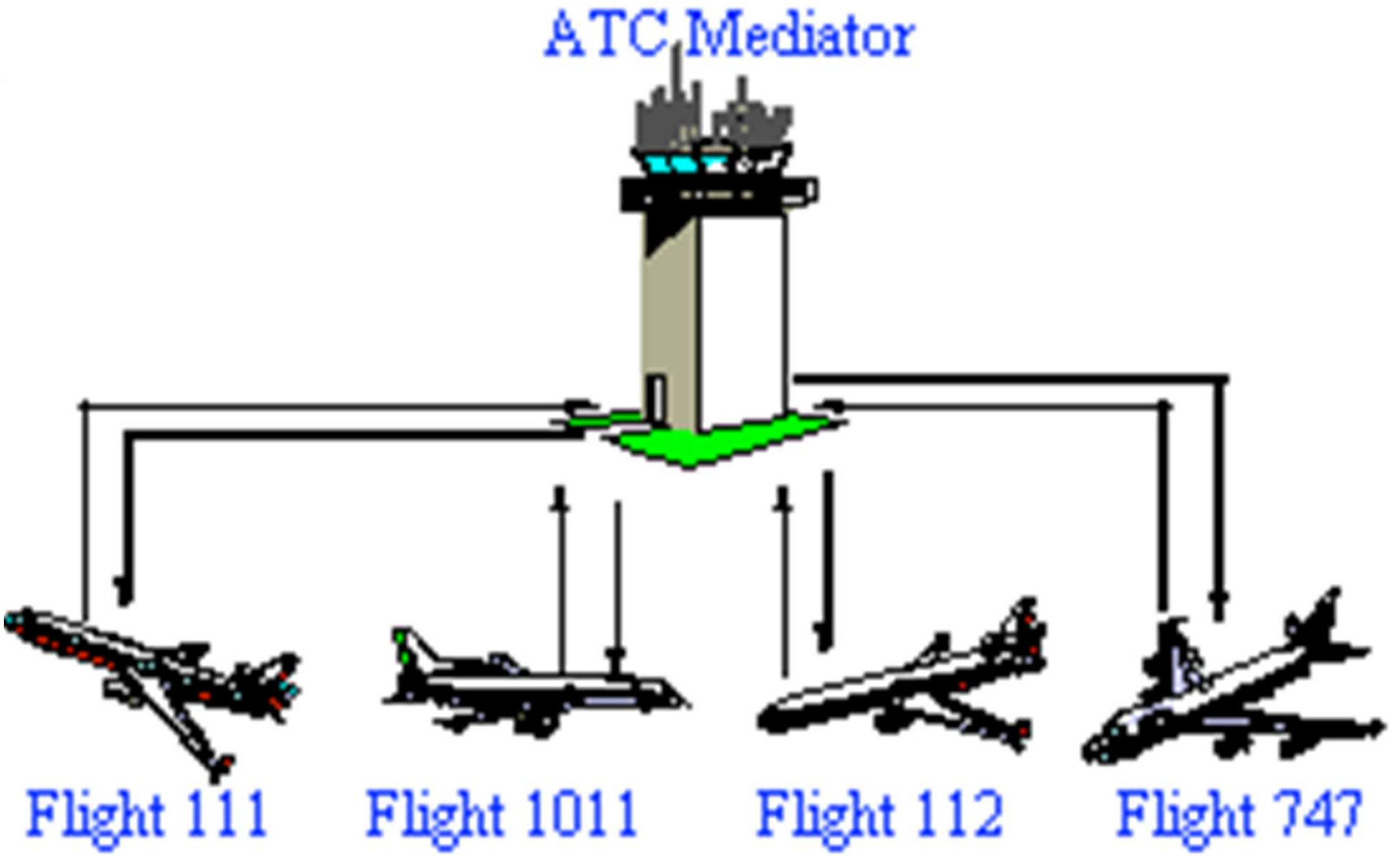
Tecniche di Progettazione: Design Patterns

