Design Patterns

Christophe Damas

José Vander Meulen

Design Patterns

- Identifient des solutions récurrentes et bonnes à des problèmes récurrents en informatique.
  - Un développeur compétent se doit d'être capable d'identifier ces problèmes.
  - Un développeur compétent se doit d'être capable d'implémenter la solution correspondante.
  - Un développeur compétent se doit d'être capable de communiquer aves ses pairs en utilisant le vocabulaire des patterns.

Patterns

- Créationnel (instancier les objets)
  - Builder
  - Abstract Factory
  - Factory Method
  - Singleton
  - Prototype
- Structurel (composition des classes et objets)
  - Adapter
  - Facade
  - Composite
  - Decorator
  - Flyweight
- Comportemental (communication entre les objets)
  - Strategy
  - Command
  - Visitor
  - Observer
  - Template Method
  - Chain of responsibility
  - Iterator
  - State

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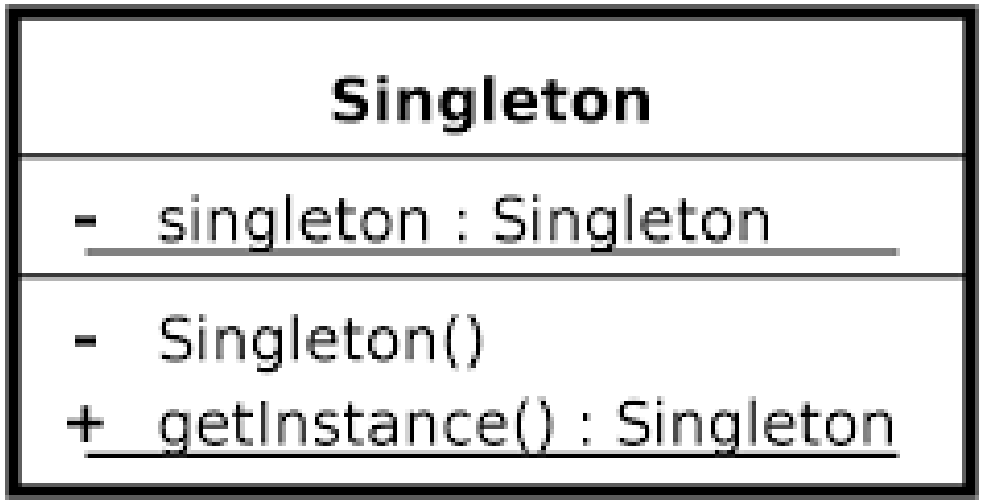
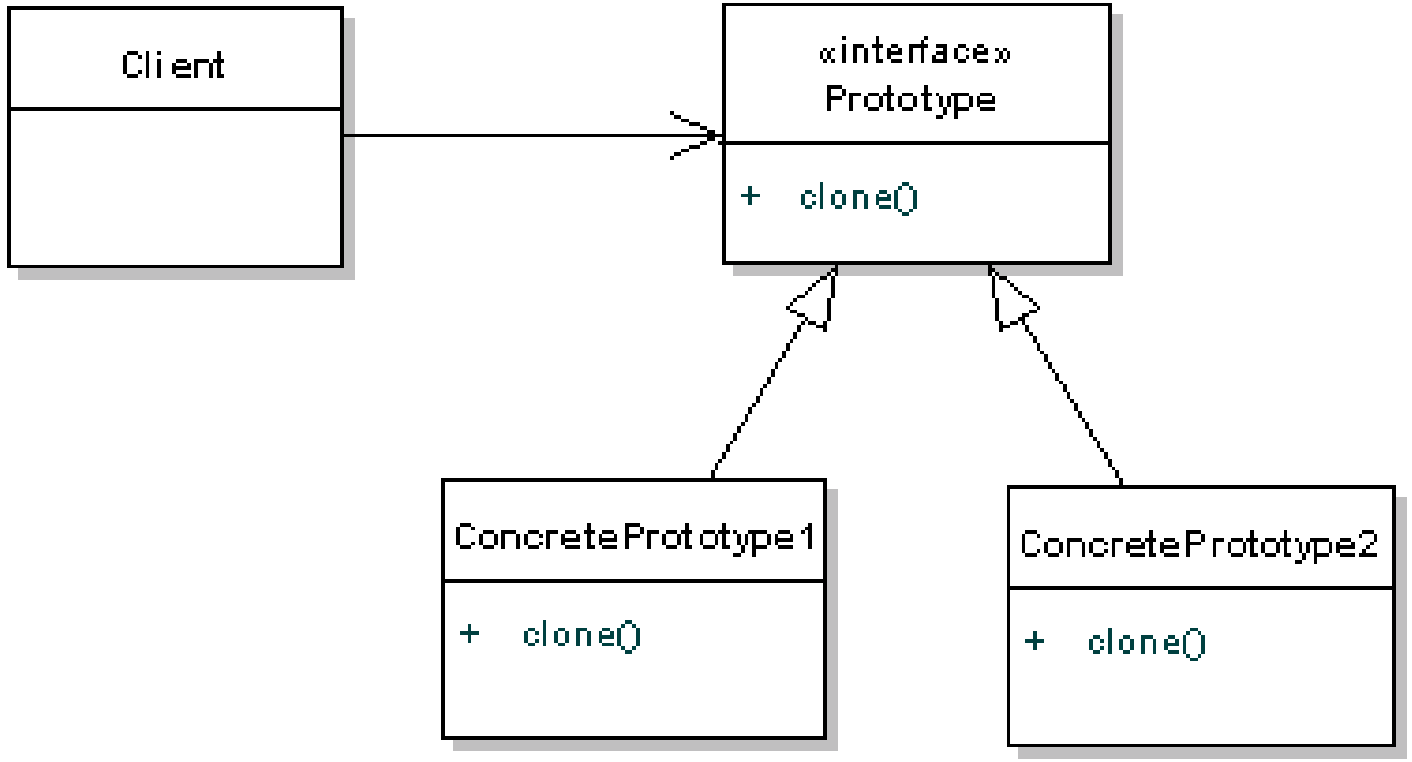
Singleton



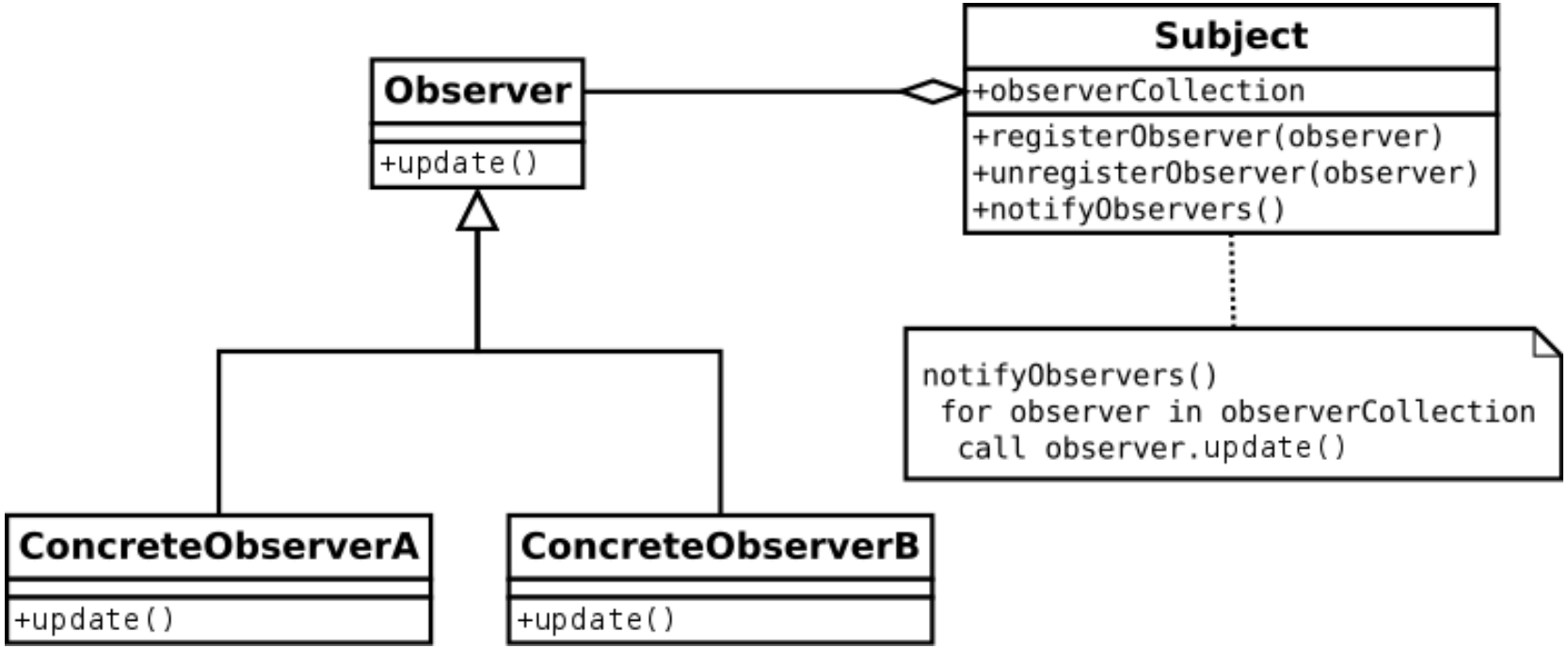
- Vous l’avez déjà vu en Atelier Java!
- Une seule instance pour une classe donnée.

