Ingineria programării

Curs 7

15 aprilie

Din Cursurile Trecute

- Design Patterns: Definitions, Elements
- GOF: Creational Patterns, Structural Patterns, Behavioral Patterns

Creational Patterns

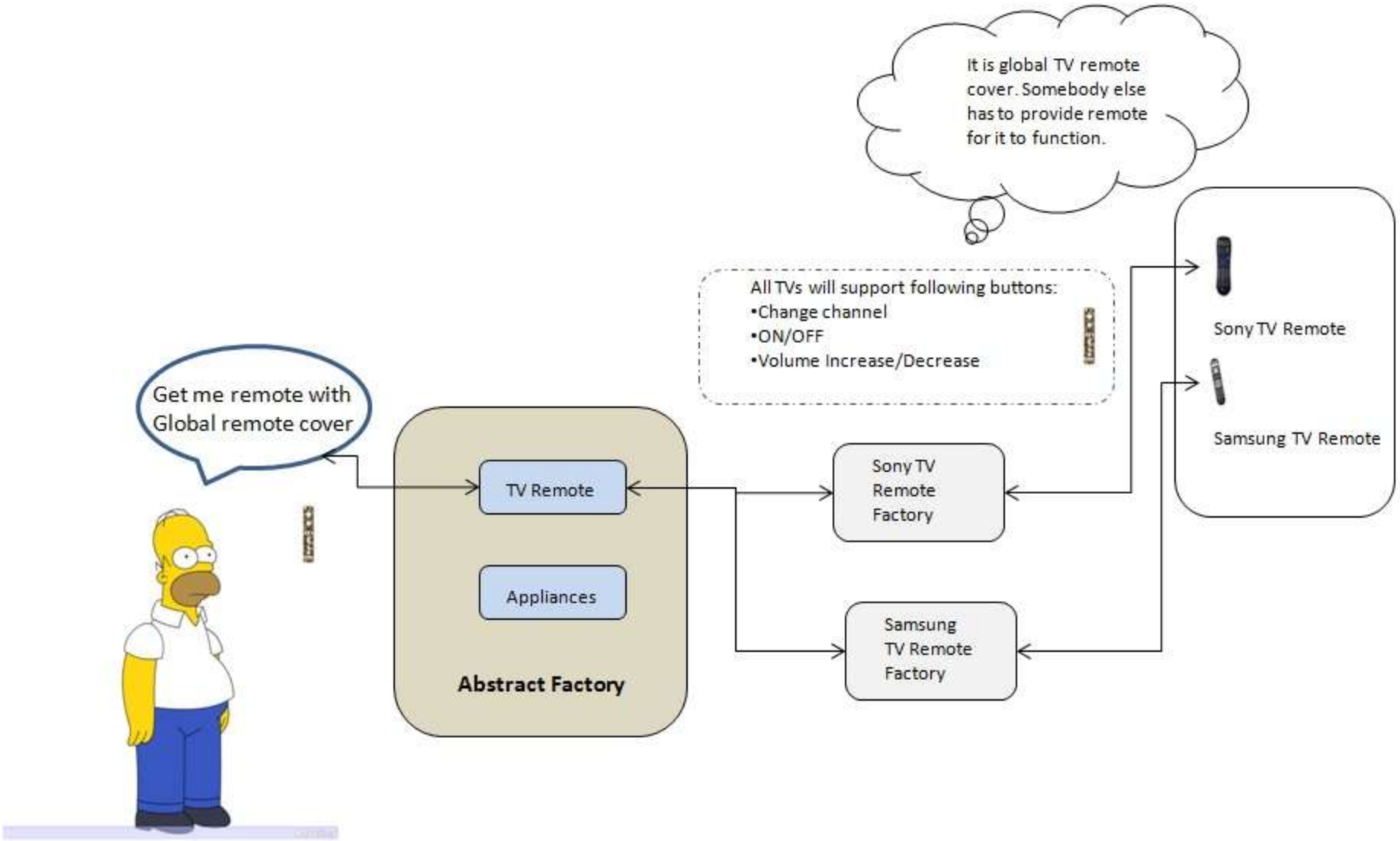
- Abstract Factory
- Builder
- Factory Method
- Prototype
- Singleton
- Lazy initialization
- Object pool
- Multiton
- Resource acquisition

Creational Patterns – Introduction

- Abstract the instantiation process
- Help **make a system independent of how its objects are created, composed, and represented**
- There are two recurring themes in these patterns:
  - First, they all encapsulate knowledge about which concrete classes the system uses
  - Second, they hide how instances of these classes are created and put together
- The creational patterns give a lot of flexibility in *what* gets created, *who creates it, how it gets created, and when*

Creational Patterns – Abstract Factory

- **Intent** – Provide an interface for creating families of related or dependent objects without specifying their concrete classes
- **Also Known As** – Kit
- **Motivation**
  - Consider a user interface toolkit that supports multiple look-and-feel standards, defines different appearances and behaviors for user interface "widgets" like scroll bars, windows, and buttons
  - To be portable across look-and-feel standards, an application should not hard-code its widgets for a particular look and feel

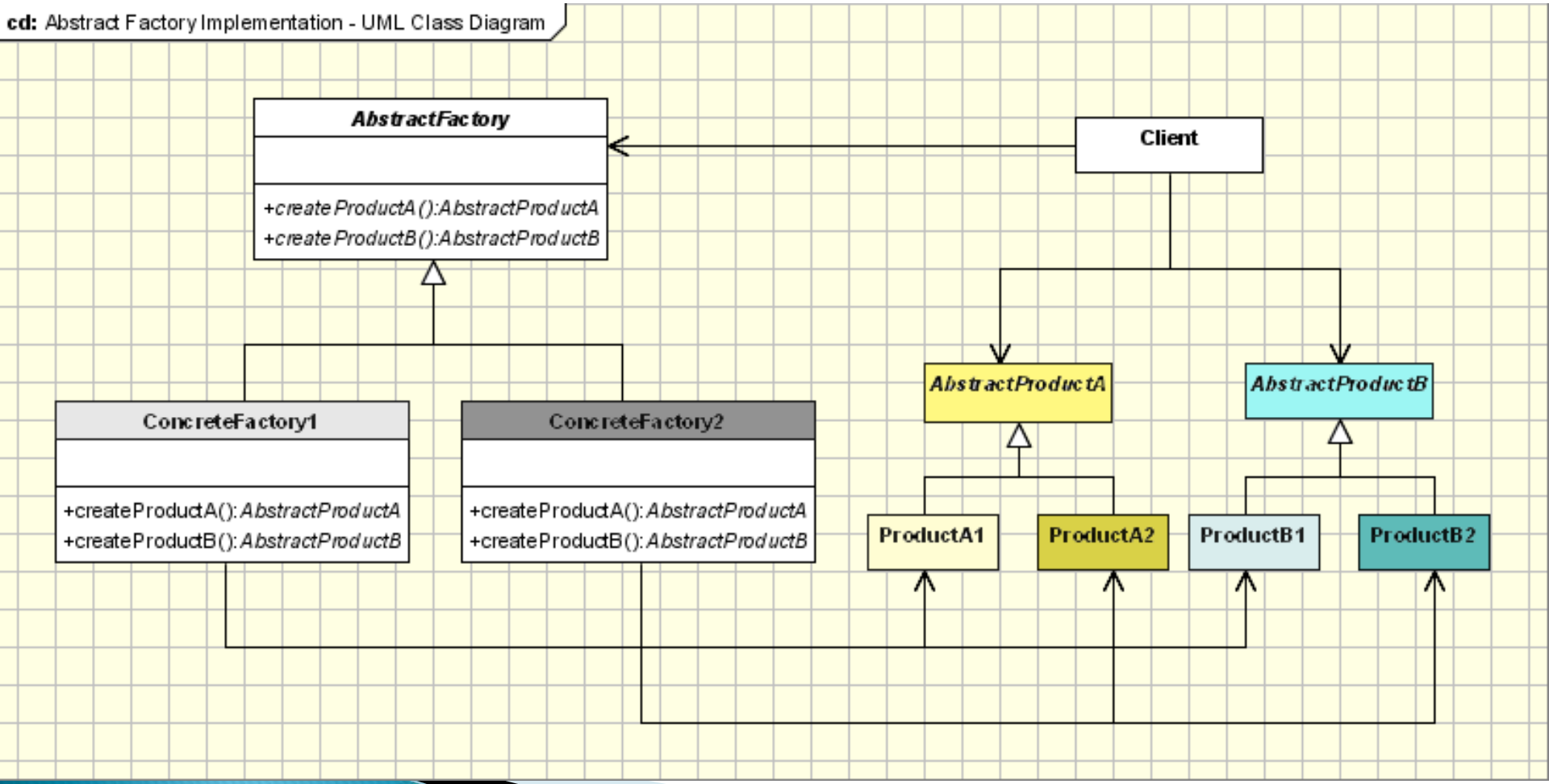

It is global TV remote cover. Somebody else has to provide remote for it to function.
All TVs will support following buttons:
•Change channel
•ON/OFF
•Volume Increase/Decrease
Sony TV Remote
Samsung TV Remote
Get me remote with Global remote cover
TV Remote
Appliances
Abstract Factory
Sony TV Remote Factory
Samsung TV Remote Factory

Abstract Factory

- **Applicability** – Use this pattern when:
  - a system should be independent of how its products are created, composed, and represented
  - a system should be configured with one of multiple families of products
  - a family of related product objects is designed to be used together, and you need to enforce this constraint
  - you want to provide a class library of products, and you want to reveal just their interfaces, not their implementations

CP – Abstract Factory

- **Abstract Factory** – maze, computer components



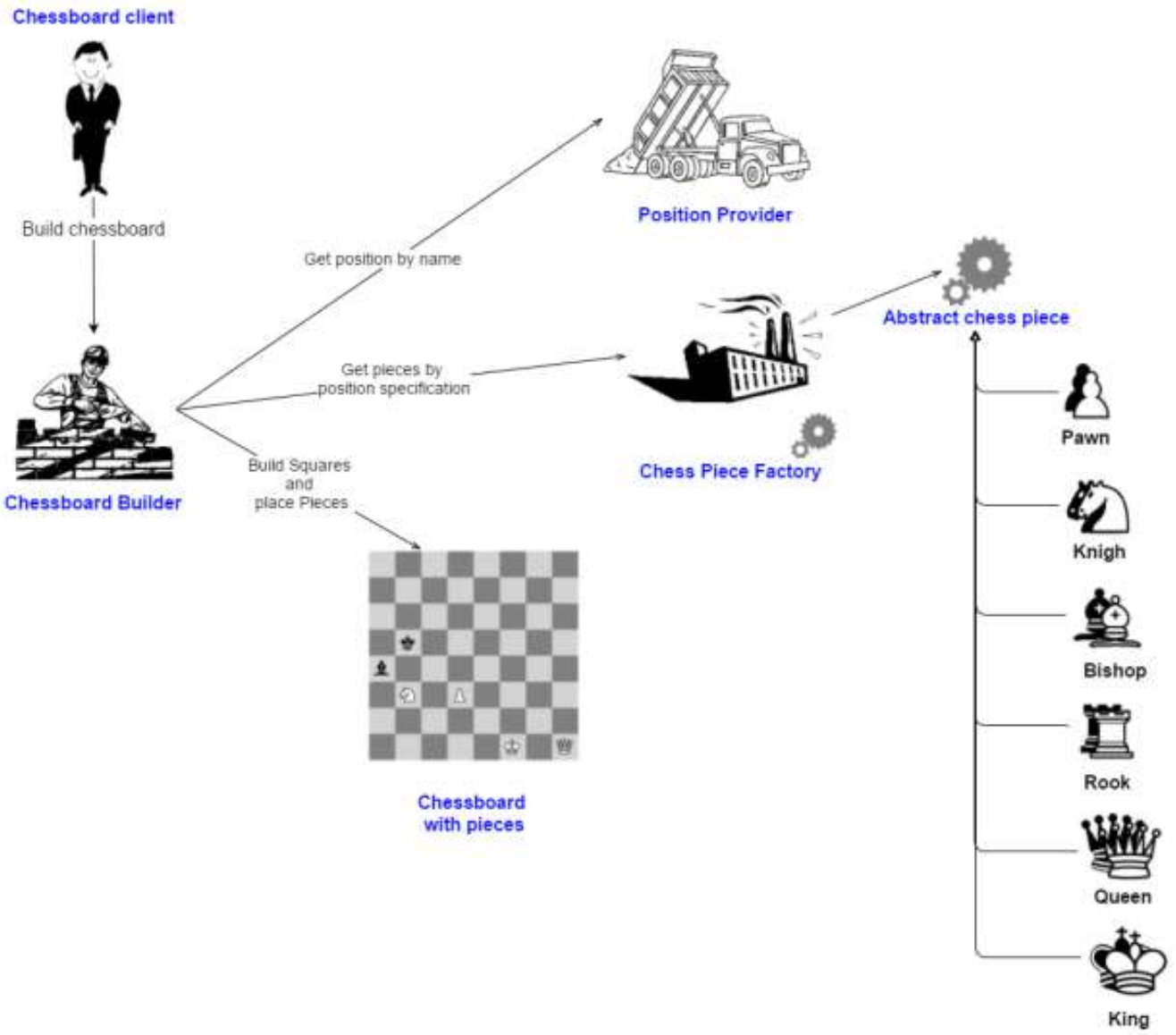
Abstract Factory– The Good, The Bad …

- Detaches creators from created objects
- Guarantees compatibility of created objects
- Preserves S and O (from SOLID)
- Code becomes complicated because of lots of extra classes

Creational Patterns – Builder

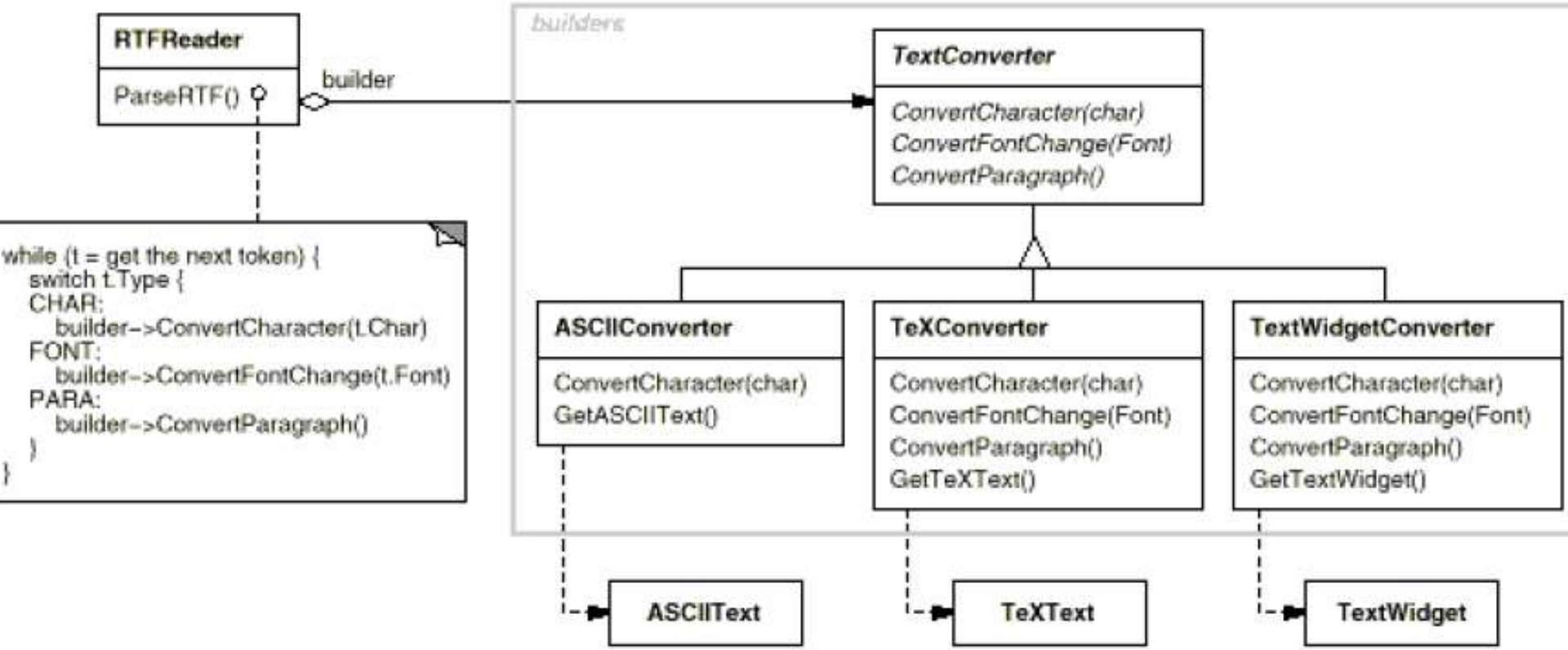
- **Intent – Separate the construction of a complex object from its representation** so that the same construction process can create different representations
- **Motivation**
  - A reader for the RTF (Rich Text Format) document exchange format should be able to convert RTF to many text formats.
  - The reader might convert RTF documents into plain ASCII text or into a text widget that can be edited interactively. The problem, however, is that the number of possible conversions is open-ended. So it should be easy to add a new conversion without modifying the reader.

