ΠΡΟΣΧΕΔΙΑΣΜΕΝΟΣ & ΕΥΕΛΙΚΤΟΣ ΠΡΟΓΡΑΜΜΑΤΙΣΜΟΣ

PLAN-DRIVEN & AGILE PROGRAMMING

Prerequisite & Desirable Courses

- *Procedural Programming (C),*
- *Principles of Software Engineering*
- *Data Bases,*
- *HCI*

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DESIGN PATTERNS

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Part of the lecture material comes from the following sources:

- http://ieeexplore.ieee.org/document/660196/
- http://www.uml.org.cn/c++/pdf/DesignPatterns.pdf
- http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=1402019
- https://www.tutorialspoint.com/design_pattern/index.htm
- https://en.wikipedia.org/wiki/Design_Patterns
- http://home.earthlink.net/~huston2/dp/
- http://www.dofactory.com/
- http://hillside.net/patterns/

DESIGN PATTERNS

INTRODUCTION

DESIGN PATTERNS

HISTORY

- *A Pattern Language: Towns, Buildings, Construction,* Christopher Alexander, 1977
- *The Timeless Way of Building,* Christopher Alexander, 1979
- *Using Pattern Languages for Object-Oriented Programs* (a paper at the OOPSLA-87 conference), Ward Cunningham and Kent Beck, 1987
- *Design Patterns,* Erich Gamma, Richard Helm, John Vlissides, and Ralph Johnson (known as the "Gang of Four", or GoF), 1994
- *Refactoring: Improving the Design of Existing Code,* Martin Fowler, 2000

DESIGN PATTERNS

KEYWORDS

- Design Patterns describe the higher-level organization of solutions to common problems
- UML is a diagramming language designed for Object-Oriented programming
  - Design Patterns are always described in UML notation
- Refactoring is restructuring code in a series of small, semantics-preserving transformations (i.e. the code keeps working) in order to make the code easier to maintain and modify
  - Refactoring often modifies or introduces Design Patterns
- Extreme Programming is a form of Agile Programming that emphasizes refactoring
- Unit testing is testing classes in isolation
  - Unit testing is an essential component of Extreme Programming
  - Unit testing is supported by JUnit

DESIGN PATTERNS

DEFINITION

- Design Patterns describe the higher-level organization of solutions to common problems
  - Design Patterns are a current hot topic in O-O design
  - UML is always used for describing Design Patterns
  - Design Patterns are used to describe refactorings
- Design Patterns represent the best practices used by experienced object-oriented software developers.
- Design Patterns are solutions to general problems that software developers faced during software development.
- These solutions were obtained by trial and error by numerous software developers over quite a substantial period of time.

DESIGN PATTERNS

ELEMENTS

- Design patterns have 4 essential elements:
  - **Pattern name**: increases vocabulary of designers
  - **Problem**: intent, context, when to apply
  - **Solution**: UML-like structure, abstract code
  - **Consequences**: results and tradeoffs

DESIGN PATTERNS

ARE NOT

- Data structures that can be encoded in classes and reused *as is* (i.e., linked lists, hash tables)
- Complex domain-specific designs (for an entire application or subsystem)
- If they are not familiar data structures or complex domain-specific subsystems, *what are they*?

- **<u>They are:</u>**
  - "Descriptions of communicating objects and classes that are customized to solve a general design problem in a particular context."

DESIGN PATTERNS

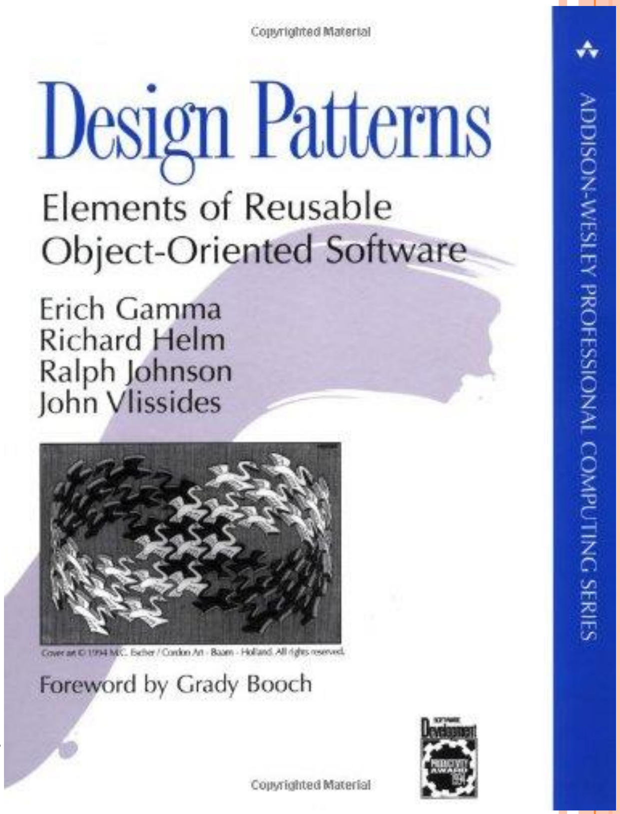
GANG OF FOUR (GOF)

In 1994, four authors Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides published a book titled **Design Patterns - Elements of Reusable Object-Oriented Software** which initiated the concept of Design Pattern in Software development.

These authors are collectively known as **Gang of Four (GOF)**.

According to these authors design patterns are primarily based on the following principles of object orientated design.

- Program to an interface not an implementation
- Favor object composition over inheritance



DESIGN PATTERNS

USAGE

Two main usages in software development.

- Common platform for developers

  Design patterns provide a standard terminology and are specific to particular scenario. For example, a singleton design pattern signifies use of single object so all developers familiar with single design pattern will make use of single object and they can tell each other that program is following a singleton pattern.

- Best Practices

  Design patterns have been evolved over a long period of time and they provide best solutions to certain problems faced during software development. Learning these patterns helps unexperienced developers to learn software design in an easy and faster way.

DESIGN PATTERNS

TYPES

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.

DESIGN PATTERNS

TYPES

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.

DESIGN PATTERNS

THE 23 PATTERNS BY *TYPE*

THE 23 GANG OF FOUR DESIGN PATTERNS

C	Abstract Factory	S	Facade	S	Proxy
S	Adapter	C	Factory Method	B	Observer
S	Bridge	S	Flyweight	C	Singleton
C	Builder	B	Interpreter	B	State
B	Chain of Responsibility	B	Iterator	B	Strategy
B	Command	B	Mediator	B	Template Method
S	Composite	B	Memento	B	Visitor
S	Decorator	C	Prototype		

DESIGN PATTERNS
THE 23 PATTERNS BY *TYPE*

Creational

- **Abstract factory pattern** groups object factories that have a common theme.
- **Builder pattern** constructs complex objects by separating construction and representation.
- **Factory method pattern** creates objects without specifying the exact class to create.
- **Prototype pattern** creates objects by cloning an existing object.
- **Singleton pattern** restricts object creation for a class to only one instance.

DESIGN PATTERNS

THE 23 *TYPES*

Structural

- **Adapter** allows classes with incompatible interfaces to work together by wrapping its own interface around that of an already existing class.
- **Bridge** decouples an abstraction from its implementation so that the two can vary independently.
- **Composite** composes zero-or-more similar objects so that they can be manipulated as one object.
- **Decorator** dynamically adds/overrides behaviour in an existing method of an object.
- **Facade** provides a simplified interface to a large body of code.
- **Flyweight** reduces the cost of creating and manipulating a large number of similar objects.
- **Proxy** provides a placeholder for another object to control access, reduce cost, and reduce complexity.

DESIGN PATTERNS

THE 23 *TYPES*

Behavioral

- **Chain of responsibility** delegates commands to a chain of processing objects.
- **Command** creates objects which encapsulate actions and parameters.
- **Interpreter** implements a specialized language.
- **Iterator** accesses the elements of an object sequentially without exposing its underlying representation.
- **Mediator** allows loose coupling between classes by being the only class that has detailed knowledge of their methods.
- **Memento** provides the ability to restore an object to its previous state (undo).
- **Observer** is a publish/subscribe pattern which allows a number of observer objects to see an event.
- **State** allows an object to alter its behavior when its internal state changes.
- **Strategy** allows one of a family of algorithms to be selected on-the-fly at runtime.
- **Template method** defines the skeleton of an algorithm as an abstract class, allowing its subclasses to provide concrete behavior.
- **Visitor** separates an algorithm from an object structure by moving the hierarchy of methods into one object.

DESIGN PATTERNS
MORE SOFTWARE PATTERNS

- Language idioms (low level, C++): Jim Coplein, Scott Meyers
  - I.e., when should you define a virtual destructor?
- Architectural (systems design): layers, reflection, broker
  - Reflection makes classes self-aware, their structure and behavior accessible for adaptation and change:
    Meta-level provides self-representation, base level defines the application logic
- *Java Enterprise Design Patterns* (distributed transactions and databases)
  - E.g., ACID Transaction: *A*tomicity (restoring an object after a failed transaction), *C*onsistency, *I*solation, and *D*urability
- **Analysis patterns** (recurring & reusable analysis models, from various domains, i.e., accounting, financial trading, health)
- **Process patterns** (software process & organization)

DESIGN PATTERNS

Refactoring and more

Based on David's L. Matuszek notes

DESIGN PATTERNS

REFACTORING

- Refactoring is:
  - restructuring (rearranging) code...
  - ...in a series of small, semantics-preserving transformations (i.e. the code keeps working)...
  - ...in order to make the code easier to maintain and modify
- Refactoring is *not* just any old restructuring
  - You need to keep the code working
  - You need small steps that preserve semantics
  - You need to have unit tests to prove the code works
- There are numerous well-known refactoring techniques
  - You should be at least somewhat familiar with these before inventing your own

DESIGN PATTERNS

When to refactor

- You should refactor:
  - Any time that you see a better way to do things
    - "Better" means making the code easier to understand and to modify in the future
  - You can do so without breaking the code
    - Unit tests are essential for this
- You should *not* refactor:
  - Stable code (code that won't ever need to change)
  - Someone else's code
    - Unless you've inherited it (and now it's yours)

DESIGN PATTERNS

DESIGN VS. CODING

- "Design" is the process of determining, in detail, what the finished product will be and how it will be put together
- "Coding" is following the plan
- In traditional engineering (building bridges), design is perhaps 15% of the total effort
- In software engineering, design is 85-90% of the total effort
  - By comparison, coding is cheap

DESIGN PATTERNS
THE REFACTORING ENVIRONMENT

- Traditional software engineering is modeled after traditional engineering practices (= design first, then code)
- Assumptions:
  - The desired end product can be determined in advance
  - Workers of a given type (plumbers, electricians, etc.) are interchangeable
- "Agile" software engineering is based on different assumptions:
  - Requirements (and therefore design) change as users become acquainted with the software
  - Programmers are professionals with varying skills and knowledge
  - Programmers are in the best position for making design decisions
- Refactoring is fundamental to agile programming
  - Refactoring is sometimes necessary in a traditional process, when the design is found to be flawed

DESIGN PATTERNS
DAVID'S L. MATUSZEK VIEW

- Design, because it is a lot more creative than simple coding, is also a lot more fun
  - Admittedly, "more fun" is not necessarily "better"
  - ...but it does help you retain good programmers
- Most small to medium-sized projects could benefit from an agile programming approach
  - We don't yet know about large projects
- Most programming methodologies attempt to turn everyone into a mediocre programmer
  - Sadly, this is probably an improvement in general
  - These methodologies work less well when you have some very good programmers

DESIGN PATTERNS

SWITCH STATEMENTS

- switch statements are very rare in properly designed object-oriented code
  - Therefore, a switch statement is a simple and easily detected "bad smell"
  - Of course, not all uses of switch are bad
  - A switch statement should *not* be used to distinguish between various kinds of object
- There are several well-defined refactorings for this case
  - The simplest is the creation of subclasses

DESIGN PATTERNS

SWITCH STATEMENTS

```
class Animal {
   final int MAMMAL = 0, BIRD = 1, REPTILE = 2;
   int myKind;  // set in constructor
   ...
   String getSkin() {
      switch (myKind) {
         case MAMMAL: return "hair";
         case BIRD: return "feathers";
         case REPTILE: return "scales";
         default: return "integument";
      }
   }
}
```

DESIGN PATTERNS

SWITCH STATEMENTS IMPROVED


```
class Animal {
    String getSkin() { return "integument"; }
}
class Mammal extends Animal {
    String getSkin() { return "hair"; }
}
class Bird extends Animal {
    String getSkin() { return "feathers"; }
}
class Reptile extends Animal {
    String getSkin() { return "scales"; }
}
```

DESIGN PATTERNS

SWITCH STATEMENTS IMPROVED, HOW?

- Adding a new animal type, such as Amphibian, does not require revising and recompiling existing code
- Mammals, birds, and reptiles are likely to differ in other ways, and we've already separated them out (so we won't need more switch statements)
- We've gotten rid of the flags we needed to tell one kind of animal from another
- Basically, we're now using Objects the way they were meant to be used

DESIGN PATTERNS

BAD SMELL EXAMPLES

- We should refactor any time we detect a "bad smell" in the code
- Examples of bad smells include:
  - Duplicate Code
  - Long Methods
  - Large Classes
  - Long Parameter Lists
  - Multi location code changes
  - Feature Envy
  - Data Clumps
  - Primitive Obsession

Some Design Patterns

DESIGN PATTERNS

UNCERTAIN DELEGATION

- Much of the point of polymorphism is that you can just send a message to an object, and the object does the right thing, depending on its type
- However, if the object might be null, you have to be careful not to send it any message
  - `if (myObject != null) myObject.doSomething();`
- Examples:
  - You have an Ocean, represented by a sparse array containing a few Fish
  - You have a TrafficGrid, some of which contains Cars and Trucks
  - You want to send output to somewhere, possibly to /dev/null
- If you do a lot with this object, you code can end up cluttered with tests for null

DESIGN PATTERNS

Solution: Null Object

- Create another kind of object, a "null object," representing the *absence* of any other kind of object
  - Example: An Ocean might contain Inhabitants, where Inhabitant is subclassed by BigFish, LittleFish, Algae, and NothingButWater
  - This way, no location in the Ocean is null
  - If Inhabitant contains a method reproduce(), the subclass NothingButWater could implement this method with an empty method body
  - If appropriate, some methods of the null object could throw an Exception
- Ideally, the superclass (Inhabitant, in this example) should be abstract

DESIGN PATTERNS
Refactoring: Introduce Null Object

- The general idea is simple: Instead of having some variables (locations in the array) be null, have them be "null objects"
- However, this requires numerous changes in the code
- It's *hazardous* to change working code—you introduce bugs that it can take days to find
- Refactoring is all about:
  - doing an operation like this in *small steps,*
  - having an *automated* set of unit tests, and
  - running unit tests *frequently*, so that if an error occurs you can pinpoint it immediately
- This approach makes refactoring much safer and protects against hard-to-find bugs
  - As a result, programmers are far more willing to refactor

DESIGN PATTERNS

INTRODUCE NULL OBJECT: IN DETAIL, I

1. Create a subclass of the source class to act as a null version of the class. Create an isNull operation on the source class and the null class. For the source class it should return false, for the null class it should return true.
   - You may find it useful to create an explicitly nullable interface for the isNull method.
   - As an alternative you can use a testing interface to test for nullness
2. Compile.
3. Find all places that can give out a null when asked for a source object. Replace them to give out a null object instead.

Design Patterns

Introduce Null Object: In detail, II

4. Find all places that compare a variable of the source type with null and replace them with a call to isNull.
   - You may be able to do this by replacing one source and its clients at a time and compiling and testing between working on sources.
   - A few assertions that check for null in places where you should no longer see it can be useful.
5. Compile and test.
6. Look for cases in which clients invoke an operation if not null and do some alternative behavior if null.
7. For each of these cases override the operation in the null class with the alternative behavior.
8. Remove the condition check for those that use the overridden behavior, compile, and test.

DESIGN PATTERNS

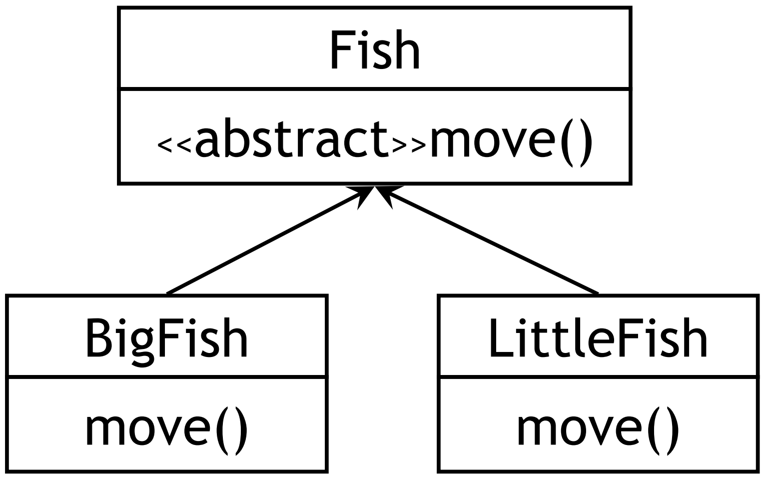
REFACTORING DETAILS

- The details of *Introduce Null Object* were copied directly from Fowler, pages 261-262
- I am *not* going into this much detail in any of the remaining examples
- Notice, however, that with this list of “baby steps” in front of you, you can do the refactoring a little at a time, with well-marked places to do testing, so that it’s very easy to catch and correct errors
- Note also that to do this, you need a good set of *totally automated tests*—otherwise the testing you have to do is just too much work, and you won’t do it
  - Unless, that is, you have a superhuman amount of discipline

DESIGN PATTERNS

SCENARIO: BIG FISH AND LITTLE FISH

- The scenario: "big fish" and "little fish" move around in an "ocean"
  - Fish move about randomly
  - A big fish can move to where a little fish is (and eat it)
  - A little fish will *not* move to where a big



DESIGN PATTERNS
PROBLEM: SIMILAR METHODS IN SUBCLASSES

- Here we have a Fish class with two subclasses, BigFish and LittleFish
  - The two kinds move the same way
  - To avoid code duplication, the move method ought to be in the superclass Fish
  - However, a LittleFish won't move to some locations where a BigFish will move
  - The test for whether it is OK to move really ought to be in the move method
- More generally, you want to have *almost* the same method in two or more sibling classes

DESIGN PATTERNS
SOLUTION: TEMPLATE METHOD

- Note: The Design Pattern is called "Template Method"; the refactoring is called "Form Template Method"
  - We won't bother making this distinction in the remainder of the lecture
- In the superclass, write the common method, but call an auxiliary method (such as okToMove) to perform the part of the logic that needs to differ
- Write the auxiliary method as an abstract method
  - This in turn requires that the superclass be abstract
- In each subclass, implement the auxiliary method according to the needs of that subclass
- When a subclass instance executes the common method, it will use its own auxiliary method as needed

DESIGN PATTERNS

THE MOVE() METHOD

- General outline of the method:
  - public void move() {

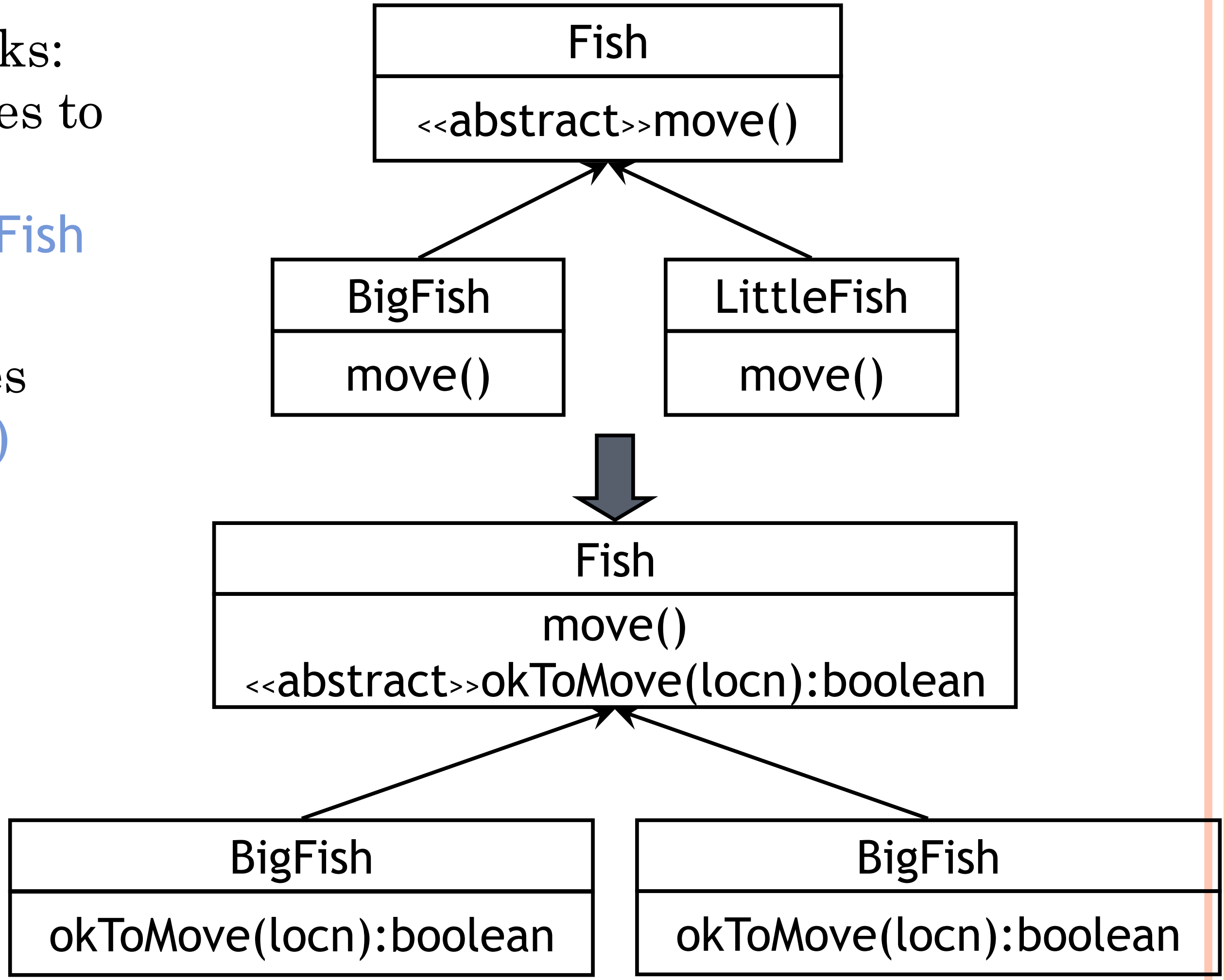
    choose a random direction; // same for both
    find the location in that direction; // same for both
    check if it's ok to move there; // different
    if it's ok, make the move; // same for both

    }
- To refactor:
  - Extract the check on whether it's ok to move
  - In the Fish class, put the actual (template) move() method
  - Create an abstract okToMove() method in the Fish class
  - Implement okToMove() in each subclass

DESIGN PATTERNS

THE FISH REFACTORING

- Note how this works: When a BigFish tries to move, it uses the move() method in Fish
- But the move() method in Fish uses the okToMove(locn) method in BigFish
- And similarly for LittleFish



DESIGN PATTERNS

PROBLEM: CONSTRUCTORS CREATE OBJECTS

- Constructors make objects. *Only* constructors can make objects. When you call a constructor of a class, you *will* get an instance of that class.
- Sometimes you want more flexibility than that—
  - You may want to guarantee that you can never have more than one object of a given class
  - You may want to create an object only if you don't already have an equivalent object
  - You may want to create an object without being sure exactly what *kind* of object you want
- The key insight is that, although only constructors make objects, you don't have to call constructors *directly*—you can call a *method* that calls the constructor for you
  - Several "creational" Design Patterns are based on this observation

DESIGN PATTERNS

SINGLETON

- A Singleton is a class that can have only one instance
  - You may want just one instance of a null object, which you use in many places
  - You may want to create just one AudioStream, so you can only play one tune at a time
- ```
  class Singleton {
      private static Singleton instance = new Singleton();
      // don't let Java give you a default public constructor
      private Singleton() { }

      Singleton getInstance() {
          return instance;
      }
      ...
  }
  ```
  ```

DESIGN PATTERNS

DETAILED DESCRPTION OF THE 23 PATTERNS OF THE FOUR GANG

and more

Creational Design Patterns

Factory Pattern

Creational: Factory Pattern

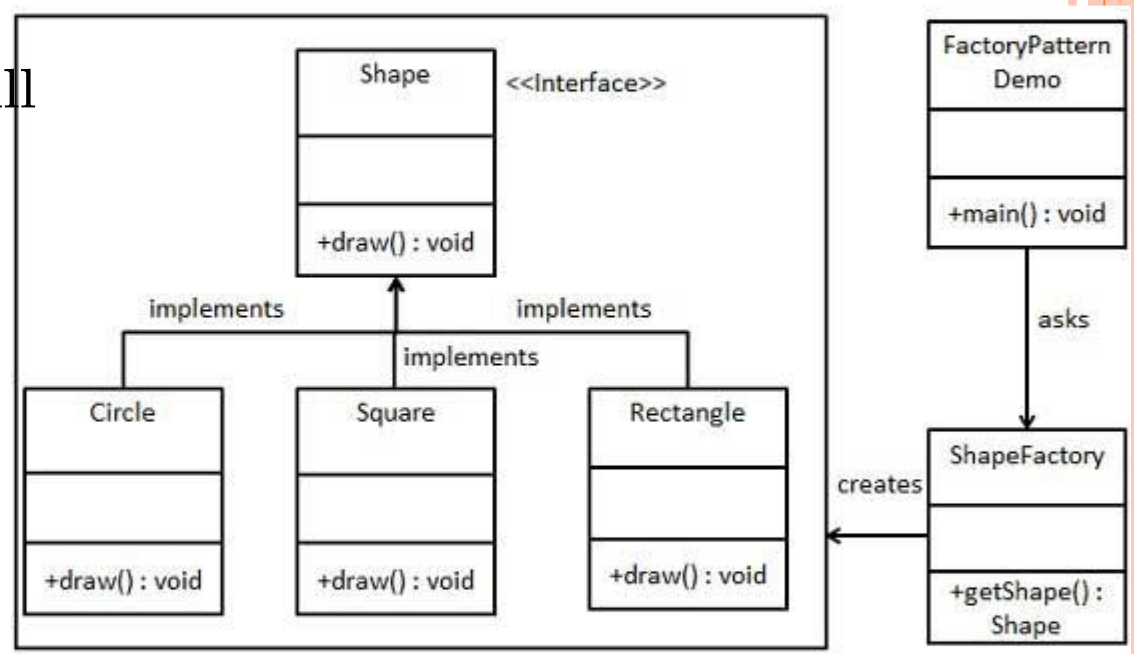
Definition

- Factory pattern is one of the most used 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.
- In Factory pattern, we create object without exposing the creation logic to the client and refer to newly created object using a common interface.

CREATIONAL: FACTORY PATTERN

IMPLEMENTATION

- Create a *Shape* interface and concrete classes implementing the *Shape* interface.
- A factory class *ShapeFactory* is defined as a next step.
- *FactoryPatternDemo*, 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.



CREATIONAL: FACTORY PATTERN

IMPLEMENTATION

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.");
   }
}
```

Step 2: Create concrete classes implementing the same interface.