Prototype



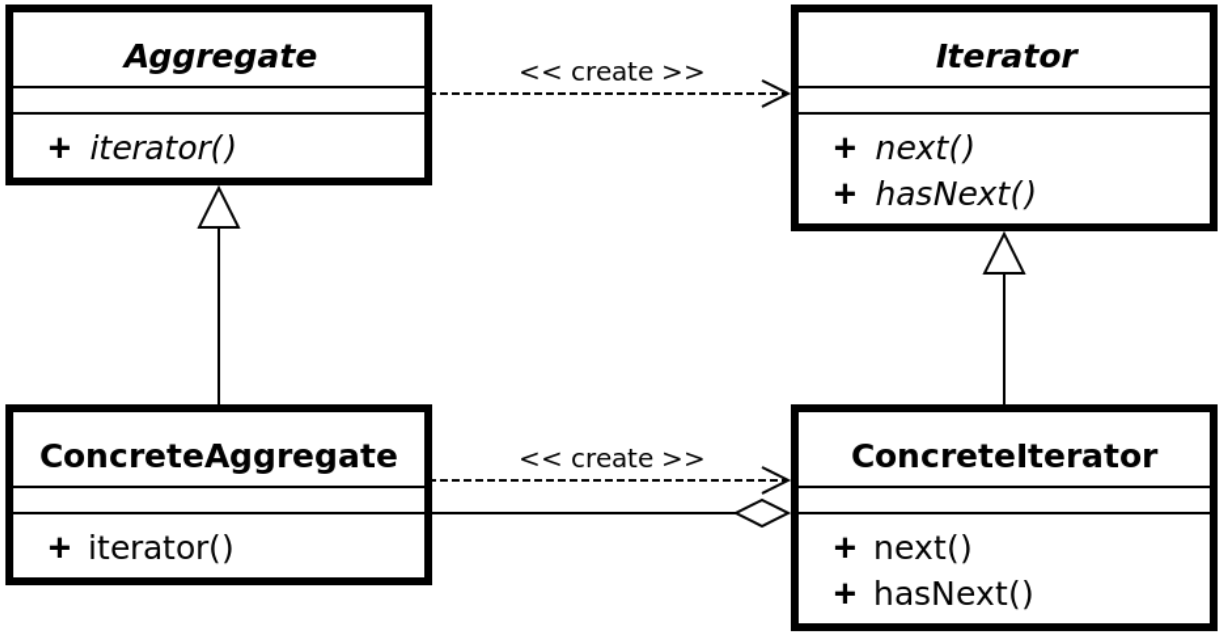
- Vous l’avez déjà rencontré en Javascript!
- La création d’objets est basé sur le clonage d’un objet passé en paramètre.

Observer



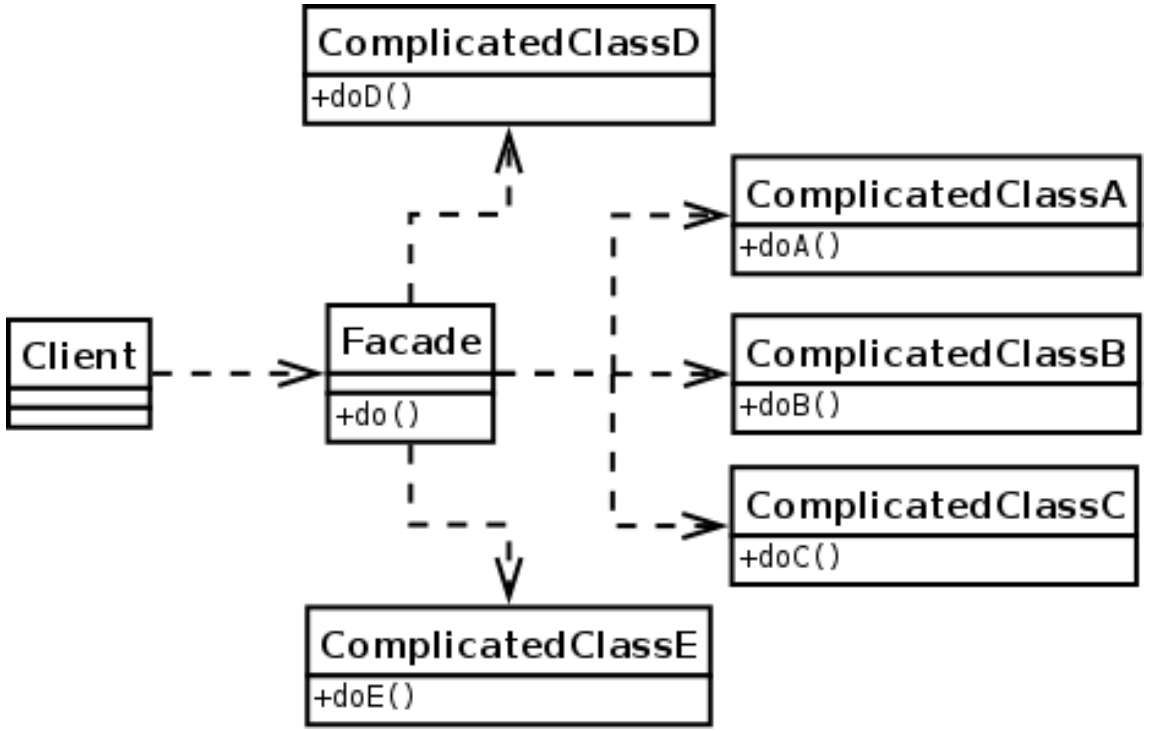
- Vous l’avez déjà rencontré!
- Un objet observé (sujet) retient une liste d’observateurs et les notifie de changement d’état en appelant une de leurs méthodes

Iterator



- Vous l’avez vu en APOO
- Fournit un moyen d’accéder séquentiellement aux éléments d’une collection d’objet sans connaitre sa représentation physique

Facade



- Vous l’avez déjà vu en projet AE avec l’UCC
- La facade présente une signature simplifiée sur un ensemble complexe d’objets.
- Rend le système plus facile à utiliser

Flyweight: exemple introductif

- Qu'affiche ce code ?

```
public class FlyweightTest {
      public static void main(String[] args) {
            Integer i=1; Integer j=1;
            System.out.println(i==j);}
}
```

- Est-ce que ce code compile ?

Flyweight: exemple introductif

- Java va en fait exécuter le programme suivant:

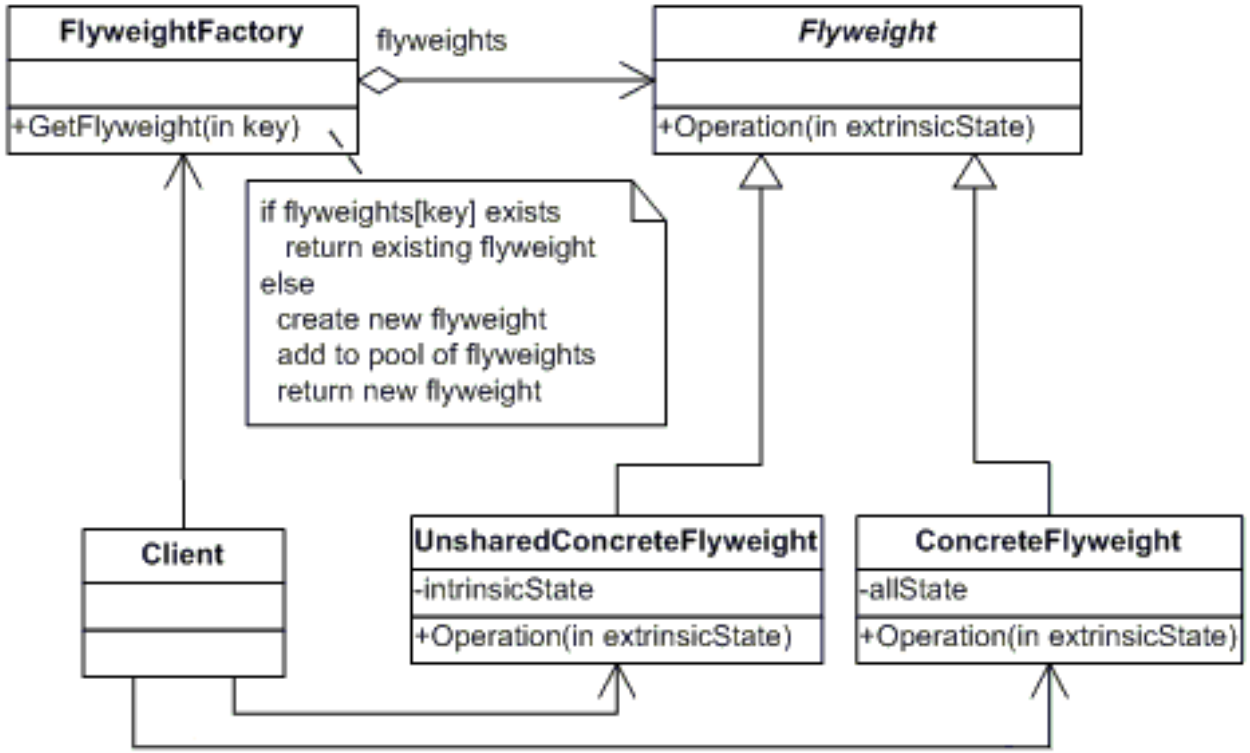
```
public class FlyweightTest {
      public static void main(String[] args) {
            Integer i=Integer.valueOf(1);
            Integer j=Integer.valueOf(1);
            System.out.println(i==j);}
}
```

- Qu'affiche ce programme ? Comment savoir ?