Builder and Factory Design Pattern - Building chessboard with pieces



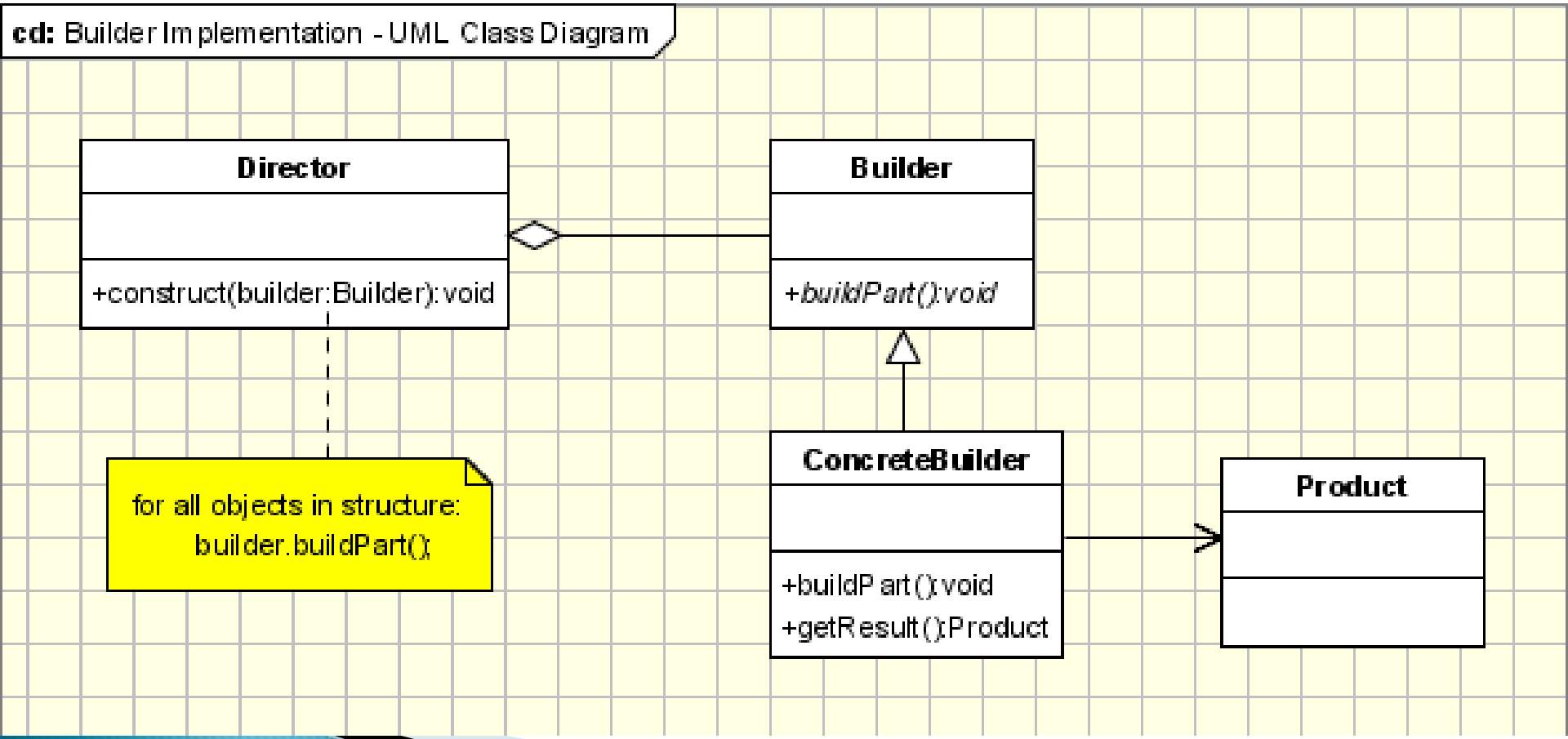
Builder 2

- Each kind of converter class takes the mechanism for creating and assembling
- The converter is separate from the reader



CP – Builder

- **Builder** – RTF Reader, Happy Meal



Builder 3

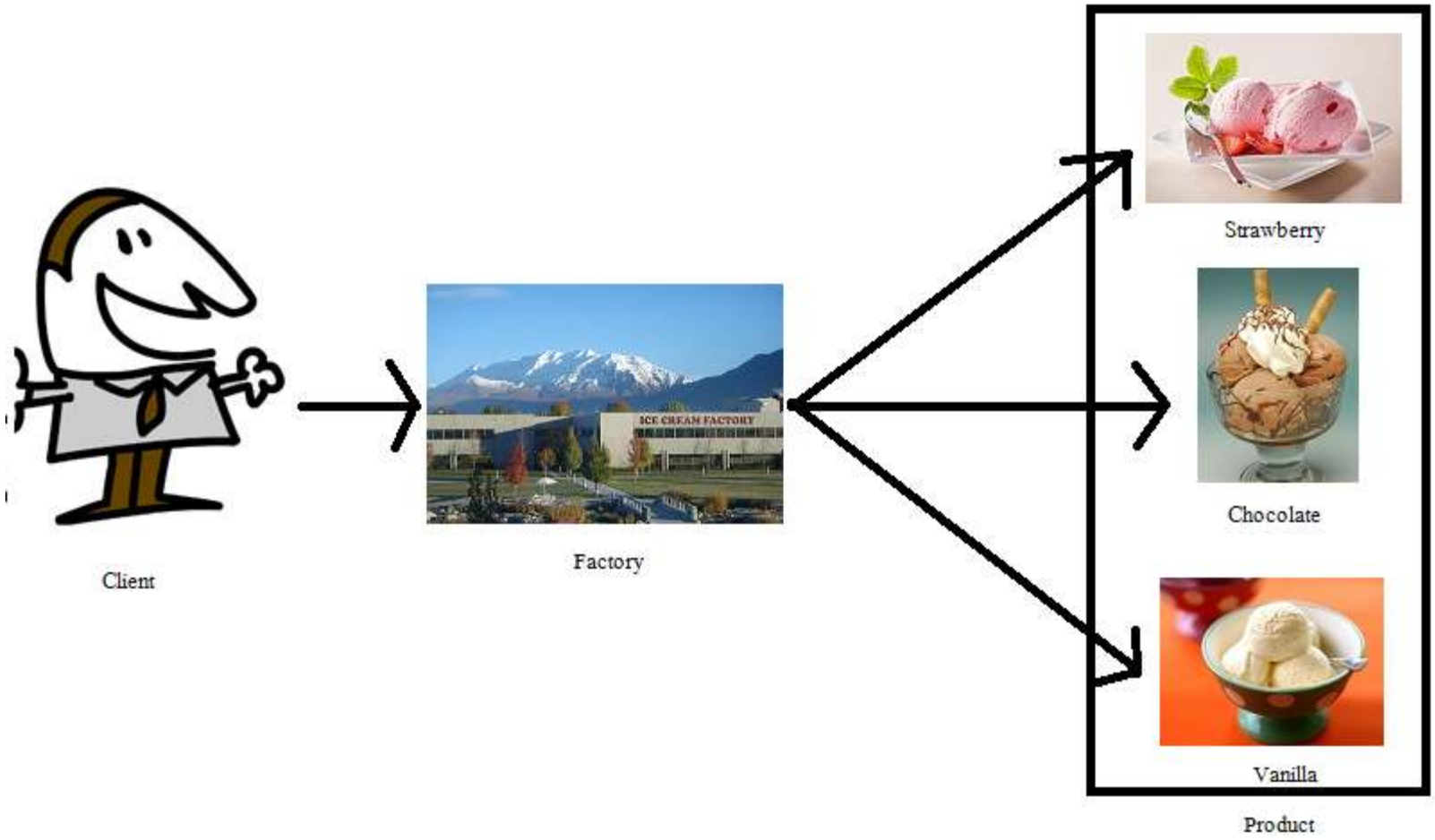
- **Applicability** – Use when the parameters required for construction are numerous, but only some are required for each specific object (different kinds of pizza)
- When you want to build different representations of similar objects (rail bridge and road bridge)

Builder – The Good, The Bad …

- Allows for step by step construction of objects
- Steps can be skipped and run later, or can be run recursively
- Allows for reusing code when building similar (but different) objects
- Preserves S (from SOLID) – decouples complex building processes from the business logic
- Code becomes complicated because of many new classes

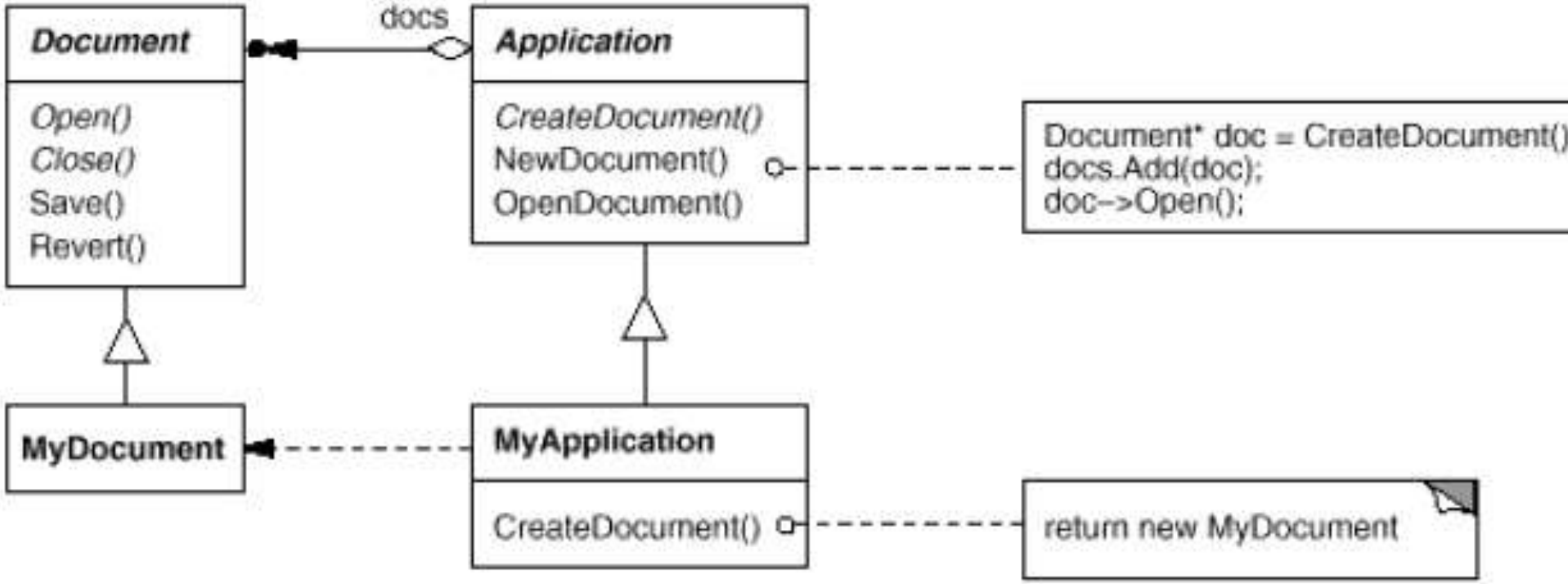
Creational Patterns – Factory Method

- **Intent** – Define an interface for creating an object, but let subclasses decide which class to instantiate
- **Also Known As** – Virtual Constructor
- **Motivation** – To create a drawing application, for example, we define the classes DrawingApplication and DrawingDocument. The Application class is responsible for managing Documents and will create them as required (at Open or New from a menu, for example)


ICE CREAM FACTORY
Strawberry
Chocolate
Vanilla
Client
Factory
Product

Factory Method 2

- Subclasses redefine an abstract CreateDocument
- It can then instantiate application-specific Documents without knowing their class
- CreateDocument is a **factory method because it's** responsible for "manufacturing" an object



Factory Method 3

- **Applicability** – Use this pattern when
  - a class can't anticipate the class of objects it must create
  - a class wants its subclasses to specify the objects it creates
  - classes delegate responsibility to one of several helper subclasses, and you want to localize the knowledge of which helper subclass is the delegate

Factory Method 4

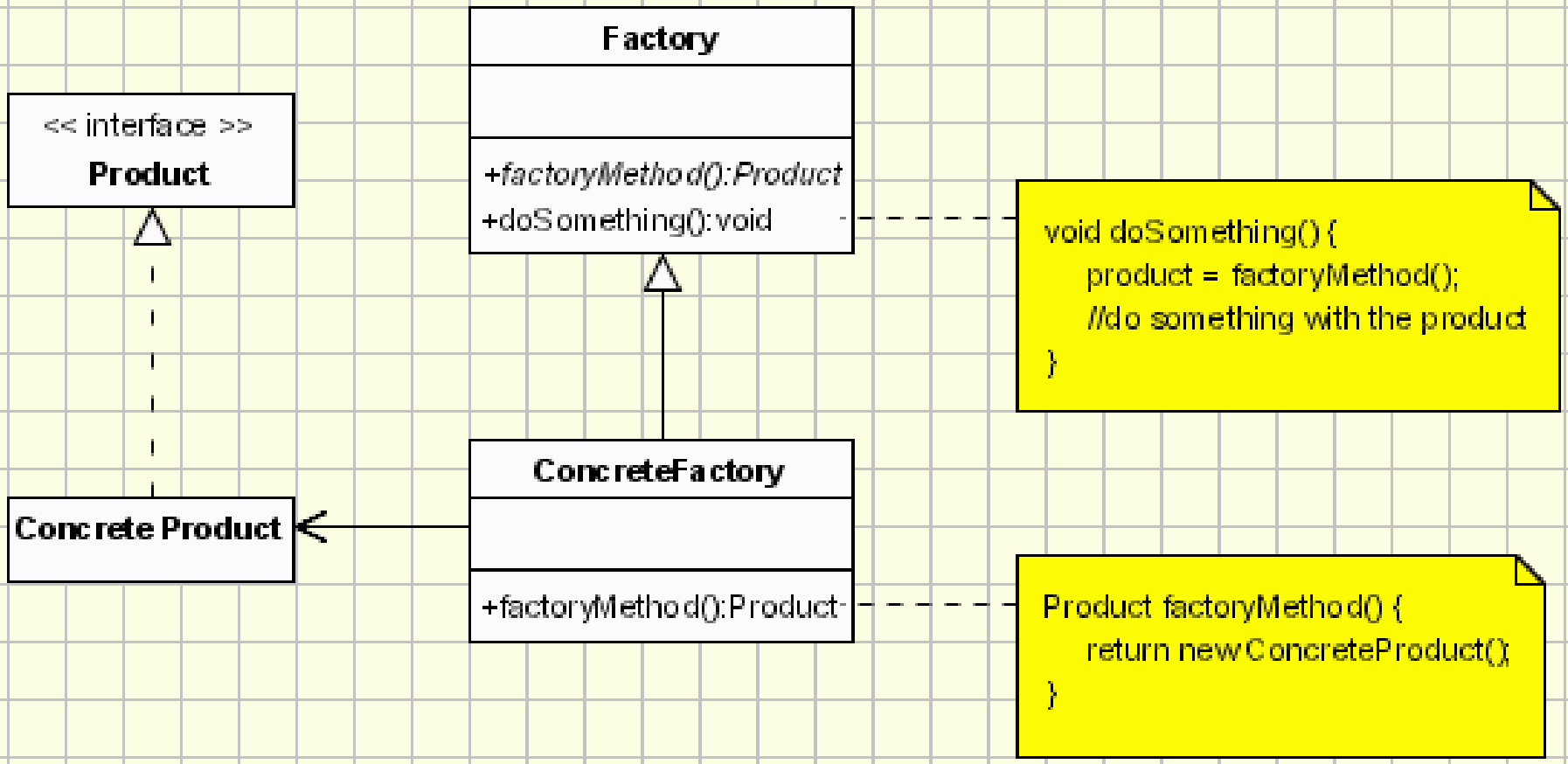
- **Consequences**

1. *Provides interconnections for subclasses*

2. *Connects parallel class hierarchies*

CP – Factory Method

- **Factory Method** – Open/New Project, Hello Mr/Ms



Factory Method– The Good, The Bad …

- Detaches creators from created objects
- Preserves S and O (from SOLID)
- Code becomes complicated because of extra (derived) classes