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.");
   }
}
```

CREATIONAL: FACTORY PATTERN

IMPLEMENTATION

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;
   }
}
```

CREATIONAL: FACTORY PATTERN

IMPLEMENTATION

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: Output

```
Inside Circle::draw() method.
Inside Rectangle::draw() method.
Inside Square::draw() method.
```

Creational Design Patterns

Abstract Factory Pattern

Creational: Abstract Factory Pattern

definition

- Abstract Factory patterns works 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.}

Creational: Abstract Factory Pattern

implementation

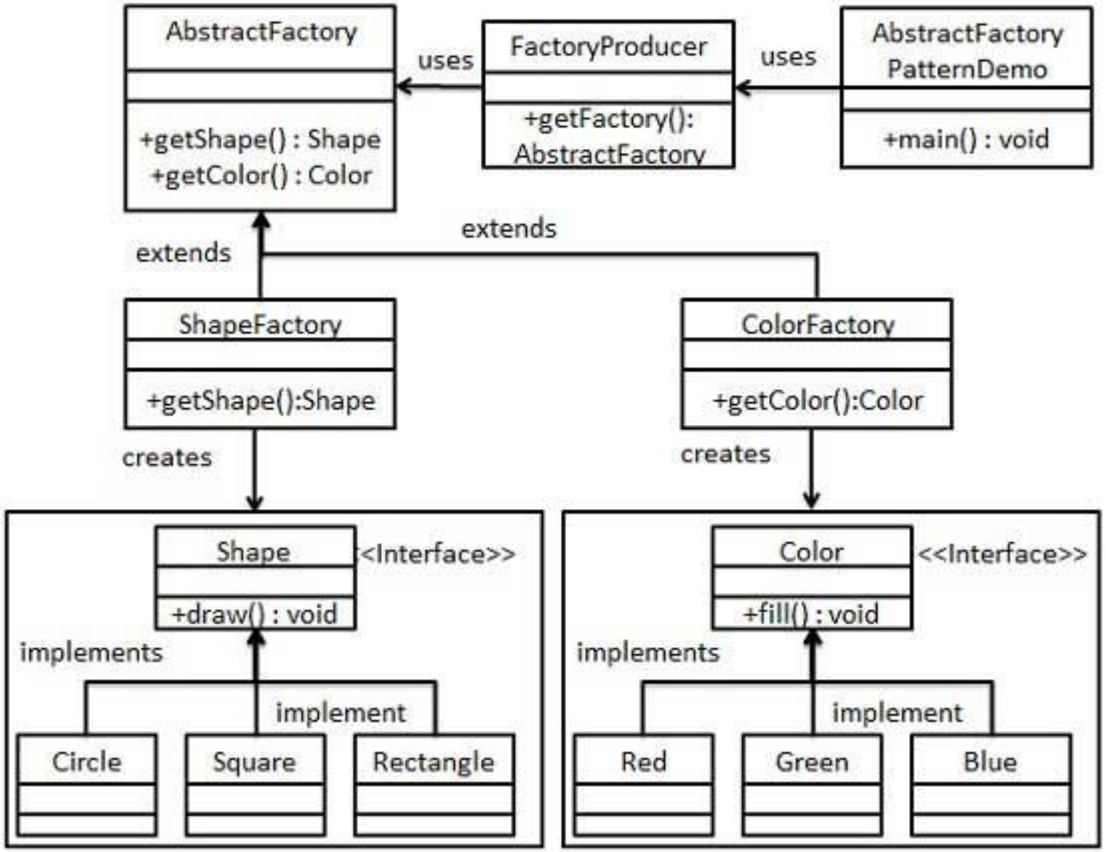
We're going to create a Shape and Color interfaces and concrete classes implementing these interfaces. We create an abstract factory class AbstractFactory as next step.

Factory classes ShapeFactory and ColorFactory are defined where each factory extends AbstractFactory.

A factory creator/generator class FactoryProducer is created.

AbstractFactoryPatternDemo, uses FactoryProducer to get a AbstractFactory object.

It will pass information (CIRCLE / RECTANGLE / SQUAREfor Shape) to AbstractFactory to get the type of object it needs. It also passes information (RED / GREEN / BLUE for Color) to AbstractFactory to get the type of object it needs.



CREATIONAL: ABSTRACT FACTORY PATTERN

IMPLEMENTATION

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.");
   }
}
```

Step 2: Create concrete classes implementing the same interface.

Square.java

```
public class Square implements Shape {
    @Override
   public void draw() {
      System.out.println("Inside Square::draw() method.");
   }
}
public class Circle implements Shape {
    @Override
   public void draw() {
      System.out.println("Inside Circle::draw() method.");
   }
}
```

Creational: Abstract Factory Pattern Implementation

Step 3: Create an interface for Colors.

Color.java

```java
public interface Color {

   void fill();

}
```

Step 4: Create concrete classes implementing the same interface.

Red.java

```java
public interface Color {

   void fill();

}

public class Red implements Color {

    @Override

   public void fill() {

      System.out.println("Inside Red::fill() method.");

   }

}
```

Step 4: Create concrete classes implementing the same interface.

Green.java

```java
public class Green implements Color {

   @Override

   public void fill() {

      System.out.println("Inside Green::fill()
method.");

   }

}
```

Blue.java

```java
public class Blue implements Color {

   @Override

   public void fill() {

     System.out.println("Inside Blue::fill() method.");

   }

}
```

Creational: Abstract Factory Pattern

Implementation

Step 5: Create an Abstract class to get factories for Color and Shape Objects.

AbstractFactory.java

```
public abstract class AbstractFactory {
   abstract Color getColor(String color);
   abstract Shape getShape(String shape) ;
}
```

CREATIONAL: ABSTRACT FACTORY PATTERN

IMPLEMENTATION

Step 6: Create Factory classes extending AbstractFactory to generate object of concrete class based on given information.

ShapeFactory.java

```java
public class ShapeFactory extends AbstractFactory {

   @Override
   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;
   }

   @Override
   Color getColor(String color) {
      return null;
   }
}
```

ColorFactory.java

```java
public class ColorFactory extends AbstractFactory {

   @Override
   public Shape getShape(String shapeType){
      return null;
   }

   @Override
   Color getColor(String color) {
      if(color == null){
         return null;
      }
      if(color.equalsIgnoreCase("RED")){
         return new Red();
      } else if(color.equalsIgnoreCase("GREEN")){
         return new Green();
      } else if(color.equalsIgnoreCase("BLUE")){
         return new Blue();
      }
      return null;
   }
}
```

Creational: Abstract Factory Pattern

Implementation

Step 7: Create a Factory generator/producer class to get factories by passing an information such as Shape or Color.

FactoryProducer.java

```
public class FactoryProducer {
   public static AbstractFactory getFactory(String choice){
      if(choice.equalsIgnoreCase("SHAPE")){
         return new ShapeFactory();
      } else if(choice.equalsIgnoreCase("COLOR")){
         return new ColorFactory();
      }
      return null;
   }
}
```

Step 8: Use the FactoryProducer to get AbstractFactory in order to get factories of concrete classes by passing an information such as type.

AbstractFactoryPatternDemo.java

```
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();
   }
}
```

Step 9: Output

- Inside Circle::draw() method.
- Inside Rectangle::draw() method.
- Inside Square::draw() method.
- Inside Red::fill() method.
- Inside Green::fill() method.
- Inside Blue::fill() method.

Creational Design Patterns

Singleton Pattern

Creational: Singleton Pattern

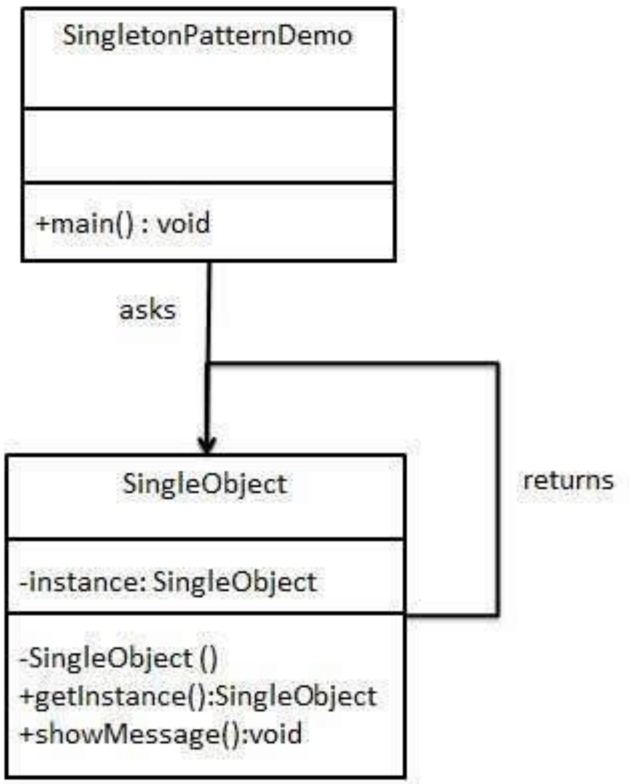
definition

- 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 way to create an object.
- This pattern involves a single class which is responsible to creates own object while making sure that only single object get 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.

CREATIONAL: SINGLETON PATTERN

IMPLEMENTATION

- We're going to create a *SingleObject* class. *SingleObject* class have its constructor as private and have a static instance of itself.
- *SingleObject* class provides a static method to get its static instance to outside world. *SingletonPatternDemo*, our demo class will use *SingleObject* class to get a *SingleObject* object.



Creational: Singleton Pattern

Implementation

Step 1: Create a Singleton Class.

SingleObject.java

```
public class SingleObject {

   //create an object of SingleObject
   private static SingleObject instance = new
SingleObject();

   //make the constructor private so that this
class cannot be
   //instantiated
   private SingleObject(){}

   //Get the only object available
   public static SingleObject getInstance(){
      return instance;
   }

   public void showMessage(){
      System.out.println("Hello World!");
   }
}
```

Step 2: Get the only object from the singleton class.

SingletonPatternDemo.java

```
public class SingletonPatternDemo {
   public static void main(String[] args) {

      //illegal construct
      //Compile Time Error: The constructor
SingleObject() is not visible
      //SingleObject object = new SingleObject();

      //Get the only object available
      SingleObject object =
SingleObject.getInstance();

      //show the message
      object.showMessage();
   }
}
```

Step 3: Verify the output.

```
Hello World!
```

Creational Design Patterns

Builder Pattern

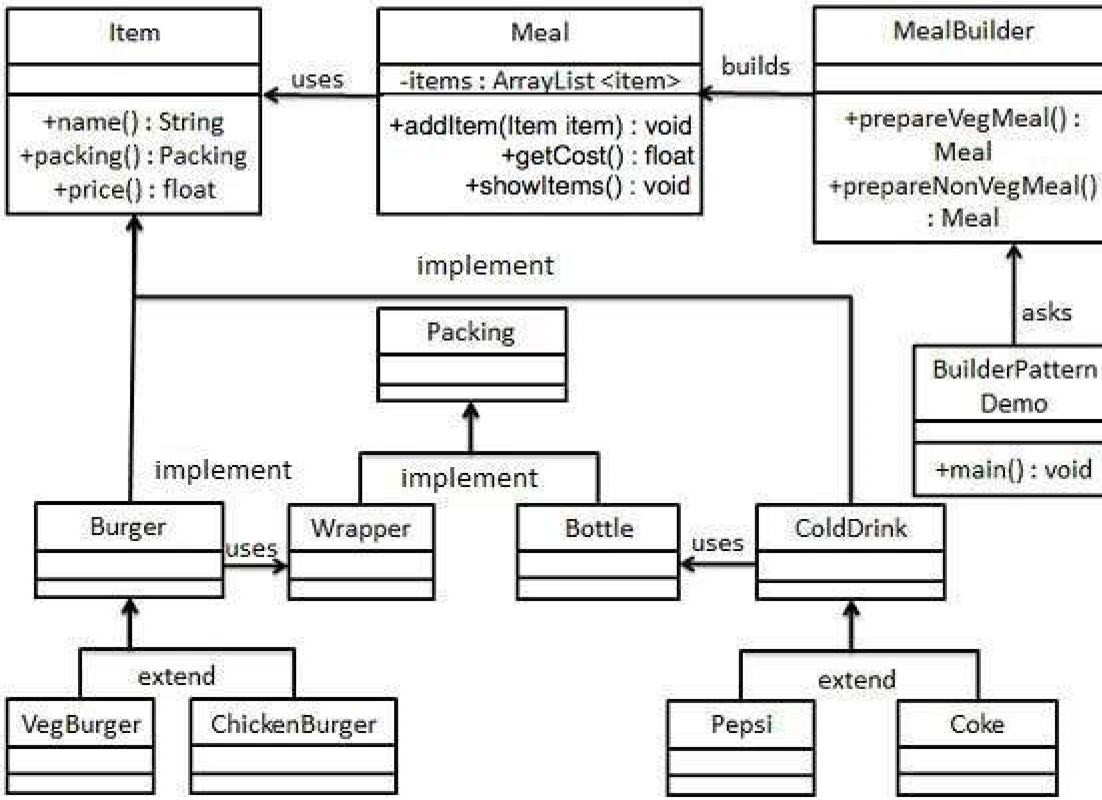
Creational: Builder Pattern

Definition

- 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.

CREATIONAL: SINGLETON PATTERN IMPLEMENTATION

- We've considered a business case of fast-food restaurant where a typical meal could be a burger and a cold drink. Burger could be either a Veg Burger or Chicken Burger and will be packed by a wrapper. Cold drink could be either a coke or pepsi and will be packed in a bottle.
- We're going to create an *Item* interface representing food items such as burgers and cold drinks and concrete classes implementing the *Item* interface and a *Packing* interface representing packaging of food items and concrete classes implementing the *Packing* interface as burger would be packed in wrapper and cold drink would be packed as bottle.
- We then create a *Meal* class having *ArrayList* of *Item* and a *MealBuilder* to build different types of *Meal* object by combining *Item*. *BuilderPatternDemo*, our demo class will use *MealBuilder* to build a *Meal*.



Creational: Singleton Pattern

Implementation

Step 1: Create an interface Item representing food item and packing.

Item.java

```
public interface Item {
   public String name();
   public Packing packing();
   public float price();
}
```

Packing.java

```
public interface Packing {
   public String pack();
}
```

Step 2: Create concreate classes implementing the Packing interface.

Wrapper.java

```
public class Wrapper implements Packing {

   @Override
   public String pack() {
      return "Wrapper";
   }
}
```

Bottle.java

```
public class Bottle implements Packing {

   @Override
   public String pack() {
      return "Bottle";
   }
}
```

Step 3: Create abstract classes implementing the item interface providing default functionalities.

Burger.java

```
public abstract class Burger implements Item {

   @Override
   public Packing packing() {
      return new Wrapper();
   }

   @Override
   public abstract float price();
}
```

ColdDrink.java

```
public abstract class ColdDrink implements Item {

         @Override
         public Packing packing() {
       return new Bottle();
         }

         @Override
         public abstract float price();
}
```

Creational: Singleton Pattern

Implementation

Step 4: Create concrete classes extending Burger and ColdDrink classes

VegBurger.java

```
public class VegBurger extends Burger {

   @Override
   public float price() {
      return 25.0f;
   }

   @Override
   public String name() {
      return "Veg Burger";
   }
}
```

ChickenBurger.java

```
public class ChickenBurger extends Burger {

   @Override
   public float price() {
      return 50.5f;
   }

   @Override
   public String name() {
      return "Chicken Burger";
   }
}
```

Coke.java

```
public class Coke extends ColdDrink {

   @Override
   public float price() {
      return 30.0f;
   }

   @Override
   public String name() {
      return "Coke";
   }
}
```

Pepsi.java

```
public class Pepsi extends ColdDrink {

   @Override
   public float price() {
      return 35.0f;
   }

   @Override
   public String name() {
      return "Pepsi";
   }
}
```

Creational: Singleton Pattern

Implementation

Step 5: 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());
   }
}
```

Creational: Singleton Pattern

Implementation

Step 8: Verify the output.

```
Veg Meal
Item : Veg Burger, Packing : Wrapper, Price : 25.0
Item : Coke, Packing : Bottle, Price : 30.0
Total Cost: 55.0

Non-Veg Meal
Item : Chicken Burger, Packing : Wrapper, Price : 50.5
Item : Pepsi, Packing : Bottle, Price : 35.0
Total Cost: 85.5
```

Creational Design Patterns

Prototype Pattern

Creational: Prototype Pattern

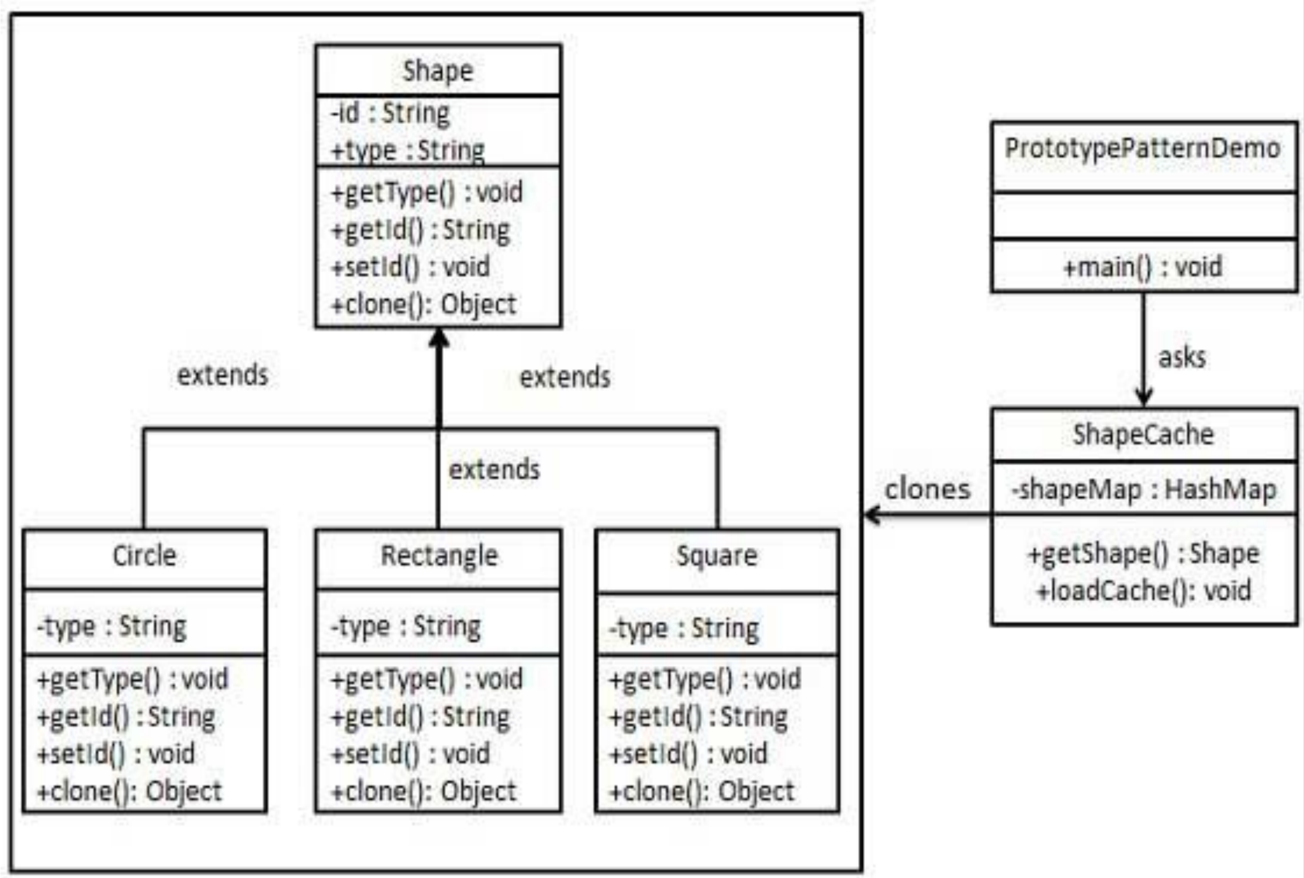
Definition

- 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 way 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, a 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.

Creational: Prototype Pattern

implementation

- We're going to create an abstract class *Shape* and concrete classes extending the *Shape* class. A class *ShapeCache* is defined as a next step which stores shape objects in a *Hashtable* and returns their clone when requested.
- *PrototypPatternDemo*, our demo class will use *ShapeCache* class to get a *Shape*object.



Creational: Prototype Pattern

Implementation

Step 1: Create an abstract class implementing *Clonable* interface.

Shape.java

```
public abstract class Shape implements Cloneable {

   private String id;
   protected String type;

   abstract void draw();

   public String getType(){
      return type;
   }

   public String getId() {
      return id;
   }

   public void setId(String id) {
      this.id = id;
   }

   public Object clone() {
      Object clone = null;
      try {
         clone = super.clone();
      } catch (CloneNotSupportedException e) {
         e.printStackTrace();
      }
      return clone;
   }
}
```

Step 2: Create concrete classes extending the above class.

Rectangle.java

```
public class Rectangle extends Shape {

   public Rectangle(){
     type = "Rectangle";
   }

   @Override
   public void draw() {
      System.out.println("Inside Rectangle::draw() method.");
   }
}
```

Square.java

```
public class Square extends Shape {

   public Square(){
     type = "Square";
   }

   @Override
   public void draw() {
      System.out.println("Inside Square::draw() method.");
   }
}
```

Circle.java

```
public class Circle extends Shape {

   public Circle(){
     type = "Circle";
   }

   @Override
   public void draw() {
      System.out.println("Inside Circle::draw() method.");
   }
}
```

Creational: Prototype Pattern

Implementation

Step 3: Create a class to get concreate classes from database and store them in a *Hashtable*.

ShapeCache.java

```
import java.util.Hashtable;

public class ShapeCache {

   private static Hashtable<String, Shape> shapeMap
      = new Hashtable<String, Shape>();

   public static Shape getShape(String shapeId) {
      Shape cachedShape = shapeMap.get(shapeId);
      return (Shape) cachedShape.clone();
   }

   // for each shape run database query and create shape
   // shapeMap.put(shapeKey, shape);
   // for example, we are adding three shapes
   public static void loadCache() {
      Circle circle = new Circle();
      circle.setId("1");
      shapeMap.put(circle.getId(),circle);

      Square square = new Square();
      square.setId("2");
      shapeMap.put(square.getId(),square);

      Rectangle rectangle = new Rectangle();
      rectangle.setId("3");
      shapeMap.put(rectangle.getId(),rectangle);
   }
}
```

Step 4: *PrototypePatternDemo* uses *ShapeCache* class to get clones of shapes stored in a *Hashtable*.

PrototypePatternDemo.java

```
public class PrototypePatternDemo {
   public static void main(String[] args) {
      ShapeCache.loadCache();

      Shape clonedShape = (Shape) ShapeCache.getShape("1");
      System.out.println("Shape : " + clonedShape.getType());

      Shape clonedShape2 = (Shape) ShapeCache.getShape("2");
      System.out.println("Shape : " + clonedShape2.getType());

      Shape clonedShape3 = (Shape) ShapeCache.getShape("3");
      System.out.println("Shape : " + clonedShape3.getType());
   }
}
```

Step 5 : Verify the output.

```
Shape : Circle
Shape : Square
Shape : Rectangle
```

STRUCTURAL DESIGN PATTERNS

ADAPTER PATTERN

STRUCTURAL: ADAPTER PATTERN

DEFINITION

- 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 plugins the memory card into card reader and card reader into the laptop so that memory card can be read via laptop.
- We are demonstrating use of Adapter pattern via following example in which an audio player device can play mp3 files only and wants to use an advanced audio player capable of playing vlc and mp4 files.