Flyweight: exemple introductif

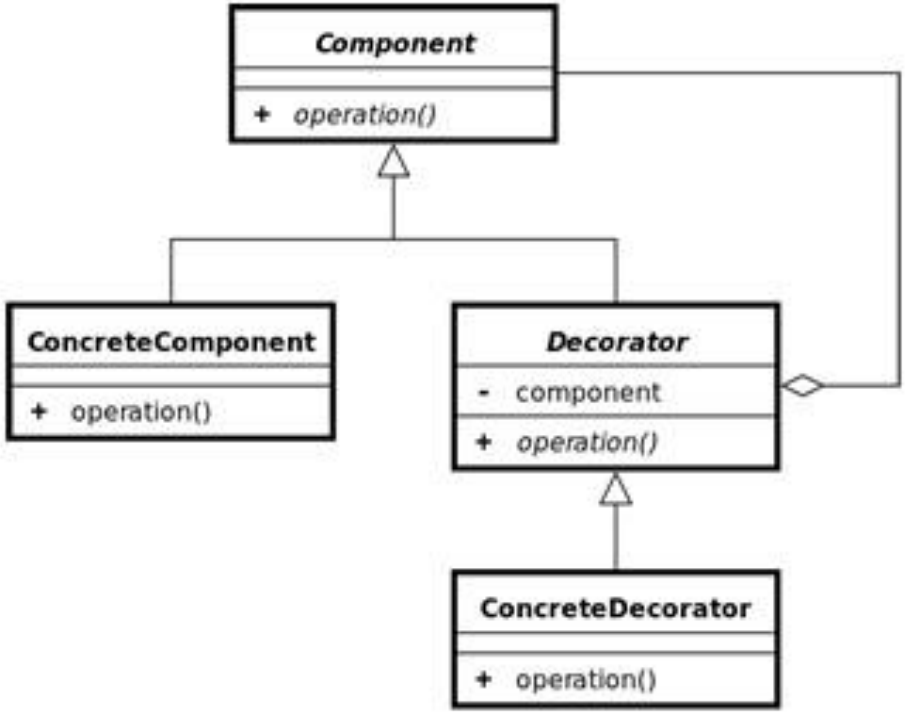
```
public class Integer{
        …
        public static Integer valueOf(int i) {
                final int offset = 128;
                if (i >= -128 && i <= 127) { // must cache
                        return IntegerCache.cache[i + offset];}
                return new Integer(i);}

        private static class IntegerCache {
                private IntegerCache() {}
                static final Integer cache[] = new Integer[-(-128) + 127 + 1];
                static {
                        for (int i = 0; i < cache.length; i++)
                                cache[i] = new Integer(i - 128);}
        }
}
```

Flyweight



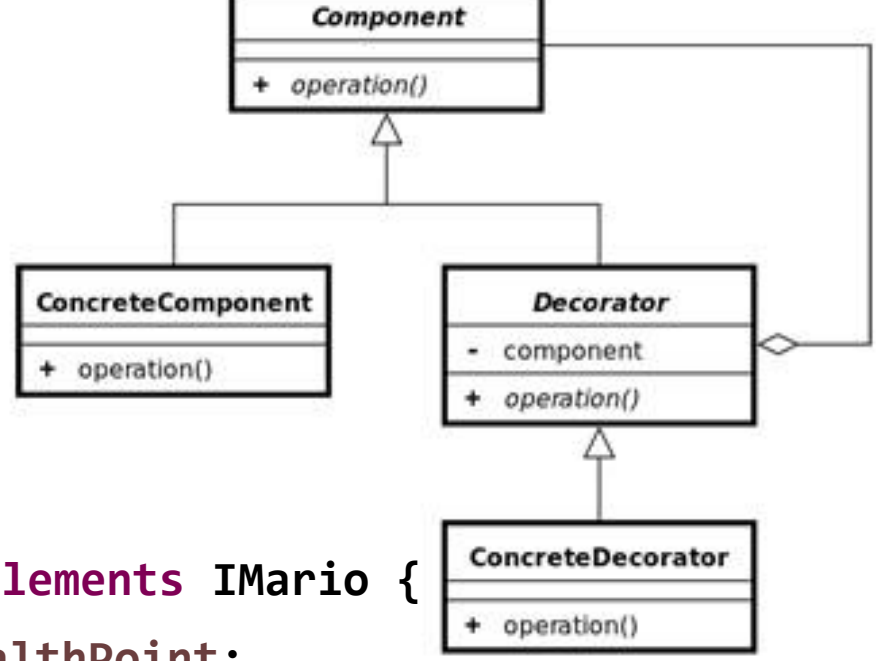
- Réduit le coût de création/manipulation de nombreux objets similaires.
- A la place d'instancier plusieurs objets identiques, on n'en instancie qu'un que l'on réutilise
- La classe Integer utilise le pattern Flyweight

Decorator



- Permet d'augmenter le comportement d'un objet dynamiquement
- Exemple: Mario

Decorator: example




```
public interface IMario {
        void jump();
        void moveForward();
        void takeDamage();
        void update();
}
```

```
public class Mario implements IMario {
        private int healthPoint;
        public Mario(int healthPoint) {
                super();
                this.healthPoint = healthPoint;}
        public void jump() {// ...}
        public void moveForward() {// ...}
        public void takeDamage() {
                healthPoint--;}
        public void update() {// ...}
}
```

Decorator: Mario

```
public class StarMario implements IMario {
  private IMario decoratedMario;
  private int timer = 1000;

  public StarMario(IMario decoratedMario) {
    this.decoratedMario = decoratedMario;}

  @Override
  public void takeDamage() {
    // StarMario does not take damage}

  @Override
  public void jump() {
    decoratedMario.jump();}

  @Override
  public void moveForward() {
    decoratedMario.moveForward();}

  @Override
  public void update() {
    timer--;
    if (timer == 0) {
      removeStar();}
    decoratedMario.update();}

  public void removeStar() {
    GameSingleton.instance.mario =
                                    decoratedMario;
  }
}
```

Template Method / Strategy

- Même objectif: Définition d'une famille d'algorithme

- Exemple: trier une liste de personnes selon différents critères

```
public class Personne {
  private String nom;
  private int age;
  private int tailleEnCm;
  private int poids;
  public Personne(String nom, int age, int tailleEnCm, int poids) {
        super();
        this.nom = nom;
        this.age = age;
        this.tailleEnCm = tailleEnCm;
        this.poids = poids;}
}
```

Template Method / Strategy: exemple

```java
public class ListePersonnesTrieeParAge {
  private Personne[] personnes;
  public ListePersonnesTrieeParAge(Personne... personnes) {
    this.personnes = personnes;
  }
  public void tri() {
    int cpt;
    Personne element;
    for (int i = 1; i < personnes.length; i++) {
      element = personnes[i];
      cpt = i - 1;
      while (cpt >= 0 && personnes[cpt].getAge()>element.getAge()) {
        personnes[cpt + 1] = personnes[cpt];
        cpt--;}
      personnes[cpt + 1] = element;}
    for (Personne pers : personnes)
      System.out.println(pers);}
  }
}
```

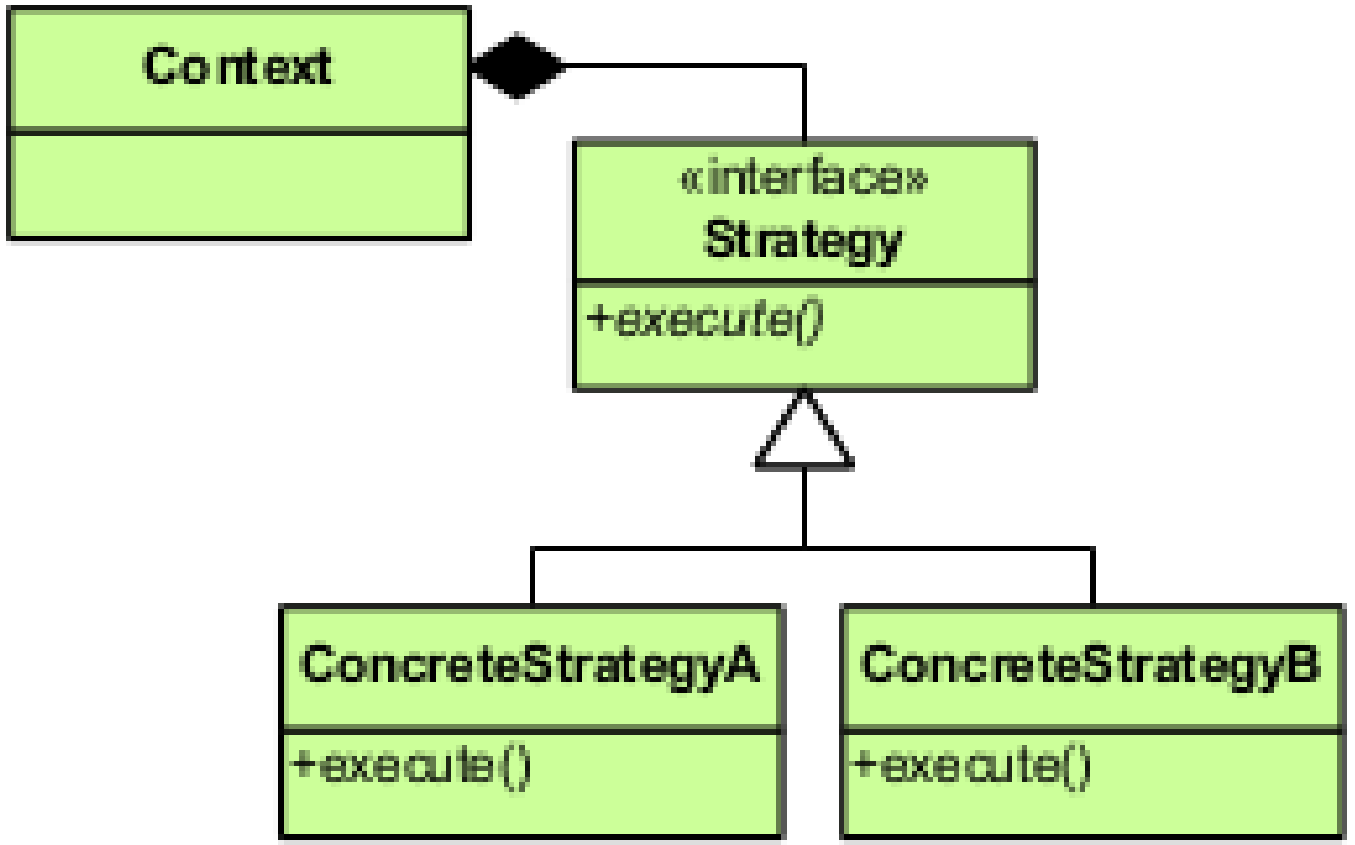
```java
public class ListePersonnesTrieeParNom {
  private Personne[] personnes;
  public ListePersonnesTrieeParAge(Personne... personnes) {
    this.personnes = personnes;
  }
  public void tri() {
    int cpt;
    Personne element;
    for (int i = 1; i < personnes.length; i++) {
      element = personnes[i];
      cpt = i - 1;
      while (cpt >= 0 && personnes[cpt].getNom()>element.getNom()) {
        personnes[cpt + 1] = personnes[cpt];
        cpt--;}
      personnes[cpt + 1] = element;}
    for (Personne pers : personnes)
      System.out.println(pers);}
  }
}
```

