**Design Patterns**

**Types of Design Patterns**

As per the design pattern reference book **Design Patterns - Elements of Reusable Object-Oriented Software** , there are 23 design patterns which can be classified in three categories: Creational, Structural and Behavioral patterns. We'll also discuss another category of design pattern: J2EE design patterns.

|  |  |
| --- | --- |
| **S.N.** | **Pattern & Description** |
| 1 | **Creational Patterns** These design patterns provide a way to create objects while hiding the creation logic, rather than instantiating objects directly using new opreator. This gives program more flexibility in deciding which objects need to be created for a given use case. |
| 2 | **Structural Patterns** These design patterns concern class and object composition. Concept of inheritance is used to compose interfaces and define ways to compose objects to obtain new functionalities. |
| 3 | **Behavioral Patterns** These design patterns are specifically concerned with communication between objects. |
| 4 | **J2EE Patterns** These design patterns are specifically concerned with the presentation tier. These patterns are identified by Sun Java Center. |

**Creational patterns**

1. **Factory Pattern**

Factory pattern is one of most used design pattern in Java. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

In Factory pattern, we create object without exposing the creation logic to the client and refer to newly created object using a common interface.

## Implementation

We're going to create a *Shape* interface and concrete classes implementing the *Shape* interface. A factory class *ShapeFactory* is defined as a next step.

*FactoryPatternDemo*, our demo class will use *ShapeFactory* to get a *Shape*object. It will pass information (*CIRCLE / RECTANGLE / SQUARE*) to*ShapeFactory* to get the type of object it needs.



## Step 1

Create an interface.

*Shape.java*

public interface Shape {

void draw();

}

## Step 2

Create concrete classes implementing the same interface.

*Rectangle.java*

public class Rectangle implements Shape {

@Override

public void draw() {

System.out.println("Inside Rectangle::draw() method.");

}

}

*Square.java*

public class Square implements Shape {

@Override

public void draw() {

System.out.println("Inside Square::draw() method.");

}

}

*Circle.java*

public class Circle implements Shape {

@Override

public void draw() {

System.out.println("Inside Circle::draw() method.");

}

}

## Step 3

Create a Factory to generate object of concrete class based on given information.

*ShapeFactory.java*

public class ShapeFactory {

//use getShape method to get object of type shape

public Shape getShape(String shapeType){

if(shapeType == null){

return null;

}

if(shapeType.equalsIgnoreCase("CIRCLE")){

return new Circle();

} else if(shapeType.equalsIgnoreCase("RECTANGLE")){

return new Rectangle();

} else if(shapeType.equalsIgnoreCase("SQUARE")){

return new Square();

}

return null;

}

}

## Step 4

Use the Factory to get object of concrete class by passing an information such as type.

*FactoryPatternDemo.java*

public class FactoryPatternDemo {

public static void main(String[] args) {

ShapeFactory shapeFactory = new ShapeFactory();

//get an object of Circle and call its draw method.

Shape shape1 = shapeFactory.getShape("CIRCLE");

//call draw method of Circle

shape1.draw();

//get an object of Rectangle and call its draw method.

Shape shape2 = shapeFactory.getShape("RECTANGLE");

//call draw method of Rectangle

shape2.draw();

//get an object of Square and call its draw method.

Shape shape3 = shapeFactory.getShape("SQUARE");

//call draw method of circle

shape3.draw();

}

}

## Step 5

Verify the output.

Inside Circle::draw() method.

Inside Rectangle::draw() method.

Inside Square::draw() method.

2) **Abstract Factory Pattern**

Abstract Factory patterns work around a super-factory which creates other factories. This factory is also called as factory of factories. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

In Abstract Factory pattern an interface is responsible for creating a factory of related objects without explicitly specifying their classes. Each generated factory can give the objects as per the Factory pattern.

public class AbstractFactoryPatternDemo {

public static void main(String[] args) {

//get shape factory

AbstractFactory shapeFactory = FactoryProducer.getFactory("SHAPE");

//get an object of Shape Circle

Shape shape1 = shapeFactory.getShape("CIRCLE");

//call draw method of Shape Circle

shape1.draw();

//get an object of Shape Rectangle

Shape shape2 = shapeFactory.getShape("RECTANGLE");

//call draw method of Shape Rectangle

shape2.draw();

//get an object of Shape Square

Shape shape3 = shapeFactory.getShape("SQUARE");

//call draw method of Shape Square

shape3.draw();

//get color factory

AbstractFactory colorFactory = FactoryProducer.getFactory("COLOR");

//get an object of Color Red

Color color1 = colorFactory.getColor("RED");

//call fill method of Red

color1.fill();

//get an object of Color Green

Color color2 = colorFactory.getColor("Green");

//call fill method of Green

color2.fill();

//get an object of Color Blue

Color color3 = colorFactory.getColor("BLUE");

//call fill method of Color Blue

color3.fill();

}

}

3) **Singleton Pattern**

Singleton pattern is one of the simplest design patterns in Java. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

This pattern involves a single class which is responsible to create an object while making sure that only single object gets created. This class provides a way to access its only object which can be accessed directly without need to instantiate the object of the class.

4) **Builder Pattern**

Builder pattern builds a complex object using simple objects and using a step by step approach. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

A Builder class builds the final object step by step. This builder is independent of other objects.

Create a Meal class having Item objects defined above.