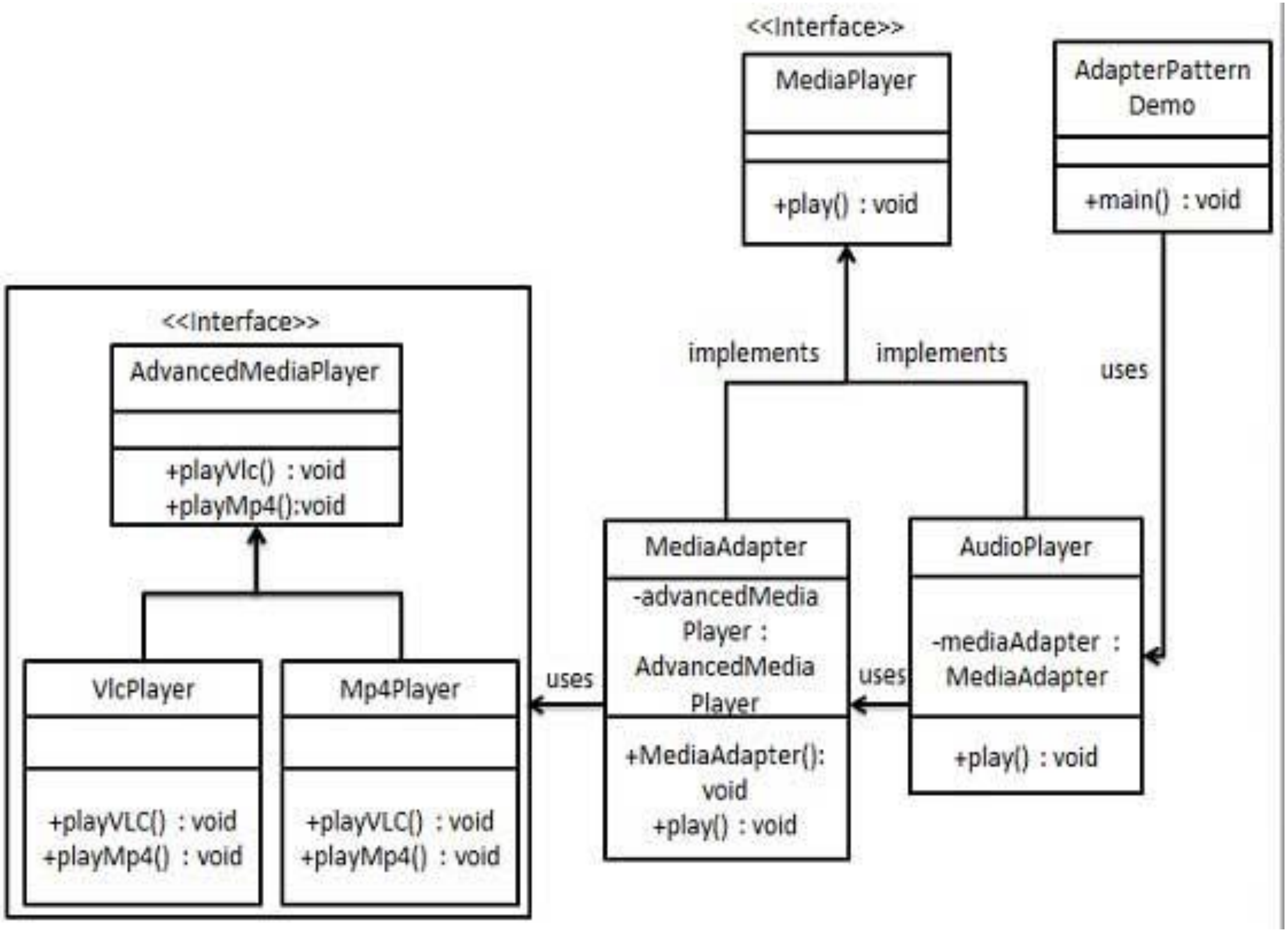
Structural: Adapter Pattern

Implementation

- We've an interface *MediaPlayer* interface and a concrete class *AudioPlayer*implementing the *MediaPlayer* interface. *AudioPlayer* can play mp3 format audio files by default.
- We're having another interface *AdvancedMediaPlayer* and concrete classes implementing the *AdvancedMediaPlayer* interface.These classes can play vlc and mp4 format files.
- We want to make *AudioPlayer* to play other formats as well. To attain this, we've created an adapter class *MediaAdapter* which implements the *MediaPlayer* interface and uses *AdvancedMediaPlayer* objects to play the required format.
- *AudioPlayer* uses the adapter class *MediaAdapter* passing it the desired audio type without knowing the actual class which can play the desired format. *AdapterPatternDemo*, our demo class will use *AudioPlayer* class to play various formats.

Structural: Adapter Pattern

Implementation



Structural : Adapter Pattern

Implementation

Step 1: Create interfaces for Media Player and Advanced Media Player.

MediaPlayer.java

```
public interface MediaPlayer {
   public void play(String audioType, String fileName);
}
```

AdvancedMediaPlayer.java

```
public interface AdvancedMediaPlayer {
   public void playVlc(String fileName);
   public void playMp4(String fileName);
}
```

Step 2: Create concrete classes implementing the *AdvancedMediaPlayer* interface.

VlcPlayer.java

```
public class VlcPlayer implements AdvancedMediaPlayer{
   @Override
   public void playVlc(String fileName) {
      System.out.println("Playing vlc file. Name: "+
fileName);
   }

   @Override
   public void playMp4(String fileName) {
      //do nothing
   }
}
```

Mp4Player.java

```
public class Mp4Player implements AdvancedMediaPlayer{

   @Override
   public void playVlc(String fileName) {
      //do nothing
   }

   @Override
   public void playMp4(String fileName) {
      System.out.println("Playing mp4 file. Name: "+
fileName);
   }
}
```

Step 3: Create adapter class implementing the *MediaPlayer* interface.

MediaAdapter.java

```
public class MediaAdapter implements MediaPlayer {

   AdvancedMediaPlayer advancedMusicPlayer;

   public MediaAdapter(String audioType){
      if(audioType.equalsIgnoreCase("vlc") ){
         advancedMusicPlayer = new VlcPlayer();
      } else if (audioType.equalsIgnoreCase("mp4")){
         advancedMusicPlayer = new Mp4Player();
      }
   }

   @Override
   public void play(String audioType, String fileName) {
      if(audioType.equalsIgnoreCase("vlc")){
         advancedMusicPlayer.playVlc(fileName);
      }else if(audioType.equalsIgnoreCase("mp4")){
         advancedMusicPlayer.playMp4(fileName);
      }
   }
}
```

Structural : Adapter Pattern

Implementation

Step 4: Create concrete class implementing the *MediaPlayer* interface.

AudioPlayer.java

```
public class AudioPlayer implements MediaPlayer {
   MediaAdapter mediaAdapter;

   @Override
   public void play(String audioType, String fileName) {

      //inbuilt support to play mp3 music files
      if(audioType.equalsIgnoreCase("mp3")){
         System.out.println("Playing mp3 file. Name: "+
fileName);
      }
      //mediaAdapter is providing support to play other file formats
      else if(audioType.equalsIgnoreCase("vlc")
         || audioType.equalsIgnoreCase("mp4")){
         mediaAdapter = new MediaAdapter(audioType);
         mediaAdapter.play(audioType, fileName);
      }
      else{
         System.out.println("Invalid media. "+
            audioType + " format not supported");
      }
   }
}
```

Step 5: Use the AudioPlayer to play different types of audio formats.

AdapterPatternDemo.java

```
public class AdapterPatternDemo {
   public static void main(String[] args) {
      AudioPlayer audioPlayer = new AudioPlayer();

      audioPlayer.play("mp3", "beyond the horizon.mp3");
      audioPlayer.play("mp4", "alone.mp4");
      audioPlayer.play("vlc", "far far away.vlc");
      audioPlayer.play("avi", "mind me.avi");
   }
}
```

Step 6: Verify the output.

```
Playing mp3 file. Name: beyond the horizon.mp3
Playing mp4 file. Name: alone.mp4
Playing vlc file. Name: far far away.vlc
Invalid media. avi format not supported
```

Structural Design Patterns

Bridge Pattern

STRUCTURAL: BRIDGE PATTERN

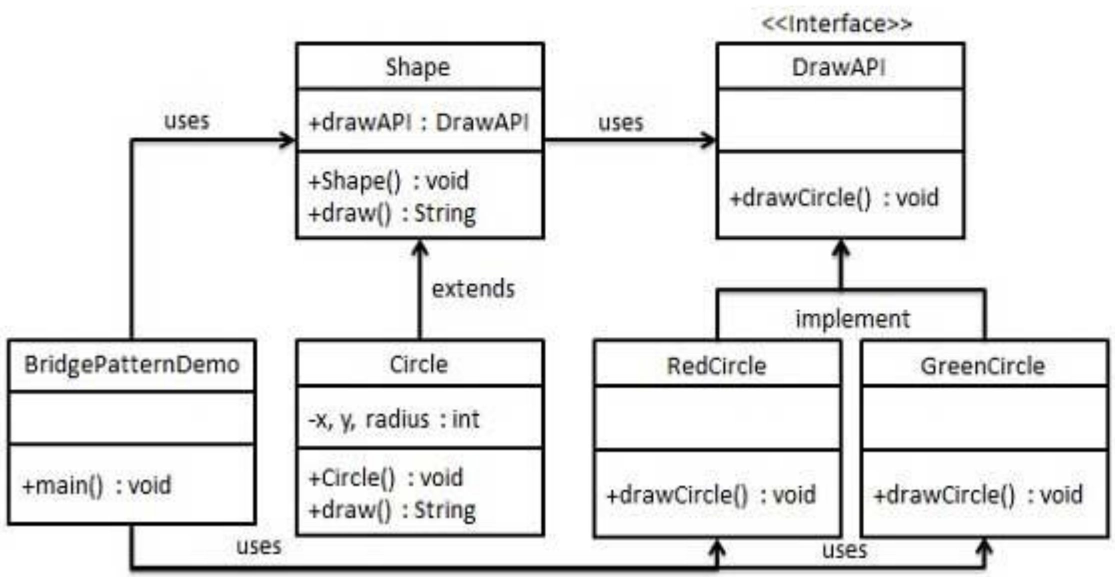
DEFINITION

- Bridge is used where 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.
- We are demonstrating use of Bridge pattern via following example in which a circle can be drawn in different colors using same abstract class method but different bridge implementer classes.

Structural : Bridge Pattern

Implementation

- We've an interface *DrawAPI* interface which is acting as a bridge implementer and concrete classes *RedCircle*, *GreenCircle* implementing the *DrawAPI*interface. *Shape* is an abstract class and will use object of *DrawAPI*. *BridgePatternDemo*, our demo class will use *Shape* class to draw different colored circle.



Structural : Bridge Pattern

Implementation

Step 1: Create bridge implementer interface.

DrawAPI.java

```
public interface DrawAPI {
   public void drawCircle(int radius, int x, int y);
}
```

Step 2: Create concrete bridge implementer classes implementing the *DrawAPI*interface.

RedCircle.java

```
public class RedCircle implements DrawAPI {
   @Override
   public void drawCircle(int radius, int x, int y) {
      System.out.println("Drawing Circle[ color: red, radius: "
         + radius +", x: " +x+", "+ y +"]");
   }
}
```

GreenCircle.java

```
public class GreenCircle implements DrawAPI {
   @Override
   public void drawCircle(int radius, int x, int y) {
      System.out.println("Drawing Circle[ color: green, radius: "
         + radius +", x: " +x+", "+ y +"]");
   }
}
```

Step 3 : Create an abstract class *Shape* using the *DrawAPI* interface.

Shape.java

```
public abstract class Shape {
   protected DrawAPI drawAPI;
   protected Shape(DrawAPI drawAPI){
      this.drawAPI = drawAPI;
   }
   public abstract void draw();
}
```

STRUCTURAL : BRIDGE PATTERN

IMPLEMENTATION

Step 3 : Create an abstract class *Shape* using the *DrawAPI* interface.

Shape.java

```
public abstract class Shape {
   protected DrawAPI drawAPI;
   protected Shape(DrawAPI drawAPI){
      this.drawAPI = drawAPI;
   }
   public abstract void draw();
}
```

Step 4: Create concrete class implementing the *Shape* interface.

Circle.java

```
public class Circle extends Shape {
   private int x, y, radius;

   public Circle(int x, int y, int radius, DrawAPI drawAPI) {
      super(drawAPI);
      this.x = x;
      this.y = y;
      this.radius = radius;
   }

   public void draw() {
      drawAPI.drawCircle(radius,x,y);
   }
}
```

Step 5 : Use the *Shape* and *DrawAPI* classes to draw different colored circles.

BridgePatternDemo.java

```
public class BridgePatternDemo {
   public static void main(String[] args) {
      Shape redCircle = new Circle(100,100, 10, new
RedCircle());
      Shape greenCircle = new Circle(100,100, 10, new
GreenCircle());

      redCircle.draw();
      greenCircle.draw();
   }
}
```

Step 6: Verify the output.

```
Drawing Circle[ color: red, radius: 10, x: 100, 100]
Drawing Circle[  color: green, radius: 10, x: 100, 100]
```

Structural Design Patterns

Filter/Criteria Pattern

STRUCTURAL: FILTER/CRITERIA PATTERN

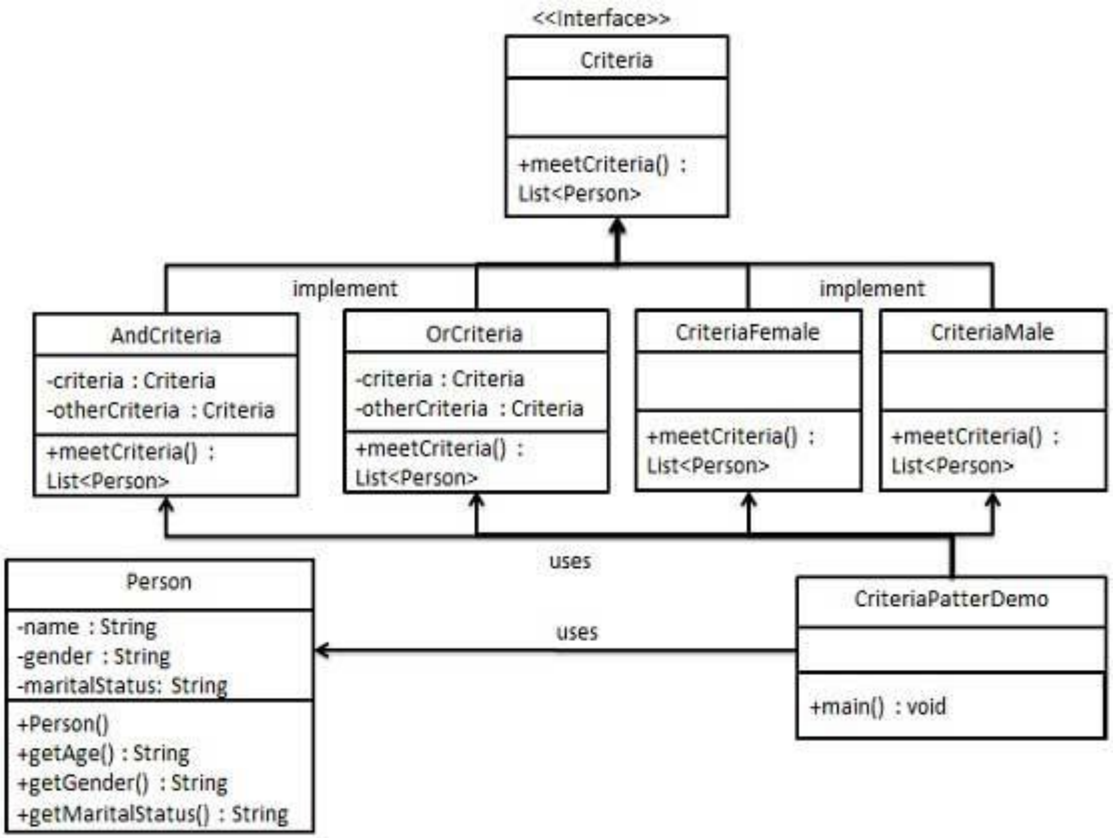
DEFINITION

- Filter pattern or Criteria pattern is a design pattern that enables developers to filter a set of objects, using different criteria, chaining them in a decoupled way through logical operations. This type of design pattern comes under structural pattern as this pattern is combining multiple criteria to obtain single criteria.

STRUCTURAL : FILTER/CRITERIA PATTERN

IMPLEMENTATION

- We're going to create a *Person* object, *Criteria* interface and concrete classes implementing this interface to filter list of *Person* objects. *CriteriaPatternDemo*, our demo class uses *Criteria* objects to filter List of *Person* objects based on various criteria and their combinations.



STRUCTURAL : FILTER/CRITERIA PATTERN IMPLEMENTATION

Step 1: Create a class on which criteria is to be applied.

Person.java

```
public class Person {

   private String name;
   private String gender;
   private String maritalStatus;

   public Person(String name,String gender,String
maritalStatus){
      this.name = name;
      this.gender = gender;
      this.maritalStatus = maritalStatus;
   }

   public String getName() {
      return name;
   }
   public String getGender() {
      return gender;
   }
   public String getMaritalStatus() {
      return maritalStatus;
   }
}
```

Step 2: Create an interface for Criteria.

Criteria.java

```
import java.util.List;

public interface Criteria {
   public List<Person> meetCriteria(List<Person> persons);
}
```

Step 3: Create concrete classes implementing the *Criteria* interface.

CriteriaMale.java

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

public class CriteriaMale implements Criteria {

   @Override
   public List<Person> meetCriteria(List<Person> persons) {
      List<Person> malePersons = new ArrayList<Person>();
      for (Person person : persons) {
         if(person.getGender().equalsIgnoreCase("MALE")){
            malePersons.add(person);
         }
      }
      return malePersons;
   }
}
Status : Married ]
```

CriteriaFemale.java

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

public class CriteriaFemale implements Criteria {

   @Override
   public List<Person> meetCriteria(List<Person> persons) {
      List<Person> femalePersons = new ArrayList<Person>();
      for (Person person : persons) {
         if(person.getGender().equalsIgnoreCase("FEMALE")){
            femalePersons.add(person);
         }
      }
      return femalePersons;
   }
}
```

Structural : Filter/Criteria Pattern

Implementation

CriteriaSingle.java

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

public class CriteriaSingle implements Criteria {
   @Override
   public List<Person> meetCriteria(List<Person> persons) {
      List<Person> singlePersons = new ArrayList<Person>();
      for (Person person : persons) {
if(person.getMaritalStatus().equalsIgnoreCase("SINGLE")){
            singlePersons.add(person);
         }
      }
      return singlePersons;
   }
}
```

AndCriteria.java

```
import java.util.List;

public class AndCriteria implements Criteria {

   private Criteria criteria;
   private Criteria otherCriteria;

   public AndCriteria(Criteria criteria, Criteria
otherCriteria) {
      this.criteria = criteria;
      this.otherCriteria = otherCriteria;
   }
   @Override
   public List<Person> meetCriteria(List<Person> persons) {
      List<Person> firstCriteriaPersons =
criteria.meetCriteria(persons);
      return
otherCriteria.meetCriteria(firstCriteriaPersons);
   }
}
```

OrCriteria.java

```
import java.util.List;

public class AndCriteria implements Criteria {

   private Criteria criteria;
   private Criteria otherCriteria;

   public AndCriteria(Criteria criteria, Criteria
otherCriteria) {
      this.criteria = criteria;
      this.otherCriteria = otherCriteria;
   }
   @Override
   public List<Person> meetCriteria(List<Person> persons) {
      List<Person> firstCriteriaItems =
criteria.meetCriteria(persons);
      List<Person> otherCriteriaItems =
otherCriteria.meetCriteria(persons);

      for (Person person : otherCriteriaItems) {
         if(!firstCriteriaItems.contains(person)){
               firstCriteriaItems.add(person);
         }
      }
      return firstCriteriaItems;
   }
}
```

Structural : Filter/Criteria Pattern

Implementation

Step4: Use different Criteria and their combination to filter out persons.

CriteriaPatternDemo.java

```
public class CriteriaPatternDemo {
   public static void main(String[] args) {
      List<Person> persons = new ArrayList<Person>();

      persons.add(new Person("Robert","Male", "Single"));
      persons.add(new Person("John","Male", "Married"));
      persons.add(new Person("Laura","Female", "Married"));
      persons.add(new Person("Diana","Female", "Single"));
      persons.add(new Person("Mike","Male", "Single"));
      persons.add(new Person("Bobby","Male", "Single"));

      Criteria male = new CriteriaMale();
      Criteria female = new CriteriaFemale();
      Criteria single = new CriteriaSingle();
      Criteria singleMale = new AndCriteria(single, male);
      Criteria singleOrFemale = new OrCriteria(single,
female);

      System.out.println("Males: ");
      printPersons(male.meetCriteria(persons));

      System.out.println("\nFemales: ");
      printPersons(female.meetCriteria(persons));

      System.out.println("\nSingle Males: ");
      printPersons(singleMale.meetCriteria(persons));

      System.out.println("\nSingle Or Females: ");
      printPersons(singleOrFemale.meetCriteria(persons));
   }

   public static void printPersons(List<Person> persons){
      for (Person person : persons) {
         System.out.println("Person : [ Name : " +
person.getName()
            +", Gender : " + person.getGender()
            +", Marital Status : " +
person.getMaritalStatus()
            +" ]");
      }
   }
}
```

Step 5: Verify the output.

```
Males:
Person : [ Name : Robert, Gender : Male, Marital Status : Single ]
Person : [ Name : John, Gender : Male, Marital Status : Married ]
Person : [ Name : Mike, Gender : Male, Marital Status : Single ]
Person : [ Name : Bobby, Gender : Male, Marital Status : Single ]

Females:
Person : [ Name : Laura, Gender : Female, Marital Status : Married ]
Person : [ Name : Diana, Gender : Female, Marital Status : Single ]

Single Males:
Person : [ Name : Robert, Gender : Male, Marital Status : Single ]
Person : [ Name : Mike, Gender : Male, Marital Status : Single ]
Person : [ Name : Bobby, Gender : Male, Marital Status : Single ]

Single Or Females:
Person : [ Name : Robert, Gender : Male, Marital Status : Single ]
Person : [ Name : Diana, Gender : Female, Marital Status : Single ]
Person : [ Name : Mike, Gender : Male, Marital Status : Single ]
Person : [ Name : Bobby, Gender : Male, Marital Status : Single ]
Person : [ Name : Laura, Gender : Female, Marital Status : Married ]
```

Structural Design Patterns

Composite Pattern

STRUCTURAL: COMPOSITE PATTERN

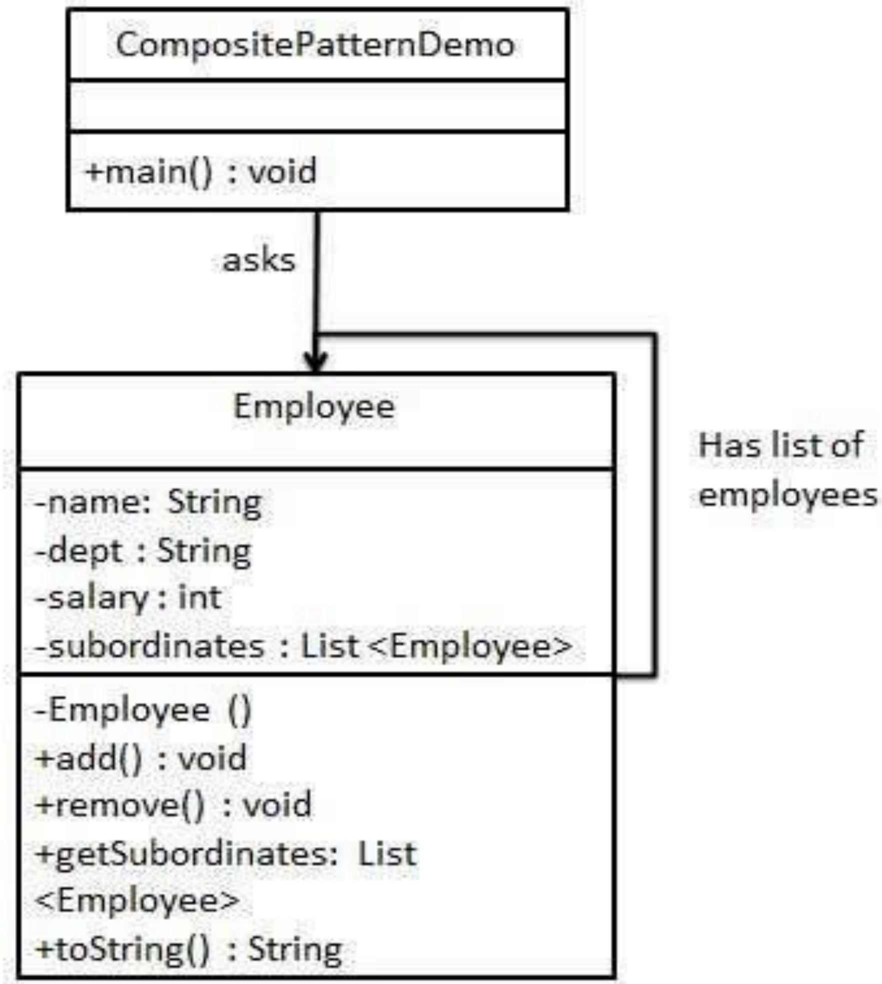
DEFINITION

- Composite pattern is used where we need to treat a group of objects in similar way as a single object. Composite pattern composes objects in term of a tree structure to represent part as well as whole hierarchy. This type of design pattern comes under structural pattern as this pattern creates a tree structure of group of objects.
- This pattern creates a class contains group of its own objects. This class provides ways to modify its group of same objects.
- We are demonstrating use of Composite pattern via following example in which show employees hierarchy of an organization.

Structural : Composite Pattern

Implementation

- We've a class *Employee* which acts as composite pattern actor class. *CompositePatternDemo*, our demo class will use *Employee* class to add department level hierarchy and print all employees.



STRUCTURAL : COMPOSITE PATTERN

IMPLEMENTATION

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("Shape: Rectangle");
   }
}
```

Circle.java

```
public class Circle implements Shape {

   @Override
   public void draw() {
      System.out.println("Shape: Circle");
   }
}
```

Step 3

Create abstract decorator class implementing the *Shape* interface.

ShapeDecorator.java

```
public abstract class ShapeDecorator implements Shape {
   protected Shape decoratedShape;

   public ShapeDecorator(Shape decoratedShape){
      this.decoratedShape = decoratedShape;
   }

   public void draw(){
      decoratedShape.draw();
   }
}
```

Step 4

Create concrete decorator class extending the *ShapeDecorator* class.

RedShapeDecorator.java

```
public class RedShapeDecorator extends ShapeDecorator {

   public RedShapeDecorator(Shape decoratedShape) {
      super(decoratedShape);
   }

   @Override
   public void draw() {
      decoratedShape.draw();
      setRedBorder(decoratedShape);
   }

   private void setRedBorder(Shape decoratedShape){
      System.out.println("Border Color: Red");
   }
}
```

Step 5

Use the *RedShapeDecorator* to decorate *Shape* objects.

