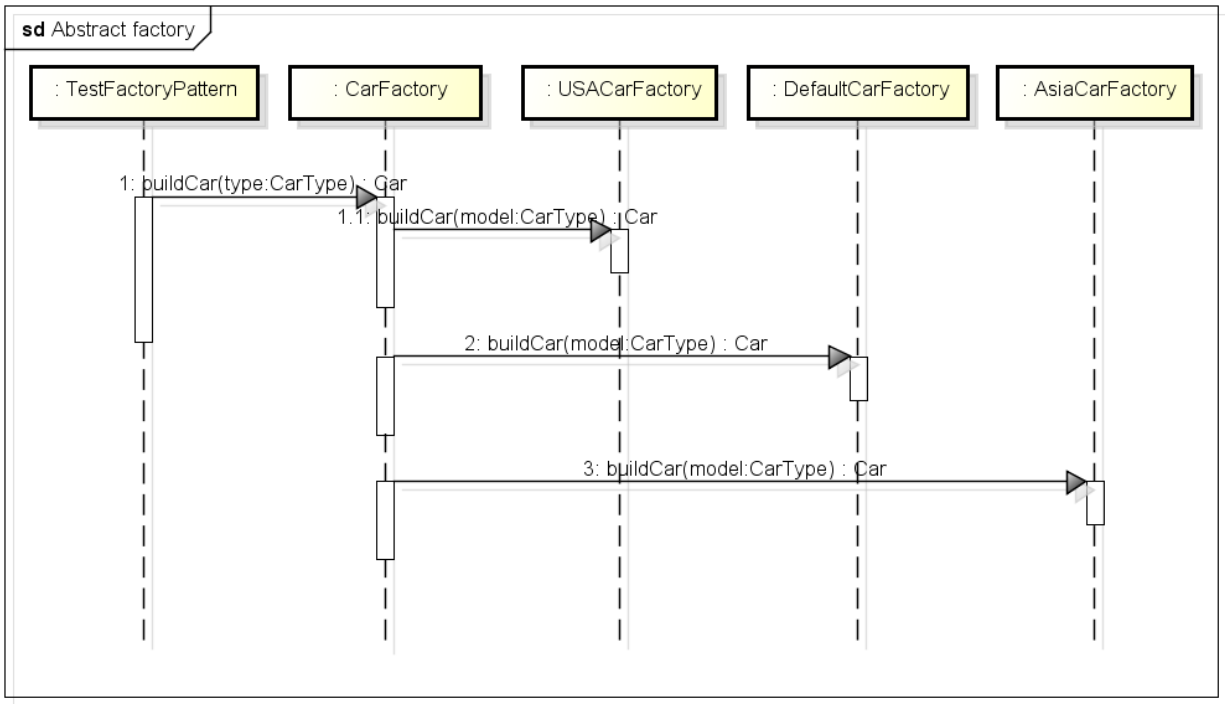
- Abstract factory pattern is yet another creational design pattern and is considered as another layer of abstraction over factory pattern
- Imagine if our car maker decide to go global. Becoming global will require to enhance the system to support different car making styles for different countries. For example we will consider USA, Asia and default for all other countries.

- First of all, we need car factories in each location specified in problem statement. i.e. USACarFactory, AsiaCarFactory and DefaultCarFactory.
- Now, our application should be smart enough to identify the location where is being used, so we should be able to use appropriate car factory without even knowing which car factory implementation will be used internally. This also saves us from someone calling wrong factory for a particular location.
- So basically, we need another layer of abstraction which will identify the location and internally use correct car factory implementation without even giving a single hint to user. This is exactly the problem, which abstract factory pattern is used to solve.
- Let’s see how abstract factory solve above issue in form of design:

Package Diagram



Sequence Diagram



Implementation in code

- Lets write all separate car factories for different locations. Begin with Car.java class

Car.java

```
public abstract class Car {


        public Car(CarType model, Location location){
              this.model = model;
              this.location = location;
```

```
	}

	protected abstract void construct();

	private CarType model = null;
	private Location location = null;

	public CarType getModel() {
		return model;
	}

	public void setModel(CarType model) {
		this.model = model;
	}

	public Location getLocation() {
		return location;
	}

	public void setLocation(Location location) {
		this.location = location;
	}

	@Override
	public String toString() {
		return ”Model- “ + model + “ built in “ +location;
	}
}
```

- This adds extra work of creating another enum for storing different locations.