Creational Patterns – Prototype

- **Intent** – Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype
- **Motivation** – You could build an editor for music scores by customizing a general framework for graphical editors and adding new objects that represent notes, rests, and staves
- The editor framework may have a palette of tools for adding these music objects to the score. The palette would also include tools for selecting, moving, and otherwise manipulating music objects

Dog Object

Leg object
Ear object
Eye object
Tail object

Name = Tommy
Age = 3 yrs
Color = white

Clone

Cloned Dog Object

Name = Tommy
Age = 3 yrs
Color = white

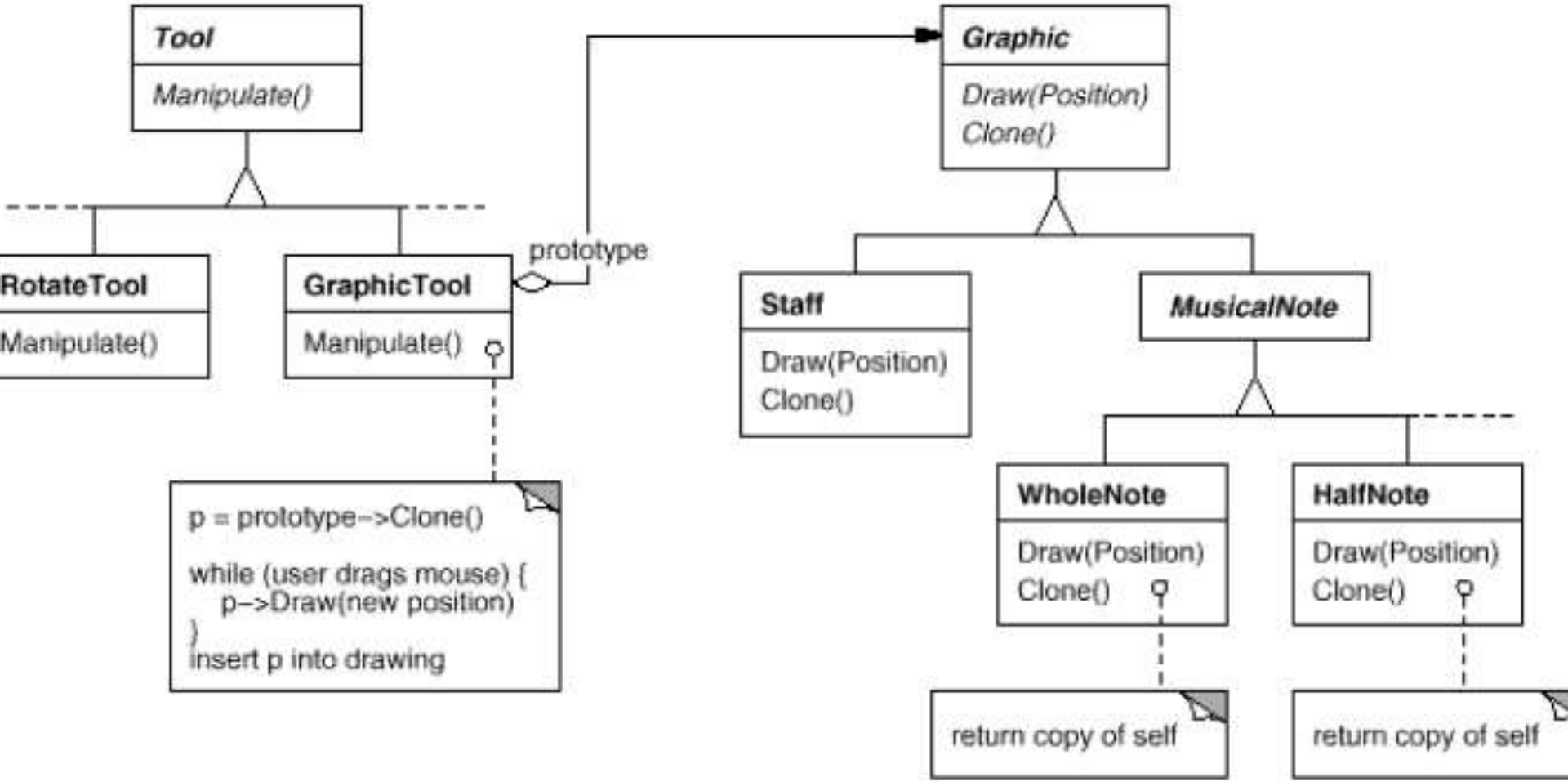
Modify

Modified Dog Object

Name = Jimmy
Age = 6 yrs
Color = Brown

Prototype 2

- We can use the Prototype pattern to reduce the number of classes

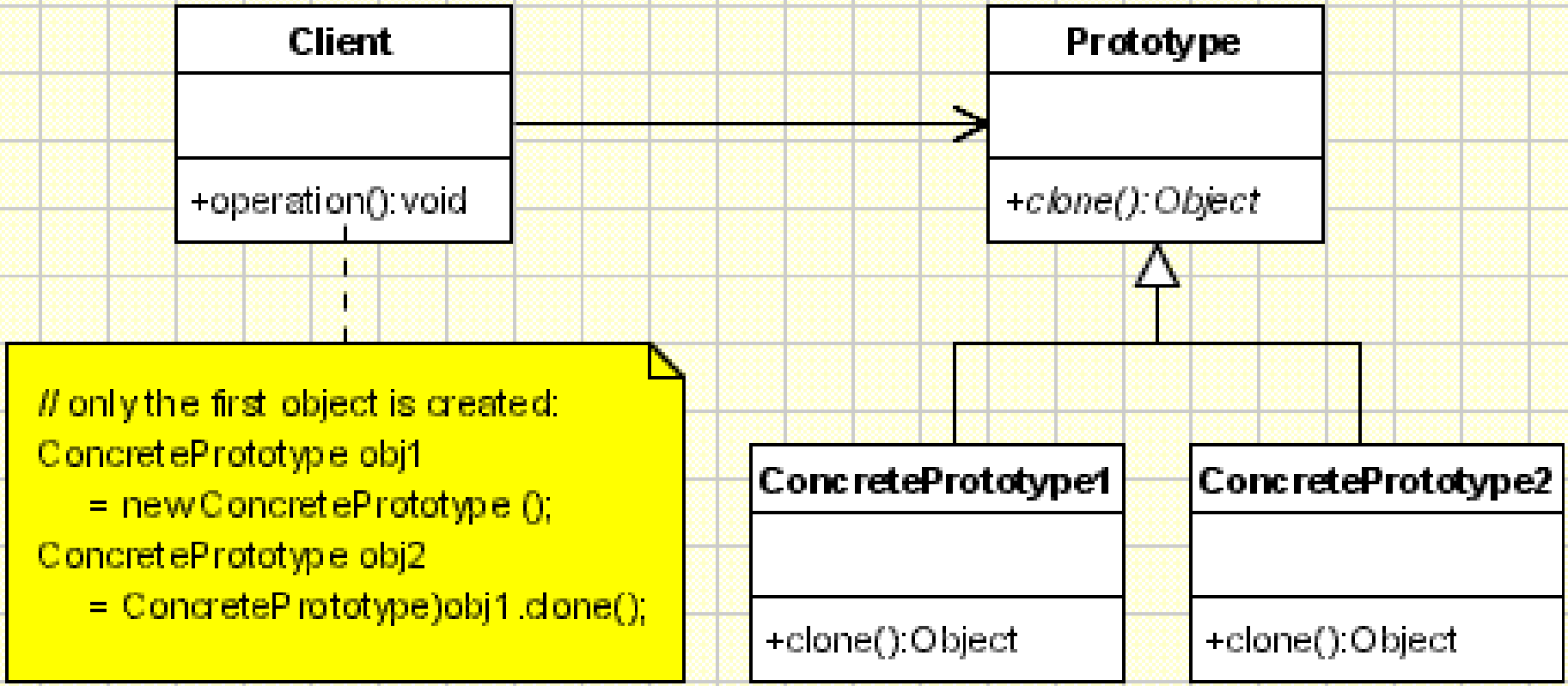


Prototype 3

- **Applicability** – Use the Prototype pattern when a system should be independent of how its products are created, composed, and represented; *and*
  - when the classes to instantiate are specified at run-time, for example, by dynamic loading; *or*
  - to avoid building a class hierarchy of factories that parallels the class hierarchy of products; *or*
  - when instances of a class can have one of only a few different combinations of state

CP – Prototype

- **Prototype** – Music editor, Clonable

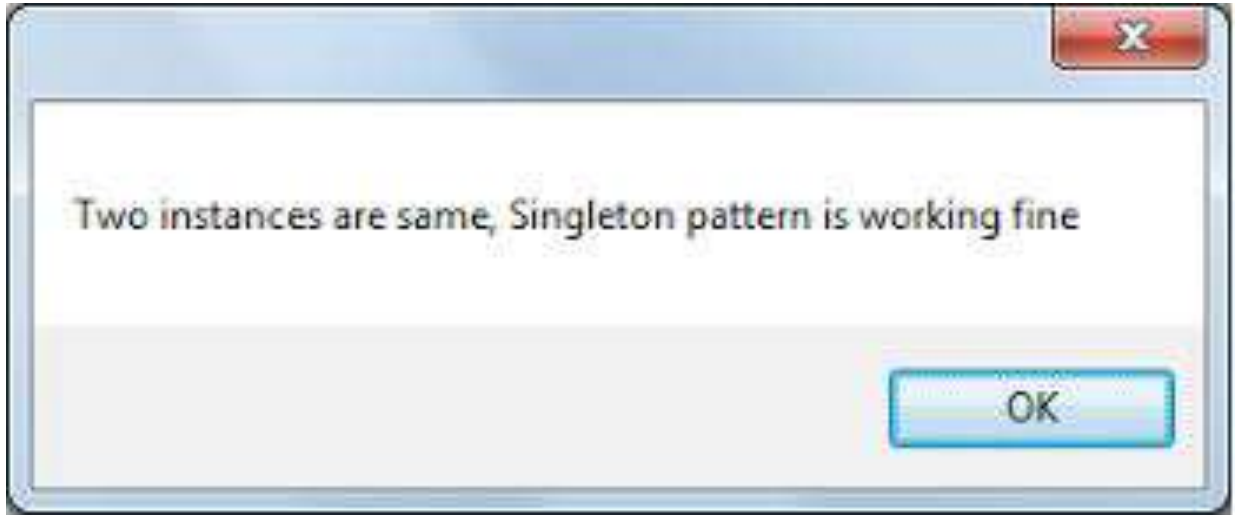


Prototype – The Good, The Bad …

- Copy objects without using the concrete class
- Skip repeated initializations
- Quickly create complex objects
- It is very hard to clone complex classes with many references

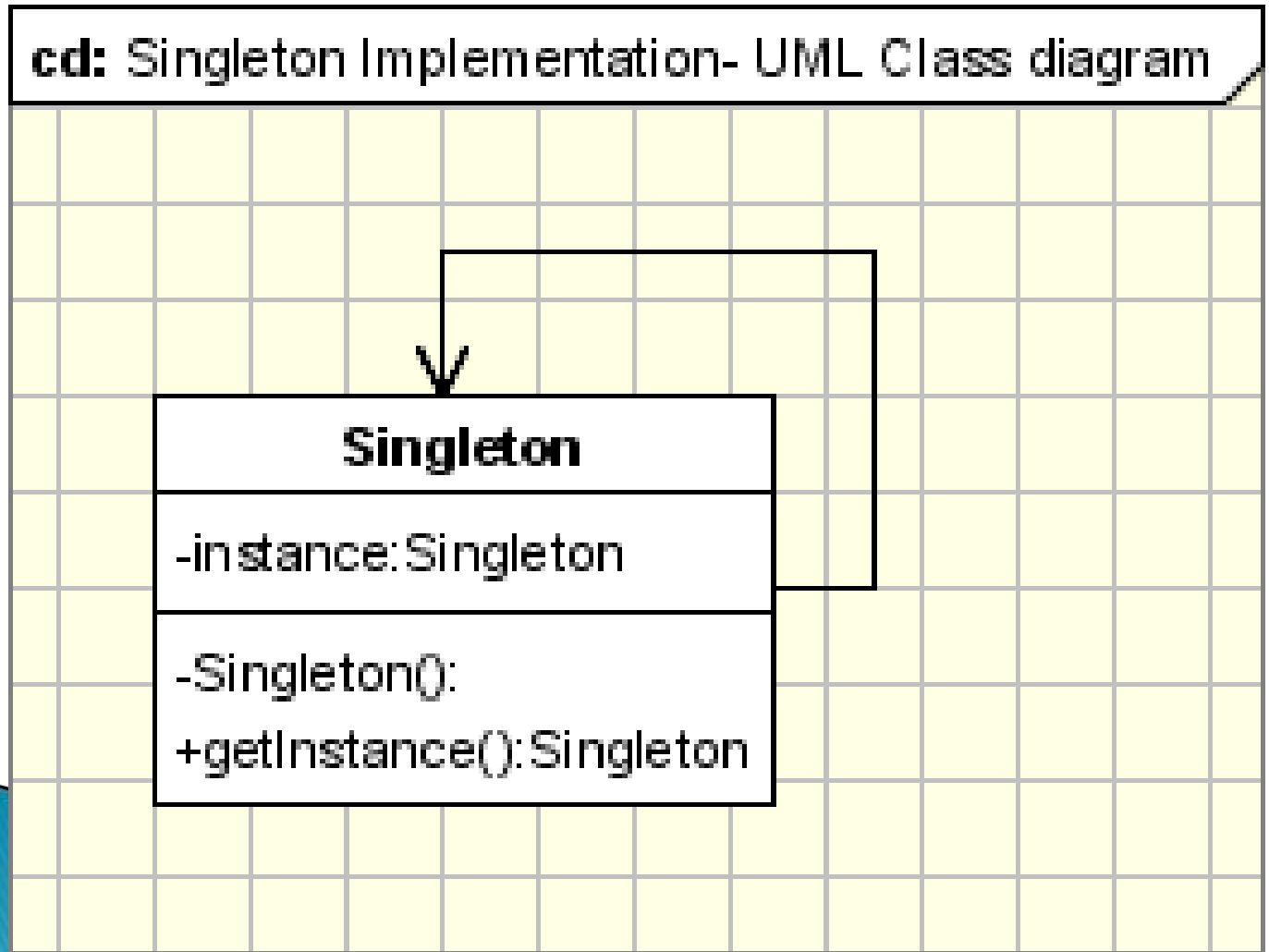
Creational Patterns – Singleton

- **Intent** – Ensure a class only has one instance, and provide a global point of access to it
- **Motivation** – It's important for some classes to have exactly one instance. There should be only one file system and one window manager. An accounting system will be dedicated to serving one company.
- How do we ensure that a class has only one instance and that the instance is easily accessible? A global variable makes an object accessible, but it doesn't keep you from instantiating multiple objects.