Exemple refactoré avec Strategy

```
public class ListePersonnes {
  private Personne[] personnes;
  public ListePersonnes(Personne... personnes) {
          this.personnes = personnes;}

  public void tri(ComparatorStrategy cs) {
    int cpt; Personne element;
    for (int i = 1; i < personnes.length; i++) {
      element = personnes[i]; cpt = i - 1;
      while (cpt >= 0 &&
           cs.compare(personnes[cpt],element)) {
        personnes[cpt + 1] = personnes[cpt]; cpt--;}
      personnes[cpt + 1] = element;}
  for (Personne pers : personnes)
    System.out.println(pers);}
}
```

```
public interface ComparatorStrategy{
  public boolean compare(Personne p1,Personne p2);
}

public class NomStrategy implements ComparatorStrategy{
  @Override
  public boolean compare(Personne p1, Personne p2) {
    return (p1.getNom().compareTo(p2.getNom())>0);}
}

public class Main{
  public static void main(String[] args) {
    Personne cd = new Personne("Damas", 40, 184, 70);
    Personne jvm = new Personne("Vander Meulen", 39, 182, 72);
    Personne grolaux = new Personne("Grolaux", 45, 180, 74);
    ListePersonnes lp = new ListePersonnes(cd, jvm, grolaux);
    lp.tri(new NomStrategy());}
}
```

Strategy

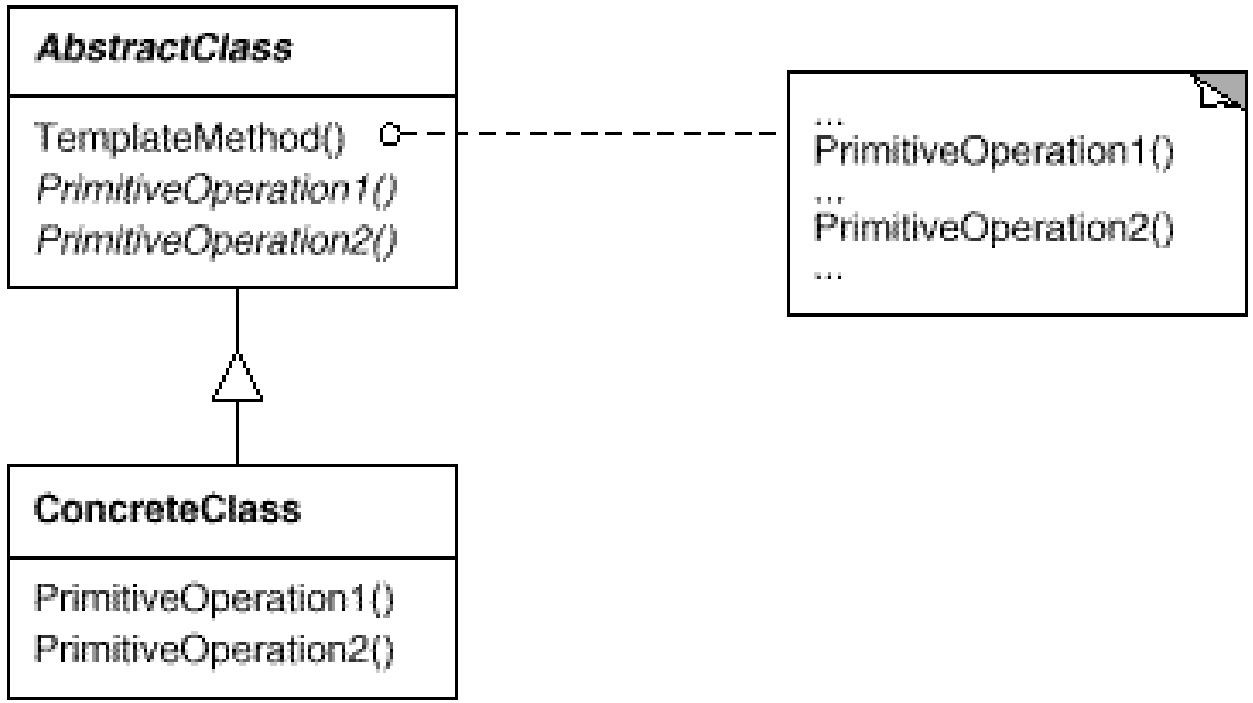

Context
«interface»
Strategy
+execute()
ConcreteStrategyA
+execute()
ConcreteStrategyB
+execute()

Exemple refactoré avec Template Method

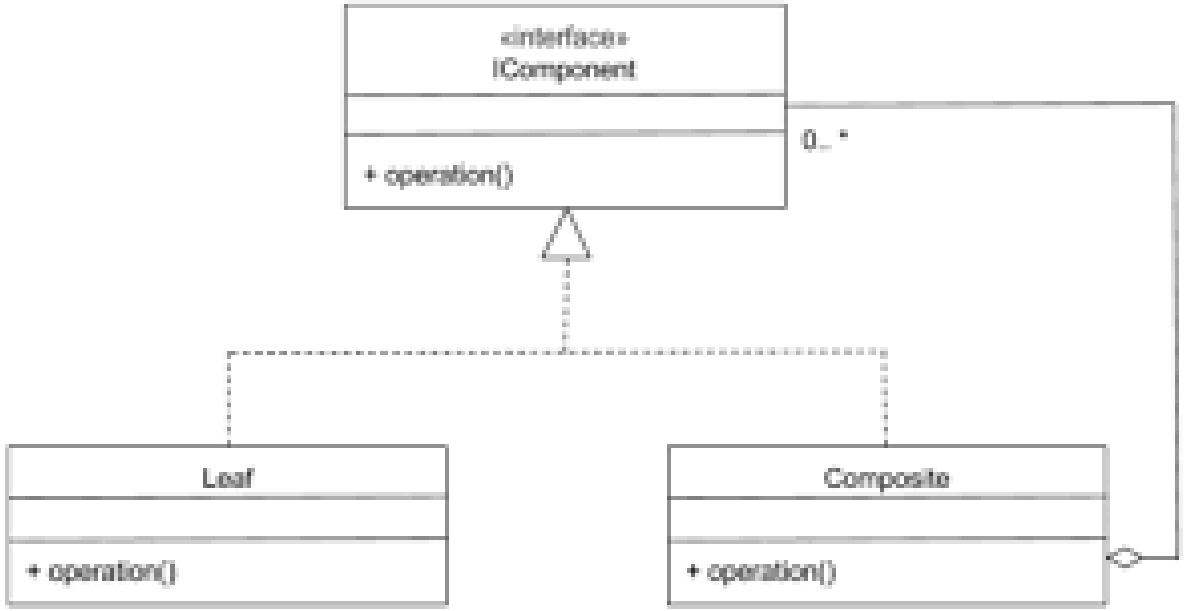
```
public abstract class ListePersonnes {
  private Personne[] personnes;
  public ListePersonnes(Personne... personnes) {
    this.personnes = personnes;}
  public void tri() {
    int cpt; Personne element;
    for (int i = 1; i < personnes.length; i++) {
      element = personnes[i]; cpt = i - 1;
      while (cpt >= 0 &&
          this.compare(personnes[cpt],element)) {
        personnes[cpt + 1] = personnes[cpt]; cpt--;}
      personnes[cpt + 1] = element;}
    for (Personne pers : personnes)
      System.out.println(pers);}

  public abstract boolean compare(Personne personne,
Personne element);
}
```

```
public class ListePersTrieeParAge extends ListePersonnes{
  public ListePersTrieeParAge(Personne... personnes) {
    super(personnes);}
  @Override
  public boolean compare(Personne p1, Personne p2) {
    return p1.getAge()>p2.getAge();}
}

public class Main{
  public static void main(String[] args) {
    Personne cd = new Personne("Damas", 40, 184, 70);
    Personne jvm = new Personne("Vander Meulen", 39, 182, 72
    Personne grolaux = new Personne("Grolaux", 45, 180, 74);
    ListePersonnes lp = new
          ListePersTrieeParAge(cd, jvm, grolaux);
    lp.tri();}
}
```

Template Method

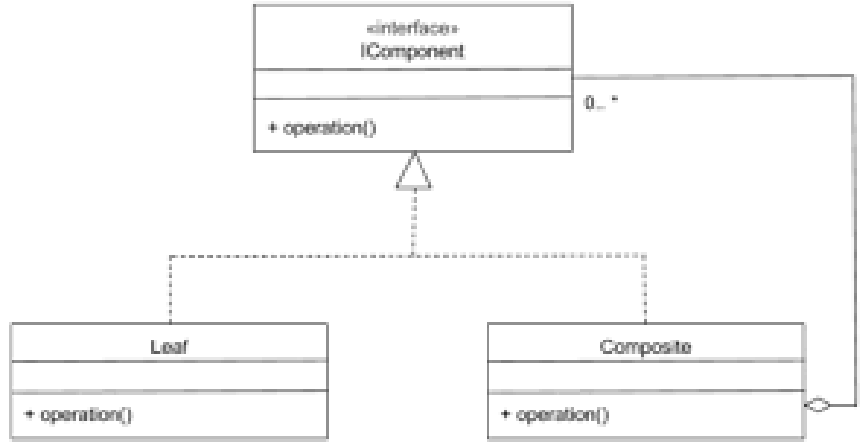


Composite



- Vous l’avez déjà vu: les arbres.
- Combine plusieurs objets similaires pour se comporter comme un objet unique.
- Exemple: logiciel de dessin