Location.java

```
public enum Location {
	DEFAULT, USA, ASIA
}
```

- All car types will also have additional location property. I am writing only for luxury car. Same follows for small and sedan also.

LuxuryCar.java

```
public class LuxuryCar extends Car
{
	public LuxuryCar(Location location)
	{
		super(CarType.LUXURY, location);
		construct();
	}

	@Override
	protected void construct() {
		System.out.println("luxury car");
		//add accessories
	}
}
```

- So for we have created basic classes. Now lets have different car factories.

AsiaCarFactory.java

```
public class AsiaCarFactory
{
	public static Car buildCar(CarType model)
	{
		Car car = null;
		switch (model)
		{
			case SMALL:
			car = new SmallCar(Location.ASIA);
			break;

			case SEDAN:
			car = new SedanCar(Location.ASIA);
			break;

			case LUXURY:
			car = new LuxuryCar(Location.ASIA);
			break;

			default:
			//throw some exception
			break;
		}
		return car;
	}
}
```

DefaultCarFactory.java

```
public class DefaultCarFactory
{
	public static Car buildCar(CarType model)
	{
		Car car = null;
		switch (model)
		{
			case SMALL:
			car = new SmallCar(Location.DEFAULT);
			break;

			case SEDAN:
			car = new SedanCar(Location.DEFAULT);
			break;

			case LUXURY:
			car = new LuxuryCar(Location.DEFAULT);
			break;

			default:
			//throw some exception
			break;
		}
		return car;
	}
}
```

USACarFactory.java

```
public class USACarFactory
```

```
{
	public static Car buildCar(CarType model)
	{
		Car car = null;
		switch (model)
		{
			case SMALL:
			car = new SmallCar(Location.USA);
			break;

			case SEDAN:
			car = new SedanCar(Location.USA);
			break;

			case LUXURY:
			car = new LuxuryCar(Location.USA);
			break;

			default:
			//throw some exception
			break;
		}
	return car;
	}
}
```

- Well, now we have all 3 different Car factories. Now, we have to abstract the way these factories are accessed. Lets see how?

```
public class CarFactory
 {
      private CarFactory() {
            //Prevent instantiation
      }

      public static Car buildCar(CarType type)
      {
            Car car = null;
            Location location = Location.ASIA; //Read location property somewhere from configuration
            //Use location specific car factory
            switch(location)
            {
                  case USA:
                  car = USACarFactory.buildCar(type);
                  break;
                  case ASIA:
                  car = AsiaCarFactory.buildCar(type);
                  break;
                  default:
                  car = DefaultCarFactory.buildCar(type);
            }
      return car;
      }
```

```
}
```

- We are done with writing code. Now lets test what we have written till now.

```
public class TestFactoryPattern
{
      public static void main(String[] args)
      {
            System.out.println(CarFactory.buildCar(CarType.SMALL));
            System.out.println(CarFactory.buildCar(CarType.SEDAN));
            System.out.println(CarFactory.buildCar(CarType.LUXURY));
      }
}
```

```
Output: (Default location is Asia)
Building small car
Model- SMALL built in ASIA
Building sedan car
Model- SEDAN built in ASIA
Building luxury car
Model- LUXURY built in ASIA
```