GoF: Mediator Memento Prototype Visitor

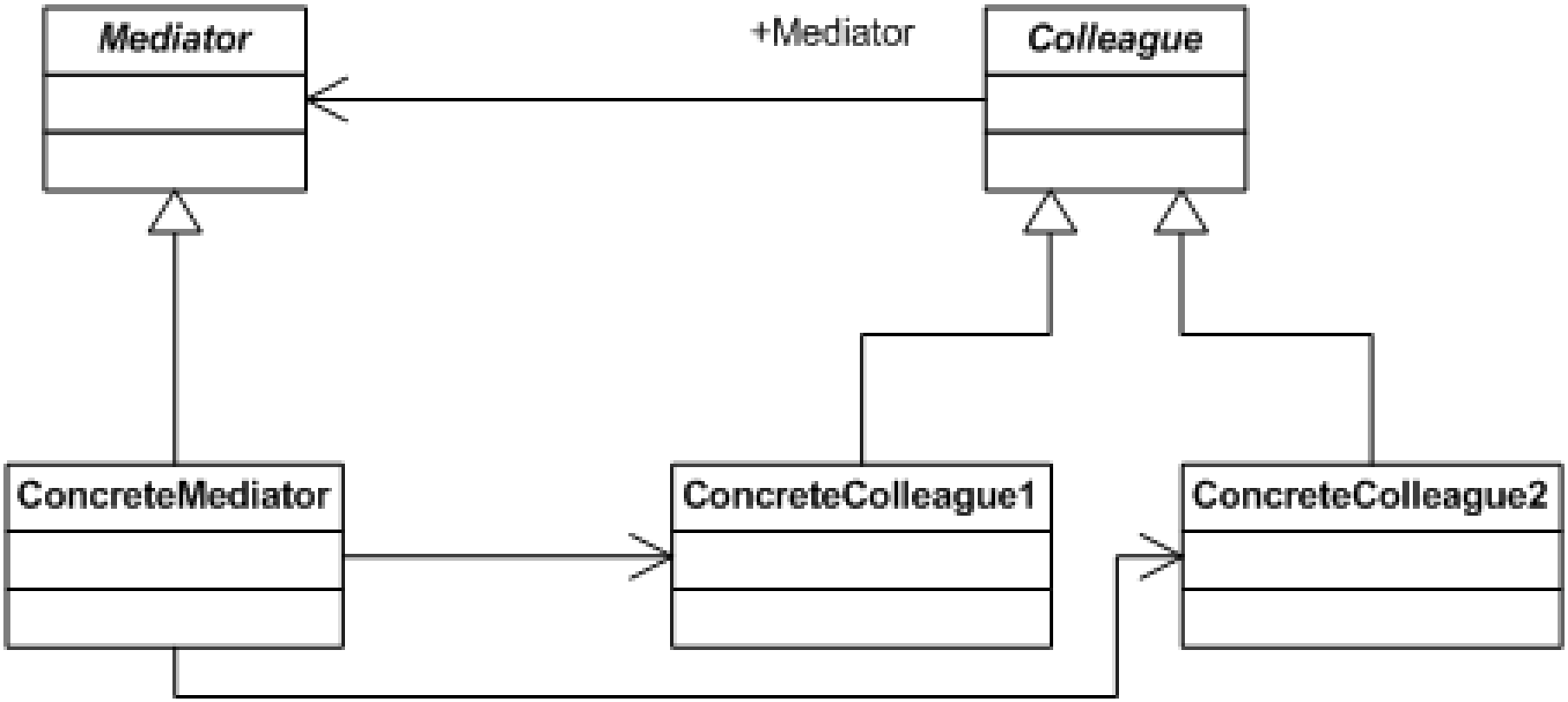
Mediator

Applicability

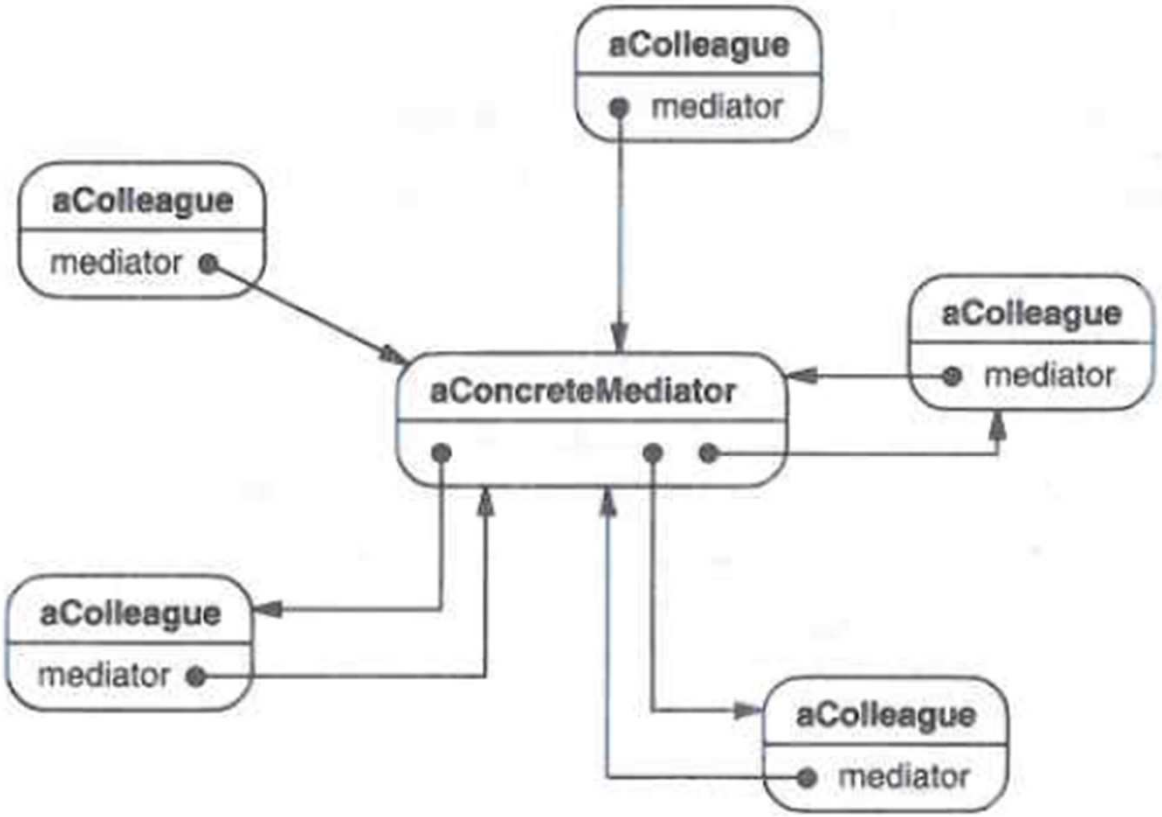
- A set of objects communicates in well-defined, but complex ways. Often with difficult because it refers to and communicates with many other unstructured dependencies.
- Reusing objects is objects.
- A behavior that's distributed between several classes should be customizable without a lot of subclassing.


ATC Mediator
Flight 111
Flight 1011
Flight 112
Flight 747

Mediator: structure



Structure


aColleague
mediator
aColleague
mediator
aColleague
mediator
aConcreteMediator
aColleague
mediator
aColleague
mediator

Consequences

- Limits subclassing
  - Localizes behavior that would be otherwise distributed among many objects. Changing this behaviour requires subclassing.
  - Changes in behavior require changing only the Mediator class
- Decouples colleague
  - Colleagues become more reusable.
  - You can have multiple types of interactions between colleagues, and you don't need to subclass or otherwise change the colleague class to do that.

Consequences

- Simplifies object protocols
  - Many-to-many interactions replaced with one-to-many interactions
  - More intuitive
  - More extensible
  - Easier to maintain
- Abstracts object cooperation
  - Mediation becomes an object itself
  - Interaction and individual behaviors are separate concepts that are encapsulated in separate objects

Consequences

- Centralizes control
  - Mediator can become very complex
  - With more complex interactions, extensibility and maintenance may become more difficult
  - Using a mediator may compromise performance

Implementation Issues

- Omitting the abstract Mediator class – possible when only one mediator exists
- Strategies for Colleague-Mediator communication
  - Observer class
  - Pointer / other identifier to "self" passed from colleague to mediator, who pass it to the other colleague(s)