Composite: exemple



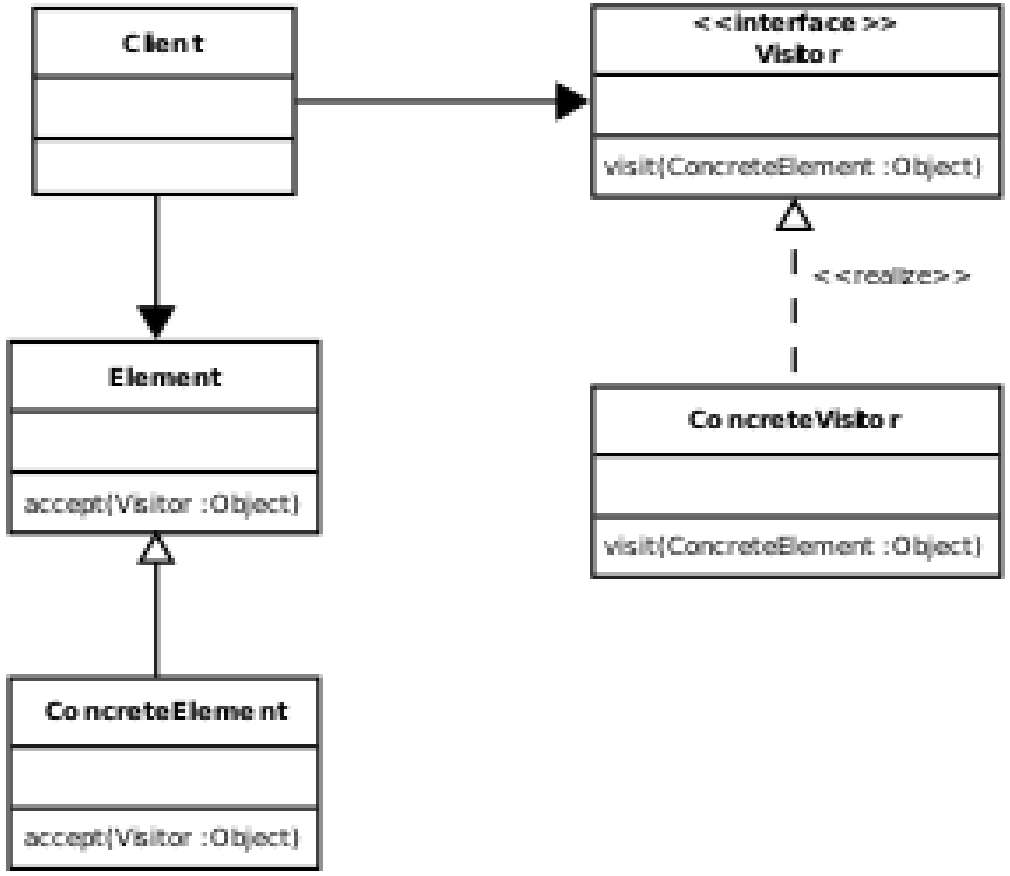

```
public interface Shape {
  void move(int x, int y);
  void draw();}

public class Circle implements Shape {
  private double diameter;
  public Circle(double diameter) {
    this.diameter=diameter;}
  @Override
  public void move(int x, int y) {
    // move a Circle}
  @Override
  public void draw() {// draw a Circle}
}

public class Square implements Shape {…}
```

```
public class CompoundShape implements Shape {
  private List<Shape> shapes= new ArrayList<Shape>();
  @Override
  public void move(int x, int y) {
    for(Shape s: shapes) {s.move(x, y);}
  }
  @Override
  public void draw() {
    for(Shape s: shapes) {s.draw();}
  }

  public void addShape(Shape s) {
    shapes.add(s);
  }
}
```

Composite example

```
public class Main {
  public static void main(String[] args) {
    Shape circle= new Circle(3.0);
    Shape square= new Square(4.0);
    CompoundShape group= new CompoundShape();
    group.addShape(circle);
    group.addShape(square);
    Shape circle2= new Circle(4.0);
    CompoundShape group2= new CompoundShape();
    group2.addShape(circle2);
    group2.addShape(group);}
}
```

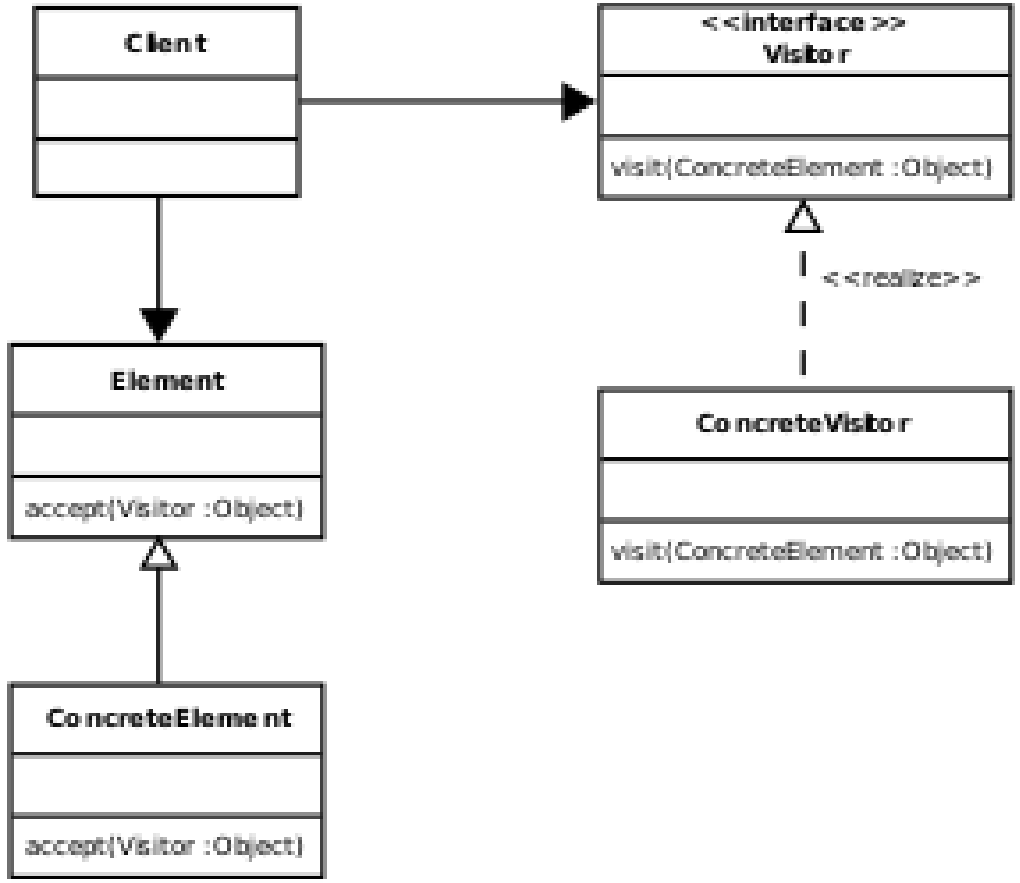
Visitor



- Représente une opération à appliquer sur les éléments d'une structure d'objets (souvent un composite)
  - Ressemble à une Strategy avec autant de méthodes que de type de nœuds différents.
- Exemple: Exporter les différentes formes dans un fichier xml

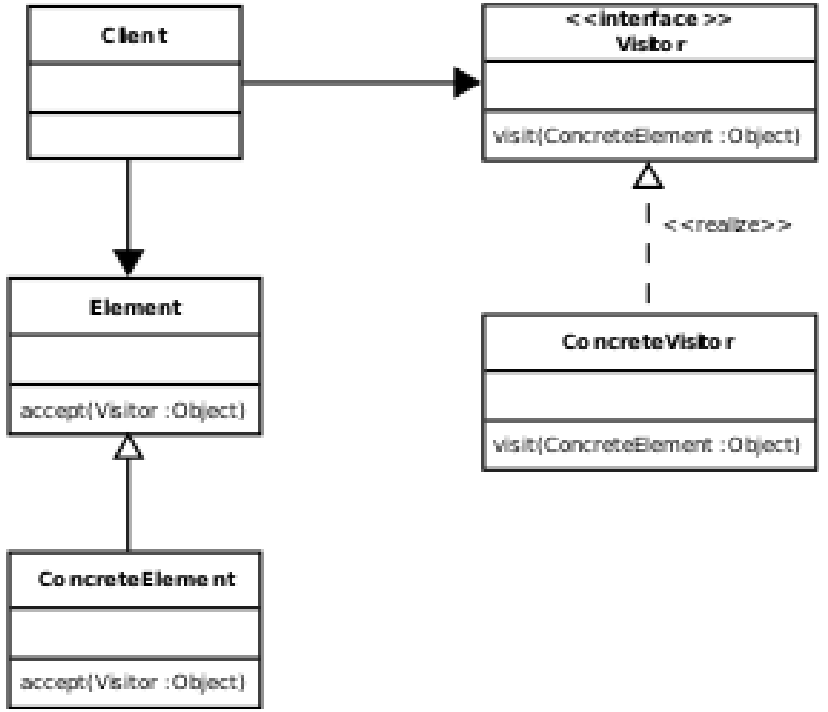
Visitor: exemple

```
public interface Visitor {
  String visitCircle(Circle circle);
  String visitSquare(Square s);
  String visitCompoundShape(CompoundShape cs);}

public interface Shape {
  void move(int x, int y);
  void draw();
  String accept(Visitor v);
}

public class Circle implements Shape {
  …
  @Override
  public String accept(Visitor v) {
    return v.visitCircle(this);}
}
```




```
public class CompoundShape implements Shape {
  …
  @Override
  public String accept(Visitor v) {
    return v.visitCompoundShape(this);}
}
```