*Meal.java*

import java.util.ArrayList;

import java.util.List;

public class Meal {

private List<Item> items = new ArrayList<Item>();

public void addItem(Item item){

items.add(item);

}

public float getCost(){

float cost = 0.0f;

for (Item item : items) {

cost += item.price();

}

return cost;

}

public void showItems(){

for (Item item : items) {

System.out.print("Item : " + item.name());

System.out.print(", Packing : " + item.packing().pack());

System.out.println(", Price : " + item.price());

}

}

}

## Step 6

Create a MealBuilder class, the actual builder class responsible to create Meal objects.

*MealBuilder.java*

public class MealBuilder {

public Meal prepareVegMeal (){

Meal meal = new Meal();

meal.addItem(new VegBurger());

meal.addItem(new Coke());

return meal;

}

public Meal prepareNonVegMeal (){

Meal meal = new Meal();

meal.addItem(new ChickenBurger());

meal.addItem(new Pepsi());

return meal;

}

}

## Step 7

BuiderPatternDemo uses MealBuider to demonstrate builder pattern.

*BuilderPatternDemo.java*

public class BuilderPatternDemo {

public static void main(String[] args) {

MealBuilder mealBuilder = new MealBuilder();

Meal vegMeal = mealBuilder.prepareVegMeal();

System.out.println("Veg Meal");

vegMeal.showItems();

System.out.println("Total Cost: " + vegMeal.getCost());

Meal nonVegMeal = mealBuilder.prepareNonVegMeal();

System.out.println("\n\nNon-Veg Meal");

nonVegMeal.showItems();

System.out.println("Total Cost: " + nonVegMeal.getCost());

}

}

5) **Prototype Pattern**

Prototype pattern refers to creating duplicate object while keeping performance in mind. This type of design pattern comes under creational pattern as this pattern provides one of the best ways to create an object.

This pattern involves implementing a prototype interface which tells to create a clone of the current object. This pattern is used when creation of object directly is costly. For example, an object is to be created after a costly database operation. We can cache the object, returns its clone on next request and update the database as and when needed thus reducing database calls.

**Structural patterns**

1. **Adapter Pattern**

Adapter pattern works as a bridge between two incompatible interfaces. This type of design pattern comes under structural pattern as this pattern combines the capability of two independent interfaces.

This pattern involves a single class which is responsible to join functionalities of independent or incompatible interfaces. A real life example could be a case of card reader which acts as an adapter between memory card and a laptop. You plugin the memory card into card reader and card reader into the laptop so that memory card can be read via laptop.

2) **Bridge Pattern**

Bridge is used when we need to decouple an abstraction from its implementation so that the two can vary independently. This type of design pattern comes under structural pattern as this pattern decouples implementation class and abstract class by providing a bridge structure between them.

This pattern involves an interface which acts as a bridge which makes the functionality of concrete classes independent from interface implementer classes. Both types of classes can be altered structurally without affecting each other.

**Behavioural patterns**

1. **Chain of Responsibility Pattern**

As the name suggests, the chain of responsibility pattern creates a chain of receiver objects for a request. This pattern decouples sender and receiver of a request based on type of request. This pattern comes under behavioral patterns.

In this pattern, normally each receiver contains reference to another receiver. If one object cannot handle the request then it passes the same to the next receiver and so on.

1. **Command Pattern**

Command pattern is a data driven design pattern and falls under behavioral pattern category. A request is wrapped under an object as command and passed to invoker object. Invoker object looks for the appropriate object which can handle this command and passes the command to the corresponding object which executes the command.

**J2EE patterns**

1. **Business Delegate Pattern**

Business Delegate Pattern is used to decouple presentation tier and business tier. It is basically use to reduce communication or remote lookup functionality to business tier code in presentation tier code. In business tier we have following entities.

* **Client** - Presentation tier code may be JSP, servlet or UI java code.
* **Business Delegate** - A single entry point class for client entities to provide access to Business Service methods.
* **LookUp Service** - Lookup service object is responsible to get relative business implementation and provide business object access to business delegate object.
* **Business Service** - Business Service interface. Concrete classes implement this business service to provide actual business implementation logic.

1. **Composite Entity Pattern**

Composite Entity pattern is used in EJB persistence mechanism. A Composite entity is an EJB entity bean which represents a graph of objects. When a composite entity is updated, internally dependent objects beans get updated automatically as being managed by EJB entity bean. Following are the participants in Composite Entity Bean.

* **Composite Entity** - It is primary entity bean. It can be coarse grained or can contain a coarse grained object to be used for persistence purpose.
* **Coarse-Grained Object** - This object contains dependent objects. It has its own life cycle and also manages life cycle of dependent objects.
* **Dependent Object** - Dependent object is an object which depends on coarse grained object for its persistence lifecycle.
* **Strategies** - Strategies represents how to implement a Composite Entity.

1. **Data Access Object Pattern**

Data Access Object Pattern or DAO pattern is used to separate low level data accessing API or operations from high level business services. Following are the participants in Data Access Object Pattern.

* **Data Access Object Interface** - This interface defines the standard operations to be performed on a model object(s).
* **Data Access Object concrete class** - This class implements above interface. This class is responsible to get data from a data source which can be database / xml or any other storage mechanism.
* **Model Object or Value Object** - This object is simple POJO containing get/set methods to store data retrieved using DAO class.