Two instances are same, Singleton pattern is working fine
OK

CP – Singleton

- **Singleton** – Logger



Singleton – The Good, The Bad …

- Guarantees a single instance
- Global access point to an instance
- Breaks S (from SOLID) – the pattern has TWO responsibilities
- Can mask high coupling or other bad design
- Is difficult to use in multi thread systems

CP – Lazy initialization

- **Lazy initialization** is the tactic of delaying the creation of an object, the calculation of a value, or some other expensive process until the first time it is needed

- How? With a **flag**
- Each time when the object is called, the **flag** is tested:
  - If it is **ready**, it is **returned**
  - If **not**, it is **initialized**

Lazy initialization – Java 1

```
public class Fruit {
  private static final Map<String,Fruit> types = new
   HashMap<String, Fruit>();
  private final String type;

  //using a private constructor to force use of the factory method
  private Fruit(String type) { this.type = type; }

  public static synchronized Fruit getFruit(String type) {
    if(!types.containsKey(type)) {
      types.put(type, new Fruit(type)); // Lazy initialization
    }
    return types.get(type);
  }
}
```

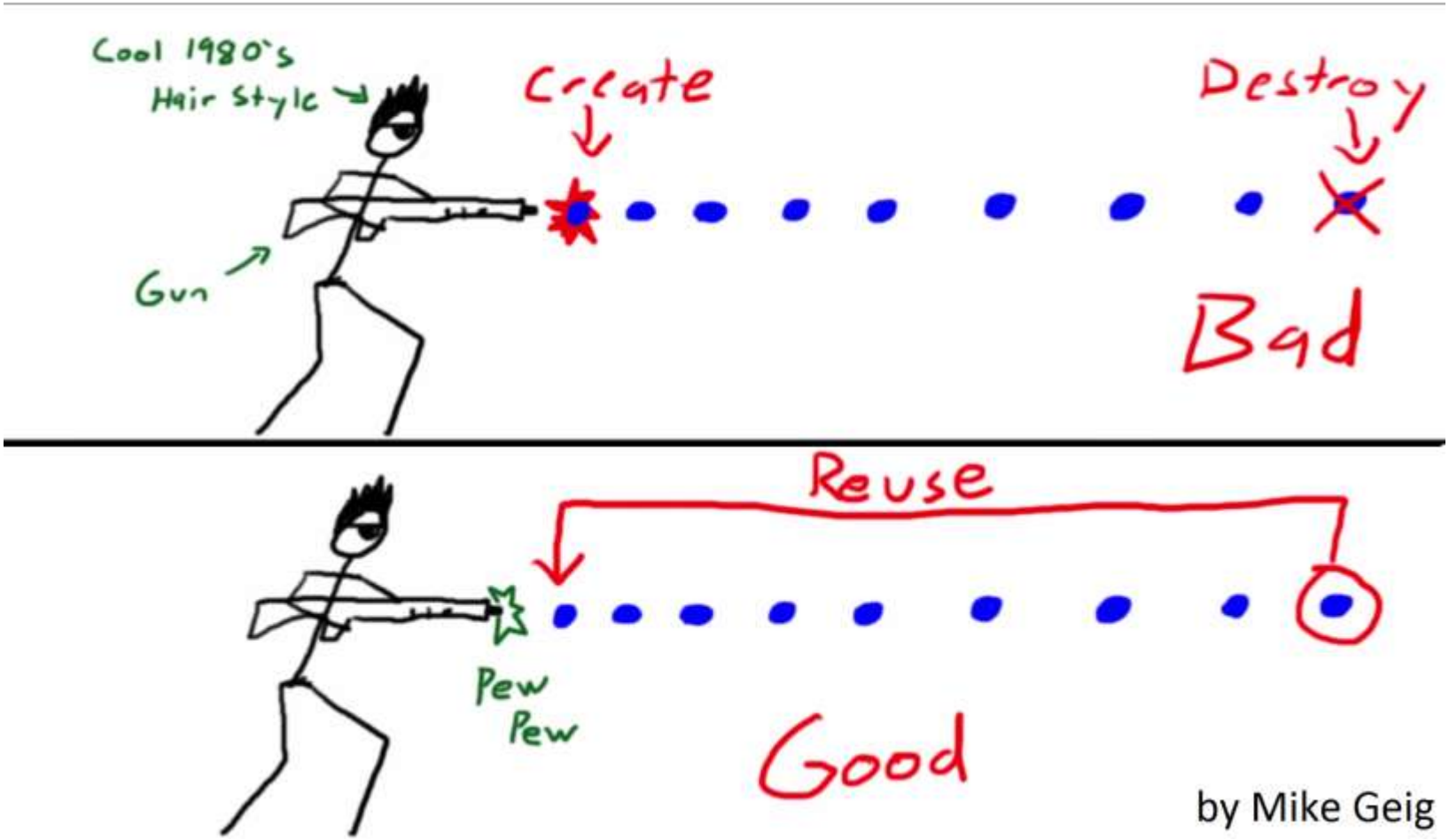
Lazy Initialization– The Good, The Bad …

- Saves on memory, since it instantiates only as needed
- More time consuming in case you need many new instances

CP – Object Pool

- **Intent**: reuse and share objects that are expensive to create.
- **Motivation**: Performance can be sometimes the key issue during the software development and **the object creation (class instantiation) is a costly step.** The Object Pool pattern offer a mechanism to reuse objects that are expensive to create
- **Why use it?** Basically, we'll use an object pool whenever there are several clients who needs the same stateless resource which is expensive to create

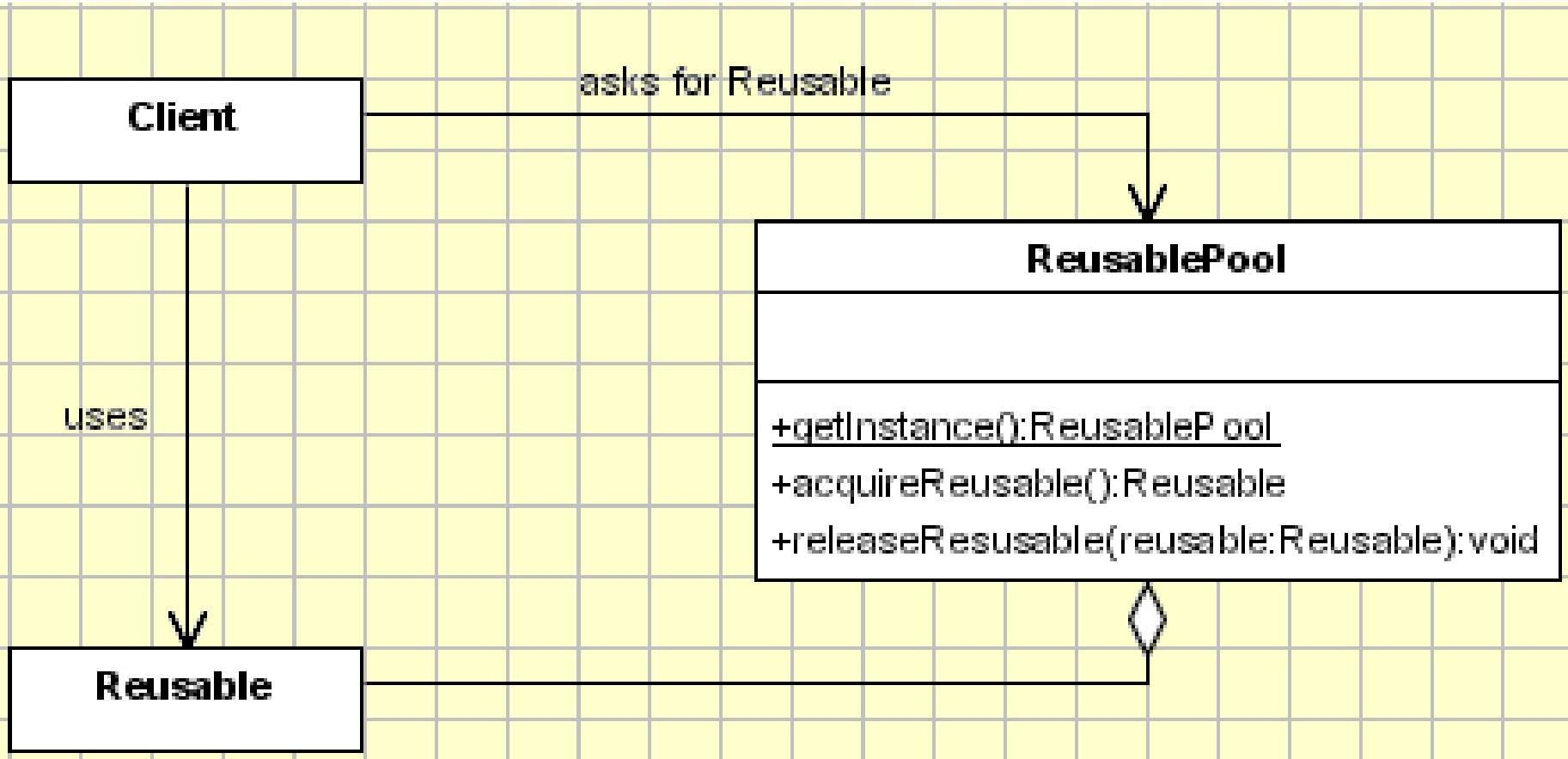
Visual Example of Object Pooling



Object Pool – Implementation (1)

- When a client asks for a Reusable object, the pool performs the following actions:
  - **Search** for an available Reusable object and **if it was found** it will be **returned** to the client.
  - **If no Reusable object was found** then it **tries to create a new one.** If this actions **succeeds** the new Reusable object will be **returned** to the client.
  - If the pool **was unable to create a new Reusable**, the pool will **wait** until a reusable object will be released.

Object Pool – Implementation (2)



Object Pool – Applicability

- Lets' take the example of the **database connections**. It's obviously that opening too many connections might affect the performance:
  - **Creating a connection is an expensive** operation
  - When there are **too many connections opened** it **takes longer to create a new one** and the database server will become overloaded

- Here the **object pool comes to manage the connections** and provide a way to reuse and share them. It can also limit the maximum number of objects that can be created

Object Pool– The Good, The Bad …

- Saves on computing resources, since it only allows for a set number of instances
- Increased overhead in terms of managing the pool
- Slow for the objects in the waiting queue

Structural Patterns 1

- **Structural patterns are concerned with how classes and objects are composed to form larger structures**

- **Example**: consider how **multiple inheritance** mixes two or more classes into one. The result is a class that combines the properties of its parent classes. This pattern is particularly useful for making independently developed class libraries work together.

Structural Patterns 2

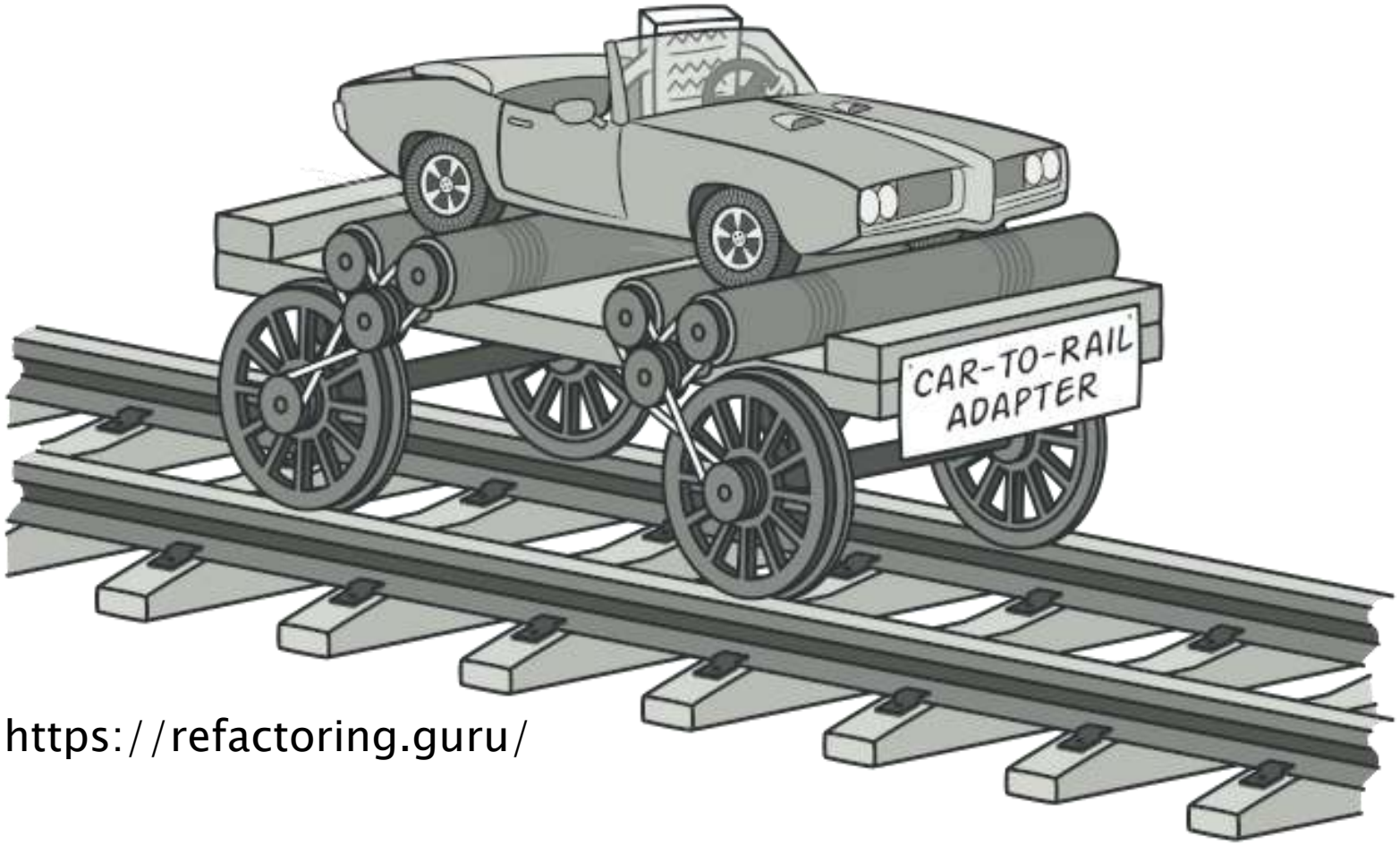
- Rather than composing interfaces or implementations, structural *object patterns* describe ways to compose objects **to realize new functionality**
- **The added flexibility of object composition** comes from the ability to change the composition at run-time

Structural Patterns

- Adapter
- Bridge
- Composite
- Decorator
- Façade
- Flyweight
- Proxy

Structural Patterns – Adapter

- **Intent**: Convert the interface of a class into another interface clients expect. Adapter lets classes work together that couldn't otherwise because of incompatible interfaces.
- **Also Known As**: Wrapper
- **Motivation**: Consider for example a drawing editor that lets users draw and arrange graphical elements (lines, polygons, text, etc.) into pictures and diagrams. The interface for graphical objects is defined by an abstract class called Shape. The editor defines a subclass of Shape for each kind of graphical object: a LineShape class for lines, a PolygonShape class for polygons, and so forth.