Visitor: exemple



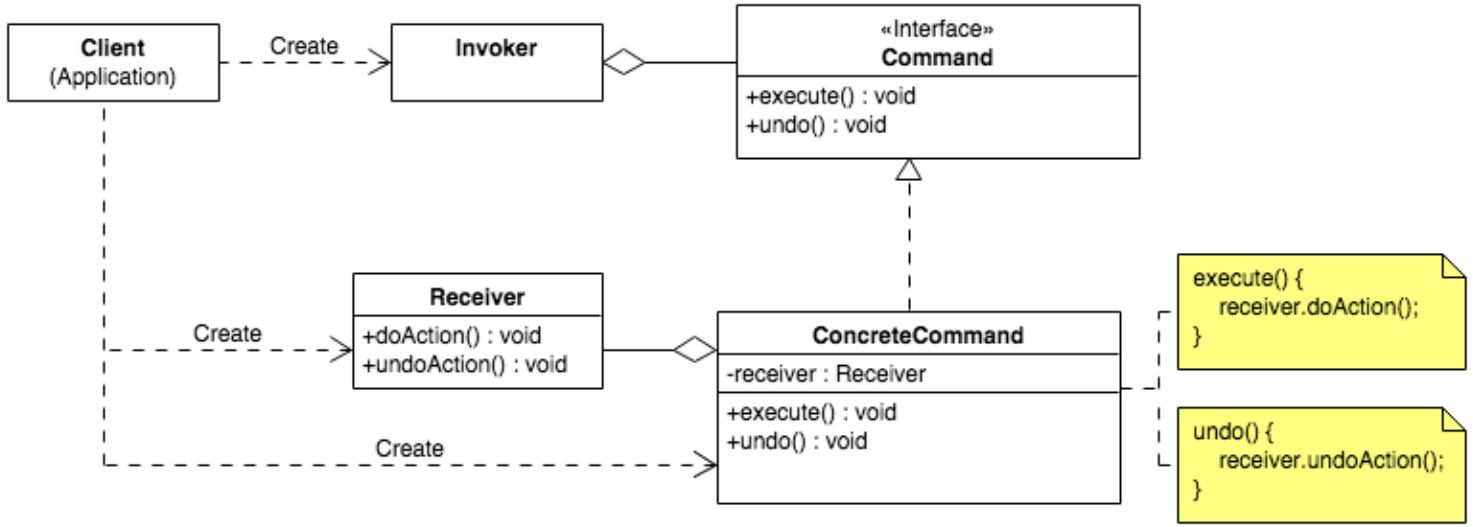

```
public class XMLExportVisitor implements Visitor {
  public String export(Shape shape) {
    StringBuilder sb = new StringBuilder();
    sb.append("<?xml version=\"1.0\" encoding=\"utf-8\"?>" + "\n");
    sb.append(shape.accept(this));
    return sb.toString();}

  public String visitCircle(Circle c) {
    return "<circle>" + "\n" + "\t<diameter>" + c.getDiameter() + "</diameter>" + "\n" + "</circle>";}

  public String visitSquare(Square s) {
    return "<square>" + "\n" + "\t<size>" + s.getSize() + "</size>" + "\n" + "</square>";}

  public String visitCompoundShape(CompoundShape cs) {
    StringBuilder sb = new StringBuilder();
    for (Shape shape : cs) {
      String obj = shape.accept(this);
      obj = "\t" + obj.replace("\n", "\n\t") + "\n";
      sb.append(obj);}
    return "<compound_shape>" + "\n" + sb.toString()+ "</compound_shape>";}
}
```

Visitor example

```
public class Main {
  public static void main(String[] args) {
    Shape circle= new Circle(3.0);
    Shape square= new Square(4.0);
    CompoundShape group= new CompoundShape();
    group.addShape(circle);
    group.addShape(square);
    Shape circle2= new Circle(4.0);
    CompoundShape group2= new CompoundShape();
    group2.addShape(circle2);
    group2.addShape(group);
    XMLExportVisitor exportVisitor = new XMLExportVisitor();
    System.out.println(exportVisitor.export(group2));}
}
```

```
<?xml version="1.0" encoding="utf-8"?>
<compound_shape>
  <circle>
    <diameter>4.0</diameter>
  </circle>
  <compound_shape>
    <circle>
      <diameter>3.0</diameter>
    </circle>
    <square>
      <size>4.0</size>
    </square>
  </compound_shape>
</compound_shape>
```

Command Pattern

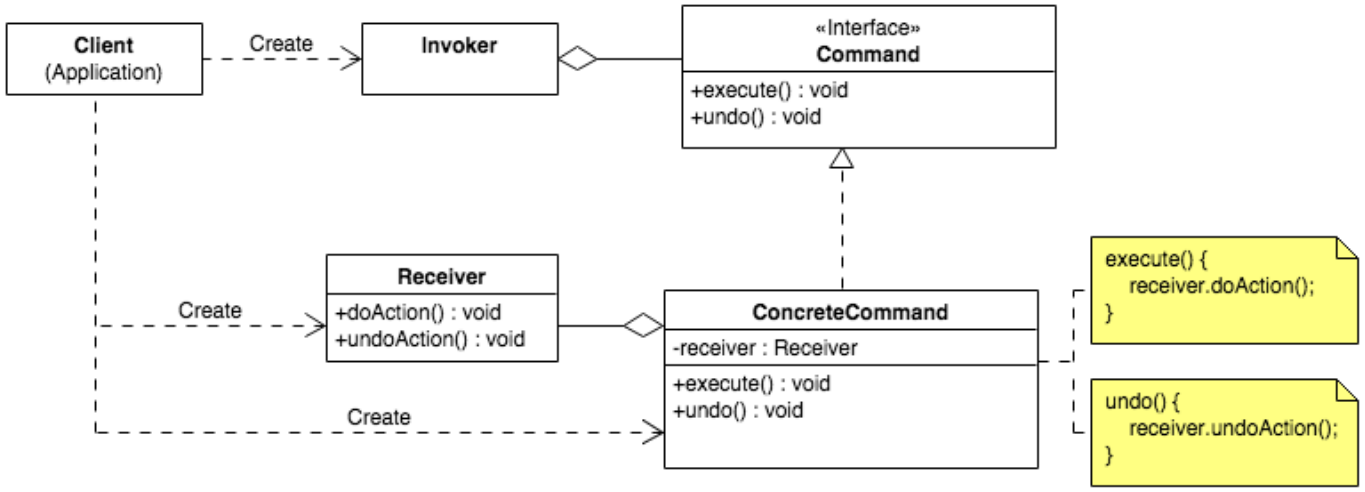


- Une commande encapsule une action à exécuter plus tard

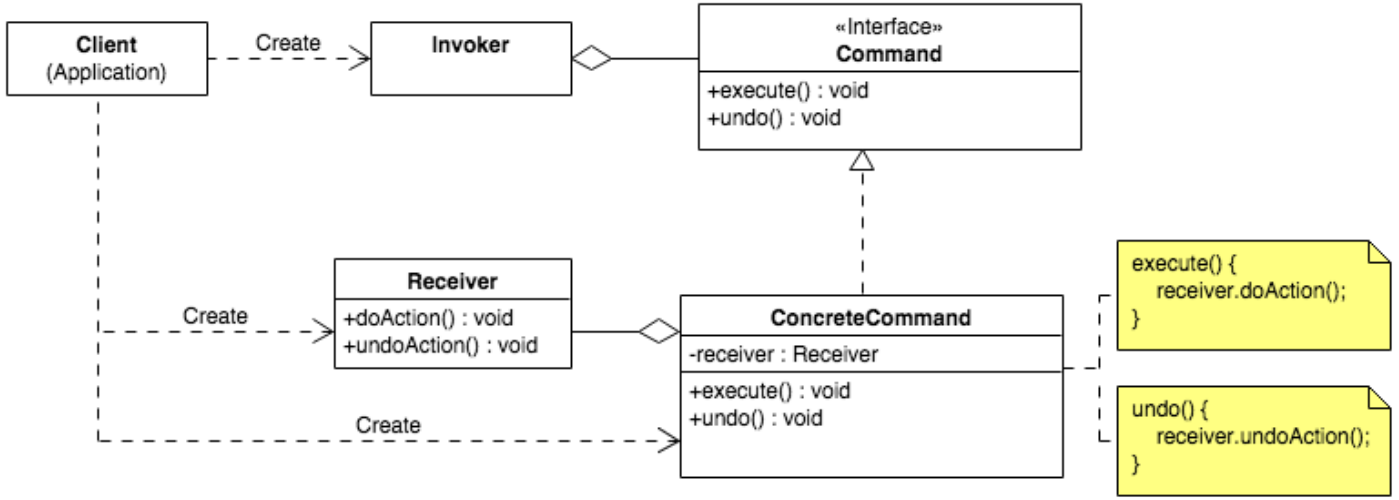
```
public class TextFile {
  private String name;
  public TextFile(String name) {this.name = name;}
  public void open() {System.out.println("Opening file " + name);}
  public void save() {System.out.println("Saving file " + name);}
  // additional text file methods (editing, writing, copying, pasting)
}

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

Command Pattern