Related Patterns

- Façade
  - Unidirectional rather than cooperative interactions between object and subsystem
  - Mediator is like a multi-way Façade pattern.
- Observer
  - May be used as a means of communication between Colleagues and the Mediator

Coordination

- Linda and tuple spaces

- BPEL (Business Process Execution Language) and web services (BPEL4WS o WS-BPEL)

Memento

Memento

- Intent
  - "Without violating encapsulation, capture and externalize an object's internal state so that the object can be restored to this state later."
- Motivation
  - When we want to store off an object's internal state without adding any complication to the object's interface.
  - Perhaps for an undo mechanism

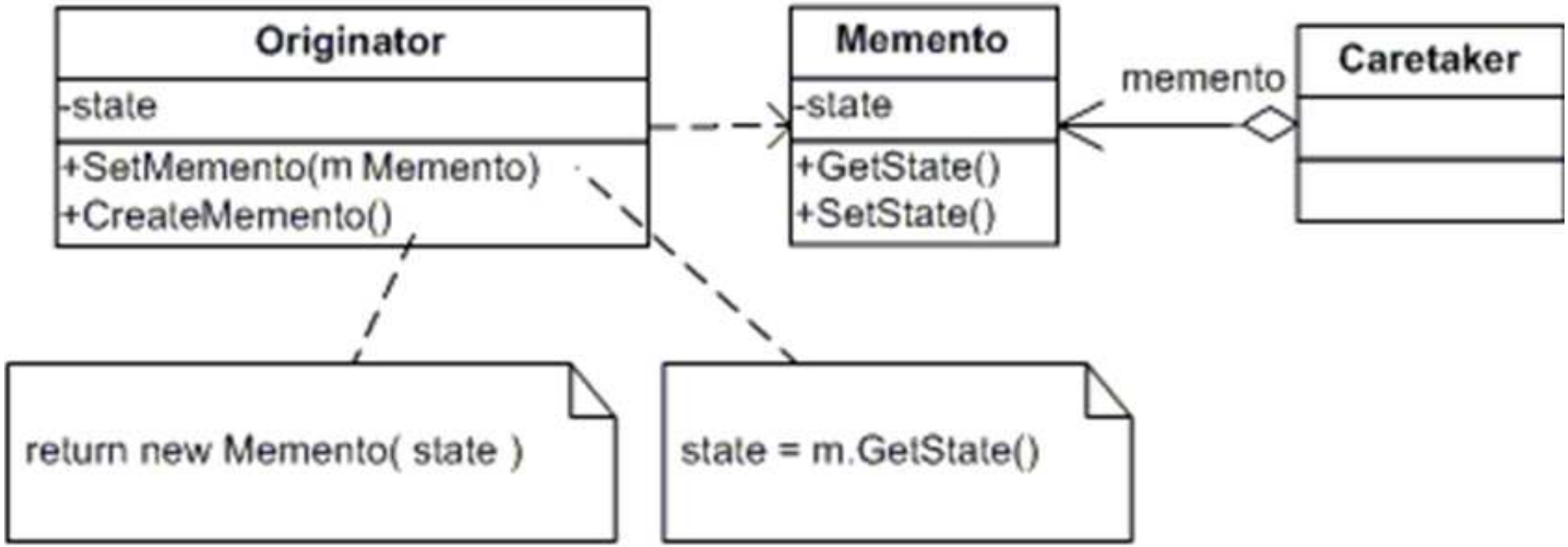
Memento pattern

- Memento:
  - a saved "snapshot" of the state of an object or objects for possible later use
  - useful for:
    - writing an Undo / Redo operation
    - ensuring consistent state in a network
    - Persistency: save / load state between executions of program

Applicability

- Use this
  - when you want to save state on a hierarchy's elements.
  - When the hierarchy's interface would be broken if implementation details were exposed.