5. Prototype Design Pattern in Java?

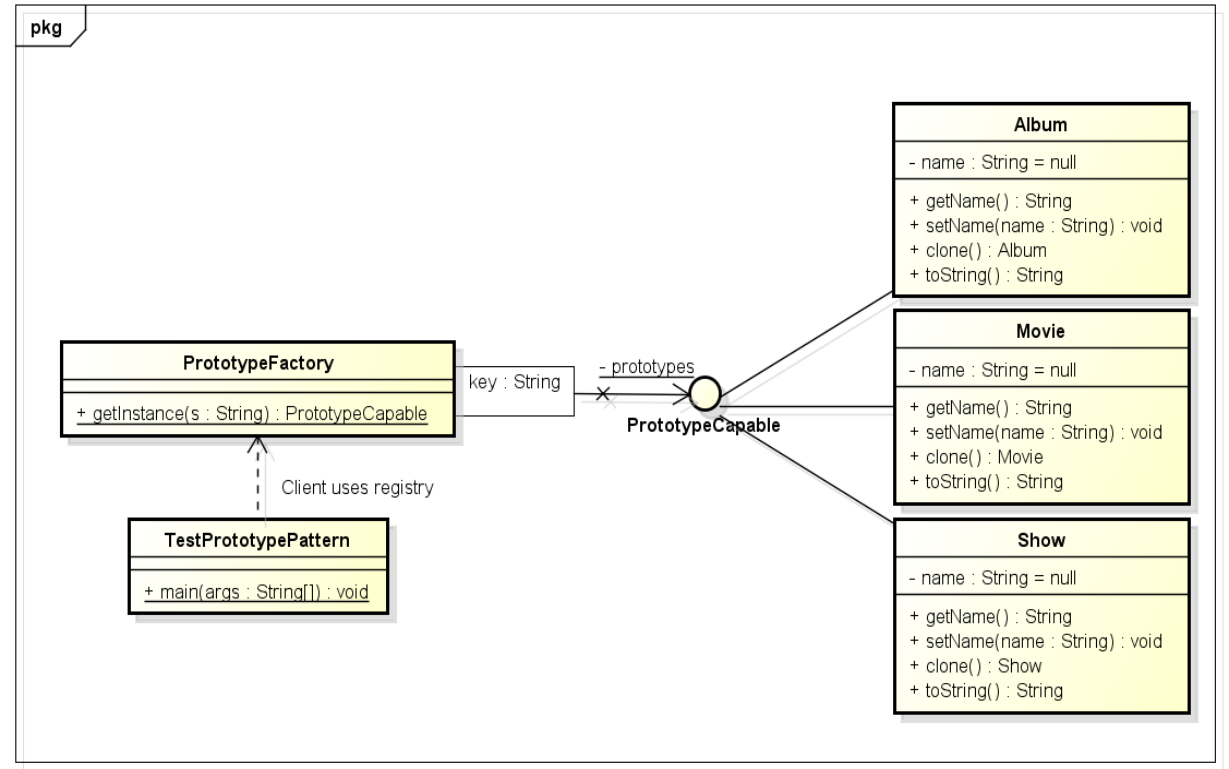
A prototype is a template of any object before the actual object is constructed. In java also, it holds the same meaning. Prototype design pattern is used in scenarios where application needs to create a number of instances of a class, which has almost same state or differs very little.

In this design pattern, an instance of actual object (i.e. prototype) is created on starting, and thereafter whenever a new instance is required, this prototype is cloned to have another instance. The main advantage of this pattern is to have minimal instance creation process which is much costly than cloning process.

Problem Statement

Let’s understand this pattern using an example. I am creating an entertainment application that will require instances of Movie, Album and Show classes very frequently. I do not want to create their instances every time as it is costly. So, I will create their prototype instances, and every time when i will need a new instance, I will just clone the prototype.