```
public class OpenTextFileOperation implements TextFileOperation {
  private TextFile textFile;
  public OpenTextFileOperation(TextFile textFile) {
    this.textFile = textFile;
  }
  @Override
  public void execute() {textFile.open();}
}

public class TextFileOperationExecutor {
  private final List<TextFileOperation> textFileOperations = new ArrayList<>();
  public void addOperation(TextFileOperation textFileOperation) {
    textFileOperations.add(textFileOperation);}
  public void executeOperations() {
    for (TextFileOperation tfo: textFileOperations) {tfo.execute();}
  }
}
```

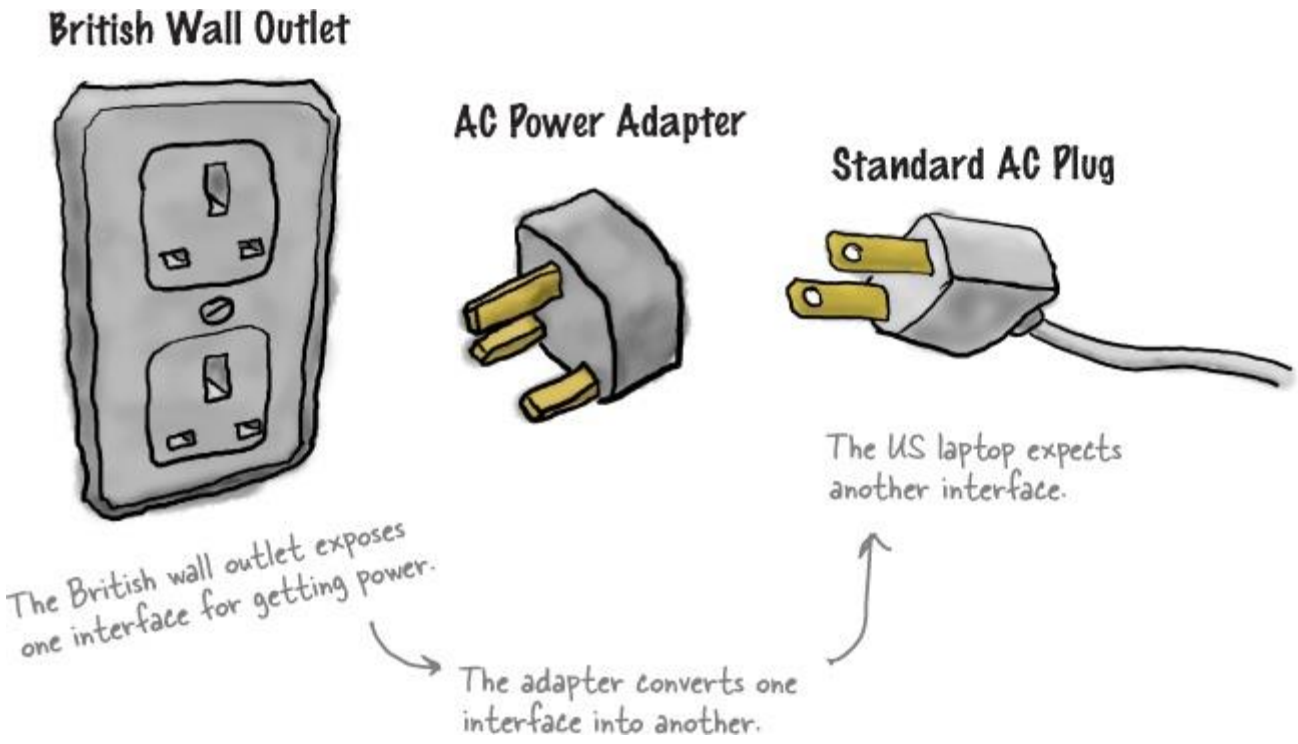


Command Pattern




```
public class Main {
  public static void main(String[] args) {
    TextFileOperationExecutor textFileOperationExecutor =
            new TextFileOperationExecutor();
    textFileOperationExecutor.addOperation(new
            OpenTextFileOperation(new TextFile("file1.txt")));
    textFileOperationExecutor.addOperation(new
            SaveTextFileOperation(new TextFile("file2.txt")));
    textFileOperationExecutor.executeOperations();}
}
```

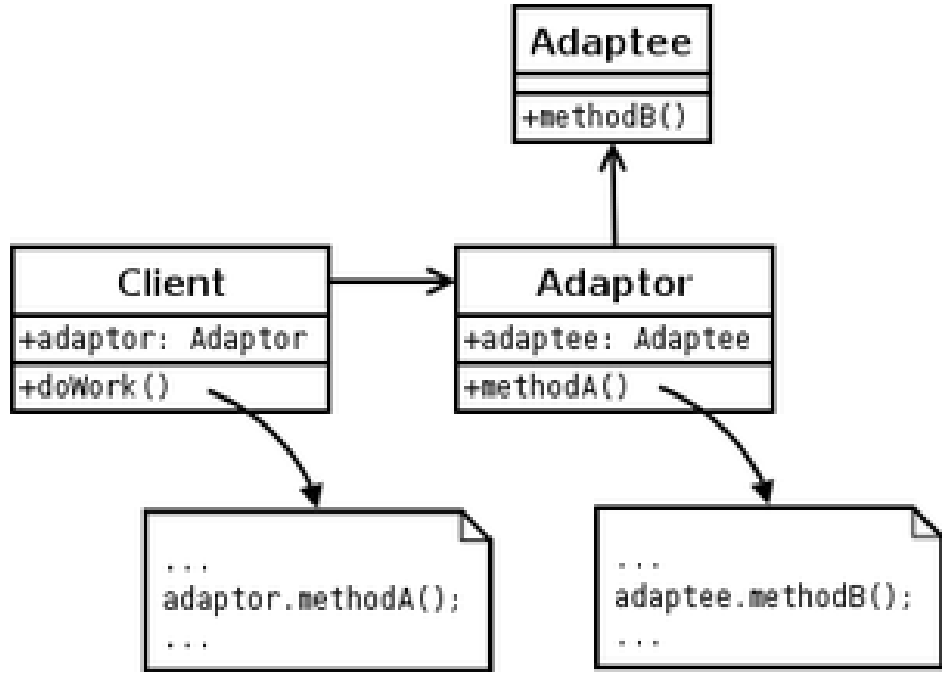
Adapter



- Le pattern permet à des classes de travailler ensemble malgré leur interface incompatible

Adapter: exemple

```
public class UKElectricalSocket {
  public void plugIn(UKPlugConnector plug) {
    plug.provideElectricity();}
}

public interface BelgianPlugConnector {
          public void giveElectricity() ;
}

public class BelgianToUKPlugConnectorAdapter
                                implements UKPlugConnector {
  private BelgianPlugConnector plug;
  public BelgianToUKPlugConnectorAdapter(BelgianPlugConnector plug)
  {this.plug = plug;}
  @Override
  public void provideElectricity() {
    plug.giveElectricity();}
}
```

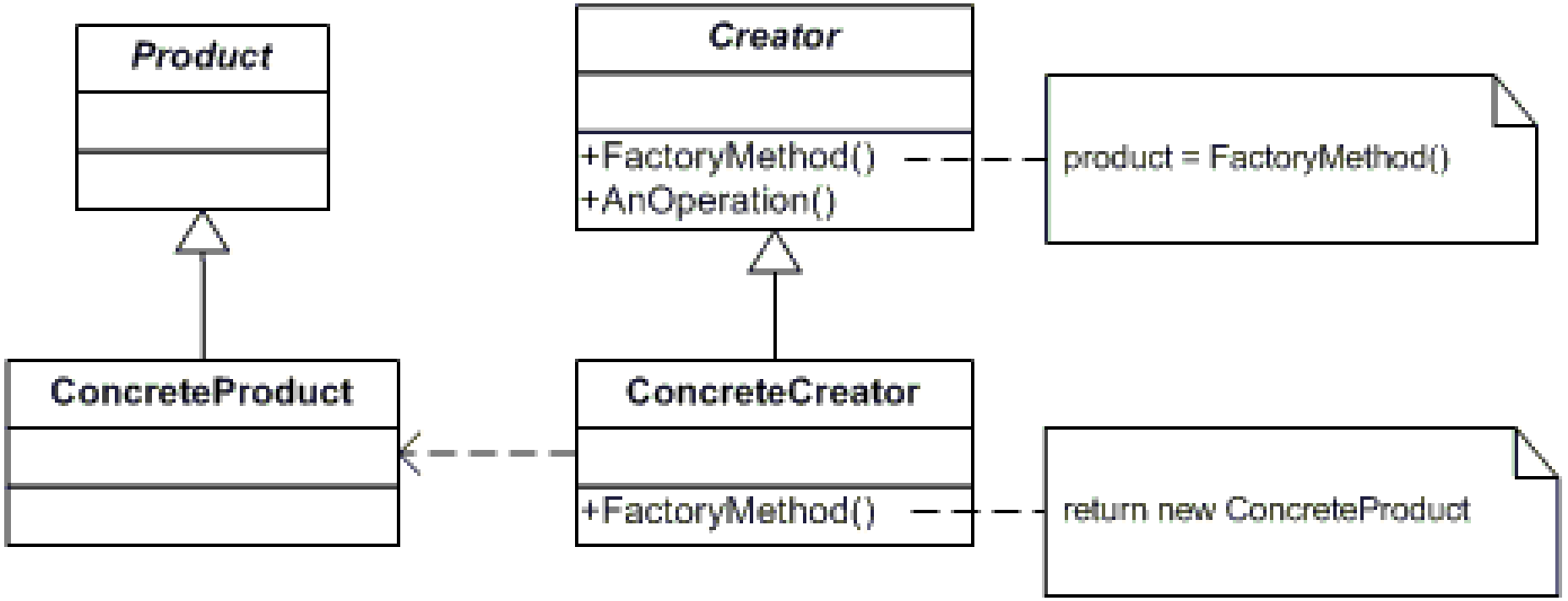