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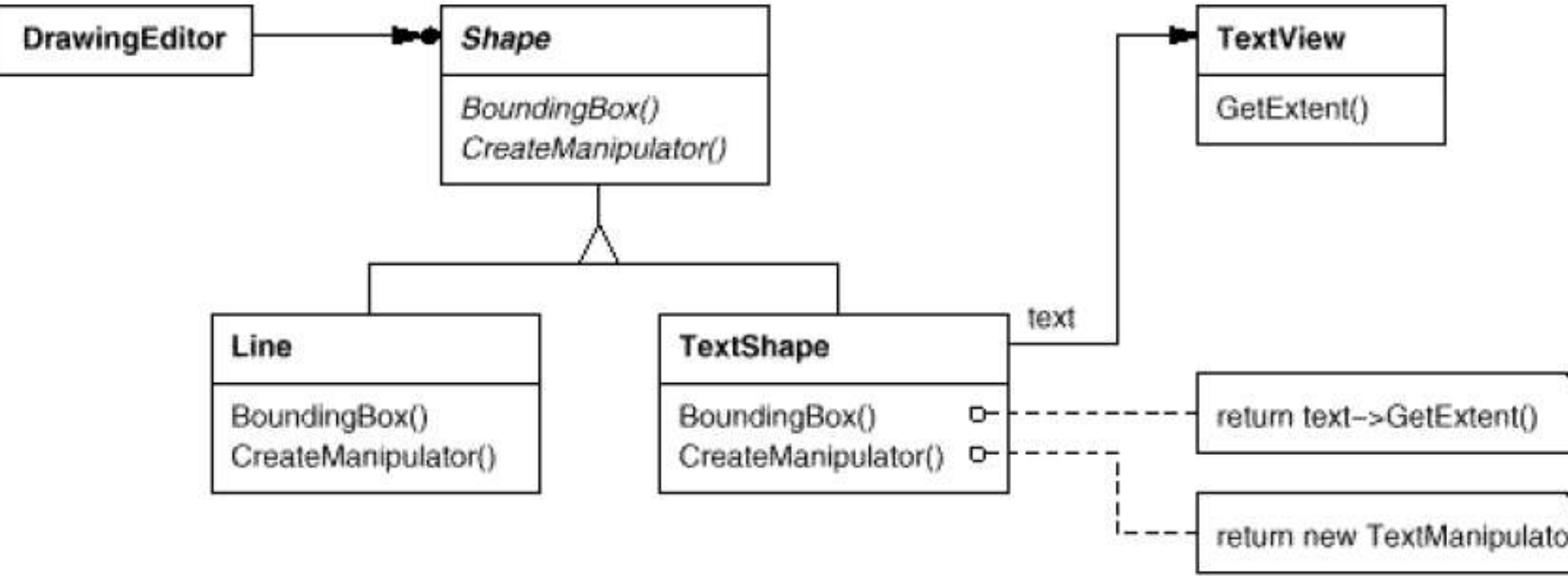
microSD
UHS-I 104MB/s
SD
UHS-I 104MB/s
HDMI Video Output
1080p @ 60Hz
Up to 4K @ 30Hz
USB-C
5Gb/s data speed
2 x USB 3.1 Gen 1
5Gb/s data speed
as well as high power
to your devices
Thunderbolt 3
Up to 5K or 2 X 4K @ 60Hz Video
Up to 40Gb/s data speed
Max 100W Power Delivery

Adapter 1

- A TextShape subclass that can display and edit text is considerably more difficult to implement
- We suppose the existence of a TextView class for displaying and editing text. So we can consider TextShape derived from these classes

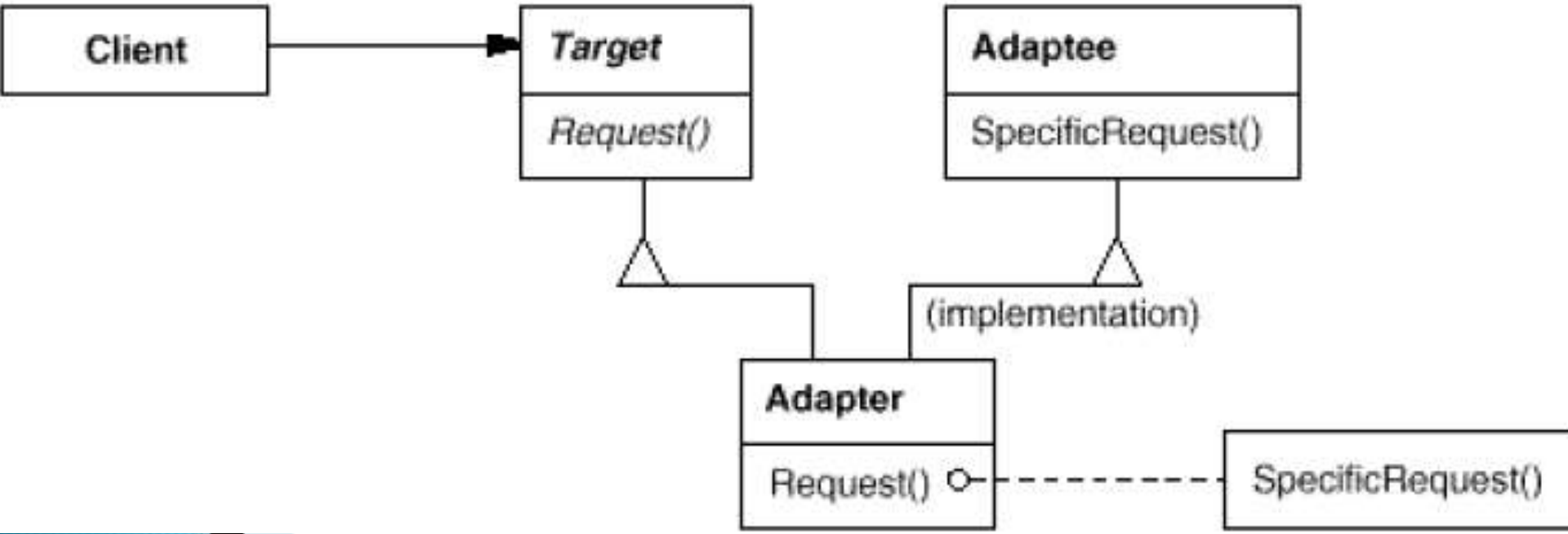


Adapter 2

- **Applicability** – Use the Adapter pattern when
  - you want to use an existing class, and its interface does not match the one you need
  - you want to create a reusable class that cooperates with unrelated or unforeseen classes, that is, classes that don't necessarily have compatible interfaces
  - *(object adapter only) you need to use several existing subclasses, but it's* impractical to adapt their interface by sub classing every one.

Adapter 3

- Structure – The Adapter pattern is used so that two unrelated interfaces can work together. This is something like we convert interface of one class into interface expected by the client.



Adapter – Example

- We all have electric sockets in our houses of different sizes and shapes. I will take an example of a socket of 15 Ampere. This is a bigger socket and the other one which is smaller is of 5 Ampere. A 15 Amp plug cannot fit into a 5 Amp socket => we will use an Adapter

- We have a 5 Amp plug and want a 5 Amp socket so that it can work. We DO NOT have a 5 Amp socket, what we have is a 15 Amp socket in which the 5 Amp plug cannot fit. The problem is how to cater to the client without changing the plug or socket.

Adapter – Java 1

```
/** The socket class has a specs for 15 AMP.*/
public interface Socket {
        public String getOutput();
}

public class Plug {
   private String specification = "5 AMP";
   public String getInput() {
        return specification;
   }
}
```

Adapter – Java 2

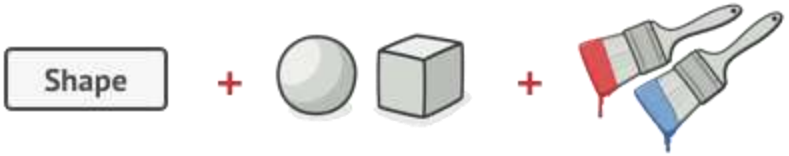
```
public class ConnectorAdapter implements Socket
{
  public String getOutput() {
      Plug plug = new Plug();
      String output = plug.getInput();
      return output;
  }
}
```

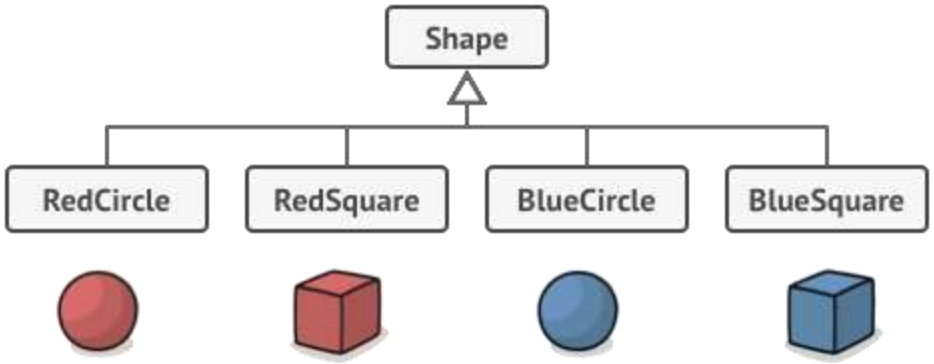
Adapter – The Good, The Bad …

- Preserves S and O (from SOLID)
- Code becomes complicated because of extra classes

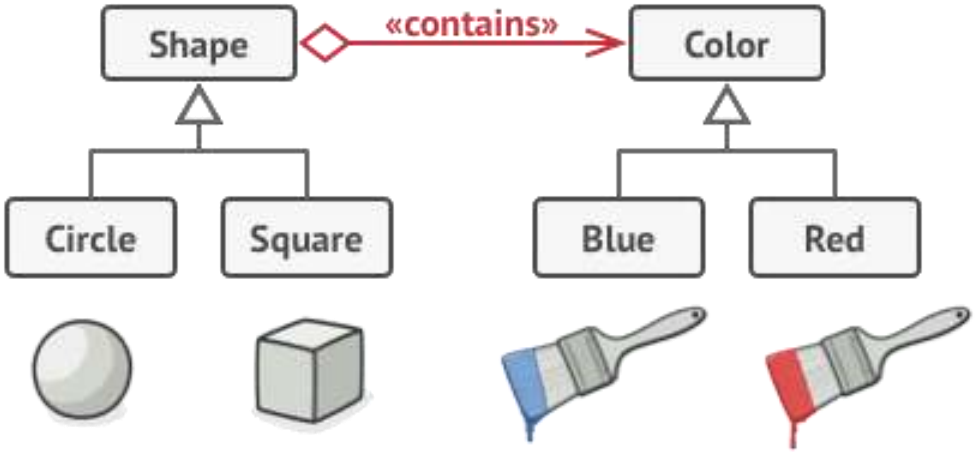
Structural Patterns – Bridge

- **Intent** – Decouple an abstraction from its implementation so that the two can vary independently
- **Also Known As** – Handle/Body
- **Motivation** – Consider the abstraction of shapes, each with its own properties. One thing all shapes can do is draw themselves. Drawing graphics to a screen can be dependent on different graphics implementations or operating systems. Shapes have to be able to be drawn on many types of operating systems





Vs.



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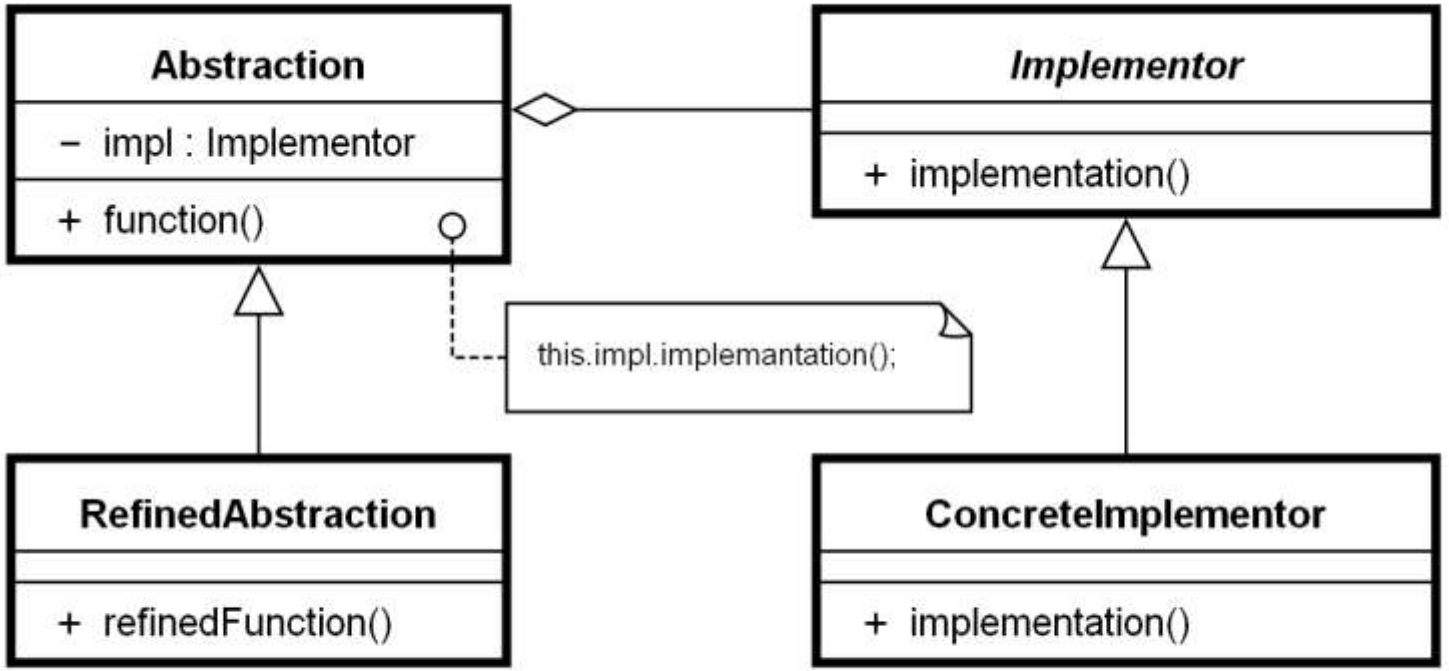
Bridge 1

- The bridge helps by allowing the creation of new implementation classes that provide the drawing implementation. Shape class provides methods for getting the size or properties of a shape. Drawing class provides an interface for drawing graphics



Bridge 2

- **Applicability** – When dividing large classes with many versions of the same feature (e.g. multiple types of network connections)
- When developing and extending classes in multiple and independent directions

Bridge – Java 1

```
interface DrawingAPI {/** "Implementor" */
  public void drawCircle(double x, double y, double
  radius);
}
/** "ConcreteImplementor" 1,2 */
class DrawingAPI1 implements DrawingAPI {
  public void drawCircle(double x, double y, double
  radius) { System.out.printf("API1” + x + y + radius);}
}
class DrawingAPI2 implements DrawingAPI {
  public void drawCircle(double x, double y, double
  radius) { System.out.printf("API2“ + x + y + radius);}
}
```

Bridge – Java 2

```
interface Shape {/** "Abstraction" */
   public void draw();
   public void resizeByPercentage(double pct); }

/** "Refined Abstraction" */
class CircleShape implements Shape {
   private double x, y, radius;
   private DrawingAPI drawingAPI;
   public CircleShape(double x, double y, double radius,
   DrawingAPI drawingAPI) {
         this.x = x; this.y = y; this.radius = radius;
         this.drawingAPI = drawingAPI;
   }
   public void draw() {drawingAPI.drawCircle(x, y, radius); }
   public void resizeByPercentage(double pct) { radius *= pct; }
}
```

Bridge – Java 3

```
/** "Client" */
class BridgePattern {
    public static void main(String[] args) {
        Shape[] shapes = new Shape[2];
        shapes[0] = new CircleShape(1, 2, 3, new DrawingAPI1());
        shapes[1] = new CircleShape(5, 7, 8, new DrawingAPI2());
        for (Shape shape : shapes) {
            shape.resizeByPercentage(2.5);
            shape.draw();
        }
    }
}
```