Implementation of Prototype Design Pattern

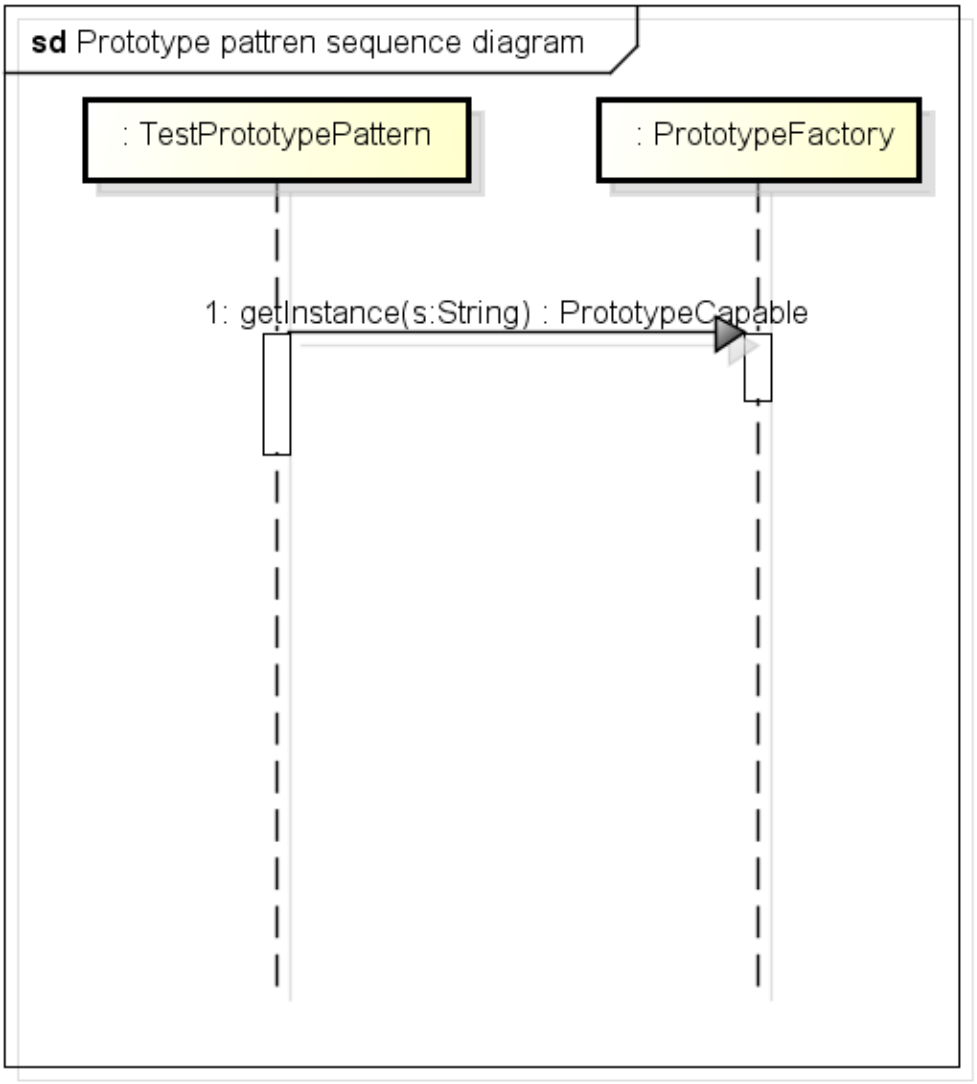


Above class diagram explains the necessary classes and their relationship.

Only one interface, “PrototypeCapable” is new addition in solution. The reason to use this interface is broken behavior of Cloneable interface. This interface helps in achieving following goals:

1. Ability to clone prototypes without knowing their actual types
2. Provides a type reference to be used in registry

Their workflow will look like this:



PrototypeCapable.java

```
package com.howtodoinjava.prototypeDemo.contract;

public interface PrototypeCapable extends Cloneable
{
    public PrototypeCapable clone() throws CloneNotSupportedException;
}
```

Movie.java, Album.java and Show.java

```
package com.howtodoinjava.prototypeDemo.model;

import com.howtodoinjava.prototypeDemo.contract.PrototypeCapable;

public class Movie  implements PrototypeCapable
{
    private String name = null;
    public String getName() {
        return name;
    }
    public void setName(String name) {
        this.name = name;
    }
    @Override
    public Movie clone() throws CloneNotSupportedException {
        System.out.println("Cloning Movie object..");
        return (Movie) super.clone();
    }
    @Override
    public String toString() {
        return "Movie";
    }
}

public class Album  implements PrototypeCapable
{
    private String name = null;
    public String getName() {
        return name;
    }
    public void setName(String name) {
        this.name = name;
    }
    @Override
    public Album clone() throws CloneNotSupportedException {
        System.out.println("Cloning Album object..");
        return (Album) super.clone();
    }
    @Override
    public String toString() {
        return "Album";
    }
}

public class Show  implements PrototypeCapable
{
    private String name = null;
```

PrototypeFactory.java

```
package com.howtodoinjava.prototypeDemo.factory;

import com.howtodoinjava.prototypeDemo.contract.PrototypeCapable;
import com.howtodoinjava.prototypeDemo.model.Album;
import com.howtodoinjava.prototypeDemo.model.Movie;
import com.howtodoinjava.prototypeDemo.model.Show;

public class PrototypeFactory
{
    public static class ModelType
    {
        public static final String MOVIE = "movie";
        public static final String ALBUM = "album";
        public static final String SHOW = "show";
    }
    private static java.util.Map<String , PrototypeCapable> prototypes
= new java.util.HashMap<String , PrototypeCapable>();

    static
    {
        prototypes.put(ModelType.MOVIE, new Movie());
        prototypes.put(ModelType.ALBUM, new Album());
        prototypes.put(ModelType.SHOW, new Show());
    }

    public static PrototypeCapable getInstance(final String s) throws
CloneNotSupportedException {
        return ((PrototypeCapable) prototypes.get(s)).clone();
    }
}
```