DecoratorPatternDemo.java

```
public class DecoratorPatternDemo {
   public static void main(String[] args) {

      Shape circle = new Circle();

      Shape redCircle = new RedShapeDecorator(new Circle());

      Shape redRectangle = new RedShapeDecorator(new Rectangle());
      System.out.println("Circle with normal border");
      circle.draw();

      System.out.println("\nCircle of red border");
      redCircle.draw();

      System.out.println("\nRectangle of red border");
      redRectangle.draw();
   }
}
```

Step 6

Verify the output.

```
Circle with normal border
Shape: Circle

Circle of red border
Shape: Circle
Border Color: Red

Rectangle of red border
Shape: Rectangle
Border Color: Red
```

Structural Design Patterns

Facade Pattern

Structural: Facade Pattern

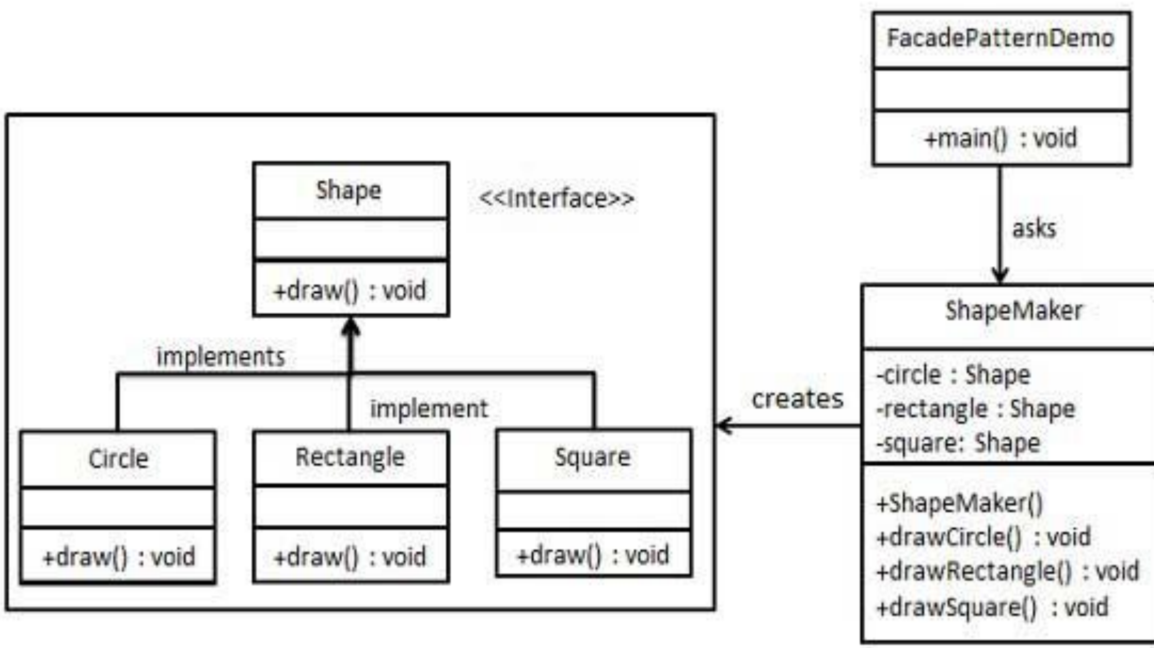
Definition

- Facade pattern hides the complexities of the system and provides an interface to the client using which the client can access the system. This type of design pattern comes under structural pattern as this pattern adds an interface to exiting system to hide its complexities.
- This pattern involves a single class which provides simplified methods which are required by client and delegates calls to existing system classes methods.

STRUCTURAL : FACADE PATTERN

IMPLEMENTATION

- We're going to create a *Shape* interface and concrete classes implementing the *Shape* interface. A facade class *ShapeMaker* is defined as a next step.
- *ShapeMaker* class uses the concrete classes to delegates user calls to these classes. *FacadePatternDemo*, our demo class will use *ShapeMaker* class to show the results.



Structural : Facade Pattern

Implementation

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("Rectangle::draw()");
   }
}
```

Square.java

```
public class Square implements Shape {

   @Override
   public void draw() {
      System.out.println("Square::draw()");
   }
}
```

Circle.java

```
public class Circle implements Shape {

   @Override
   public void draw() {
      System.out.println("Circle::draw()");
   }
}
```

Step 3: Create a facade class.

ShapeMaker.java

```
public class ShapeMaker {
   private Shape circle;
   private Shape rectangle;
   private Shape square;

   public ShapeMaker() {
      circle = new Circle();
      rectangle = new Rectangle();
      square = new Square();
   }

   public void drawCircle(){
      circle.draw();
   }
   public void drawRectangle(){
      rectangle.draw();
   }
   public void drawSquare(){
      square.draw();
   }
}
```

Step 4: Use the facade to draw various types of shapes.

FacadePatternDemo.java

```
public class FacadePatternDemo {
   public static void main(String[] args) {
      ShapeMaker shapeMaker = new ShapeMaker();

      shapeMaker.drawCircle();
      shapeMaker.drawRectangle();
      shapeMaker.drawSquare();
   }
}
```

Step 5: Verify the output.

```
Circle::draw()
Rectangle::draw()
Square::draw()
```

Structural Design Patterns

Flyweight Pattern

STRUCTURAL: FLYWEIGHT PATTERN

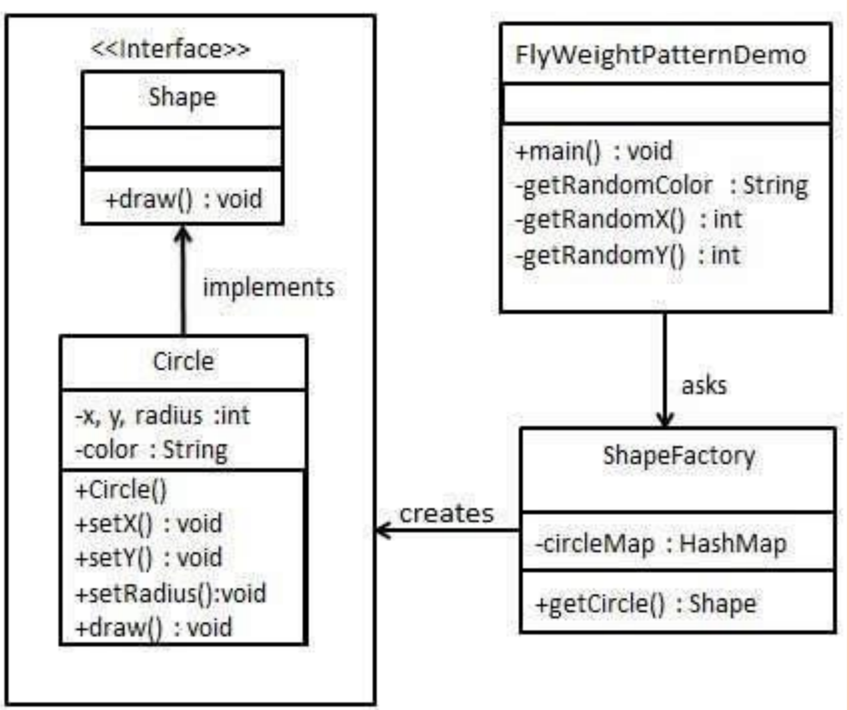
DEFINITION

- Flyweight pattern is primarily used to reduce the number of objects created, to decrease memory footprint and increase performance. This type of design pattern comes under structural pattern as this pattern provides ways to decrease objects count thus improving application required objects structure.
- Flyweight pattern try to reuse already existing similar kind objects by storing them and creates new object when no matching object is found. We'll demonstrate this pattern by drawing 20 circle of different locations but we'll creating only 5 objects. Only 5 colors are available so color property is used to check already existing *Circle* objects.

STRUCTURAL : FLYWEIGHT PATTERN

IMPLEMENTATION

- We're going to create a *Shape* interface and concrete class *Circle* implementing the *Shape* interface. A factory class *ShapeFactory* is defined as a next step.
- *ShapeFactory* have a *HashMap* of *Circle* having key as color of the *Circle* object. Whenever a request comes to create a circle of particular color to *ShapeFactory*. *ShapeFactory* checks the circle object in its *HashMap*, if object of *Circle* found, that object is returned otherwise a new object is created, stored in hashmap for future use and returned to client.
- *FlyWeightPatternDemo*, our demo class will use *ShapeFactory* to get a *Shape*object. It will pass information (*red / green / blue/ black / white*) to *ShapeFactory* to get the circle of desired color it needs.



STRUCTURAL : FLYWEIGHT PATTERN

IMPLEMENTATION

Step 1: Create an interface.

Shape.java

```java
public interface Shape {
   void draw();
}
```

Step 2: Create concrete class implementing the same interface.

Circle.java

```java
public class Circle implements Shape {
   private String color;
   private int x;
   private int y;
   private int radius;

   public Circle(String color){
      this.color = color;
   }

   public void setX(int x) {
      this.x = x;
   }

   public void setY(int y) {
      this.y = y;
   }

   public void setRadius(int radius) {
      this.radius = radius;
   }

   @Override
   public void draw() {
      System.out.println("Circle: Draw() [Color : " + color
         +", x : " + x +", y :" + y +", radius :" + radius);
   }
}
```

Step 3: Create a Factory to generate object of concrete class based on given information.

ShapeFactory.java

```java
import java.util.HashMap;

public class ShapeFactory {
   private static final HashMap<String, Shape> circleMap =
new HashMap();

   public static Shape getCircle(String color) {
      Circle circle = (Circle)circleMap.get(color);

      if(circle == null) {
         circle = new Circle(color);
         circleMap.put(color, circle);
         System.out.println("Creating circle of color : " +
color);
      }
      return circle;
   }
}
```

Structural : Flyweight Pattern

Implementation

Step 4: Use the Factory to get object of concrete class by passing an information such as color.

FlyweightPatternDemo.java

```
public class FlyweightPatternDemo {
   private static final String colors[] =
      { "Red", "Green", "Blue", "White", "Black" };
   public static void main(String[] args) {

      for(int i=0; i < 20; ++i) {
         Circle circle =
            (Circle)ShapeFactory.getCircle(getRandomColor());
         circle.setX(getRandomX());
         circle.setY(getRandomY());
         circle.setRadius(100);
         circle.draw();
      }
   }
   private static String getRandomColor() {
      return colors[(int)(Math.random()*colors.length)];
   }
   private static int getRandomX() {
      return (int)(Math.random()*100 );
   }
   private static int getRandomY() {
      return (int)(Math.random()*100);
   }
}
```

Step 5: Verify the output.

```
Creating circle of color : Black
Circle: Draw() [Color : Black, x : 36, y :71, radius :100
Creating circle of color : Green
Circle: Draw() [Color : Green, x : 27, y :27, radius :100
Creating circle of color : White
Circle: Draw() [Color : White, x : 64, y :10, radius :100
Creating circle of color : Red
Circle: Draw() [Color : Red, x : 15, y :44, radius :100
Circle: Draw() [Color : Green, x : 19, y :10, radius :100
Circle: Draw() [Color : Green, x : 94, y :32, radius :100
Circle: Draw() [Color : White, x : 69, y :98, radius :100
Creating circle of color : Blue
Circle: Draw() [Color : Blue, x : 13, y :4, radius :100
Circle: Draw() [Color : Green, x : 21, y :21, radius :100
Circle: Draw() [Color : Blue, x : 55, y :86, radius :100
Circle: Draw() [Color : White, x : 90, y :70, radius :100
Circle: Draw() [Color : Green, x : 78, y :3, radius :100
Circle: Draw() [Color : Green, x : 64, y :89, radius :100
Circle: Draw() [Color : Blue, x : 3, y :91, radius :100
Circle: Draw() [Color : Blue, x : 62, y :82, radius :100
Circle: Draw() [Color : Green, x : 97, y :61, radius :100
Circle: Draw() [Color : Green, x : 86, y :12, radius :100
Circle: Draw() [Color : Green, x : 38, y :93, radius :100
Circle: Draw() [Color : Red, x : 76, y :82, radius :100
Circle: Draw() [Color : Blue, x : 95, y :82, radius :100
```

Structural Design Patterns

Proxy Pattern

Structural: Proxy Pattern

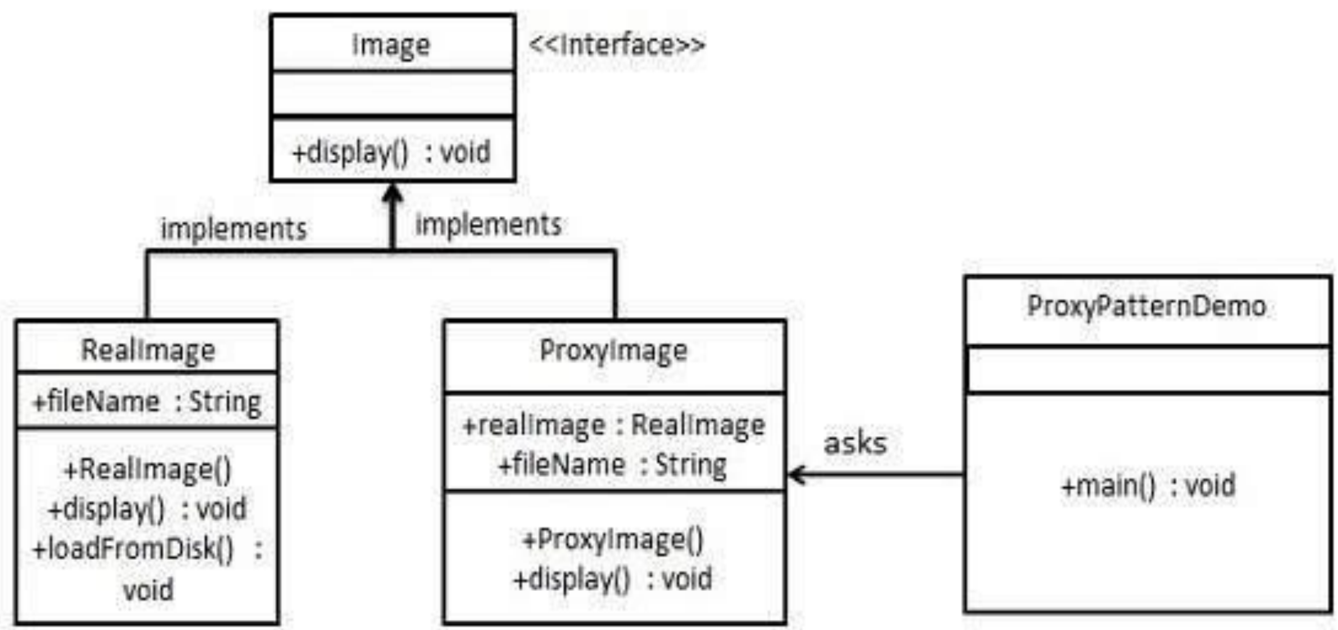
Definition

- In Proxy pattern, a class represents functionality of another class. This type of design pattern comes under structural pattern.
- In Proxy pattern, we create object having original object to interface its functionality to outer world.

Structural : Proxy Pattern

Implementation

- We're going to create a *Image* interface and concrete classes implementing the *Image* interface. *ProxyImage* is a a proxy class to reduce memory footprint of *RealImage* object loading.
- *ProxyPatternDemo*, our demo class will use *ProxyImage* to get a *Image* object to load and display as it needs.



Structural : Proxy Pattern

Implementation

Step 1: Create an interface.

Image.java

```
public interface Image {
   void display();
}
```

Step 2: Create concrete classes implementing the same interface.

RealImage.java

```
public class RealImage implements Image {

   private String fileName;

   public RealImage(String fileName){
      this.fileName = fileName;
      loadFromDisk(fileName);
   }

   @Override
   public void display() {
      System.out.println("Displaying " + fileName);
   }

   private void loadFromDisk(String fileName){
      System.out.println("Loading " + fileName);
   }
}
```

ProxyImage.java

```
public class ProxyImage implements Image{

   private RealImage realImage;
   private String fileName;

   public ProxyImage(String fileName){
      this.fileName = fileName;
   }

   @Override
   public void display() {
      if(realImage == null){
         realImage = new RealImage(fileName);
      }
      realImage.display();
   }
}
```

Step 3: Use the *ProxyImage* to get object of *RealImage* class when required.

ProxyPatternDemo.java

```
public class ProxyPatternDemo {

   public static void main(String[] args) {
      Image image = new ProxyImage("test_10mb.jpg");

      //image will be loaded from disk
      image.display();
      System.out.println("");
      //image will not be loaded from disk
      image.display();
   }
}
```

Step 4: Verify the output.

```
Loading test_10mb.jpg
Displaying test_10mb.jpg

Displaying test_10mb.jpg
```

Behavioral Design Patterns

Chain of Responsibility Pattern

Behavioral: Chain of Responsibility Pattern

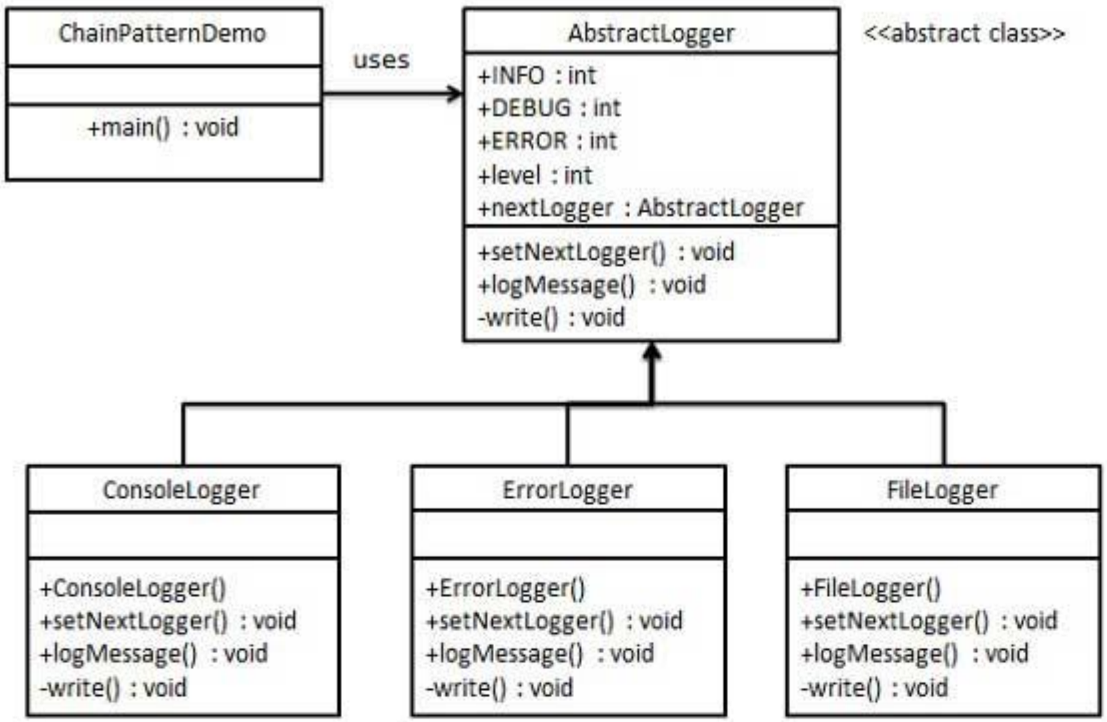
Definition

- As the name suggest, 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.

Behavioral : Chain of Responsibility Pattern

Implementation

- We've created an abstract class *AbstractLogger* with a level of logging. Then we've created three types of loggers extending the *AbstractLogger*. Each logger checks the level of message to its level and print accordingly otherwise does not print and pass the message to its next logger.



Behavioral : Chain of Responsibility Pattern

implementation

Step 1: Create an abstract logger class.

AbstractLogger.java

```
public abstract class AbstractLogger {
   public static int INFO = 1;
   public static int DEBUG = 2;
   public static int ERROR = 3;

   protected int level;

   //next element in chain or responsibility
   protected AbstractLogger nextLogger;

   public void setNextLogger(AbstractLogger nextLogger){
      this.nextLogger = nextLogger;
   }

   public void logMessage(int level, String message){
      if(this.level <= level){
         write(message);
      }
      if(nextLogger !=null){
         nextLogger.logMessage(level, message);
      }
   }

   abstract protected void write(String message);

}
```

Step 2: Create concrete classes extending the logger.

ConsoleLogger.java

```
public class ConsoleLogger extends AbstractLogger {

   public ConsoleLogger(int level){
      this.level = level;
   }

   @Override
   protected void write(String message) {
      System.out.println("Standard Console::Logger: " +
message);
   }
}
```

ErrorLogger.java

```
public class ErrorLogger extends AbstractLogger {

   public ErrorLogger(int level){
      this.level = level;
   }

   @Override
   protected void write(String message) {
      System.out.println("Error Console::Logger: " +
message);
   }
}
```

FileLogger.java

```
public class FileLogger extends AbstractLogger {

   public FileLogger(int level){
      this.level = level;
   }

   @Override
   protected void write(String message) {
      System.out.println("File::Logger: " + message);
   }
```

Behavioral : Chain of Responsibility Pattern

implementation

Step 3: Create different types of loggers. Assign them error levels and set next logger in each logger. Next logger in each logger represents the part of the chain.

ChainPatternDemo.java

```java
public class ChainPatternDemo {

   private static AbstractLogger getChainOfLoggers(){

      AbstractLogger errorLogger = new
ErrorLogger(AbstractLogger.ERROR);
      AbstractLogger fileLogger = new
FileLogger(AbstractLogger.DEBUG);
      AbstractLogger consoleLogger = new
ConsoleLogger(AbstractLogger.INFO);

      errorLogger.setNextLogger(fileLogger);
      fileLogger.setNextLogger(consoleLogger);

      return errorLogger;
   }

   public static void main(String[] args) {
      AbstractLogger loggerChain = getChainOfLoggers();

      loggerChain.logMessage(AbstractLogger.INFO,
         "This is an information.");

      loggerChain.logMessage(AbstractLogger.DEBUG,
         "This is an debug level information.");

      loggerChain.logMessage(AbstractLogger.ERROR,
         "This is an error information.");
   }
}
```

Step 4: Verify the output.

```
Standard Console::Logger: This is an information.
File::Logger: This is an debug level information.
Standard Console::Logger: This is an debug level
information.
Error Console::Logger: This is an error information.
File::Logger: This is an error information.
Standard Console::Logger: This is an error information.
```

Behavioral Design Patterns

Command Pattern

Behavioral: Command Pattern

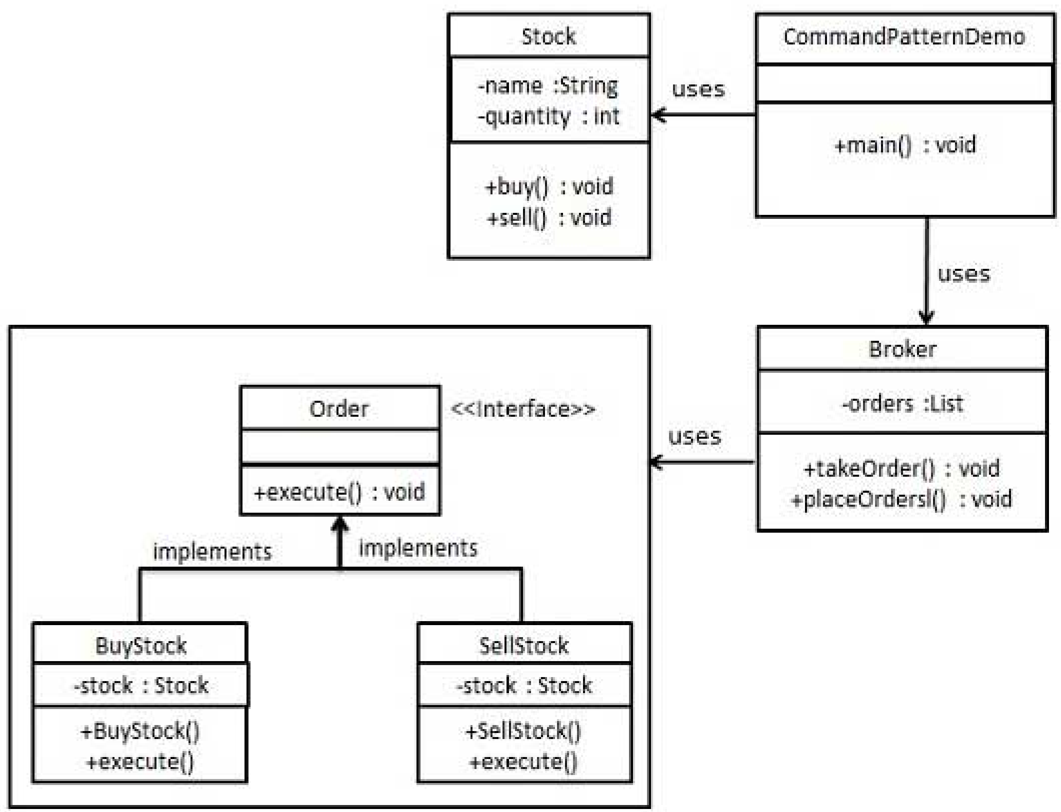
Definition

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

BEHAVIORAL : COMMAND PATTERN

IMPLEMENTATION

- We've created an interface *Order* which is acting as a command. We've created a *Stock* class which acts as a request. We've concrete command classes *BuyStock* and *SellStock* implementing *Order* interface which will do actual command processing. A class *Broker* is created which acts as a invoker object. It can take order and place orders.
- *Broker* object uses command pattern to identify which object will execute which command based on type of command. *CommandPatternDemo*, our demo class will use *Broker* class to demonstrate command pattern.



Behavioral : Command Pattern

Implementation

Step 1: Create a command interface.

Order.java

```
public interface Order {
   void execute();
}
```

Step 2: Create a request class.

Stock.java

```
public class Stock {

   private String name = "ABC";
   private int quantity = 10;

   public void buy(){
      System.out.println("Stock [ Name: "+name+",
         Quantity: " + quantity +" ] bought");
   }
   public void sell(){
      System.out.println("Stock [ Name: "+name+",
         Quantity: " + quantity +" ] sold");
   }
}
```

Step 3: Create concrete classes implementing the *Order* interface.

BuyStock.java

```
public class BuyStock implements Order {
   private Stock abcStock;

   public BuyStock(Stock abcStock){
      this.abcStock = abcStock;
   }

   public void execute() {
      abcStock.buy();
   }
}
```

SellStock.java

```
public class SellStock implements Order {
   private Stock abcStock;

   public SellStock(Stock abcStock){
      this.abcStock = abcStock;
   }

   public void execute() {
      abcStock.sell();
   }
}
```

Behavioral : Command Pattern

Implementation

Step 4: Create command invoker class.

Broker.java

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

   public class Broker {
   private List<Order> orderList = new
ArrayList<Order>();

   public void takeOrder(Order order){
      orderList.add(order);
   }

   public void placeOrders(){
      for (Order order : orderList) {
         order.execute();
      }
      orderList.clear();
   }
}
```

Step 5: Use the Broker class to take and execute commands.