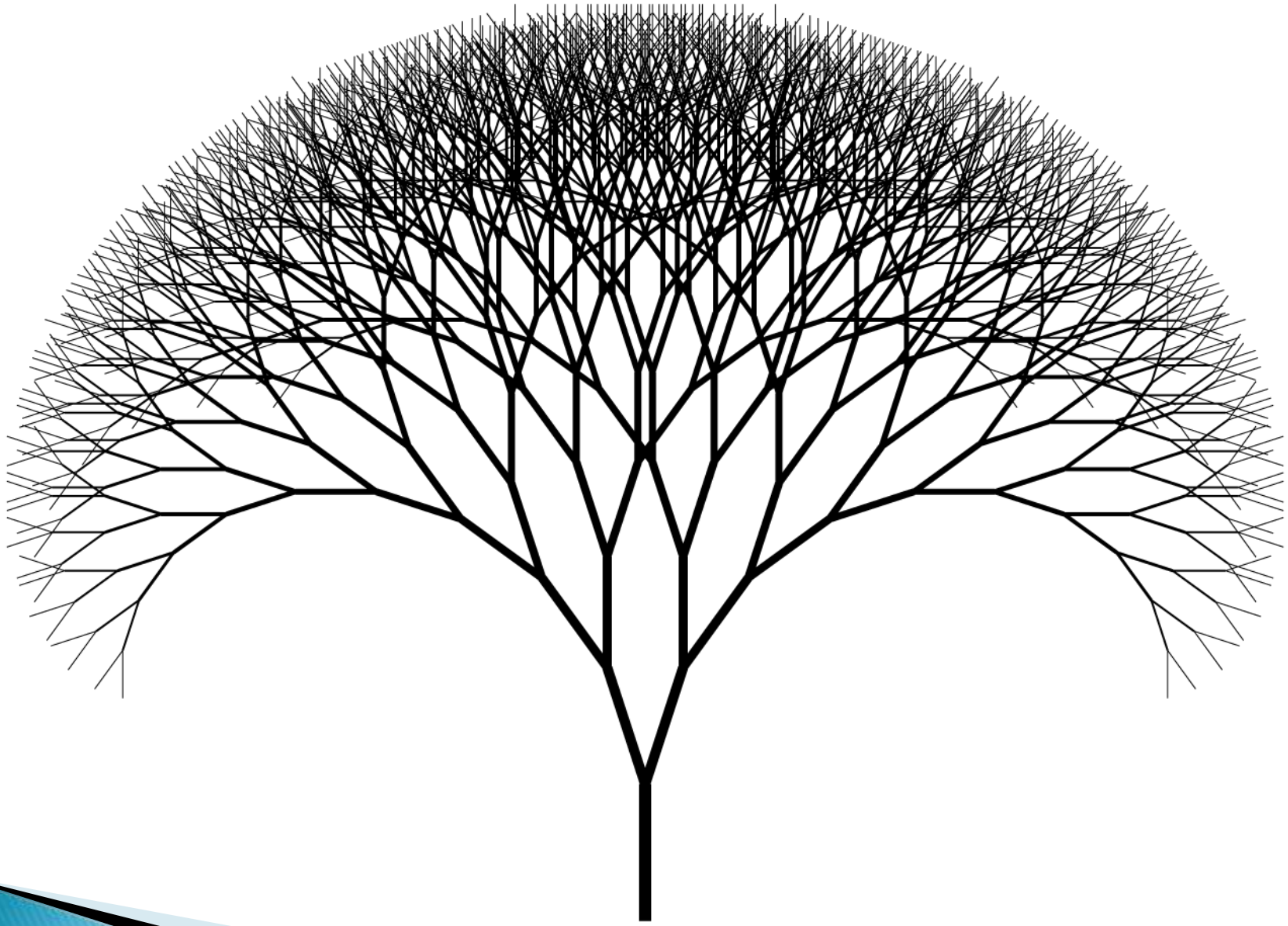
Bridge – The Good, The Bad …

- Preserves S and O (from SOLID)
- Allows for platform independent systems
- High level connections
- Code becomes complicated and splits cohesive classes

Structural Patterns – Composite

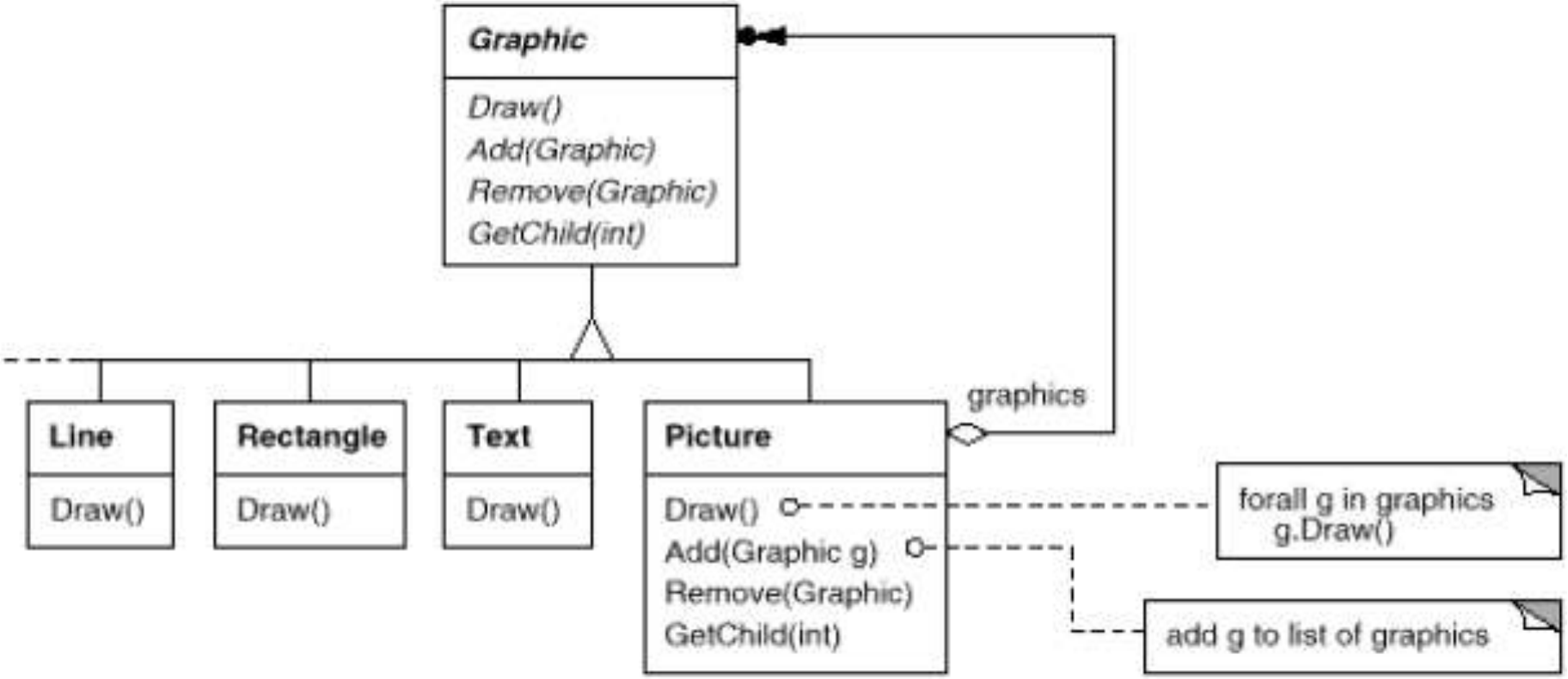
- **Intent** – Compose objects into tree structures to represent part-whole hierarchies. **Composite lets clients treat individual objects and compositions of objects uniformly**

- **Motivation** – Code that uses these classes must treat primitive and container objects differently, even if most of the time the user treats them identically.



Composite 1

- Graphics applications like drawing editors and schematic capture systems let users build complex diagrams out of simple components

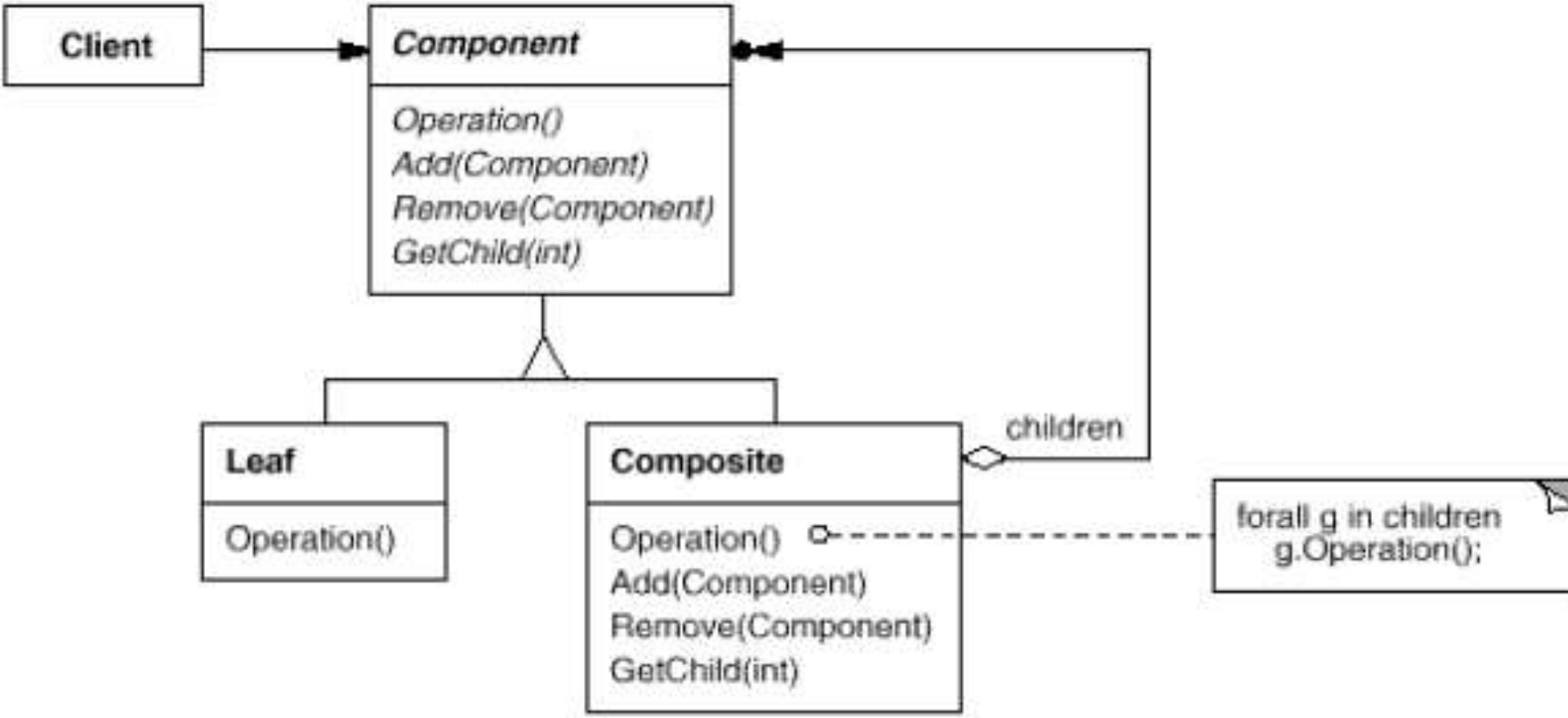


Composite 2

- **Applicability** – Use this pattern when
  - you want to represent part-whole hierarchies of objects
  - you want clients to be able to ignore the difference between compositions of objects and individual objects
  - Clients will treat all objects in the composite structure uniformly

Composite 3

- Structure



Composite – Example

- The most common example in this pattern is of a company's employee hierarchy

- The employees of a company are at various positions. Now, say in a hierarchy, the manager has subordinates; also the Project Leader has subordinates, i.e. employees reporting to him/her. The developer has no subordinates

Composite – Java 1

```
public class Employee {
        private String name; private double salary;
        private Vector subordinates;

        public Vector getSubordinates() {return subordinates;}
        public void setSubordinates(Vector subordinates) {
                this.subordinates = subordinates;}

        public Employee(String name, double sal) {
                setName(name);setSalary(sal);
                subordinates = new Vector();
        }
        public void add(Employee e) {subordinates.addElement(e);}
        public void remove(Employee e) {subordinates.remove(e);}
}
```

Composite – Java 2

```
private void addEmployeesToTree() {
   Employee CFO = new Employee("CFO", 3000);
   Employee headFinance1 = new Employee("HF. North", 2000);
   Employee headFinance2 = new Employee("HF. West", 2200);
   Employee accountant1 = new Employee("Accountant1", 1000);
   Employee accountant2 = new Employee("Accountant2", 900);
   Employee accountant3 = new Employee("Accountant3", 1100);
   Employee accountant4 = new Employee("Accountant4", 1200);

   CFO.add(headFinance1); CFO.add(headFinance2);
   headFinance1.add(accountant1);headFinance1.add(accountant4);
   headFinance2.add(accountant2);headFinance2.add(accountant3);
}
```

CFO = chief financial officer

Composite – Java 3

- Once we have filled the tree up, now we can get the tree for any employee and find out whether that employee has subordinates with the following condition.

```
Vector subOrdinates = emp.getSubordinates();
if (subOrdinates.size() != 0)
    getTree(subOrdinates);
else
    System.out.println("No Subordinates for the
Employee: "+emp.getName());
```

Composite – The Good, The Bad …

- Preserves O (from SOLID), because new classes can easily be added to the hierarchy
- Using polymorphism and inheritance works well for complex tree structures
- Prone to overgeneralization
- Difficult to provide a common interface

Structural Patterns – Decorator

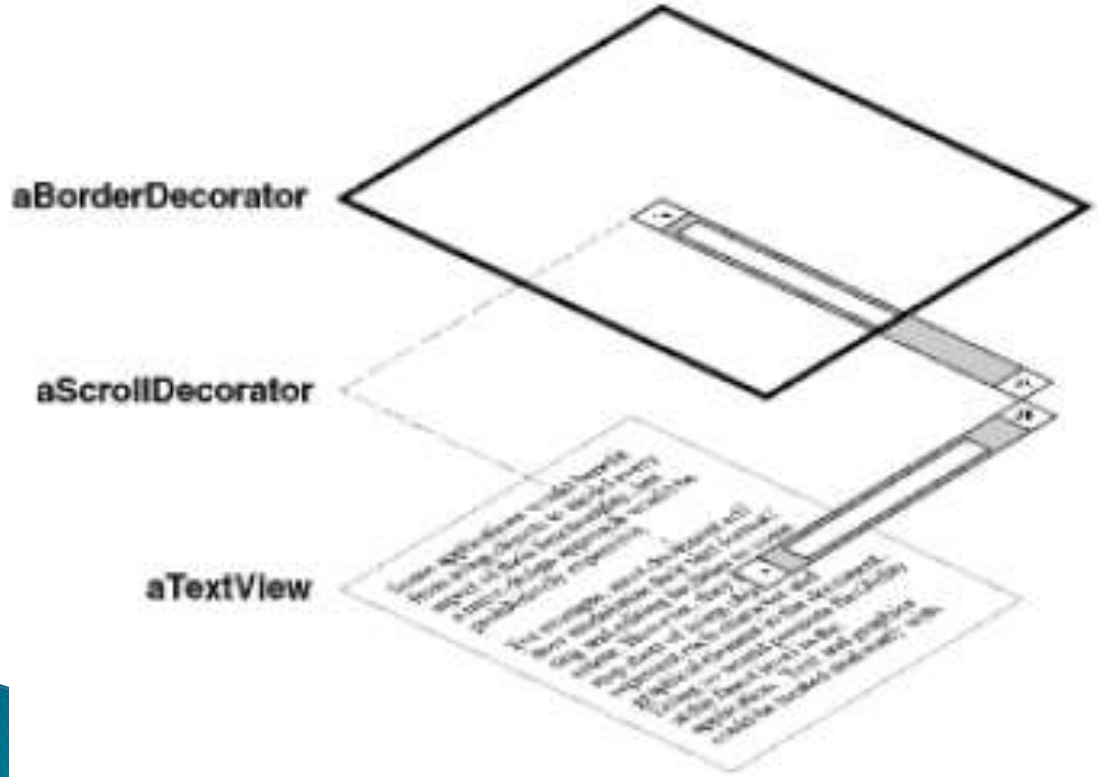
- **Intent – Attach additional responsibilities to an object dynamically.** Decorators provide a flexible alternative to subclassing for extending functionality
- **Also Known As –** Wrapper (*similar Adapter*)
- **Motivation –** Sometimes we want to add responsibilities to individual objects, not to an entire class. A graphical user interface toolkit, for example, should let you add properties like borders or behaviors like scrolling to any user interface component