TestPrototypePattern

```
package com.howtodoinjava.prototypeDemo.client;

import com.howtodoinjava.prototypeDemo.factory.PrototypeFactory;
import
com.howtodoinjava.prototypeDemo.factory.PrototypeFactory.ModelType;

public class TestPrototypePattern
{
    public static void main(String[] args)
    {
        try
        {
            String moviePrototype  =
PrototypeFactory.getInstance(ModelType.MOVIE).toString();
            System.out.println(moviePrototype);

            String albumPrototype  =
PrototypeFactory.getInstance(ModelType.ALBUM).toString();
            System.out.println(albumPrototype);

            String showPrototype  =
PrototypeFactory.getInstance(ModelType.SHOW).toString();
            System.out.println(showPrototype);

        }
        catch (CloneNotSupportedException e)
        {
            e.printStackTrace();
        }
    }
}
```

When you run the client code, following is the output.

```
Cloning Movie object..
Movie
Cloning Album object..
Album
Cloning Show object..
Show
```

Adapter Design Pattern

- A similar example is your *mobile charger* or your *laptop charger* which can be used with any power supply without fear of the variance power supply in different locations. That is also called power “adapter”.

- In programming as well, adapter pattern is used for similar purposes. It enables two incompatible interfaces to work smoothly with each other.

- Adapter design pattern is one of the **structural design pattern** and its used so that two unrelated interfaces can work together. The object, that joins these unrelated interfaces, is called an Adapter.
- An adapter pattern is also known as **Wrapper pattern** as well.
- Adapter Design is very useful for the system integration when some other existing components have to be adopted by the existing system without sourcecode modifications.

Example:

- If you want to read the system input through command prompt in java then given below code is common way to do it:

```
BufferedReader br = new BufferedReader(new
InputStreamReader(System.in));
System.out.print("Enter String");
String s = br.readLine();
System.out.print("Enter input: " + s);
```

- This input stream natively reads the data from the console in bytes stream.

- BufferedReader reads a character stream.

Bridge Design Pattern

- Bridge design pattern is used to decouple a class into two parts – abstraction and it's implementation
- so that both can evolve in future without affecting each other.
- It increases the loose coupling between class abstraction and its implementation.

Problem Statement:

- Let's say, we are designing **an application which can be download and store files on any operating system**.
- I want to design the system in such a way, I should be able to add more platform support in future with minimum change.
- Additionally, If I want to add more support in downloader class (e.g. delete the download in windows only), then It should not affect the client code as well as linux downloader.

Solution:

- We will use bridge pattern to solve this. We will break the downloader component into abstraction and implementer parts.
- Here I am creating two interfaces, **FileDownloaderAbstraction** represents the abstraction with which client will interact
- And **FileDownloadImplementor** which represents the implementation. In this way, both hierarchies can evolve separately without affecting each other.

FileDownloaderAbstraction.java

```
public interface FileDownloaderAbstraction
{
    public Object download(String path);

    public boolean store(Object object);
}
```

FileDownloaderAbstractionImpl.java

```
public class FileDownloaderAbstractionImpl implements
FileDownloaderAbstraction {

    private FileDownloadImplementor provider = null;

    public FileDownloaderAbstractionImpl(FileDownloadImplementor provider) {
        super();
        this.provider = provider;
    }

    @Override
    public Object download(String path)
    {
        return provider.downloadFile(path);
    }

    @Override
    public boolean store(Object object)
    {
        return provider.storeFile(object);
    }
}
```

FileDownloadImplementor.java

```
public interface FileDownloadImplementor
{
    public Object downloadFile(String path);

    public boolean storeFile(Object object);
}
```

LinuxFileDownloadImplementor.java

```
public class LinuxFileDownloadImplementor implements
FileDownloadImplementor
{
    @Override
    public Object downloadFile(String path) {
        return new Object();
    }

    @Override
    public boolean storeFile(Object object) {
        System.out.println("File downloaded successfully in LINUX !!");
        return true;
    }
```

WindowsFileDownloadImplementor.java

```
public class WindowsFileDownloadImplementor implements
FileDownloadImplementor
{
    @Override
    public Object downloadFile(String path) {
        return new Object();
    }

    @Override
    public boolean storeFile(Object object) {
        System.out.println("File downloaded successfully in WINDOWS !!");
        return true;
    }
}
```

Client.java

```
public class Client
{
    public static void main(String[] args)
    {
        String os = "linux";
        FileDownloaderAbstraction downloader = null;

        switch (os)
        {
            case "windows":
                downloader = new FileDownloaderAbstractionImpl( new
WindowsFileDownloadImplementor() );
                break;

            case "linux":
                downloader = new FileDownloaderAbstractionImpl( new
LinuxFileDownloadImplementor() );
                break;

            default:
                System.out.println("OS not supported !!");
        }

        Object fileContent = downloader.download("some path");
        downloader.store(fileContent);
    }
}

Output:

File downloaded successfully in LINUX !!
```

Change in implementation does not affect abstraction

Let's say you want to add delete feature at implementation layer for all downloaders (an internal feature) which client should not know about.