CommandPatternDemo.java

```
public class CommandPatternDemo {
   public static void main(String[] args) {
      Stock abcStock = new Stock();
      BuyStock buyStockOrder = new BuyStock(abcStock);
      SellStock sellStockOrder = new
SellStock(abcStock);

      Broker broker = new Broker();
      broker.takeOrder(buyStockOrder);
      broker.takeOrder(sellStockOrder);

      broker.placeOrders();
   }
}
```

Step 6: Verify the output.

```
Stock [ Name: ABC, Quantity: 10 ] bought
Stock [ Name: ABC, Quantity: 10 ] sold
```

Behavioral Design Patterns

Interpreter Pattern

Behavioral: Interpreter Pattern

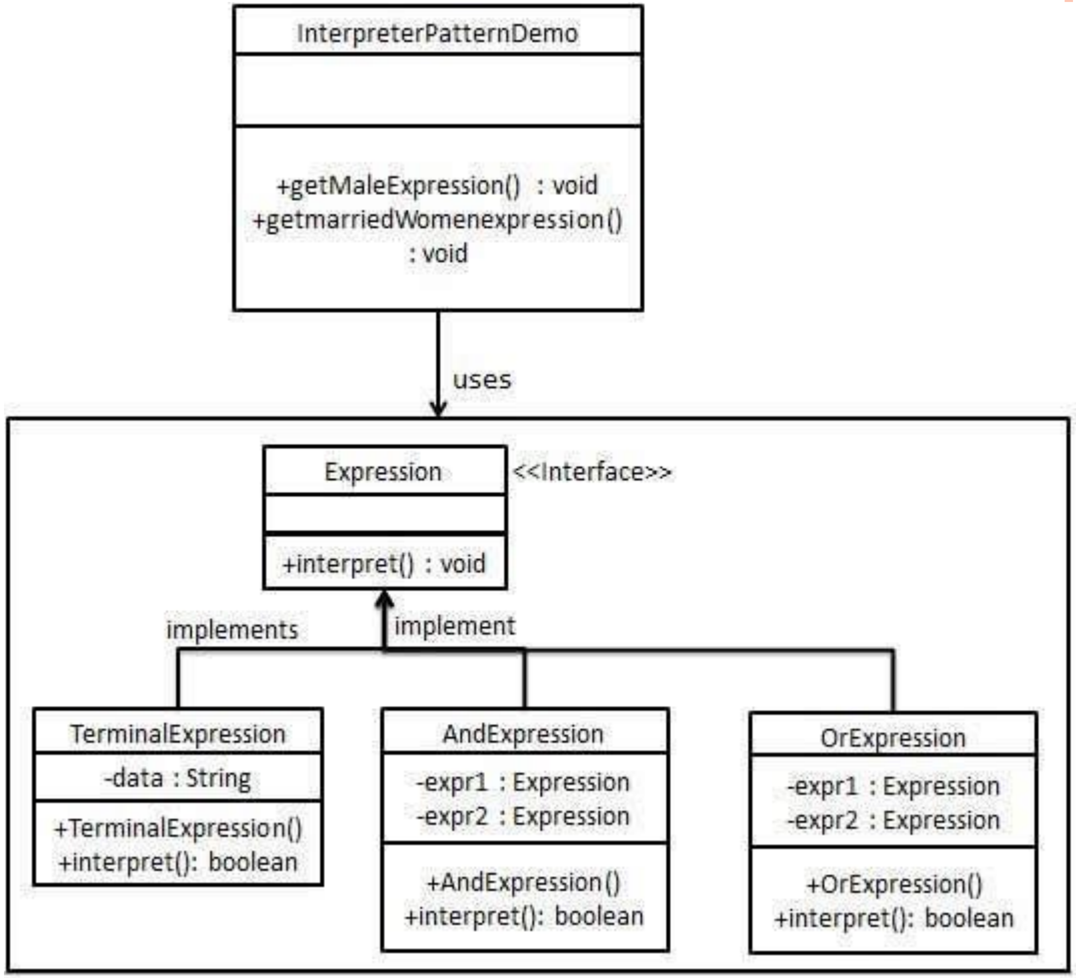
definition

- Interpreter pattern provides way to evaluate language grammar or expression. This type of pattern comes under behavioral patterns. This pattern involves implementing a expression interface which tells to interpret a particular context. This pattern is used in SQL parsing, symbol processing engine etc.

Behavioral : Interpreter Pattern

implementation

- We're going to create an interface *Expression* and concrete classes implementing the *Expression* interface. A class *TerminalExpression* is defined which acts as a main interpreter of context in question. Other classes *OrExpression*, *AndExpression* are used to create combinational expressions.
- *InterpreterPatternDemo*, our demo class will use *Expression* class to create rules and demonstrate parsing of expressions.



Behavioral : Interpreter Pattern

Implementation

Step 1: Create an expression interface.

Expression.java

```
public interface Expression {
   public boolean interpret(String context);
}
```

Step 2: Create concrete classes implementing the above interface.

TerminalExpression.java

```
public class TerminalExpression implements Expression {

   private String data;

   public TerminalExpression(String data){
      this.data = data;
   }

   @Override
   public boolean interpret(String context) {
      if(context.contains(data)){
         return true;
      }
      return false;
   }
}
```

OrExpression.java

```
public class OrExpression implements Expression {

   private Expression expr1 = null;
   private Expression expr2 = null;

   public OrExpression(Expression expr1, Expression expr2) {
      this.expr1 = expr1;
      this.expr2 = expr2;
   }

   @Override
   public boolean interpret(String context) {
      return expr1.interpret(context) ||
expr2.interpret(context);
   }
}
```

AndExpression.java

```
public class AndExpression implements Expression {

   private Expression expr1 = null;
   private Expression expr2 = null;

   public AndExpression(Expression expr1, Expression expr2) {
      this.expr1 = expr1;
      this.expr2 = expr2;
   }

   @Override
   public boolean interpret(String context) {
      return expr1.interpret(context) &&
expr2.interpret(context);
   }
}
```

Step 3:

InterpreterPatternDemo uses *Expression* class to create rules and then parse them.

InterpreterPatternDemo.java

```java
public class InterpreterPatternDemo {

   //Rule: Robert and John are male
   public static Expression getMaleExpression(){
      Expression robert = new TerminalExpression("Robert");
      Expression john = new TerminalExpression("John");
      return new OrExpression(robert, john);
   }

   //Rule: Julie is a married women
   public static Expression getMarriedWomanExpression(){
      Expression julie = new TerminalExpression("Julie");
      Expression married = new 
TerminalExpression("Married");
      return new AndExpression(julie, married);
   }

   public static void main(String[] args) {
      Expression isMale = getMaleExpression();
      Expression isMarriedWoman = 
getMarriedWomanExpression();

      System.out.println("John is male? " + 
isMale.interpret("John"));
      System.out.println("Julie is a married women? " 
      + isMarriedWoman.interpret("Married Julie"));
   }
}
```

Step 4: Verify the output.

```
John is male? true
Julie is a married women? true
```

Behavioral Design Patterns

Iterator Pattern

Behavioral: Iterator Pattern

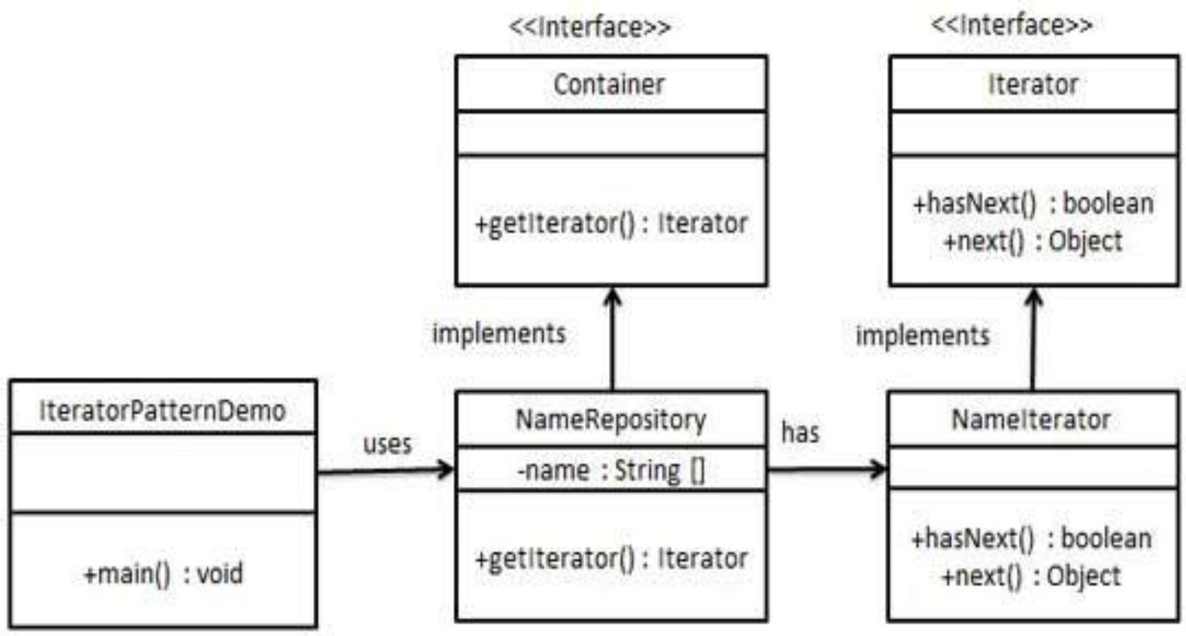
Definition

- Iterator pattern is very commonly used design pattern in Java and .Net programming environment. This pattern is used to get a way to access the elements of a collection object in sequential manner without any need to know its underlying representation.
- Iterator pattern falls under behavioral pattern category.

Behavioral : Iterator Pattern

implementation

- We're going to create a *Iterator* interface which narrates navigation method and a *Container* interface which retruns the iterator . Concrete classes implementing the *Container* interface will be responsible to implement *Iterator* interface and use it
- *IteratorPatternDemo*, our demo class will use *NamesRepository*, a concrete class implementation to print a *Names* stored as a collection in *NamesRepository*



Behavioral : Iterator Pattern

Implementation

Step 1: Create interfaces.

Iterator.java

```
public interface Iterator {
   public boolean hasNext();
   public Object next();
}
```

Container.java

```
public interface Container {
   public Iterator getIterator();
}
```

Step 2: Create concrete class implementing the *Container* interface. This class has inner class *NameIterator* implementing the *Iterator* interface.

NameRepository.java

```
public class NameRepository implements Container {
   public String names[] = {"Robert" , "John" ,"Julie" ,
"Lora"};

   @Override
   public Iterator getIterator() {
      return new NameIterator();
   }

   private class NameIterator implements Iterator {

      int index;

      @Override
      public boolean hasNext() {
         if(index < names.length){
            return true;
         }
         return false;
      }

      @Override
      public Object next() {
         if(this.hasNext()){
            return names[index++];
         }
         return null;
      }
   }
}
```

Step 3: Use the *NameRepository* to get iterator and print names.

IteratorPatternDemo.java

```
public class IteratorPatternDemo {

   public static void main(String[] args) {
      NameRepository namesRepository = new NameRepository();

      for(Iterator iter = namesRepository.getIterator();
iter.hasNext();){
         String name = (String)iter.next();
         System.out.println("Name : " + name);
      }
   }
}
```

Step 4: Verify the output.

```
Name : Robert
Name : John
Name : Julie
Name : Lora
```

Behavioral Design Patterns

Mediator Pattern

Behavioral: Mediator Pattern

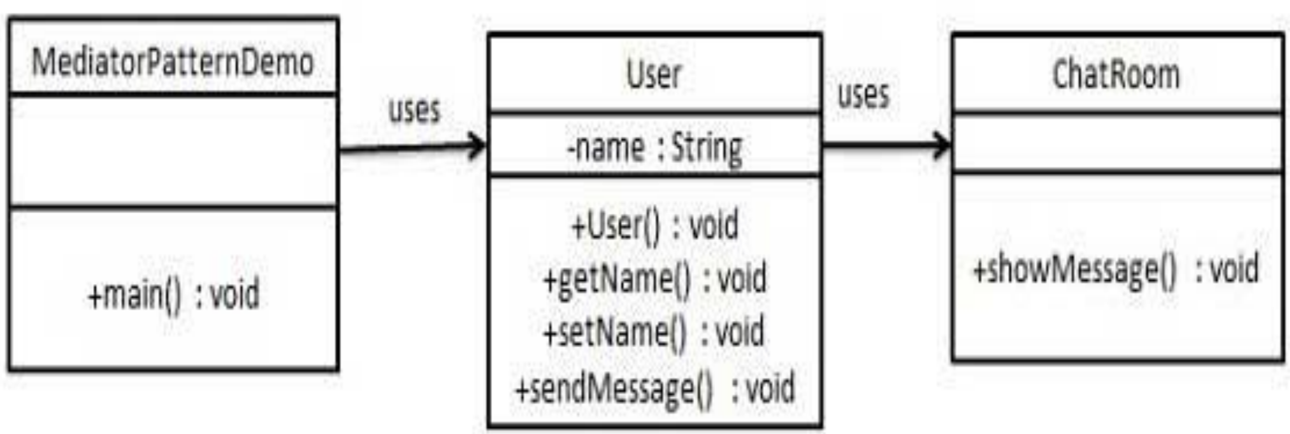
Definition

- Mediator pattern is used to reduce communication complexity between multiple objects or classes. This pattern provides a mediator class which normally handles all the communications between different classes and supports easy maintainability of the code by loose coupling. Mediator pattern falls under behavioral pattern category.

Behavioral : Mediator Pattern

Implementation

- We're demonstrating mediator pattern by example of a Chat Room where multiple users can send message to Chat Room and it is the responsibility of Chat Room to show the messages to all users. We've created two classes *ChatRoom* and *User*. *User* objects will use *ChatRoom* method to share their messages.
- *MediatorPatternDemo*, our demo class will use *User* objects to show communication between them.



BEHAVIORAL : MEDIATOR PATTERN

IMPLEMENTATION

Step 1: Create mediator class.

ChatRoom.java

```
import java.util.Date;

public class ChatRoom {
   public static void showMessage(User user, String
message){
      System.out.println(new Date().toString()
         + " [" + user.getName() +"] : " + message);
   }
}
```

Step 2: Create user class

User.java

```
public class User {
   private String name;

   public String getName() {
      return name;
   }

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

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

```
   public void sendMessage(String message){
      ChatRoom.showMessage(this,message);
   }
}
```

Step 3: Use the *User* object to show communications between them.

MediatorPatternDemo.java

```
public class MediatorPatternDemo {
   public static void main(String[] args) {
      User robert = new User("Robert");
      User john = new User("John");

      robert.sendMessage("Hi! John!");
      john.sendMessage("Hello! Robert!");
   }
}
```

Step 4: Verify the output.

```
Thu Jan 31 16:05:46 IST 2013 [Robert] : Hi! John!
Thu Jan 31 16:05:46 IST 2013 [John] : Hello! Robert!
```

Behavioral Design Patterns

Memento Pattern

Behavioral: Memento Pattern

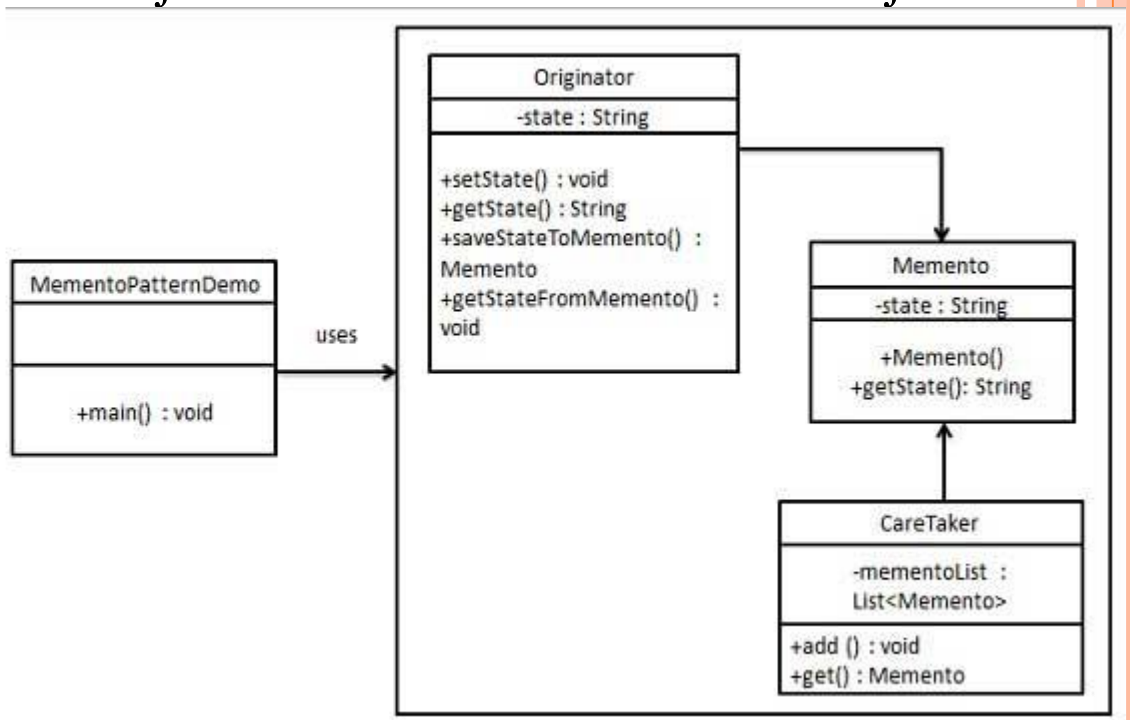
definition

- Memento pattern is used to reduce where we want to restore state of an object to a previous state. Memento pattern falls under behavioral pattern category.

BEHAVIORAL : MEMENTO PATTERN

IMPLEMENTATION

- Memento pattern uses three actor classes. Memento contains state of an object to be restored. Originator creates and stores states in Memento objects and Caretaker object which is responsible to restore object state from Memento. We've created classes *Memento*, *Originator* and *CareTaker*.
- *MementoPatternDemo*, our demo class will use *CareTaker* and *Originator*objects to show restoration of object states.



Behavioral : Memento Pattern

Implementation

Step 1: Create Memento class.

Memento.java

```java
public class Memento {
   private String state;

   public Memento(String state){
      this.state = state;
   }

   public String getState(){
      return state;
   }
}
```

Step 2: Create Originator class

Originator.java

```java
public class Originator {
   private String state;

   public void setState(String state){
      this.state = state;
   }

   public String getState(){
      return state;
   }

   public Memento saveStateToMemento(){
      return new Memento(state);
   }

   public void getStateFromMemento(Memento Memento){
      state = Memento.getState();
   }
}
```

Step 3: Create CareTaker class

CareTaker.java

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

```java
public class CareTaker {
   private List<Memento> mementoList = new ArrayList<Memento>();

   public void add(Memento state){
      mementoList.add(state);
   }

   public Memento get(int index){
      return mementoList.get(index);
   }
}
```

Step 4: Use *CareTaker* and *Originator* objects.

MementoPatternDemo.java

```java
public class MementoPatternDemo {
   public static void main(String[] args) {
      Originator originator = new Originator();
      CareTaker careTaker = new CareTaker();
      originator.setState("State #1");
      originator.setState("State #2");
      careTaker.add(originator.saveStateToMemento());
      originator.setState("State #3");
      careTaker.add(originator.saveStateToMemento());
      originator.setState("State #4");
      System.out.println("Current State: " + 
originator.getState());
      originator.getStateFromMemento(careTaker.get(0));
      System.out.println("First saved State: " + 
originator.getState());
      originator.getStateFromMemento(careTaker.get(1));
      System.out.println("Second saved State: " + 
originator.getState());
   }
}
```

Step 5: Verify the output.

```
Current State: State #4
First saved State: State #2
Second saved State: State #3
```

Behavioral Design Patterns

Observer Pattern

Behavioral: Observer Pattern

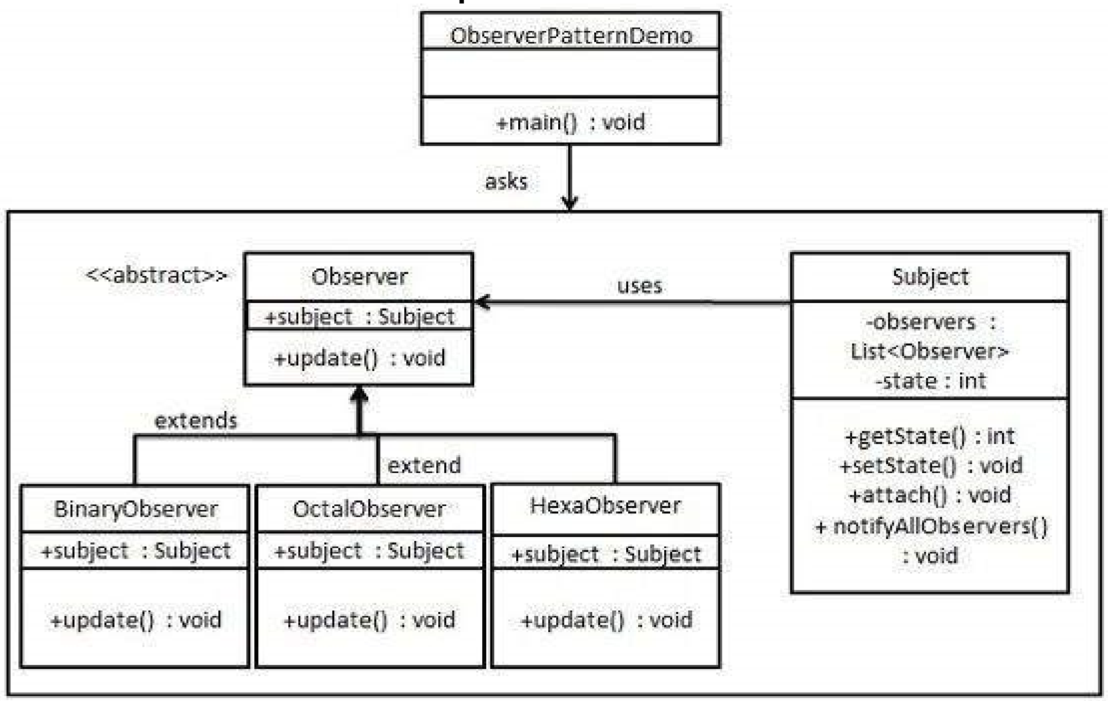
Definition

- Observer pattern is used when there is one to many relationship between objects such as if one object is modified, its depenedent objects are to be notified automatically. Observer pattern falls under behavioral pattern category.

BEHAVIORAL : OBSERVER PATTERN

IMPLEMENTATION

- Observer pattern uses three actor classes. Subject, Observer and Client. Subject, an object having methods to attach and de-attach observers to a client object. We've created classes *Subject*, *Observer* abstract class and concrete classes extending the abstract class the *Observer*.
- *ObserverPatternDemo*, our demo class will use *Subject* and concrete class objects to show observer pattern in action.



Behavioral : Observer Pattern

Implementation

Step 1: Create Subject class.

Subject.java

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

public class Subject {

   private List<Observer> observers
      = new ArrayList<Observer>();
   private int state;

   public int getState() {
      return state;
   }

   public void setState(int state) {
      this.state = state;
      notifyAllObservers();
   }

   public void attach(Observer observer){
      observers.add(observer);
   }

   public void notifyAllObservers(){
      for (Observer observer : observers) {
         observer.update();
      }
   }
}
```

Step 2: Create Observer class.

Observer.java

```
public abstract class Observer {
   protected Subject subject;
   public abstract void update();
}
```

Step 3: Create concrete observer classes

BinaryObserver.java

```
public class BinaryObserver extends Observer{

   public BinaryObserver(Subject subject){
      this.subject = subject;
      this.subject.attach(this);
   }

   @Override
   public void update() {
      System.out.println( "Binary String: "
      + Integer.toBinaryString( subject.getState() ) );
   }
}
```

OctalObserver.java

```
public class OctalObserver extends Observer{

   public OctalObserver(Subject subject){
      this.subject = subject;
      this.subject.attach(this);
   }

   @Override
   public void update() {
     System.out.println( "Octal String: "
     + Integer.toOctalString( subject.getState() ) );
   }
}
```

Behavioral : Observer Pattern

Implementation

HexaObserver.java

```java
public class HexaObserver extends Observer{

   public HexaObserver(Subject subject){
      this.subject = subject;
      this.subject.attach(this);
   }

   @Override
   public void update() {
      System.out.println( "Hex String: "
      + Integer.toHexString( subject.getState()
).toUpperCase() );
   }
}
```

Step 4: Use *Subject* and concrete observer objects.