```
public class Main {
  public static void main(String[] args) {
    BelgianPlugConnector plugConnector =
                    new BelgianPhilipsPlugConnector();
    UKElectricalSocket electricalSocket =
                    new UKElectricalSocket();
    UKPlugConnector ukAdapter =
          new  BelgianToUKPlugConnectorAdapter(plugConnector
    electricalSocket.plugIn(ukAdapter);}
}
```

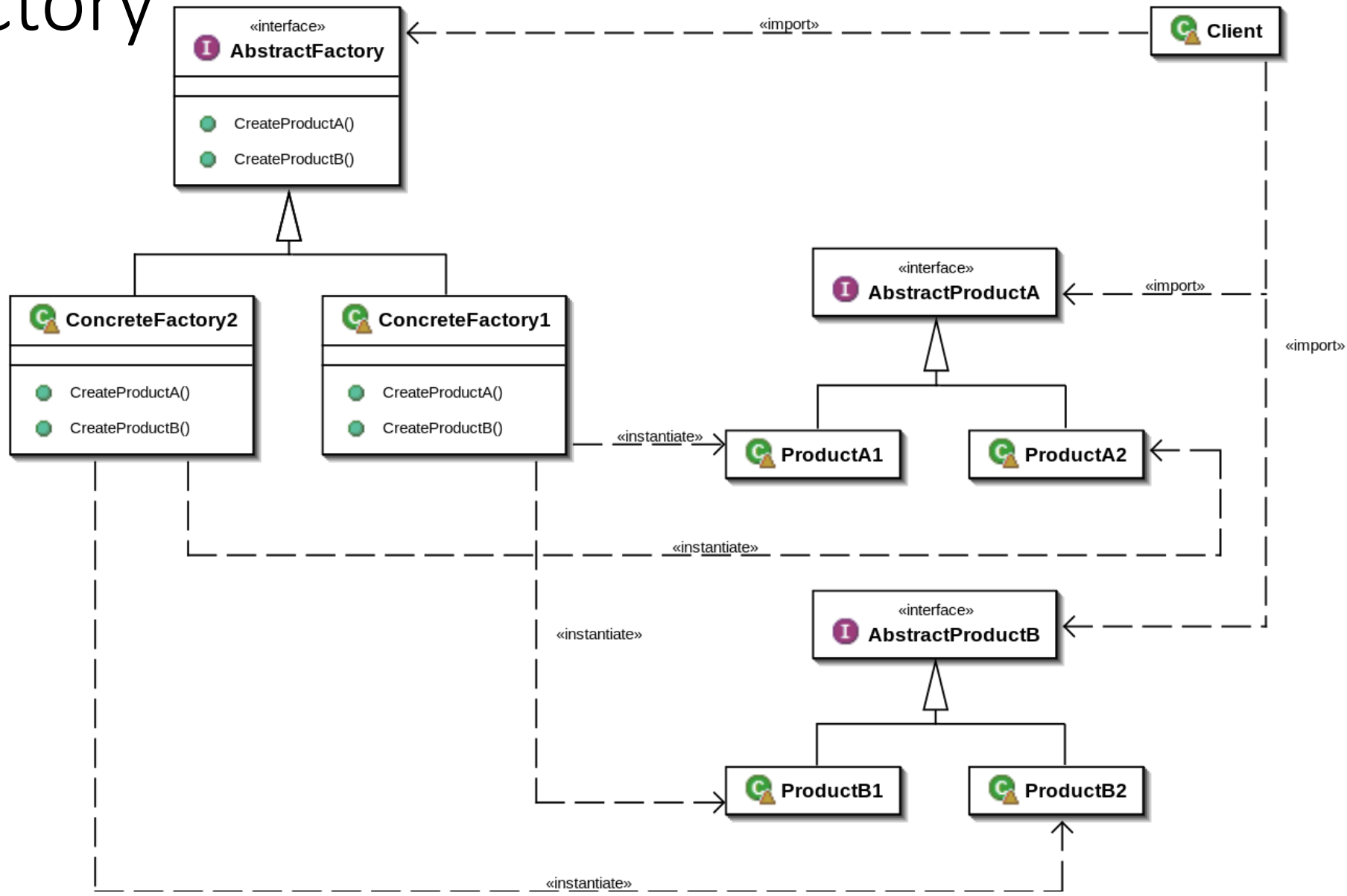
Suite du cours …

- Le but de ce cours est de maitriser tous les patterns
- A chaque séance sera proposé un (ou plusieurs) exercice(s) d'un des types suivant :
  - Identifier un pattern déjà implémenté dans du code.
  - Identifier un pattern pour la résolution d'un problème donné et l'implémenter
  - Identifier un pattern afin d'améliorer un code déjà existant et adapter ce code (refactoring)
- L'évaluation finale consistera en des exercices similaires:
  - Moodle accessible durant l'examen
  - Vous avez droit à une feuille recto/verso supplémentaire

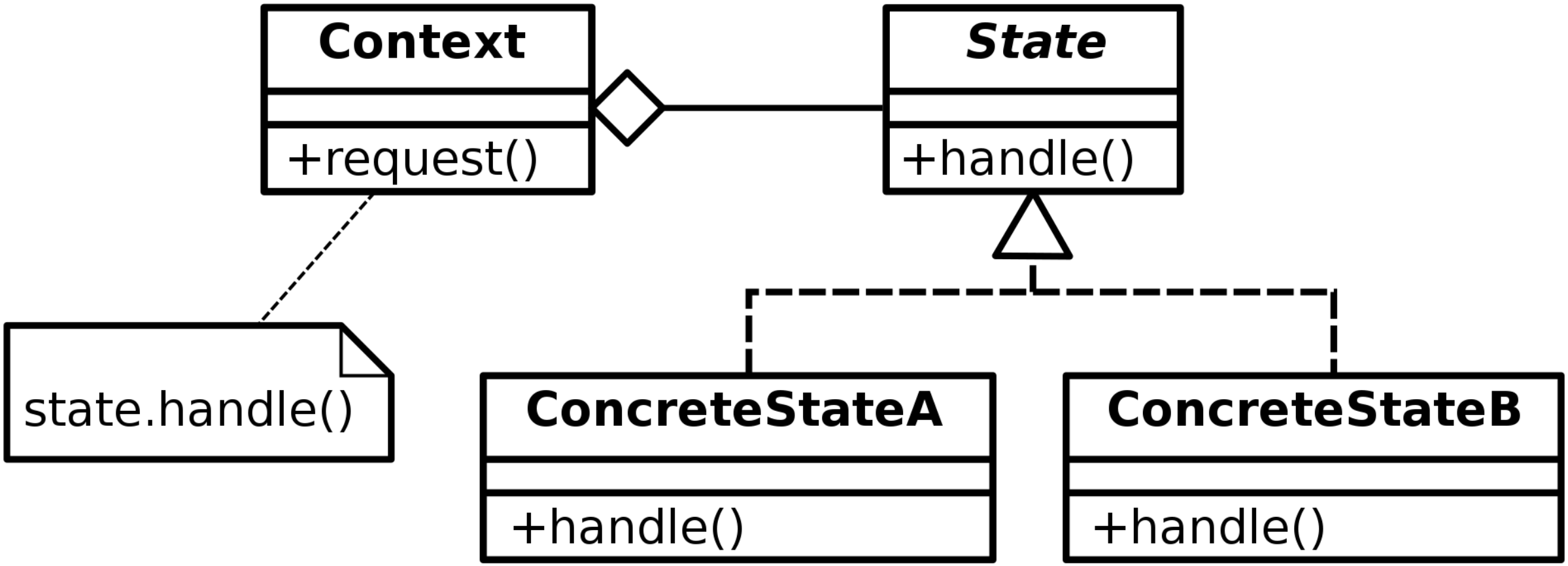
Factory Method



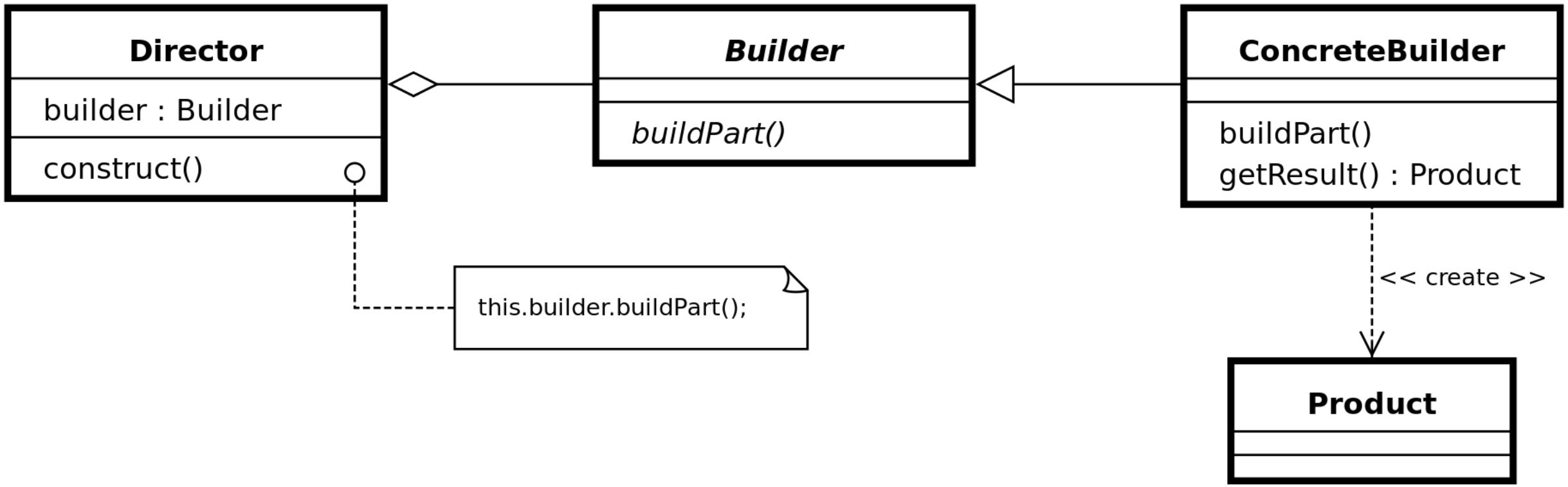
Abstract Factory



State


Context
+request()
State
+handle()
state.handle()
ConcreteStateA
+handle()
ConcreteStateB
+handle()

Builder


Director
builder : Builder
construct()
Builder
buildPart()
ConcreteBuilder
buildPart()
getResult() : Product
this.builder.buildPart();
<< create >>
Product

Chain Of Responsibility