FileDownloadImplementor.java

```
public interface FileDownloadImplementor
{
    public Object downloadFile(String path);

    public boolean storeFile(Object object);

    public boolean delete(String object);
}
```

LinuxFileDownloadImplementor.java

```
public class LinuxFileDownloadImplementor implements
FileDownloadImplementor
{
    @Override
    public Object downloadFile(String path) {
        return new Object();
    }

    @Override
    public boolean storeFile(Object object) {
        System.out.println("File downloaded successfully in LINUX !!");
        return true;
    }

    @Override
    public boolean delete(String object) {
        return false;
    }
```

WindowsFileDownloadImplementor.java

```
public class WindowsFileDownloadImplementor implements
FileDownloadImplementor
{
    @Override
    public Object downloadFile(String path) {
        return new Object();
    }

    @Override
    public boolean storeFile(Object object) {
        System.out.println("File downloaded successfully in LINUX !!");
        return true;
    }

    @Override
    public boolean delete(String object) {
        return false;
    }
}
```

Above change does not affect the abstraction layer, so client will not be impacted at all.

Composite Design Pattern

Composite design pattern is a **structural pattern** which modifies the structure of an object. This pattern is most suitable in cases where you need to work with **objects which form a tree like hierarchy**.

Problem Stament

Let's suppose we are building a financial application. We have customers with multiple bank accounts. We are asked to prepare a design which can be useful to generate the customer's consolidated account view which is able to show **customer's total account balance as well as consolidated account statement** after merging all the account statements. So, application should be able to generate:
1) Customer's total account balance from all accounts

2) Consolidated account statement

Solution

As here we are dealing with account objects which form a tree-like structure in which we will traverse and do some operations on account objects only, so we can apply composite design pattern.

Component.java

```
import java.util.ArrayList;
import java.util.List;

public abstract class Component
{
    AccountStatement accStatement;

    protected List<Component> list = new ArrayList<>();

    public abstract float getBalance();

    public abstract AccountStatement getStatement();

    public void add(Component g) {
        list.add(g);
    }

    public void remove(Component g) {
        list.remove(g);
    }

    public Component getChild(int i) {
        return (Component) list.get(i);
    }
}
```

CompositeAccount.java

```
public class CompositeAccount extends Component
{
    private float totalBalance;
    private AccountStatement compositeStmt, individualStmt;

    public float getBalance() {
        totalBalance = 0;
        for (Component f : list) {
            totalBalance = totalBalance + f.getBalance();
        }
        return totalBalance;
    }

    public AccountStatement getStatement() {
        for (Component f : list) {
            individualStmt = f.getStatement();
            compositeStmt.merge(individualStmt);
        }
        return compositeStmt;
    }
}
```

AccountStatement.java

```
public class AccountStatement
{
    public void merge(AccountStatement g)
    {
        //Use this function to merge all account statements
    }
}
```

DepositAccount.java

```
public class DepositAccount extends Component
{
    private String accountNo;
    private float accountBalance;

    private AccountStatement currentStmt;

    public DepositAccount(String accountNo, float accountBalance) {
        super();
        this.accountNo = accountNo;
        this.accountBalance = accountBalance;
    }

    public String getAccountNo() {
        return accountNo;
    }

    public float getBalance() {
        return accountBalance;
    }

    public AccountStatement getStatement() {
        return currentStmt;
    }
}
```

SavingsAccount.java

```
public class SavingsAccount extends Component
{
    private String accountNo;
    private float accountBalance;

    private AccountStatement currentStmt;

    public SavingsAccount(String accountNo, float accountBalance) {
        super();
        this.accountNo = accountNo;
        this.accountBalance = accountBalance;
    }

    public String getAccountNo() {
        return accountNo;
    }

    public float getBalance() {
        return accountBalance;
    }

    public AccountStatement getStatement() {
        return currentStmt;
    }
}
```