ObserverPatternDemo.java

```java
public class ObserverPatternDemo {
   public static void main(String[] args) {
      Subject subject = new Subject();

      new HexaObserver(subject);
      new OctalObserver(subject);
      new BinaryObserver(subject);

      System.out.println("First state change: 15");
      subject.setState(15);
      System.out.println("Second state change: 10");
      subject.setState(10);
   }
}
```

Step 5: Verify the output.

```
First state change: 15
Hex String: F
Octal String: 17
Binary String: 1111
Second state change: 10
Hex String: A
Octal String: 12
Binary String: 1010
```

Behavioral Design Patterns

State Pattern

Behavioral: State Pattern

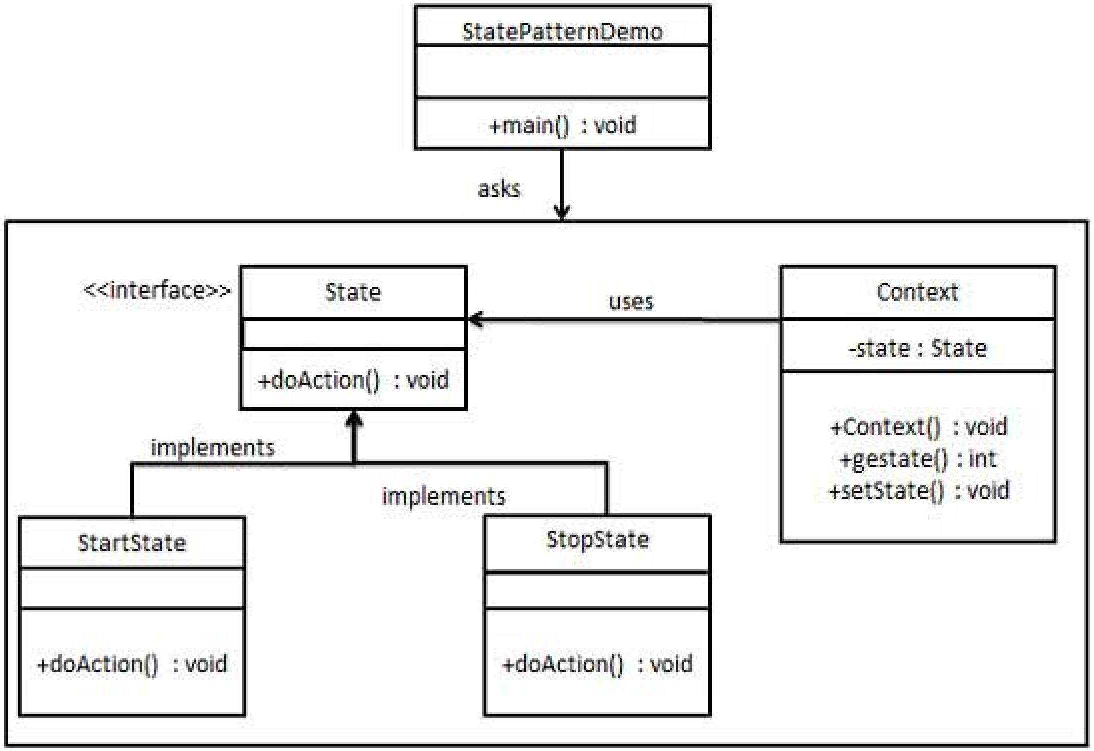
Definition

- In State pattern a class behavior changes based on its state. This type of design pattern comes under behavior pattern.
- In State pattern, we create objects which represent various states and a context object whose behavior varies as its state object changes.

Behavioral : State Pattern

Implementation

- We're going to create a *State* interface defining a action and concrete state classes implementing the *State* interface. *Context* is a class which carries a State.
- *StaePatternDemo*, our demo class will use *Context* and state objects to demonstrate change in Context behavior based on type of state it is in.



BEHAVIORAL : STATE PATTERN IMPLEMENTATION

Step 1: Create an interface.

Image.java

```
public interface State {
   public void doAction(Context context);
}
```

Step 2: Create concrete classes implementing the same interface.

StartState.java

```
public class StartState implements State {

   public void doAction(Context context) {
      System.out.println("Player is in start state");
      context.setState(this);
   }

   public String toString(){
      return "Start State";
   }
}
```

StopState.java

```
public class StopState implements State {

   public void doAction(Context context) {
      System.out.println("Player is in stop state");
      context.setState(this);
   }

   public String toString(){
      return "Stop State";
   }
}
```

Step 3: Create *Context* Class.

Context.java

```
public class Context {
   private State state;

   public Context(){
      state = null;
   }

   public void setState(State state){
      this.state = state;
   }

   public State getState(){
      return state;
   }
}
```

BEHAVIORAL : STATE PATTERN IMPLEMENTATION

Step 4: Use the *Context* to see change in behaviour when *State* changes.

StatePatternDemo.java

```
public class StatePatternDemo {
   public static void main(String[] args) {
      Context context = new Context();

      StartState startState = new StartState();
      startState.doAction(context);

      System.out.println(context.getState().toString());

      StopState stopState = new StopState();
      stopState.doAction(context);

      System.out.println(context.getState().toString());
   }
}
```

Step 5: Verify the output.

```
Player is in start state
Start State
Player is in stop state
Stop State
```

Behavioral Design Patterns

Null Object Pattern

Behavioral: Null Object Pattern

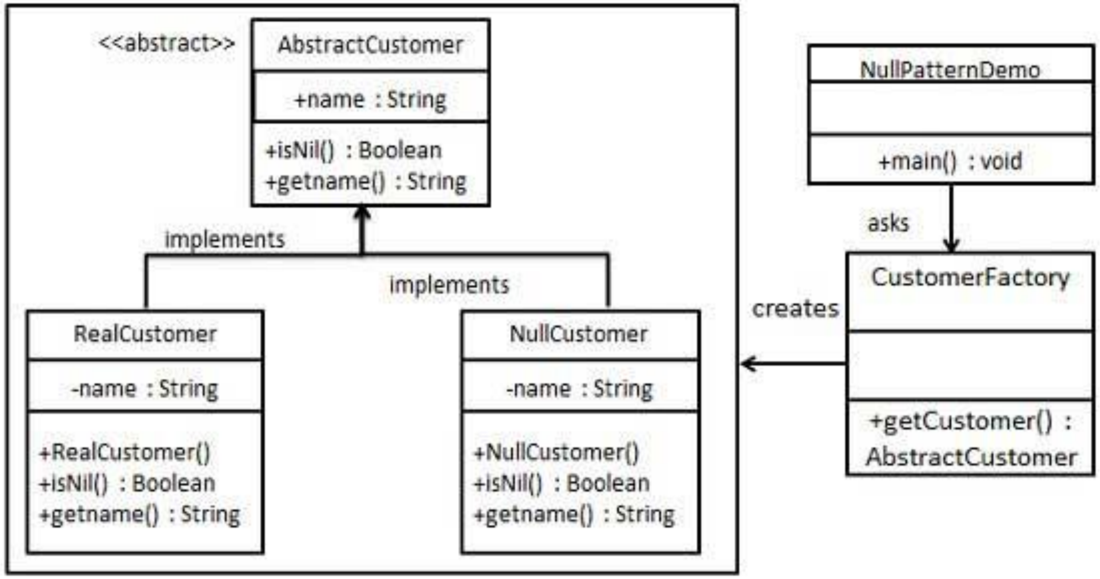
Definition

- In Null Object pattern, a null object replaces check of NULL object instance. Instead of putting if check for a null value, Null Object reflects a do nothing relationship. Such Null object can also be used to provide default behaviour in case data is not available.
- In Null Object pattern, we create a abstract class specifying the various operations to be done, concreate classes extending this class and a null object class providing do nothing implemention of this class and will be used seemlessly where we need to check null value.

BEHAVIORAL : NULL OBJECT PATTERN

IMPLEMENTATION

- We're going to create a *AbstractCustomer* abstract class defining opearations, here the name of the customer and concrete classes extending the *AbstractCustomer* class. A factory class *CustomerFactory* is created to return either *RealCustomer* or *NullCustomer* objects based on the name of customer passed to it.
- *NullPatternDemo*, our demo class will use *CustomerFactory* to demonstrate use of Null Object pattern.



Behavioral : Null Object Pattern

Implementation

Step 1: Create an abstract class.

AbstractCustomer.java

```
public abstract class AbstractCustomer {
   protected String name;
   public abstract boolean isNil();
   public abstract String getName();
}
```

Step 2: Create concrete classes extending the above class.

RealCustomer.java

```
public class RealCustomer extends AbstractCustomer {

   public RealCustomer(String name) {
      this.name = name;
   }

   @Override
   public String getName() {
      return name;
   }

   @Override
   public boolean isNil() {
      return false;
   }
}
```

NullCustomer.java

```
public class NullCustomer extends AbstractCustomer {
   @Override
   public String getName() {
      return "Not Available in Customer Database";
   }

   @Override
   public boolean isNil() {
      return true;
   }
}
```

Step 3: Create *CustomerFactory* Class.

CustomerFactory.java

```
public class CustomerFactory {

   public static final String[] names = {"Rob", "Joe",
"Julie"};

   public static AbstractCustomer getCustomer(String
name){
      for (int i = 0; i < names.length; i++) {
         if (names[i].equalsIgnoreCase(name)){
            return new RealCustomer(name);
         }
      }
      return new NullCustomer();
   }
}
```

BEHAVIORAL : NULL OBJECT PATTERN

IMPLEMENTATION

Step 4: Use the *CustomerFactory* get either *RealCustomer* or *NullCustomer* objects based on the name of customer passed to it.

NullPatternDemo.java

```
public class NullPatternDemo {
   public static void main(String[] args) {

      AbstractCustomer customer1 =
CustomerFactory.getCustomer("Rob");
      AbstractCustomer customer2 =
CustomerFactory.getCustomer("Bob");
      AbstractCustomer customer3 =
CustomerFactory.getCustomer("Julie");
      AbstractCustomer customer4 =
CustomerFactory.getCustomer("Laura");

      System.out.println("Customers");
      System.out.println(customer1.getName());
      System.out.println(customer2.getName());
      System.out.println(customer3.getName());
      System.out.println(customer4.getName());
   }
}
```

Step 5: Verify the output.

```
Customers
Rob
Not Available in Customer Database
Julie
Not Available in Customer Database
```

Behavioral Design Patterns

Strategy Pattern

BEHAVIORAL: STRATEGY PATTERN

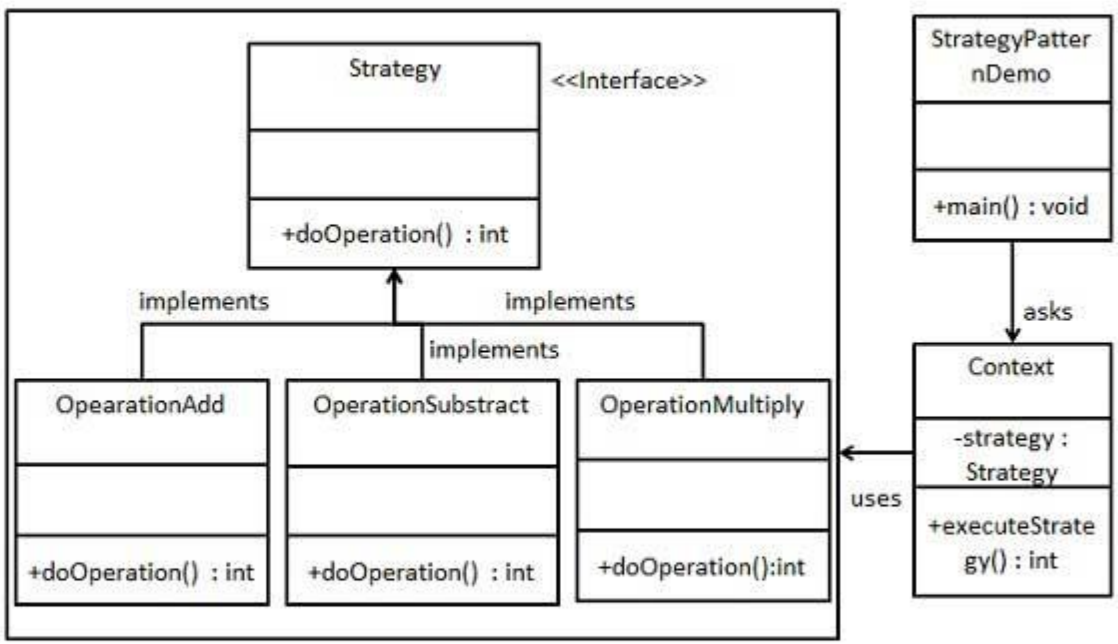
DEFINITION

- In Strategy pattern, a class behavior or its algorithm can be changed at run time. This type of design pattern comes under behavior pattern.
- In Strategy pattern, we create objects which represent various strategies and a context object whose behavior varies as per its strategy object. The strategy object changes the executing algorithm of the context object.

Behavioral : Strategy Pattern

Implementation

- We're going to create a *Strategy* interface defining a action and concrete strategy classes implementing the *Strategy* interface. *Context* is a class which uses a Strategy.
- *StrategyPatternDemo*, our demo class will use *Context* and strategy objects to demonstrate change in Context behaviour based on strategy it deploys or uses.



BEHAVIORAL : STRATEGY PATTERN

IMPLEMENTATION

Step 1: Create an interface.

Strategy.java

```
public interface Strategy {
   public int doOperation(int num1, int num2);
}
```

Step 2: Create concrete classes implementing the same interface.

OperationAdd.java

```
public class OperationAdd implements Strategy{
   @Override
   public int doOperation(int num1, int num2) {
      return num1 + num2;
   }
}
```

OperationSubstract.java

```
public class OperationSubstract implements Strategy{
   @Override
   public int doOperation(int num1, int num2) {
      return num1 - num2;
   }
}
```

OperationMultiply.java

```
public class OperationMultiply implements Strategy{
   @Override
   public int doOperation(int num1, int num2) {
      return num1 * num2;
   }
}
```

Step 3: Create *Context* Class.

Context.java

```
public class Context {
   private Strategy strategy;

   public Context(Strategy strategy){
      this.strategy = strategy;
   }

   public int executeStrategy(int num1, int num2){
      return strategy.doOperation(num1, num2);
   }
}
```

Behavioral : Strategy Pattern

Implementation

Step 4: Use the *Context* to see change in behaviour when it changes its *Strategy*.

StatePatternDemo.java

```
public class StrategyPatternDemo {
   public static void main(String[] args) {
      Context context = new Context(new
OperationAdd());
      System.out.println("10 + 5 = " +
context.executeStrategy(10, 5));

      context = new Context(new
OperationSubstract());
      System.out.println("10 - 5 = " +
context.executeStrategy(10, 5));

      context = new Context(new
OperationMultiply());
      System.out.println("10 * 5 = " +
context.executeStrategy(10, 5));
   }
}
```

Step 5: Verify the output.

```
10 + 5 = 15
10 - 5 = 5
10 * 5 = 50
```

Behavioral Design Patterns

Template Pattern

Behavioral: Template Pattern

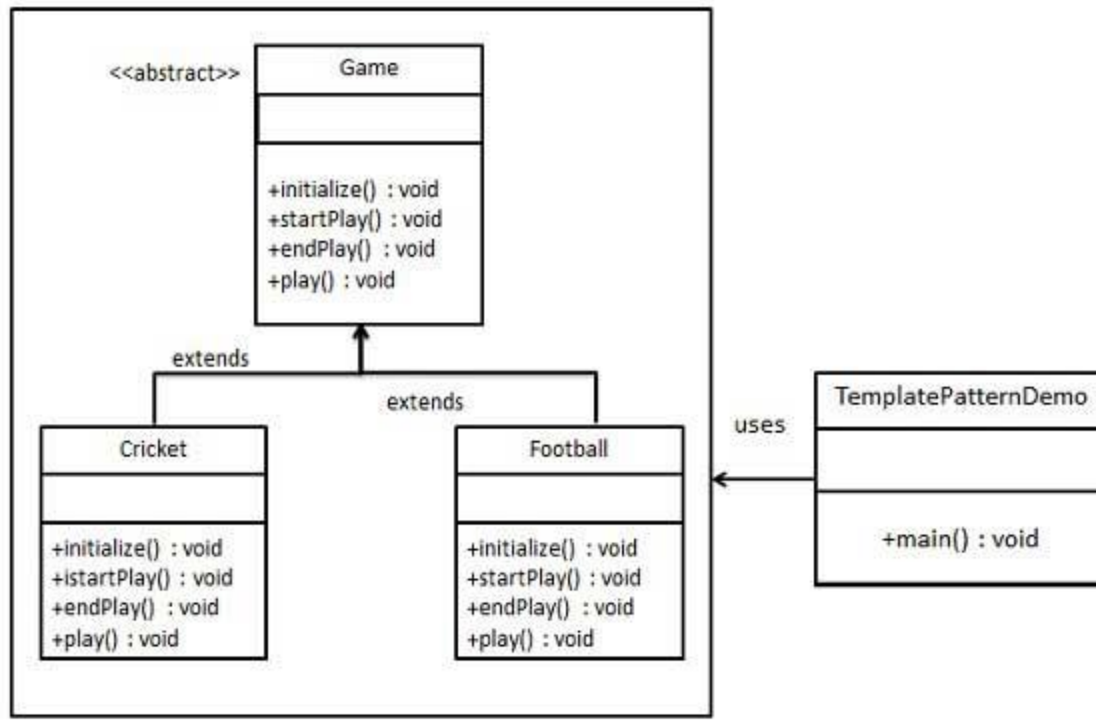
Definition

- In Template pattern, an abstract class exposes defined way(s)/template(s) to execute its methods. Its subclasses can overrides the method implementations as per need basis but the invocation is to be in the same way as defined by an abstract class. This pattern comes under behavior pattern category.

BEHAVIORAL : TEMPLATE PATTERN

IMPLEMENTATION

- We're going to create a *Game* abstract class defining operations with a template method set to be final so that it cannot be overridden. *Cricket* and *Football* are concrete classes extend *Game* and override its methods.
- *TemplatePatternDemo*, our demo class will use *Game* to demonstrate use of template pattern.



BEHAVIORAL : TEMPLATE PATTERN

IMPLEMENTATION

Step 1: Create an abstract class with a template method being final.

Game.java

```java
public abstract class Game {
   abstract void initialize();
   abstract void startPlay();
   abstract void endPlay();

   //template method
   public final void play(){

      //initialize the game
      initialize();

      //start game
      startPlay();

      //end game
      endPlay();
   }
}
```

Step 2: Create concrete classes extending the above class.

Cricket.java

```java
public class Cricket extends Game {

   @Override
   void endPlay() {
      System.out.println("Cricket Game Finished!");
   }

   @Override
   void initialize() {
      System.out.println("Cricket Game Initialized! Start playing.");
   }

   @Override
   void startPlay() {
      System.out.println("Cricket Game Started. Enjoy the game!");
   }
}
```

Football.java

```java
public class Football extends Game {
   @Override
   void endPlay() {
      System.out.println("Football Game Finished!");
   }

   @Override
   void initialize() {
      System.out.println("Football Game Initialized! Start playing.");
   }

   @Override
   void startPlay() {
      System.out.println("Football Game Started. Enjoy the game!");
   }
}
```

Behavioral : Template Pattern

Implementation

Step 3: Use the *Game*'s template method play() to demonstrate a defined way of playing game.

TemplatePatternDemo.java

```
public class TemplatePatternDemo {
   public static void main(String[] args) {

      Game game = new Cricket();
      game.play();
      System.out.println();
      game = new Football();
      game.play();
   }
}
```

Step 4: Verify the output.

```
Cricket Game Initialized! Start playing.
Cricket Game Started. Enjoy the game!
Cricket Game Finished!

Football Game Initialized! Start playing.
Football Game Started. Enjoy the game!
Football Game Finished!
```

Behavioral Design Patterns

Visitor Pattern

Behavioral: Visitor Pattern

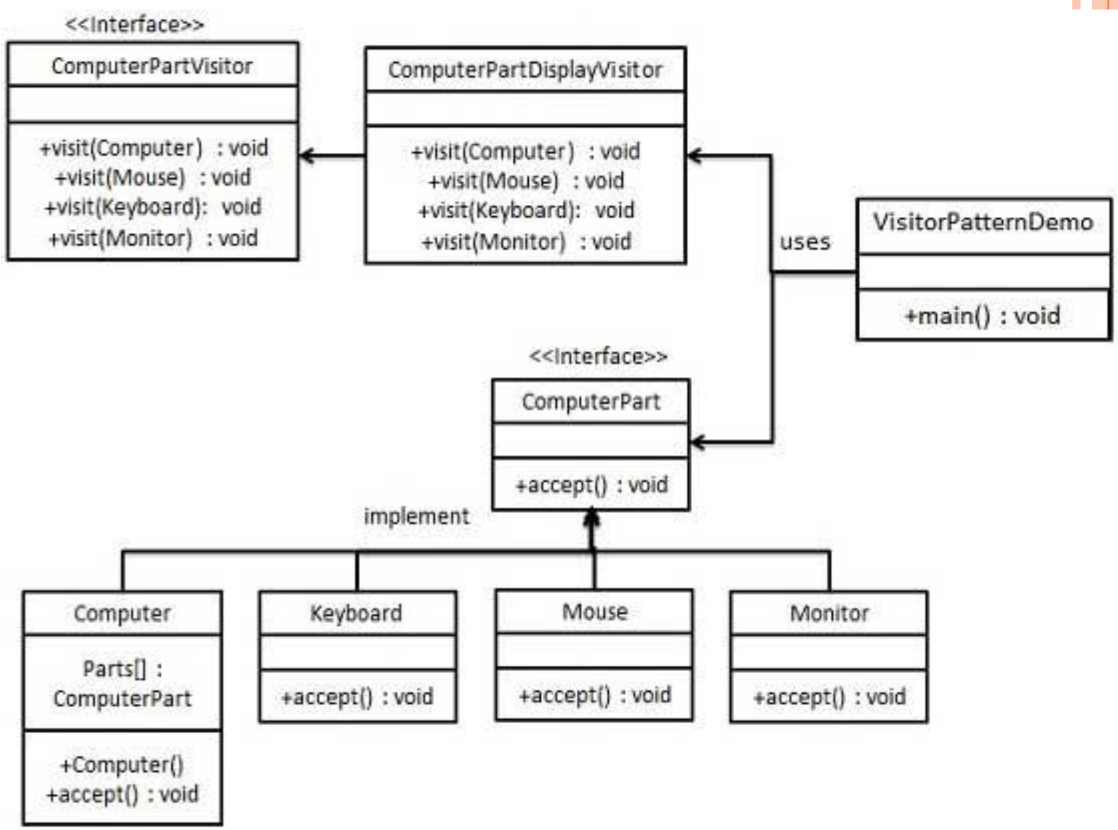
Definition

- In Visitor pattern, we use a visitor class which changes the executing algorithm of an element class. By this way, execution algorithm of element can varies as visitor varies. This pattern comes under behavior pattern category. As per the pattern, element object has to accept the visitor object so that visitor object handles the operation on the element object.

BEHAVIORAL : VISITOR PATTERN

IMPLEMENTATION

- We're going to create a *ComputerPart* interface defining accept opearation.*Keyboard*, *Mouse*, *Monitor* and *Computer* are concrete classes implementing *ComputerPart* interface. We'll define another interface *ComputerPartVisitor* which will define a visitor class operations. *Computer* uses concrete visitor to do corresponding action.
- *VisitorPatternDemo*, our demo class will use *Computer*, *Computer PartVisitor*classes to demonstrate use of visitor pattern.



Behavioral : Visitor Pattern implementation

Step 1: Define an interface to represent element.

ComputerPart.java

```
public interface class ComputerPart {
   public void accept(ComputerPartVisitor computerPartVisitor);
}
```

Step 2: Create concrete classes extending the above class.

Keyboard.java

```
public class Keyboard  implements ComputerPart {

   @Override
   public void accept(ComputerPartVisitor computerPartVisitor) {
      computerPartVisitor.visit(this);
   }
}
```

Monitor.java

```
public class Monitor  implements ComputerPart {

   @Override
   public void accept(ComputerPartVisitor computerPartVisitor) {
      computerPartVisitor.visit(this);
   }
}
```

Mouse.java

```
public class Mouse  implements ComputerPart {

   @Override
   public void accept(ComputerPartVisitor computerPartVisitor) {
      computerPartVisitor.visit(this);
   }
}
```

Computer.java

```
public class Computer implements ComputerPart {

   ComputerPart[] parts;

   public Computer(){
      parts = new ComputerPart[] {new Mouse(), new Keyboard(), new Monitor()};
   }


   @Override
   public void accept(ComputerPartVisitor computerPartVisitor) {
      for (int i = 0; i < parts.length; i++) {
         parts[i].accept(computerPartVisitor);
      }
      computerPartVisitor.visit(this);
   }
}
```

Behavioral : Visitor Pattern implementation

Step 3: Define an interface to represent visitor.

ComputerPartVisitor.java

```
public interface ComputerPartVisitor {
        public void visit(Computer computer);
        public void visit(Mouse mouse);
        public void visit(Keyboard keyboard);
        public void visit(Monitor monitor);
}
```

Step 4: Create concrete visitor implementing the above class.

ComputerPartDisplayVisitor.java

```
public class ComputerPartDisplayVisitor implements
ComputerPartVisitor {

   @Override
   public void visit(Computer computer) {
      System.out.println("Displaying Computer.");
   }

   @Override
   public void visit(Mouse mouse) {
      System.out.println("Displaying Mouse.");
   }

   @Override
   public void visit(Keyboard keyboard) {
      System.out.println("Displaying Keyboard.");
   }

   @Override
   public void visit(Monitor monitor) {
      System.out.println("Displaying Monitor.");
   }
}
```

Step 5: Use the *ComputerPartDisplayVisitor* to display parts of *Computer*.