Component

Decorators

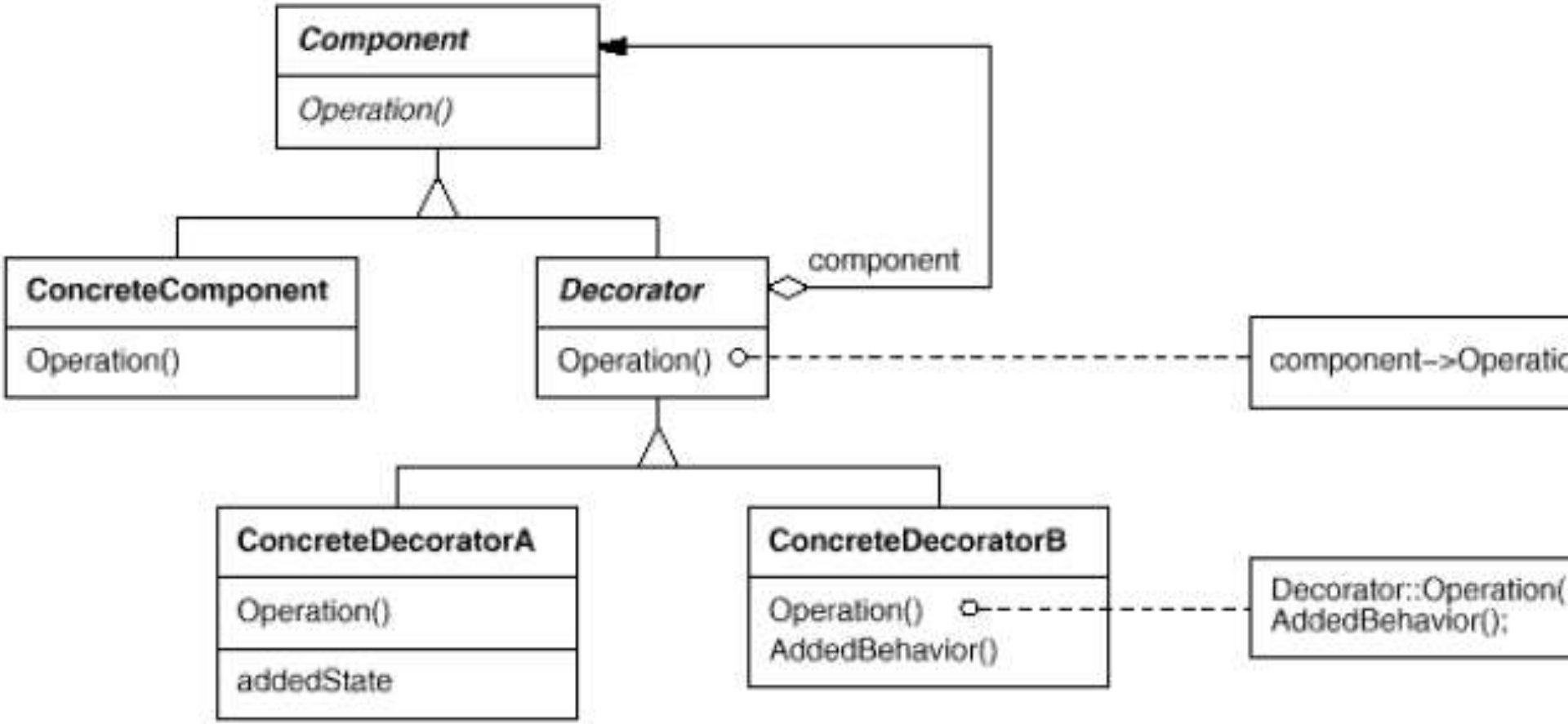
Decorator 1

- A more flexible approach is to enclose the component in another object that adds the border. The enclosing object is called a **decorator**



Decorator 2

- Structure



Decorator 3

- **Applicability** – Use Decorator
  - to add responsibilities to individual objects dynamically and transparently
  - for responsibilities that can be withdrawn
  - when extension by subclassing is impractical

Decorator – Example

- Suppose we have some 6 objects and 2 of them need a special behavior, we can do this with the help of a decorator

- Let's take an example of a **Christmas tree**. There is a need to decorate a Christmas tree. Now we have many branches which need to be decorated in different ways

Decorator – Java 1

```
public abstract class Decorator {
  /** The method places each decorative item on
  the tree. */
  public abstract void place(Branch branch);
}
public class ChristmasTree {
  private Branch branch;
  public Branch getBranch() {
      return branch;
  }
}
```

Decorator – Java 2

```
public class BallDecorator extends Decorator {
  public BallDecorator(ChristmasTree tree) {
      Branch branch = tree.getBranch();
      place(branch);
  }

  public void place(Branch branch) {
      branch.put("ball");
  }
}
```

Decorator – Java 3

- Similarly, we can make StarDecorator and RufflesDecorator

StarDecorator decorator = new StarDecorator(new ChristmasTree());

- This way the decorator will be instantiated and a branch of the Christmas tree will be decorated.

Decorator – The Good, The Bad …

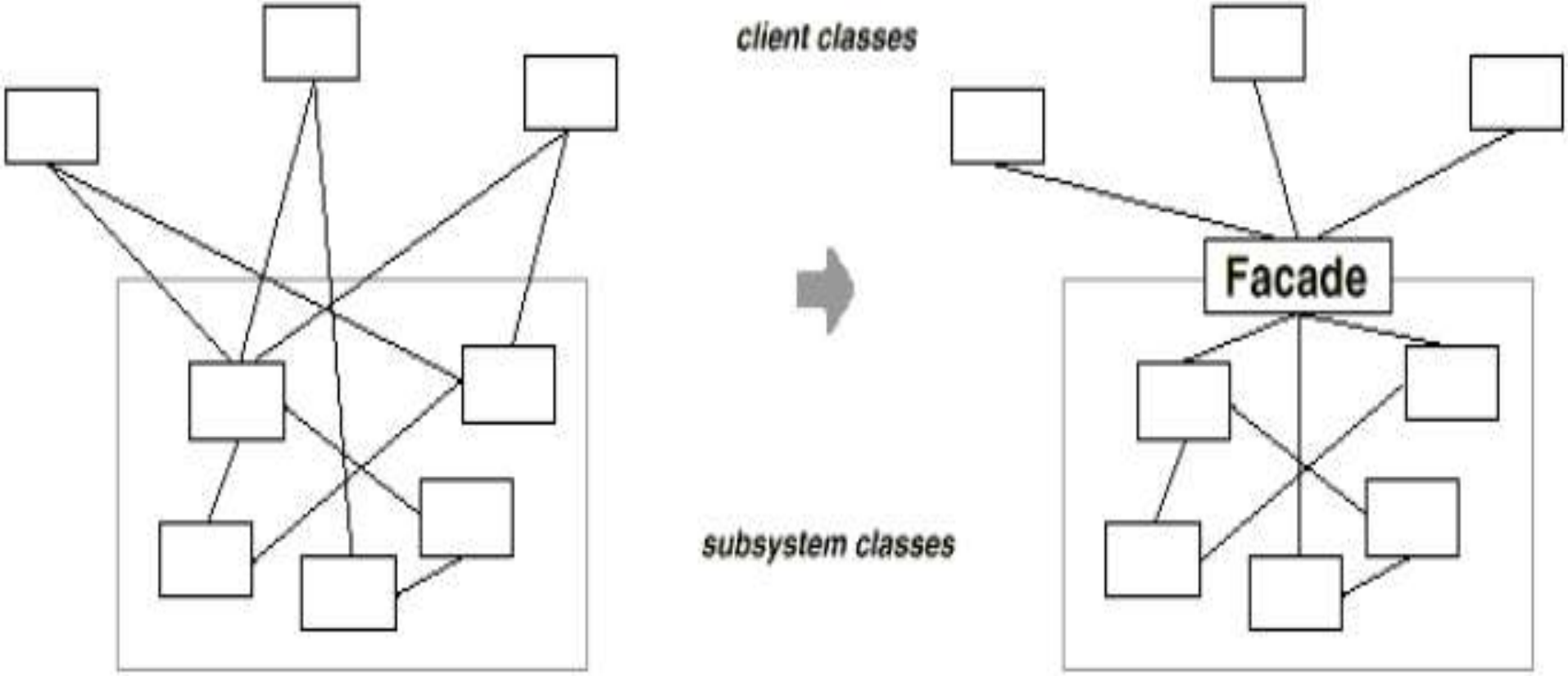
- Change object behavior without inheritance
- Preserves S (from SOLID) – a large class can be split in smaller ones
- Can add multiple behaviors by adding multiple decorations
- Change an object's responsibilities at runtime
- The sequence of applying decorators matters
- Difficult to remove a decorator from the middle of the pile
- The code is hard to manage

Structural Patterns – Façade

- **Intent – Provide a unified interface to a set of interfaces in a subsystem**
- **Motivation** – Consider for example a programming environment that gives applications access to its compiler subsystem. This subsystem contains classes such as *Scanner, Parser, ProgramNode, BytecodeStream,* and *ProgramNodeBuilder* that implement the compiler. Some specialized applications might need to access these classes directly. But most clients of a compiler want to compile some code

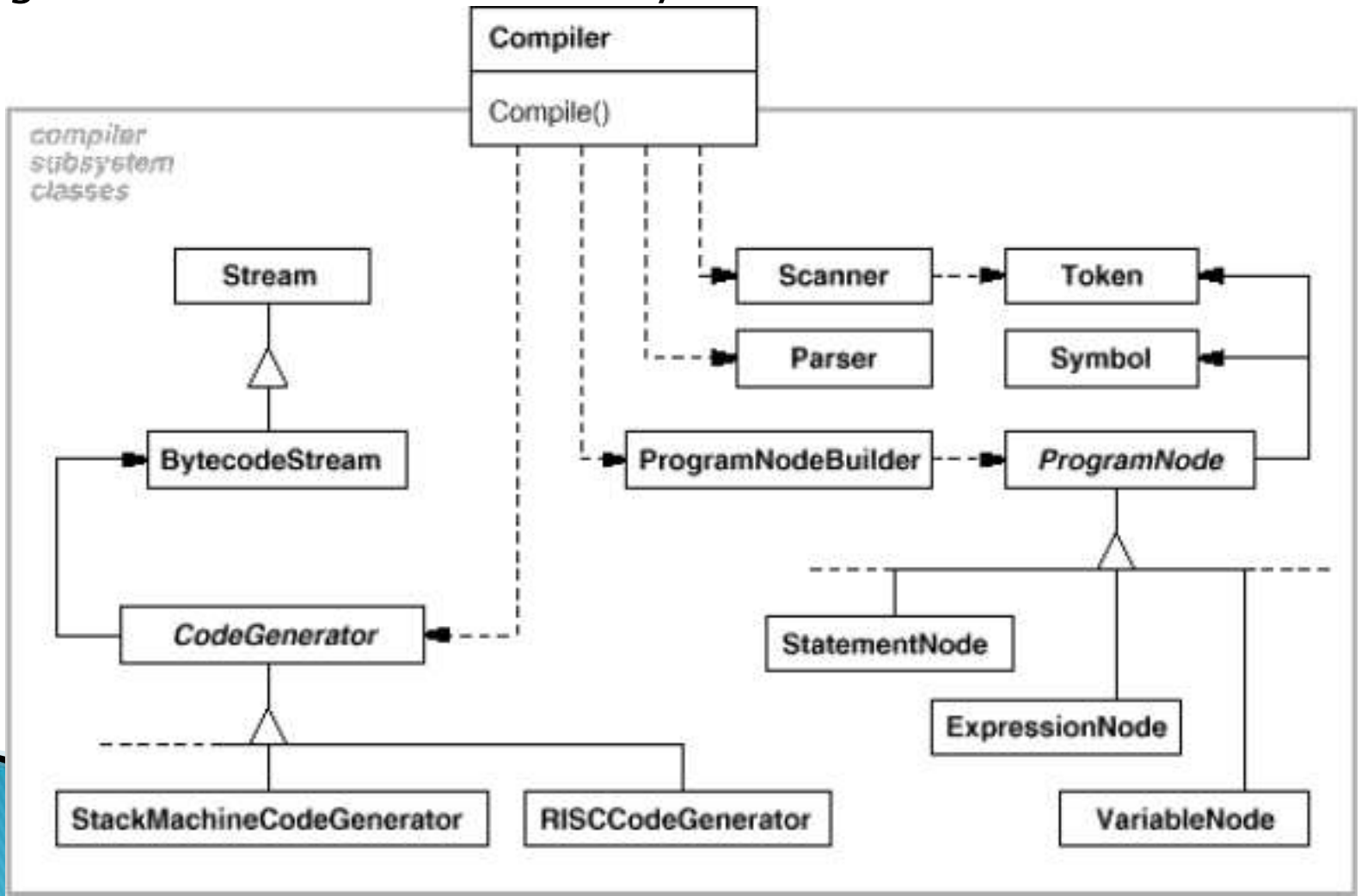
Façade 1

- A common design goal **is to minimize the communication and dependencies between** subsystems



Façade 2

- The compiler facade makes life easier for most programmers without hiding the lower-level functionality from the few that need it



Façade 3

- **Applicability** – Use the Facade pattern when
  - you want to provide a simple interface to a complex subsystem
  - there are many dependencies between clients and the implementation classes of an abstraction
  - you want to layer your subsystems

Façade – Example 1

- Facade as the name suggests means the face of the building. The people walking past the road can only see this glass face of the building. The face hides all the complexities of the building and displays a friendly face.
- Facade hides the complexities of the system and provides an interface to the client from where the client can access the system. In Java, the interface JDBC can be called a façade
- Other examples?

Façade – Example 2

- Let's consider a **store**. This store has a store keeper. In the storage, there are a lot of things stored e.g. **packing material, raw material and finished goods**.
- You, as client want access to different goods. You do not know where the different materials are stored. You just have access to store keeper who knows his store well. Here, the store keeper acts as the facade, as he hides the complexities of the system Store.

Façade – Java 1

```
public interface Store {
  public Goods getGoods();
}

public class FinishedGoodsStore implements Store
{
  public Goods getGoods() {
      FinishedGoods finishedGoods = new FinishedGoods();
      return finishedGoods;
  }
}
```

Façade – Java 2

```
public class StoreKeeper {
  public RawMaterialGoods getRawMaterialGoods() {
      RawMaterialStore store = new RawMaterialStore();
      RawMaterialGoods rawMaterialGoods =
  (RawMaterialGoods)store.getGoods();
      return rawMaterialGoods;
  }
  …
}
```

Façade – Java 3

```
public class Client {
  public static void main(String[] args) {
      StoreKeeper keeper = new StoreKeeper();
      RawMaterialGoods rawMaterialGoods =
      keeper.getRawMaterialGoods();
  }
}
```

Façade – The Good, The Bad …

- Isolates and mask system complexity from the user
- The façade class runs the risk of being coupled to everything

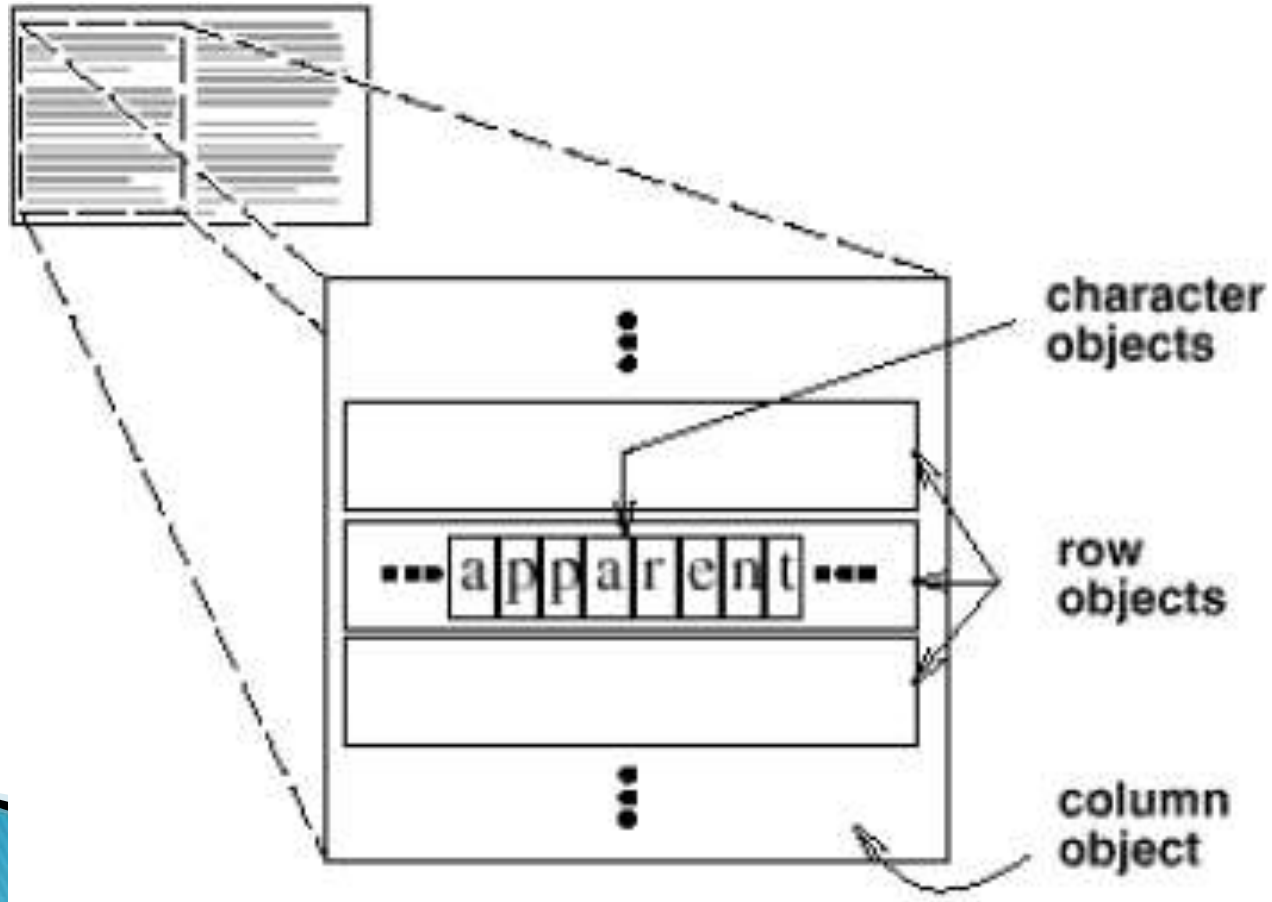
Structural Patterns – Flyweight

- **Intent – Use sharing to support large numbers of fine-grained objects efficiently**