Client.java

```
public class Client
{
    public static void main(String[] args)
    {
        // Creating a component tree
        Component component = new CompositeAccount();

        // Adding all accounts of a customer to component
        component.add(new DepositAccount("DA001", 100));
        component.add(new DepositAccount("DA002", 150));
        component.add(new SavingsAccount("SA001", 200));

        // getting composite balance for the customer
        float totalBalance = component.getBalance();
        System.out.println("Total Balance : " + totalBalance);

        AccountStatement mergedStatement = component.getStatement();
        //System.out.println("Merged Statement : " + mergedStatement);
    }
}
```

Output:

```
Total Balance : 450.0
```

Proxy Design Pattern

According to GoF definition of **proxy design pattern**, a proxy object provide **a surrogate or placeholder** for another object to control access to it.

A proxy object hides the original object and control access to it. We can use proxy when we may want to use a class that can perform as an interface to something else.
Proxy is heavily used to implement lazy loading related usecases where we do not want to create full object until it is actually needed.
A proxy can be used to add an additional security layer around the original object as well.

Real world example of proxy pattern

In hibernate, we write the code to fetch entities from the database. Hibernate returns an object which a proxy (by dynamically constructed by Hibernate by extending the domain class) to the underlying entity class. The client code is able to read the data whatever it needs to read with the proxy.These proxy entity classes help in implementing lazy loading scenarios where associated entities are fetched only when they are requested explicitly. It helps in improving performance of DAO operations.

Proxy design pattern example

In given example, we have a RealObject which client need to access to do something. It will ask the framework to provide an instance of RealObject. But as the access to this object needs to be guarded, framework returns the reference to RealObjectProxy.
Any call to proxy object is used for additional requirements and the call is passed to real object.

RealObject.java

```
public interface RealObject
{
    public void doSomething();
}
```

RealObjectImpl.java

```
public class RealObjectImpl implements RealObject {

    @Override
    public void doSomething() {
        System.out.println("Performing work in real object");
    }

}
```

RealObjectProxy.java

```
public class RealObjectProxy extends RealObjectImpl
{
    @Override
    public void doSomething()
    {
        //Perform additional logic and security
        //Even we can block the operation execution
        System.out.println("Delegating work on real object");
        super.doSomething();
    }
}
```

Client.java

```
public class Client
{
    public static void main(String[] args)
    {
        RealObject proxy = new RealObjectProxy();
        proxy.doSomething();
    }
}
```

Program output.
Console

```
Delegating work on real object
Performing work in real object
```

Chain of Responsibility Design Pattern

- The Chain of Responsibility is known as a behavioral pattern.
- The main objective of this pattern is that it avoids coupling the sender of the request to the receiver, giving more than one object the opportunity to handle the request.
- Chain of Responsibility allows a number of classes to attempt to handle a request, independently of any other object along the chain. Once the request is handled, it completes it's journey through the chain.

Problem Statement

- The problem statement is to design a system for **support service system** consisting of front desk, supervisor, manager and director.
- Any client can call to front desk and will ask for a solution. If front desk is able to solve the issue, it will; otherwise will pass to supervisor.
- Similarly, supervisor will try to solve the issue and if he is able to then he will solve; else pass to manager.
- Same way, manager will either solve the issue or pass to director.
- Director will either solve the issue or reject it.

Proposed solution

- Above problem is a good candidate for using chain of responsibility pattern. We can define the handler at each level i.e. support desk, supervisor, manager and director.
- Then we can define a chain for handling the support request. This chain must follow the sequence:

Support desk > supervisor > manager > director

Iterator Design Pattern

As name implies, iterator helps in **traversing the collection of objects in a defined manner** which is useful the client applications. During iteration, client programs can perform various other operations on the elements as per requirements.

Example of iterator pattern

- In Java, we have **java.util.Iterator** interface and it's specific implementations such as ListIterator.
- All Java collections provide some internal implementations of Iterator interface which is used to iterate over collection elements.
- Java iterator example

```
    List<String> names = Arrays.asList("alex", "brian", "charles");

    Iterator<String> namesIterator = names.iterator();

    while (namesIterator.hasNext())
    {
        String currentName = namesIterator.next();

        System.out.println(currentName);
}
```

Iterator design pattern example

In this iterator pattern example, we are creating a collection which can holds instances of Topic class and will provide an iterator to iterate over tokens collections in a sequence.
Topic.java

```
public class Topic
{
    private String name;

    public Topic(String name) {
        super();
        this.name = name;
    }

    public String getName() {
        return name;
    }

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

Iterator.java