VisitorPatternDemo.java

```
public class VisitorPatternDemo {
   public static void main(String[] args) {

      ComputerPart computer = new Computer();
      computer.accept(new ComputerPartDisplayVisitor());
   }
}
```

Step 6: Verify the output.

```
Displaying Mouse.
Displaying Keyboard.
Displaying Monitor.
Displaying Computer.
```

J2EE Design Patterns

MVC Pattern

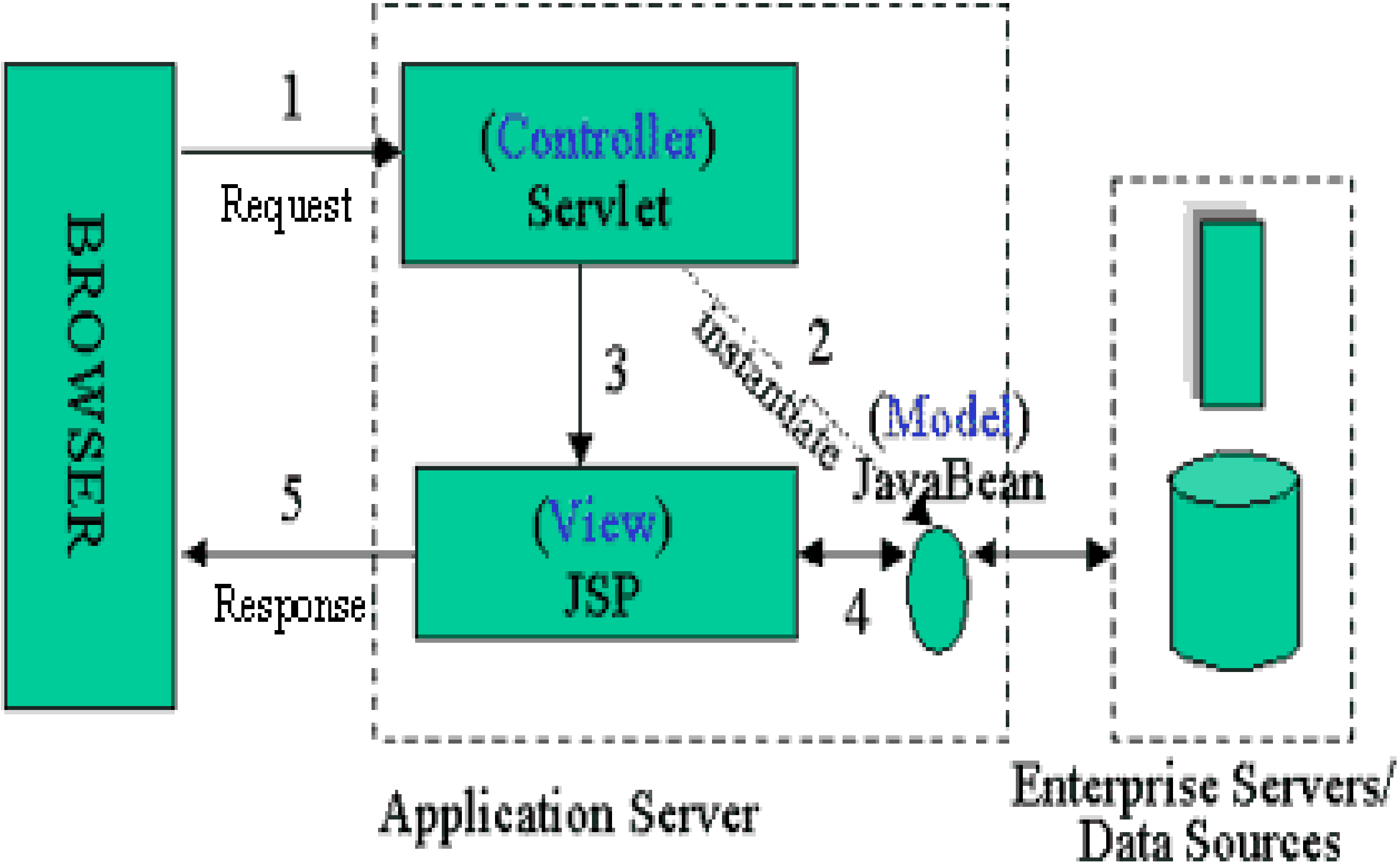
J2EE : MVC PATTERN

DEFINITION

MVC Pattern stands for Model-View-Controller Pattern. This pattern is used to separate application's concerns.

- **Model** - Model represents an object or JAVA POJO carrying data. It can also have logic to update controller if its data changes.
- **View** - View represents the visualization of the data that model contains.
- **Controller** - Controller acts on both Model and view. It controls the data flow into model object and updates the view whenever data changes. It keeps View and Model separate.

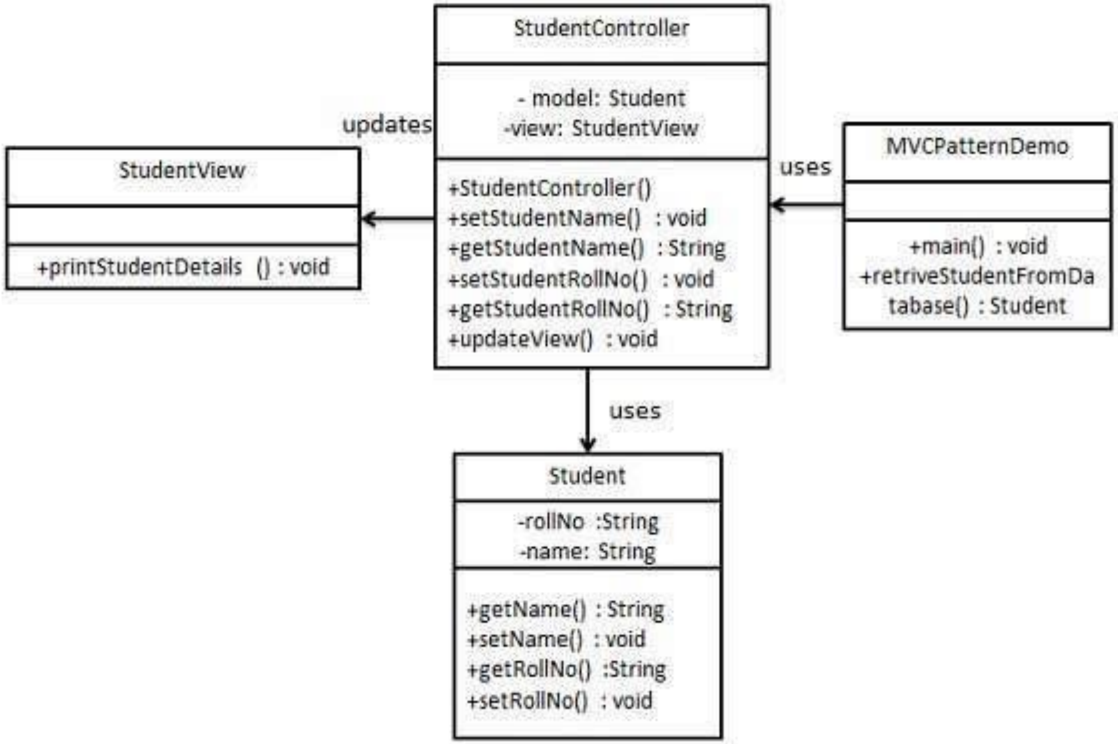
J2EE : MVC Pattern Structure



J2EE: MVC PATTERN

IMPLEMENTATION

- We're going to create a *Student* object acting as a model.*StudentView* will be a view class which can print student details on console and *StudentController* is the controller class responsible to store data in *Student* object and update view *StudentView* accordingly.
- *MVCPatternDemo*, our demo class will use *StudentController* to demonstrate use of MVC pattern.



J2EE: MVC Pattern Implementation

Step 1: Create Model.

Student.java

```
public class Student {
   private String rollNo;
   private String name;
   public String getRollNo() {
      return rollNo;
   }
   public void setRollNo(String rollNo) {
      this.rollNo = rollNo;
   }
   public String getName() {
      return name;
   }
   public void setName(String name) {
      this.name = name;
   }
}
```

Step 2: Create View.

StudentView.java

```
public class StudentView {
   public void printStudentDetails(String studentName,
String studentRollNo){
      System.out.println("Student: ");
      System.out.println("Name: " + studentName);
      System.out.println("Roll No: " + studentRollNo);
   }
}
```

Step 3: Create Controller.

StudentController.java

```
public class StudentController {
   private Student model;
   private StudentView view;

   public StudentController(Student model, StudentView
view){
      this.model = model;
      this.view = view;
   }

   public void setStudentName(String name){
      model.setName(name);
   }

   public String getStudentName(){
      return model.getName();
   }

   public void setStudentRollNo(String rollNo){
      model.setRollNo(rollNo);
   }

   public String getStudentRollNo(){
      return model.getRollNo();
   }

   public void updateView(){
      view.printStudentDetails(model.getName(),
model.getRollNo());
   }
}
```

J2EE: MVC Pattern Implementation

Step 4: Use the *StudentController* methods to demonstrate MVC design pattern usage.

MVCPatternDemo.java

```
public class MVCPatternDemo {
   public static void main(String[] args) {

      //fetch student record based on his roll no from the database
      Student model  = retriveStudentFromDatabase();

      //Create a view : to write student details on console
      StudentView view = new StudentView();

      StudentController controller = new StudentController(model, view);

      controller.updateView();

      //update model data
      controller.setStudentName("John");

      controller.updateView();
   }

   private static Student retriveStudentFromDatabase(){
      Student student = new Student();
      student.setName("Robert");
      student.setRollNo("10");
      return student;
   }
}
```

Step 5: Verify the output.

```
Student:
Name: Robert
Roll No: 10
Student:
Name: Julie
Roll No: 10
```

J2EE Design Patterns

Business Delegate Pattern

J2EE : Business Delegate Pattern

definition

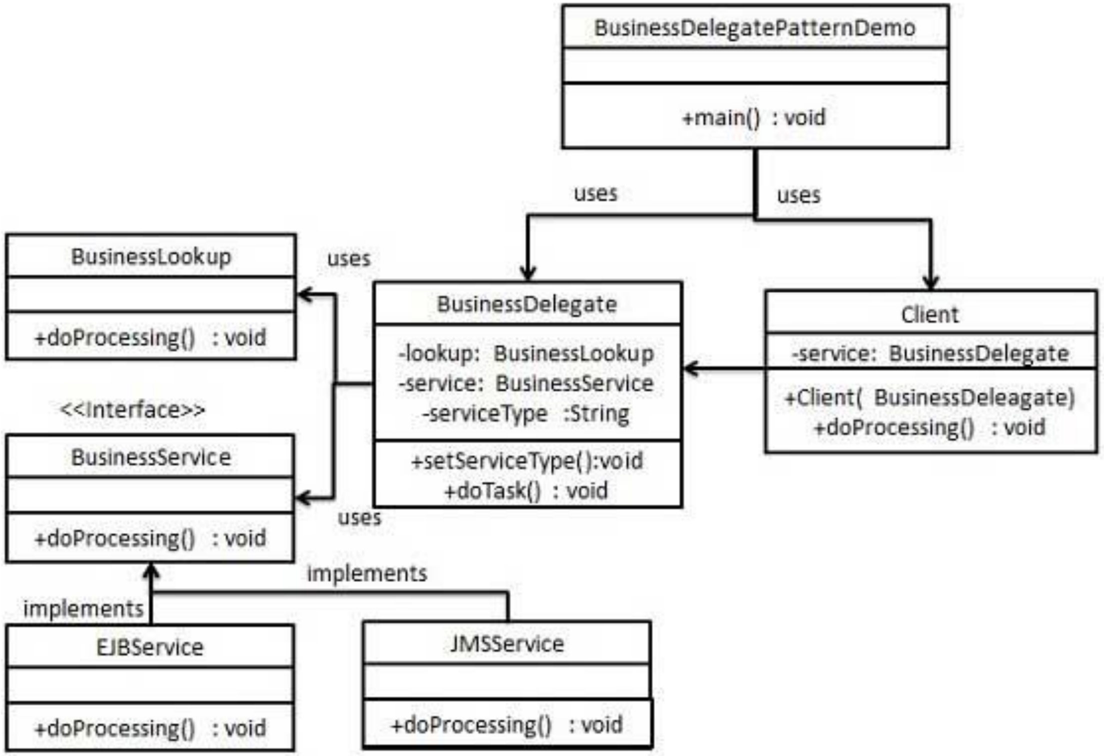
Business Delegate Pattern is used to decouple presentation tier and business tier. It is basically use to reduce communication or remote lookup functionality to business tier code in presentation tier code. In business tier we've following entities.

- **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 implements this business service to provide actual business implementation logic.

J2EE: Business Delegate Pattern

Implementation

- We're going to create a *Client*, *BusinessDelegate*, *BusinessService*, *LookUpService*, *JMSService* and *EJBService* representing various entities of Business Delegate pattern.
- *BusinessDelegatePatternDemo*, our demo class will use *BusinessDelegate* and *Client* to demonstrate use of Business Delegate pattern.



J2EE: Business Delegate Pattern

Implementation

Step 1: Create BusinessService Interface.

BusinessService.java

```
public interface BusinessService {
   public void doProcessing();
}
```

Step 2: Create Concreate Service Classes.

EJBService.java

```
public class EJBService implements BusinessService {

   @Override
   public void doProcessing() {
      System.out.println("Processing task by invoking 
EJB Service");
   }
}
```

JMSService.java

```
public class JMSService implements BusinessService {

   @Override
   public void doProcessing() {
      System.out.println("Processing task by invoking 
JMS Service");
   }
}
```

Step 3: Create Business Lookup Service.

BusinessLookUp.java

```
public class BusinessLookUp {
   public BusinessService getBusinessService(String 
serviceType){
      if(serviceType.equalsIgnoreCase("EJB")){
         return new EJBService();
      }else {
         return new JMSService();
      }
   }
}
```

Step 4: Create Business Delegate.

BusinessLookUp.java

```
public class BusinessDelegate {
   private BusinessLookUp lookupService = new 
BusinessLookUp();
   private BusinessService businessService;
   private String serviceType;

   public void setServiceType(String serviceType){
      this.serviceType = serviceType;
   }

   public void doTask(){
      businessService = 
lookupService.getBusinessService(serviceType);
      businessService.doProcessing();
   }
}
```

J2EE: Business Delegate Pattern

Implementation

Step 5: Create Client.

Student.java

```
public class Client {

   BusinessDelegate businessService;

   public Client(BusinessDelegate businessService){
      this.businessService  = businessService;
   }

   public void doTask(){
      businessService.doTask();
   }
}
```

Step 6: Use BusinessDelegate and Client classes to demonstrate Business Delegate pattern.

BusinessDelegatePatternDemo.java

```
public class BusinessDelegatePatternDemo {

   public static void main(String[] args) {

      BusinessDelegate businessDelegate = new
BusinessDelegate();
      businessDelegate.setServiceType("EJB");

      Client client = new Client(businessDelegate);
      client.doTask();

      businessDelegate.setServiceType("JMS");
      client.doTask();
   }
}
```

Step 7: Verify the output.

```
Processing task by invoking EJB Service
Processing task by invoking JMS Service
```

J2EE Design Patterns

Composite Entity Pattern

J2EE : Composite Entity Pattern

Definition

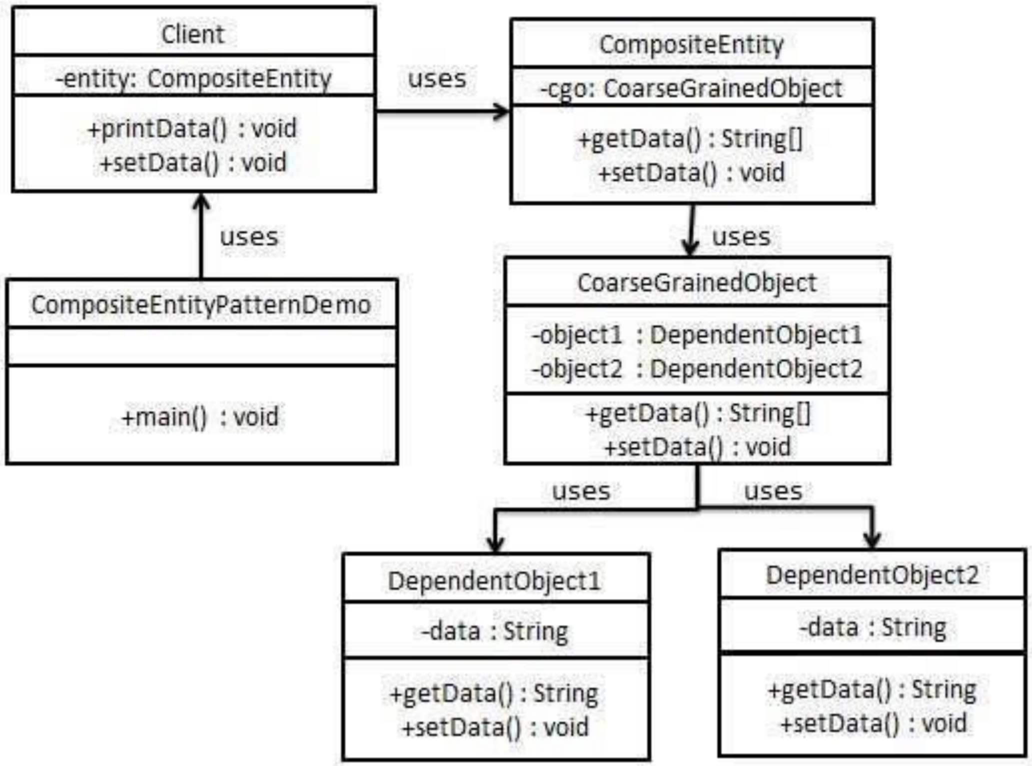
Composite Entity pattern is used in EJB persistence mechanism. A Composite entity is an EJB entity bean which represents a graph of objects. When a composite entity is updated, internally dependent objects beans get updated automatically as being managed by EJB entity bean. Following are the participants 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 objects is an object which depends on Coarse-Grained object for its persistence lifecycle.
- **Strategies** - Strategies represents how to implement a Composite Entity.

J2EE: COMPOSITE ENTITY PATTERN

IMPLEMENTATION

- We're going to create *CompositeEntity* object acting as CompositeEntity. *CoarseGrainedObject* will be a class which contains dependent objects. *CompositeEntityPatternDemo*, our demo class will use *Client* class to demonstrate use of Composite Entity pattern.



J2EE: Composite Entity Pattern

Implementation

Step 1: Create Dependent Objects.

DependentObject1.java

```
public class DependentObject1 {

   private String data;

   public void setData(String data){
      this.data = data;
   }

   public String getData(){
      return data;
   }
}
```

DependentObject2.java

```
public class DependentObject2 {

   private String data;

   public void setData(String data){
      this.data = data;
   }

   public String getData(){
      return data;
   }
}
```

Step 2: Create Coarse Grained Object.

CoarseGrainedObject.java

```
public class CoarseGrainedObject {
   DependentObject1 do1 = new DependentObject1();
   DependentObject2 do2 = new DependentObject2();

   public void setData(String data1, String data2){
      do1.setData(data1);
      do2.setData(data2);
   }

   public String[] getData(){
      return new String[] {do1.getData(),do2.getData()};
   }
}
```

Step 3: Create Composite Entity.

CompositeEntity.java

```
public class CompositeEntity {
   private CoarseGrainedObject cgo = new
CoarseGrainedObject();

   public void setData(String data1, String data2){
      cgo.setData(data1, data2);
   }

   public String[] getData(){
      return cgo.getData();
   }
}
```

J2EE: Composite Entity Pattern

Implementation

Step 4: Create Client class to use Composite Entity.

Client.java

```
public class Client {
   private CompositeEntity compositeEntity = new CompositeEntity();

   public void printData(){
      for (int i = 0; i < compositeEntity.getData().length; i++) {
         System.out.println("Data: " + compositeEntity.getData()[i]);
      }
   }

   public void setData(String data1, String data2){
      compositeEntity.setData(data1, data2);
   }
}
```

Step 5: Use the *Client* to demonstrate Composite Entity design pattern usage.

CompositeEntityPatternDemo.java

```
public class CompositeEntityPatternDemo {
   public static void main(String[] args) {
      Client client = new Client();
      client.setData("Test", "Data");
      client.printData();
      client.setData("Second Test", "Data1");
      client.printData();
   }
}
```

Step 6: Verify the output.

```
Data: Test
Data: Data
Data: Second Test
Data: Data1
```

J2EE Design Patterns

Data Access Object Pattern

J2EE : Data Access Object

Definition

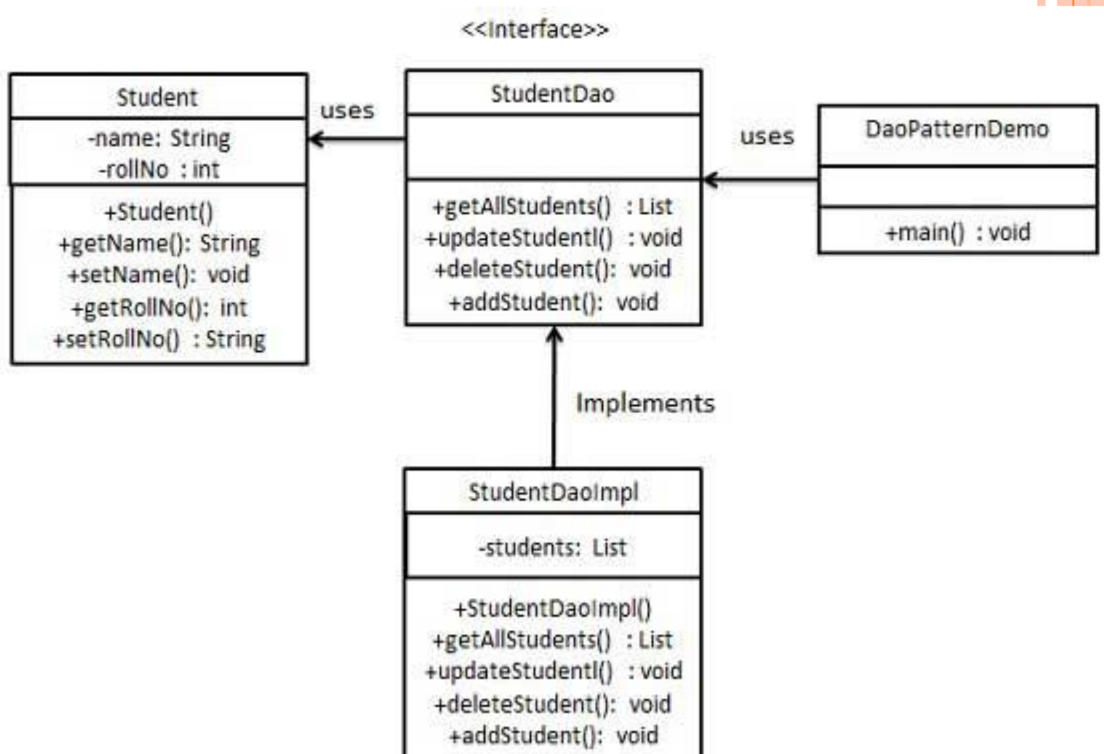
Data Access Object Pattern or DAO pattern is used to separate low level data accessing API or operations from high level business services. Following are the participants in Data Access Object Pattern.

- **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 datasource 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.

J2EE: DATA ACCESS OBJECT

IMPLEMENTATION

- We're going to create a *Student* object acting as a Model or Value Object.*StudentDao* is Data Access Object Interface.*StudentDaoImpl* is concrete class implementing Data Access Object Interface. *DaoPatternDemo*, our demo class will use *StudentDao* demonstrate use of Data Access Object pattern.



J2EE: Data Access Object Pattern

Implementation

Step 1: Create Value Object.

Student.java

```
public class Student {
   private String name;
   private int rollNo;

   Student(String name, int rollNo){
      this.name = name;
      this.rollNo = rollNo;
   }

   public String getName() {
      return name;
   }

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

   public int getRollNo() {
      return rollNo;
   }

   public void setRollNo(int rollNo) {
      this.rollNo = rollNo;
   }
}
```

Step 2: Create Data Access Object Interface.

StudentDao.java

```
import java.util.List;

public interface StudentDao {
   public List<Student> getAllStudents();
   public Student getStudent(int rollNo);
   public void updateStudent(Student student);
   public void deleteStudent(Student student);
}
```

Step 3: Create concreate class implementing above interface.

StudentDaoImpl.java

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

public class StudentDaoImpl implements StudentDao {

   //list is working as a database
   List<Student> students;

   public StudentDaoImpl(){
      students = new ArrayList<Student>();
      Student student1 = new Student("Robert",0);
      Student student2 = new Student("John",1);
      students.add(student1);
      students.add(student2);
   }
```

J2EE: Data Access Object Pattern

Implementation

```java
@Override
   public void deleteStudent(Student student) {
      students.remove(student.getRollNo());
      System.out.println("Student: Roll No " +
student.getRollNo()
         +", deleted from database");
   }

   //retrive list of students from the database
   @Override
   public List<Student> getAllStudents() {
      return students;
   }
   @Override
   public Student getStudent(int rollNo) {
      return students.get(rollNo);
   }
   @Override
   public void updateStudent(Student student) {

students.get(student.getRollNo()).setName(student.getNam
e());
      System.out.println("Student: Roll No " +
student.getRollNo()
         +", updated in the database");
   }
}
```

Step 4: Use the *StudentDao* to demonstrate Data Access Object pattern usage.

CompositeEntityPatternDemo.java

```java
public class DaoPatternDemo {
   public static void main(String[] args) {
      StudentDao studentDao = new StudentDaoImpl();

      //print all students
      for (Student student :
studentDao.getAllStudents()) {
         System.out.println("Student: [RollNo : "
            +student.getRollNo()+", Name :
"+student.getName()+" ]");
      }

      //update student
      Student student
=studentDao.getAllStudents().get(0);
      student.setName("Michael");
      studentDao.updateStudent(student);

      //get the student
      studentDao.getStudent(0);
      System.out.println("Student: [RollNo : "
         +student.getRollNo()+", Name :
"+student.getName()+" ]");
   }
}
```

Step 5: Verify the output.