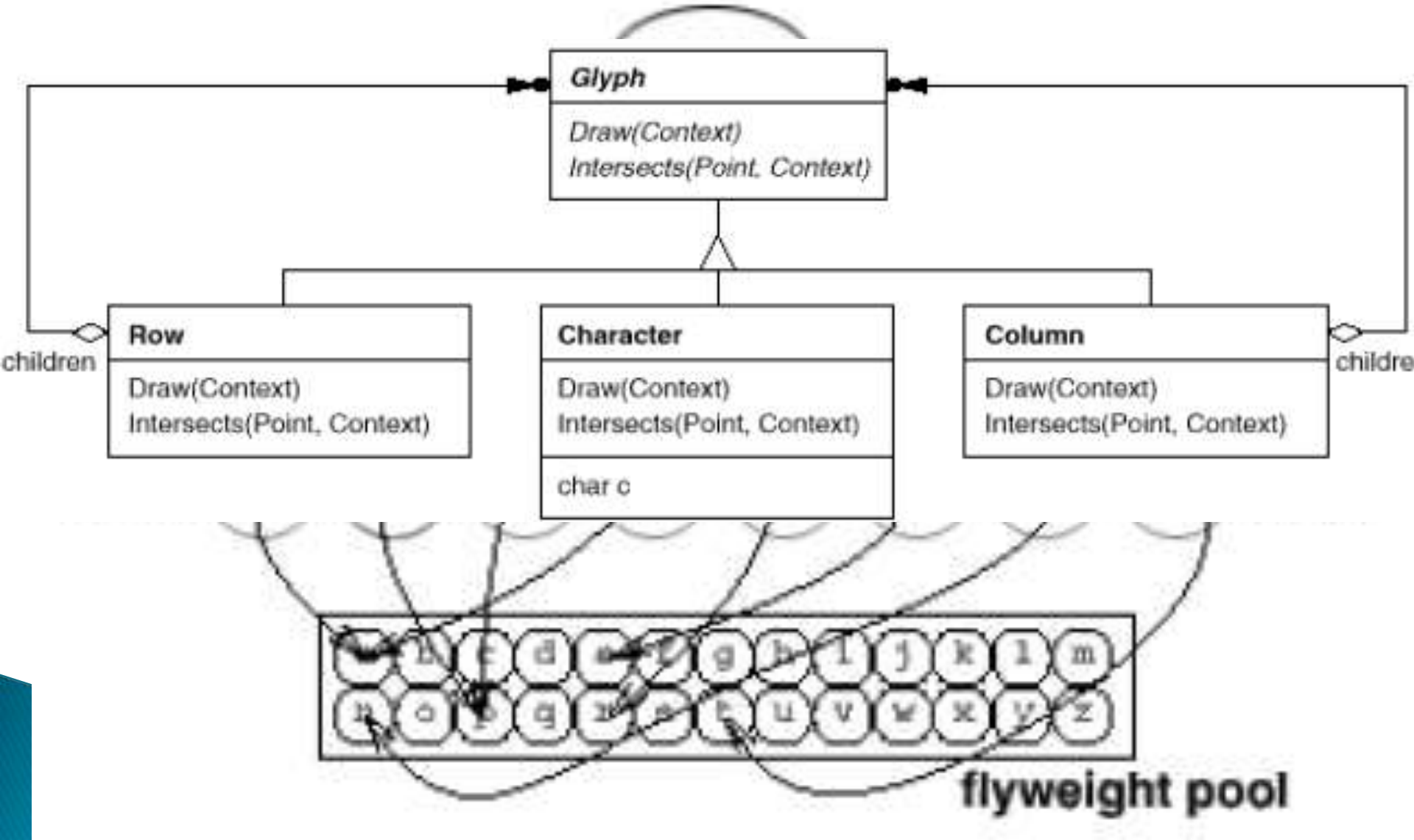
- **Motivation –** Some applications could benefit from using objects throughout their design, but a naive implementation would be prohibitively expensive.
- For example, most document editor implementations have text formatting and editing facilities that are modularized to some extent.

Flyweight 1

- The following diagram shows how a document editor can use objects to represent characters



Flyweight 2


Glyph
Draw(Context)
Intersects(Point, Context)
Row
Draw(Context)
Intersects(Point, Context)
Character
Draw(Context)
Intersects(Point, Context)
char c
Column
Draw(Context)
Intersects(Point, Context)
children
childre
flyweight pool

Flyweight 3

- **Applicability** – Use the Flyweight pattern when
  - Supporting a large number of objects that:
    - Are similar
    - Share at least some attributes
    - Are too numerous to easily store whole in memory

Flyweight – Example

- **A Flyweight is an object that minimizes memory use by sharing as much data as possible with other similar objects**

- A classic example usage of the flyweight pattern are the data structures for graphical representation of characters in a word processor. It would be nice to have, for each character in a document, a glyph object containing its *font outline, font metrics*, and other formatting data, but it would amount to hundreds or thousands of bytes for each character. Instead, are used the flyweights called **FontData**

Flyweight – Java 1

```
public enum FontEffect {
   BOLD, ITALIC, SUPERSCRIPT, SUBSCRIPT, STRIKETHROUGH
}
public final class FontData {
   private static final WeakHashMap<FontData,
   WeakReference<FontData>> FLY_WEIGHT_DATA = new
   WeakHashMap<FontData, WeakReference<FontData>>();
   private final int pointSize;
   private final String fontFace;
   private final Color color;
   private final Set<FontEffect> effects;

   private FontData(int pointSize, String fontFace, Color color,
   EnumSet<FontEffect> effects) {
         this.pointSize = pointSize;
         this.fontFace = fontFace;
         this.color = color;
         this.effects = Collections.unmodifiableSet(effects);
   }
```

Flyweight – Java 2

```
public static FontData create(int pointSize, String
  fontFace, Color color, FontEffect... effects) {
  EnumSet<FontEffect> effectsSet =
  EnumSet.noneOf(FontEffect.class);
  for (FontEffect fontEffect : effects) {
  effectsSet.add(fontEffect); }
  FontData data = new FontData(pointSize, fontFace,
  color, effectsSet);
  if (!FLY_WEIGHT_DATA.containsKey(data)) {
       FLY_WEIGHT_DATA.put(data, new
       WeakReference<FontData> (data));
  }
  return FLY_WEIGHT_DATA.get(data).get();
}
```

Flyweight – The Good, The Bad …

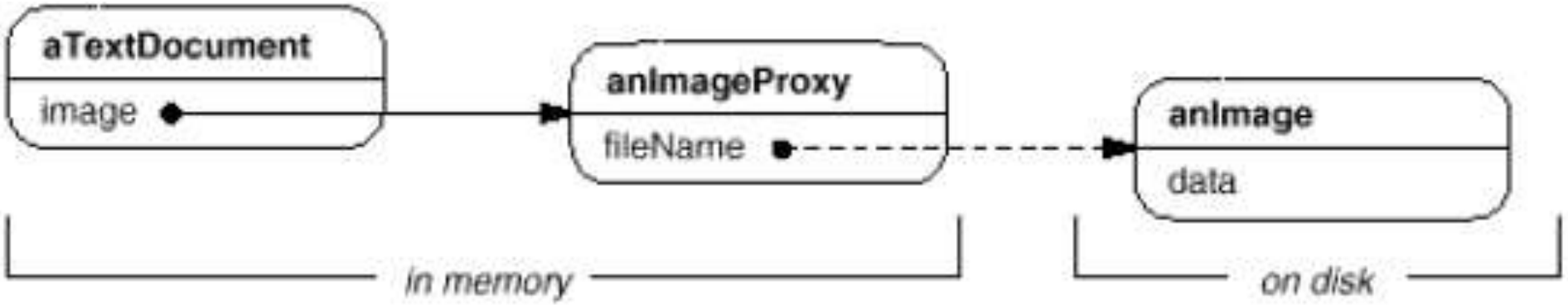
- Saves on memory in the case of large numbers of objects
- Becomes costly in processing time
- The code is complicated and not intuitive

Structural Patterns – Proxy

- **Intent – Provide a surrogate or placeholder for another object to control access to it.**
- **Also Known As** – Surrogate
- **Motivation** – Consider a document editor that can embed graphical objects in a document. Some graphical objects, like large raster images, can be expensive to create. But opening a document should be fast, so we should avoid creating all the expensive objects at once when the document is opened. This isn't necessary anyway, because not all of these objects will be visible in the document at the same time

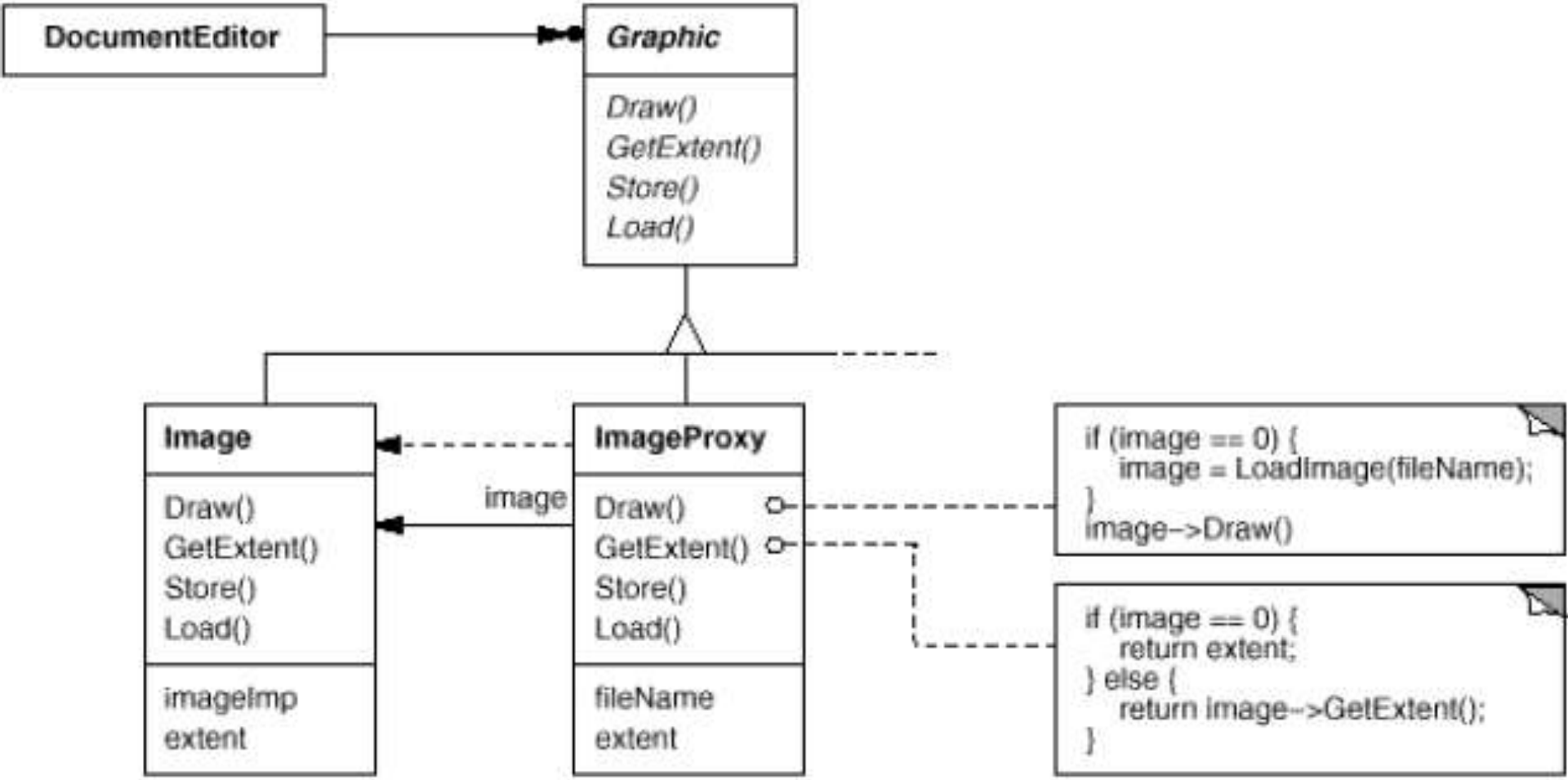
Proxy 1

- The solution is to use another object, an image **proxy, that acts as a stand-in** for the real image. The proxy acts just like the image and takes care of instantiating it when it's required.



Proxy 2

- The following class diagram illustrates this example in more detail



Proxy 3

- **Applicability** – Use the Proxy pattern when
  - You need to provide some interposed service between the application logic and the client
  - Provide some lightweight version of a service or resource
  - Screen or restrict user access to a resource or service

Proxy – Example

- Let’ say we need to withdraw money to make some purchase. The way we will do it is, go to an ATM and get the money, or purchase straight with a cheque.
- In old days when ATMs and cheques were not available, what used to be the way??? Well, get your passbook, go to bank, get withdrawal form there, stand in a queue and withdraw money. Then go to the shop where you want to make the purchase.
- In this way, we can say that ATM or cheque in modern times act as proxies to the Bank.

Proxy – Java 1

```
public class Bank {
   private int numberInQueue;

   public double getMoneyForPurchase(double amountNeeded) {
         You you = new You("Prashant");
         Account account = new Account();
         String accountNumber = you.getAccountNumber();
         boolean gotPassbook = you.getPassbook();
         int number = getNumberInQueue();

         while (number != 0) {number--; }

         boolean isBalanceSufficient =
   account.checkBalance(accountNumber, amountNeeded);
         if(isBalanceSufficient)
                  return amountNeeded;
         else
                  return 0;
   }

   private int getNumberInQueue() {
         return numberInQueue;}
}
```

Proxy – Java 2

```
public class ATMProxy {
  public double getMoneyForPurchase(double amountNeeded){
    You you = new You("Prashant");
    Account account = new Account();
    boolean isBalanceAvailable = false;
    if(you.getCard()) {
        isBalanceAvailable =
        account.checkBalance(you.getAccountNumber(),
        amountNeeded);
   }

   if(isBalanceAvailable)
        return amountNeeded;
   else
        return 0;
   }
}
```

Proxy – The Good, The Bad …

- The provided service can be changed without affecting the client
- The proxy is available even if the base service or resource may be unavailable
- Preserves O (from SOLID) – you can add new proxies without changing the service or client
- It usually delays the response to the client
- The code is complicated because of increased number of classes

Bibliografie

- Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides: *Design Patterns: Elements of Reusable Object-Oriented Software* (GangOfFour)

Links

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- Gang-Of-Four: http://c2.com/cgi/wiki?GangOfFour, http://www.uml.org.cn/c%2B%2B/pdf/DesignPatterns.pdf
- Design Patterns Book: http://c2.com/cgi/wiki?DesignPatternsBook
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- Overview of Design Patterns: http://www.mindspring.com/~mgrand/pattern_synopses.htm
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