```
public interface Iterator<E>
{
    void reset();   // reset to the first element

    E next();   // To get the next element

    E currentItem();    // To retrieve the current element

    boolean hasNext();  // To check whether there is any next element or not.
}
```

TopicIterator.java

```
public class TopicIterator implements Iterator<Topic> {

    private Topic[] topics;
    private int position;

    public TopicIterator(Topic[] topics)
    {
        this.topics = topics;
        position = 0;
    }

    @Override
    public void reset() {
        position = 0;
    }

    @Override
    public Topic next() {
        return topics[position++];
    }

    @Override
    public Topic currentItem() {
        return topics[position];
    }

    @Override
    public boolean hasNext() {
        if(position >= topics.length)
            return false;
        return true;
    }
}
```

List.java

```
public interface List<E>
{
    Iterator<E> iterator();
}
```

TopicList.java

```
public class TopicList implements List<Topic>
{
    private Topic[] topics;

    public TopicList(Topic[] topics)
    {
        this.topics = topics;
    }

    @Override
    public Iterator<Topic> iterator() {
        return new TopicIterator(topics);
    }
}
```

The client code to use the iterator will be like this.
Main.java

```
public class Main
{
    public static void main(String[] args)
    {
        Topic[] topics = new Topic[5];
        topics[0] = new Topic("topic1");
        topics[1] = new Topic("topic2");
        topics[2] = new Topic("topic3");
        topics[3] = new Topic("topic4");
        topics[4] = new Topic("topic5");

        List<Topic> list = new TopicList(topics);

        Iterator<Topic> iterator = list.iterator();

        while(iterator.hasNext()) {
            Topic currentTopic = iterator.next();
            System.out.println(currentTopic.getName());
        }
    }
}
```

Strategy Design Pattern

- **Strategy design pattern** is behavioral design pattern where we choose a specific implementation of algorithm or task in run time – out of multiple other implementations for same task.

Problem Statement

- Let's solve a design problem to understand strategy pattern in more detail.
- I want to design a social media application which allows me to connect to my friends on all four social platforms i.e. Facebook, Google Plus, Twitter and Orkut (for example sake).
- Now I want that client should be able to tell the name of friend and desired platform – then my application should connect to him transparently.
- More importantly, if I want to add more social platforms into application then application code should accommodate it without breaking the design.

Observer Design Pattern

observer pattern defines a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically. It is also referred to as the **publish-subscribe pattern**.

A observer object can register or unregister from subject at any point of time. It helps is making the objects objects **loosely coupled**.

Real world example of observer pattern

- A real world example of observer pattern can be any social media platform such as Facebook or twitter. When a person updates his status – all his followers gets the notification.A follower can follow or unfollow another person at any point of time. Once unfollowed, person will not get the notifications from subject in future.

Example:

Visitor pattern

visitor design pattern is a way of separating an algorithm from an object structure on which it operates. A practical result of this separation is the ability to add new operations to existing object structures without modifying those structures. It is one way to follow the **open/closed principle** (one of **SOLID design principles**).

Problem Statement

Suppose we have an application which manage routers in different environments. Routers should be capable of sending and receiving char data from other nodes and application should be capable of configuring routers in different environment.
Essentially, design should flexible enough to support the changes in way that **routers can be configured for additional environments in future, without much modifications in source code**.

Template Method Design Pattern

It defines the sequential steps to execute a multi-step algorithm and optionally can provide a default implementation as well (based on requirements).

Problem Statement

Lets say we need to build any house which is generally have certain steps. Some steps have default implementation and some steps are very specific to implementer with no default implementation.

Steps with default implementation

- Construction of base foundation
- Construction of roof

Steps with "NO" default implementation

- Construction of walls
- Construction of windows and doors
- Painting
- Interior decorating

Solution

In above problem, we have certain steps in **fixed order** which all building classes must follow. So, we can use template method design pattern to solve this problem.

Command Design Pattern

Command pattern is a behavioral design pattern which is useful to **abstract business logic into actions** which we call *commands*. This command object helps in loose coupling between two classes where one class (invoker) shall call a method on other class (receiver) to perform a business operation.

Suppose we need to build a remote control for home automation system which shall control different lights/electrical units of the home. A single button in remote may be able to perform same operation on similar devices e.g. a TV ON/OFF button can be used to turn ON/OFF different TV set in different rooms.

Here this remote will be a programmable remote and it would be used to turn on and off various lights/fan etc.