```
Student: [RollNo : 0, Name : Robert ]
Student: [RollNo : 1, Name : John ]
Student: Roll No 0, updated in the database
Student: [RollNo : 0, Name : Michael ]
```

J2EE Design Patterns

Front Controller Pattern

J2EE : Front Controller

Definition

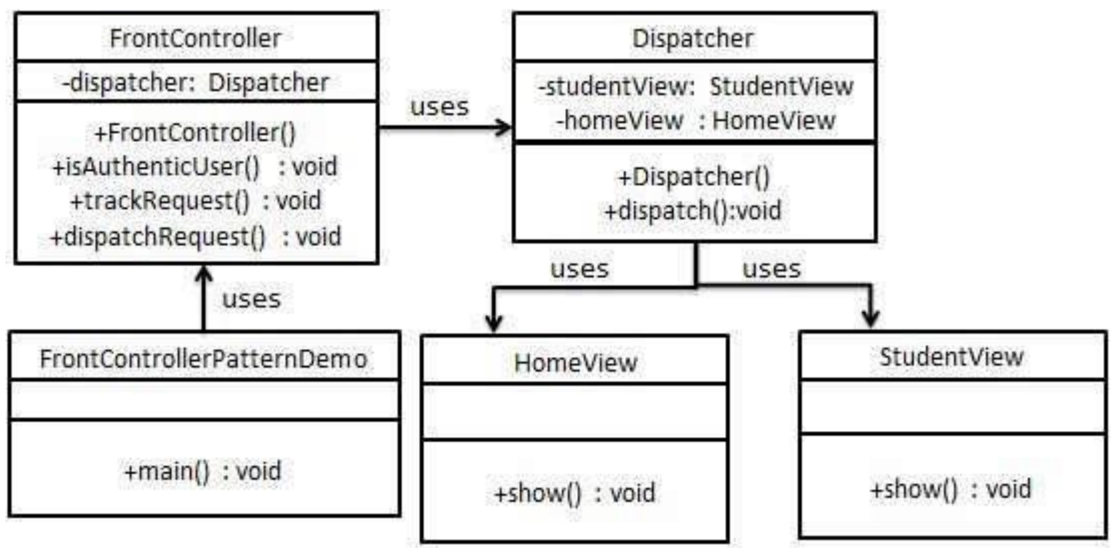
The front controller design pattern is used to provide a centralized request handling mechanism so that all requests will be handled by a single handler. This handler can do the authentication/ authorization/ logging or tracking of request and then pass the requests to corresponding handlers. Following are the entities of this type of design pattern.

- **Front Controller** - Single handler for all kind of request coming to the application (either web based/ desktop based).
- **Dispatcher** - Front Controller may use a dispatcher object which can dispatch the request to corresponding specific handler.
- **View** - Views are the object for which the requests are made.

J2EE: Front Controller

Implementation

- We're going to create a *FrontController*,*Dispatcher* to act as Front Controller and Dispatcher correspondingly. *HomeView* and *StudentView* represent various views for which requests can come to front controller.
- *FrontControllerPatternDemo*, our demo class will use *FrontController* ato demonstrate Front Controller Design Pattern.



J2EE: Front Controller Pattern

Implementation

Step 1: Create Views.

HomeView.java

```
public class HomeView {
   public void show(){
      System.out.println("Displaying Home Page");
   }
}
```

StudentView.java

```
public class StudentView {
   public void show(){
      System.out.println("Displaying Student Page");
   }
}
```

Step 2: Create Dispatcher.

Dispatcher.java

```
public class Dispatcher {
   private StudentView studentView;
   private HomeView homeView;
   public Dispatcher(){
      studentView = new StudentView();
      homeView = new HomeView();
   }

   public void dispatch(String request){
      if(request.equalsIgnoreCase("STUDENT")){
         studentView.show();
      }else{
         homeView.show();
      }
   }
}
```

Step 3: Create FrontController

Context.java

```
public class FrontController {

   private Dispatcher dispatcher;

   public FrontController(){
      dispatcher = new Dispatcher();
   }

   private boolean isAuthenticUser(){
      System.out.println("User is authenticated 
successfully.");
      return true;
   }

   private void trackRequest(String request){
      System.out.println("Page requested: " + request);
   }

   public void dispatchRequest(String request){
      //log each request
      trackRequest(request);
      //authenticate the user
      if(isAuthenticUser()){
         dispatcher.dispatch(request);
      }
   }
}
```

J2EE: Front Controller Pattern

Implementation

Step 4: Use the *FrontController* to demonstrate Front Controller Design Pattern.

FrontControllerPatternDemo.java

```
public class FrontControllerPatternDemo {
   public static void main(String[] args) {
      FrontController frontController = new
FrontController();
      frontController.dispatchRequest("HOME");
      frontController.dispatchRequest("STUDENT");
   }
}
```

Step 5: Verify the output.

```
Page requested: HOME
User is authenticated successfully.
Displaying Home Page
Page requested: STUDENT
User is authenticated successfully.
Displaying Student Page
```

J2EE Design Patterns

Intercepting Filter Pattern

J2EE : INTERCEPTING FILTER

DEFINITION

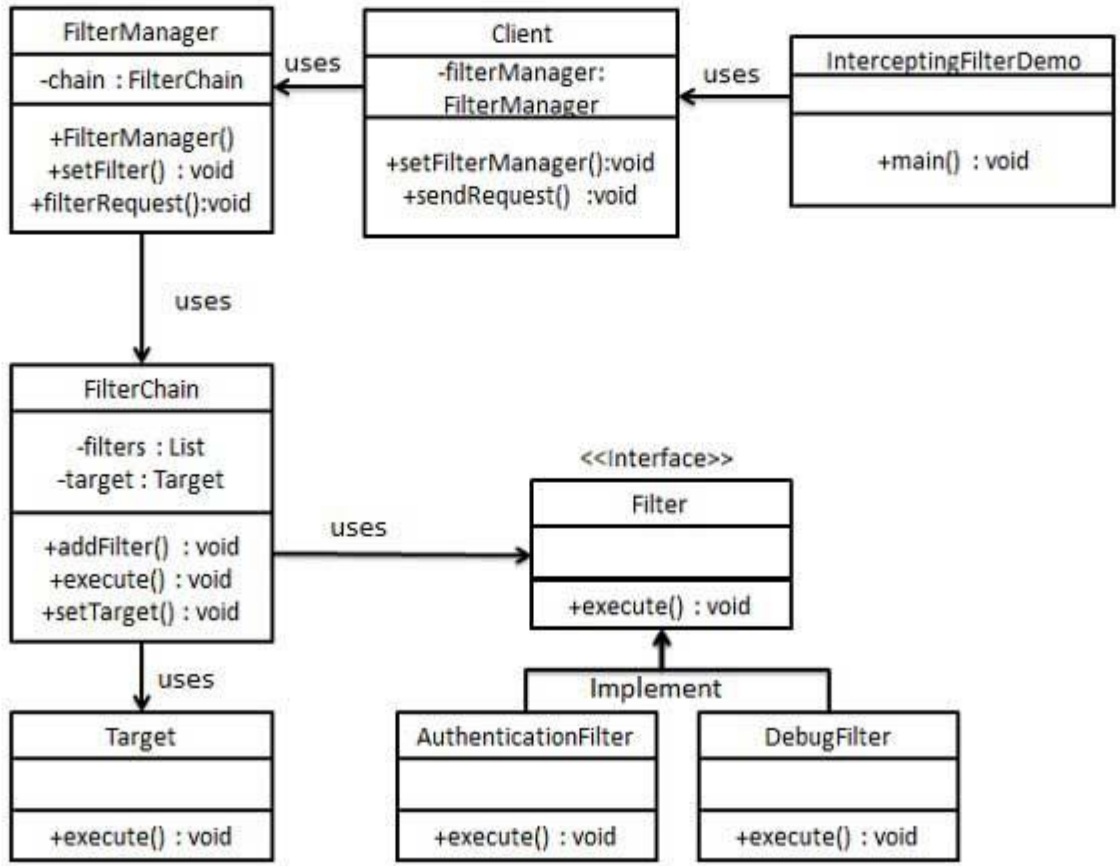
The intercepting filter design pattern is used when we want to do some pre-processing / post-processing with request or response of the application. Filters are defined and applied on the request before passing the request to actual target application. Filters can do the authentication/ authorization/ logging or tracking of request and then pass the requests to corresponding handlers. Following are the entities of this type of design pattern.

- **Filter** - Filter which will perform certain task prior or after execution of request by request handler.
- **Filter Chain** - Filter Chain carries multiple filters and help to execute them in defined order on target.
- **Target** - Target object is the request handler
- **Filter Manager** - Filter Manager manages the filters and Filter Chain.
- **Client** - Client is the object who sends request to the Target object.

J2EE: Intercepting Filter

Implementation

- We're going to create a *FilterChain*,*FilterManager*, *Target*, *Client* as various objects representing our entities.*AuthenticationFilter* and *DebugFilter* represents concrete filters.
- *InterceptingFilterDemo*, our demo class will use *Client* to demonstrate Intercepting Filter Design Pattern.



J2EE: Intercepting Filter Pattern

Implementation

Step 1: Create Filter interface.

Filter.java

```
public interface Filter {
   public void execute(String request);
}
```

Step 2: Create concrete filters.

AuthenticationFilter.java

```
public class AuthenticationFilter implements Filter {
   public void execute(String request){
      System.out.println("Authenticating request: " +
request);
   }
}
```

DebugFilter.java

```
public class DebugFilter implements Filter {
   public void execute(String request){
      System.out.println("request log: " + request);
   }
}
```

Step 3: Create Target

Target.java

```
public class Target {
   public void execute(String request){
      System.out.println("Executing request: " +
request);
   }
}
```

Step 4: Create Filter Chain

FilterChain.java

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

public class FilterChain {
   private List<Filter> filters = new
ArrayList<Filter>();
   private Target target;

   public void addFilter(Filter filter){
      filters.add(filter);
   }

   public void execute(String request){
      for (Filter filter : filters) {
         filter.execute(request);
      }
      target.execute(request);
   }

   public void setTarget(Target target){
      this.target = target;
   }
}
```

J2EE: Intercepting Filter Pattern

Implementation

Step 5: Create Filter Manager

FilterManager.java

```
public class FilterManager {
   FilterChain filterChain;

   public FilterManager(Target target){
      filterChain = new FilterChain();
      filterChain.setTarget(target);
   }
   public void setFilter(Filter filter){
      filterChain.addFilter(filter);
   }

   public void filterRequest(String request){
      filterChain.execute(request);
   }
}
```

Step 6: Create Client

Client.java

```
public class Client {
   FilterManager filterManager;

   public void setFilterManager(FilterManager
filterManager){
      this.filterManager = filterManager;
   }

   public void sendRequest(String request){
      filterManager.filterRequest(request);
   }
}
```

Step 7: Use the *Client* to demonstrate Intercepting Filter Design Pattern.

FrontControllerPatternDemo.java

```
public class InterceptingFilterDemo {
   public static void main(String[] args) {
      FilterManager filterManager = new
FilterManager(new Target());
      filterManager.setFilter(new
AuthenticationFilter());
      filterManager.setFilter(new DebugFilter());

      Client client = new Client();
      client.setFilterManager(filterManager);
      client.sendRequest("HOME");
   }
}
```

Step 8: Verify the output.

```
Authenticating request: HOME
request log: HOME
Executing request: HOME
```

J2EE Design Patterns

Service Locator Pattern

J2EE : Service Locator

Definition

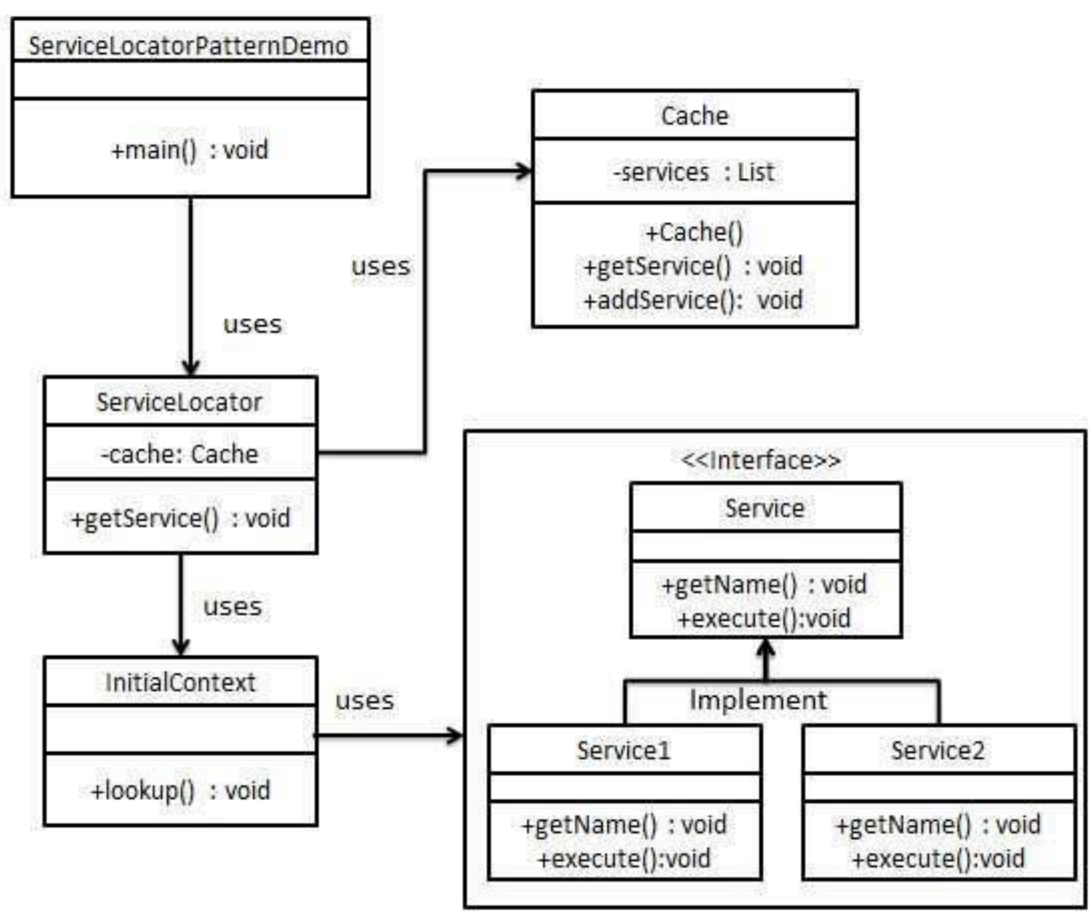
The service locator design pattern is used when we want to locate various services using JNDI lookup. Considering high cost of looking up JNDI for a service, Service Locator pattern makes use of caching technique. For the first time a service is required, Service Locator looks up in JNDI and caches the service object. Further lookup or same service via Service Locator is done in its cache which improves the performance of application to great extent. Following are the entities of this type of design pattern.

- **Service** - Actual Service which will process the request. Reference of such service is to be looked upon in JNDI server.
- **Context / Initial Context** -JNDI Context, carries the reference to service used for lookup purpose.
- **Service Locator** - Service Locator is a single point of contact to get services by JNDI lookup, caching the services.
- **Cache** - Cache to store references of services to reuse them
- **Client** - Client is the object who invokes the services via ServiceLocator.

J2EE: Service Locator

Implementation

- We're going to create a *ServiceLocator*,*InitialContext*, *Cache*, *Service* as various objects representing our entities.*Service1* and *Service2* represents concrete services.
- *ServiceLocatorPatternDemo*, our demo class is acting as a client here and will use *ServiceLocator* to demonstrate Service Locator Design Pattern.



J2EE: Service Locator Pattern

Implementation

Step 1: Create Service interface.

Service.java

```
public interface Service {
   public String getName();
   public void execute();
}
```

Step 2: Create concrete services.

Service1.java

```
public class Service1 implements Service {
   public void execute(){
      System.out.println("Executing Service1");
   }

   @Override
   public String getName() {
      return "Service1";
   }
}
```

Service2.java

```
public class Service2 implements Service {
   public void execute(){
      System.out.println("Executing Service2");
   }

   @Override
   public String getName() {
      return "Service2";
   }
}
```

Step 3: Create InitialContext for JNDI lookup

InitialContext.java

```
public class InitialContext {
```

```
   public Object lookup(String jndiName){
      if(jndiName.equalsIgnoreCase("SERVICE1")){
         System.out.println("Looking up and creating a new 
Service1 object");
         return new Service1();
      }else if (jndiName.equalsIgnoreCase("SERVICE2")){
         System.out.println("Looking up and creating a new 
Service2 object");
         return new Service2();
      }
      return null;
   }
}
```

Step 4: Create Cache

Cache.java

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

public class Cache {

   private List<Service> services;

   public Cache(){
      services = new ArrayList<Service>();
   }

   public Service getService(String serviceName){
      for (Service service : services) {
 
if(service.getName().equalsIgnoreCase(serviceName)){
            System.out.println("Returning cached 
"+serviceName+" object");
            return service;
         }
```

J2EE: Service Locator Pattern

Implementation

```
}
      return null;
   }

   public void addService(Service newService){
      boolean exists = false;
      for (Service service : services) {

if(service.getName().equalsIgnoreCase(newService.getName()))
){
            exists = true;
         }
      }
      if(!exists){
         services.add(newService);
      }
   }
}
```

Step 5: Create Service Locator

ServiceLocator.java

```
public class ServiceLocator {
   private static Cache cache;

   static {
      cache = new Cache();
   }

   public static Service getService(String jndiName){

      Service service = cache.getService(jndiName);

      if(service != null){
         return service;
      }
```

```
         InitialContext context = new InitialContext();
         Service service1 = (Service)context.lookup(jndiName);
         cache.addService(service1);
         return service1;
      }
}
```

Step 6: Use the *ServiceLocator* to demonstrate Service Locator Design Pattern.

ServiceLocatorPatternDemo.java

```
public class ServiceLocatorPatternDemo {
   public static void main(String[] args) {
      Service service =
ServiceLocator.getService("Service1");
      service.execute();
      service = ServiceLocator.getService("Service2");
      service.execute();
      service = ServiceLocator.getService("Service1");
      service.execute();
      service = ServiceLocator.getService("Service2");
      service.execute();
   }
}
```

Step 7: Verify the output.

```
Looking up and creating a new Service1 object
Executing Service1
Looking up and creating a new Service2 object
Executing Service2
Returning cached  Service1 object
Executing Service1
Returning cached  Service2 object
Executing Service2
```

J2EE Design Patterns

Transfer Object Pattern

J2EE : Transfer Object

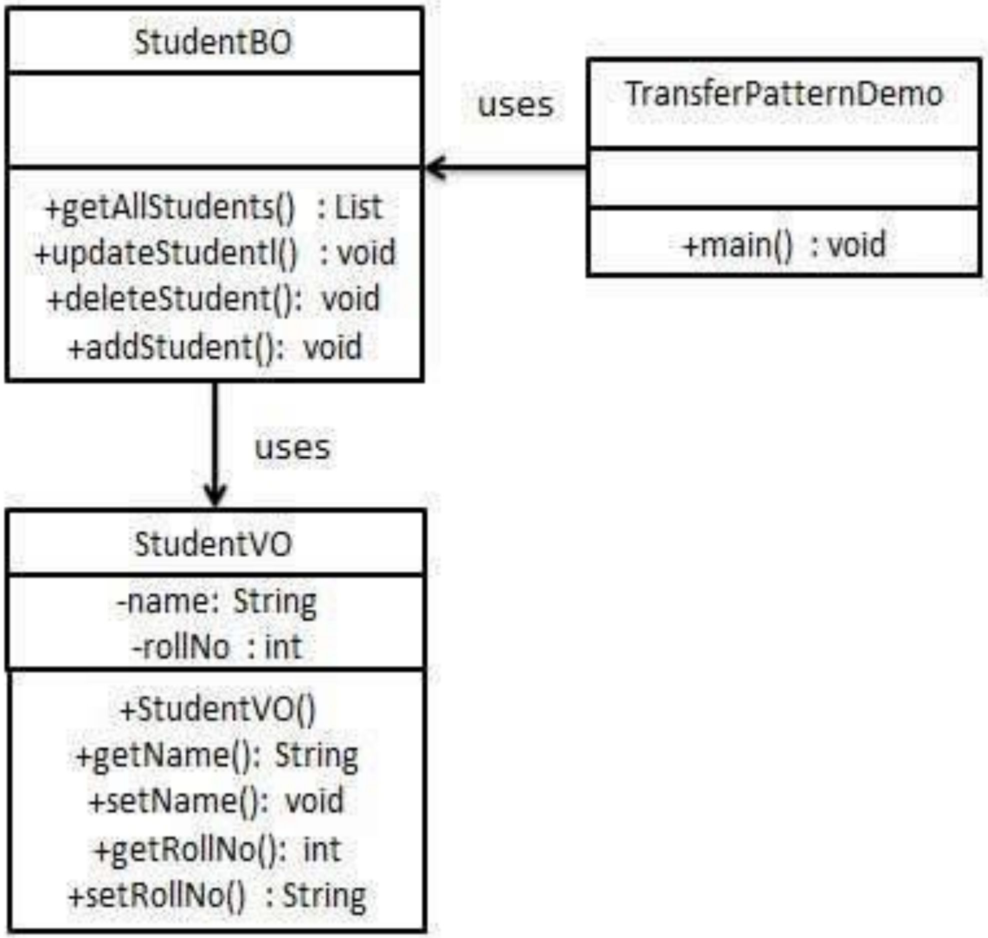
Definition

The Transfer Object pattern is used when we want to pass data with multiple attributes in one shot from client to server. Transfer object is also known as Value Object. Transfer Object is a simple POJO class having getter/setter methods and is serializable so that it can be transferred over the network. It do not have any behavior. Server Side business class normally fetches data from the database and fills the POJO and send it to the client or pass it by value. For client, transfer object is read-only. Client can create its own transfer object and pass it to server to update values in database in one shot. Following are the entities of this type of design pattern.

- **Business Object** - Business Service which fills the Transfer Object with data.
- **Transfer Object** -Simple POJO, having methods to set/get attributes only.
- **Client** - Client either requests or sends the Transfer Object to Business Object.

J2EE: Transfer Object implementation

- We're going to create a *StudentBO* as Business Object,*Student* as Transfer Object representing our entities.
- *TransferObjectPatternDemo*, our demo class is acting as a client here and will use *StudentBO* and *Student* to demonstrate Transfer Object Design Pattern.



J2EE: Transfer Object Pattern

Implementation

Step 1: Create Transfer Object.
StudentVO.java

```
public class StudentVO {
   private String name;
   private int rollNo;

   StudentVO(String name, int rollNo){
      this.name = name;
      this.rollNo = rollNo;
   }

   public String getName() {
      return name;
   }

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

   public int getRollNo() {
      return rollNo;
   }

   public void setRollNo(int rollNo) {
      this.rollNo = rollNo;
   }
}
```

Step 2: Create Business Object.
StudentBO.java

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

public class StudentBO {

   //list is working as a database
   List<StudentVO> students;

   public StudentBO(){
      students = new ArrayList<StudentVO>();
      StudentVO student1 = new StudentVO("Robert",0);
      StudentVO student2 = new StudentVO("John",1);
      students.add(student1);
      students.add(student2);
   }
   public void deleteStudent(StudentVO student) {
      students.remove(student.getRollNo());
      System.out.println("Student: Roll No "
      + student.getRollNo() +", deleted from database");
   }

   //retrive list of students from the database
   public List<StudentVO> getAllStudents() {
      return students;
   }

   public StudentVO getStudent(int rollNo) {
      return students.get(rollNo);
   }
```

J2EE: Transfer Object Pattern

Implementation

```
public void updateStudent(StudentVO student) {

students.get(student.getRollNo()).setName(student.getNam
e());
      System.out.println("Student: Roll No "
      + student.getRollNo() +", updated in the
database");
   }
}
```

Step 3: Use the *StudentBO* to demonstrate Transfer Object Design Pattern.

TransferObjectPatternDemo.java

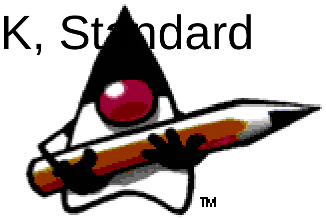
```
public class TransferObjectPatternDemo {
   public static void main(String[] args) {
      StudentBO studentBusinessObject = new StudentBO();

      //print all students
      for (StudentVO student :
studentBusinessObject.getAllStudents()) {
         System.out.println("Student: [RollNo : "
         +student.getRollNo()+", Name :
"+student.getName()+" ]");
      }

      //update student
      StudentVO student
=studentBusinessObject.getAllStudents().get(0);
      student.setName("Michael");
      studentBusinessObject.updateStudent(student);

      //get the student
      studentBusinessObject.getStudent(0);
      System.out.println("Student: [RollNo : "
      +student.getRollNo()+", Name :
"+student.getName()+" ]");
   }
}
```

Step 4: Verify the output.

```
Student: [RollNo : 0, Name : Robert ]
Student: [RollNo : 1, Name : John ]
Student: Roll No 0, updated in the database
Student: [RollNo : 0, Name : Michael ]
```

Useful Links on Design Patterns

Wiki Page for Design Patterns - Check out design patterns in a very generic way
Java Programming/Design Patterns - A very good article on Design Patterns
The Java™ Tutorials -The Java Tutorials are practical guides for programmers who want to use the Java programming language to create applications.
Java™ 2 SDK, Standard Edition - Official site for Java™ 2 SDK, Standard Edition
Java DesignPatterns - Short articles on Design Patterns.



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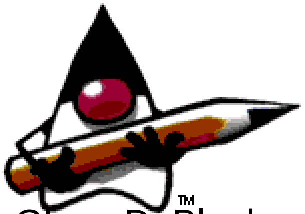

Books

- Larman, chapters 25 and 26, CSE432 , Object-Oriented Software , Engineering, Glenn D. Blank, Lehigh University
- *Timeless Way of Building*, Alexander, ISBN 0-19-502402-8
- *A Pattern Language*, Alexander, 0-19-501-919-9
- *Design Patterns*, Gamma, et al., 0-201-63361-2 CD version 0-201-63498-8
- *Pattern-Oriented Software Architecture*, *Vol. 1*, Buschmann, et al., 0-471-95869-7
- *Pattern-Oriented Software Architecture, Vol. 2*, Schmidt, et al., 0-471-60695-2
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- The Pattern Almanac 2000, Rising, 0-201-61567-3

Early Papers

- “Object-Oriented Patterns,” P. Coad; Comm. of the ACM, 9/92
- “Documenting Frameworks using Patterns,” R. Johnson; OOPSLA ’92
- “Design Patterns: Abstraction & Reuse of Object-Oriented Design,” Gamma, Helm, Johnson, Vlissides, ECOOP ’93

USEFUL BOOKS ON JAVA DESIGN PATTERNS