Structure


Originator
-state
+SetMemento(m Memento)
+CreateMemento()
Memento
-state
+GetState()
+SetState()
memento
Caretaker
return new Memento(state)
state = m.GetState()

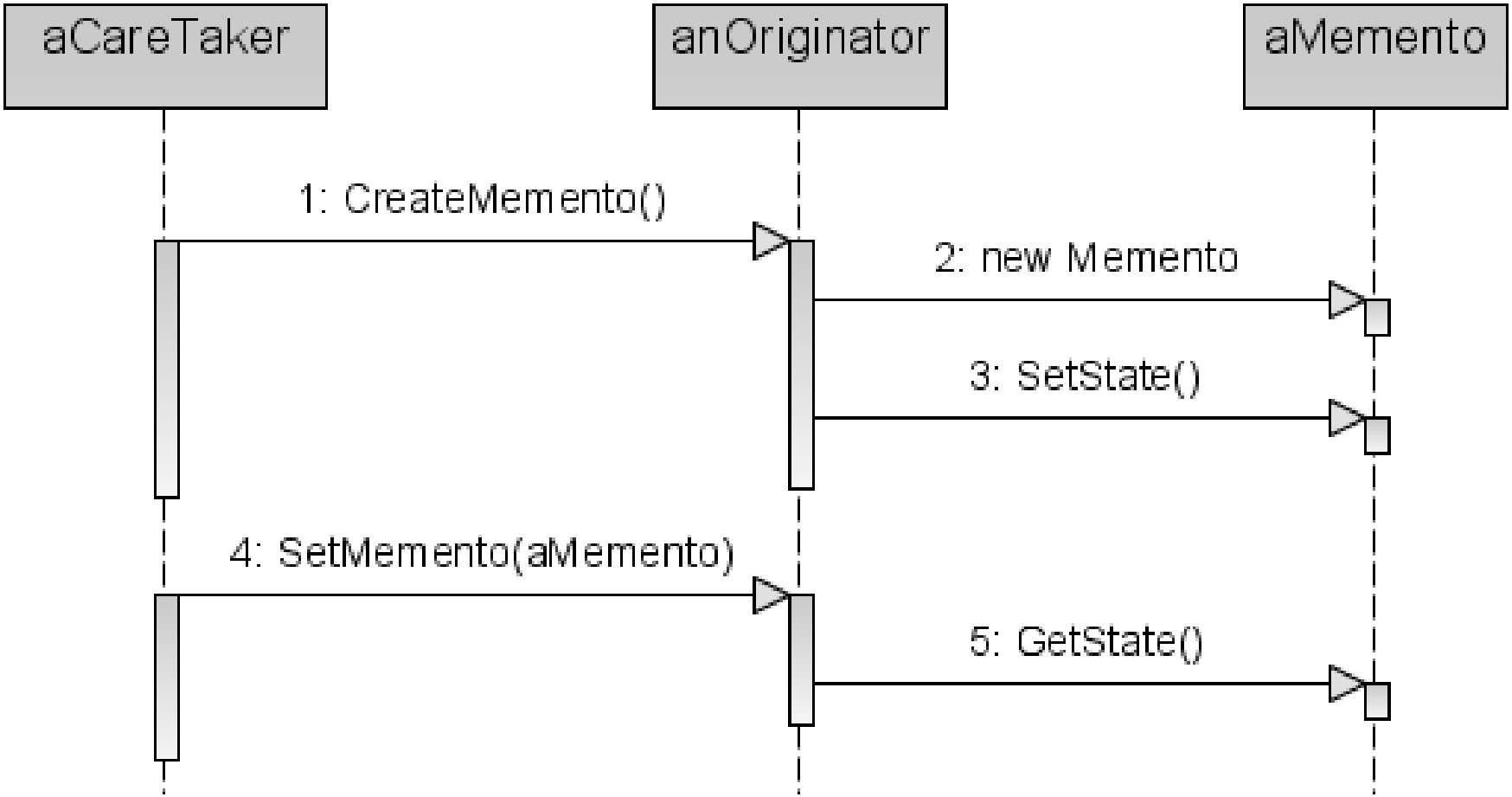
Participants

- Memento
  - stores the state of the Originator
- Originator
  - Creates the memento
  - "Uses the memento to restore its internal state"
- CareTaker
  - Keeps track of the Memento
  - Never uses the Memento's Interface to the Originator

Collaboration

- Caretaker requests a memento from an Originator.
- Originator passes back memento.
- Originator uses it to restore state.

Collaboration



Consequences (good)

- “Preserves Encapsulation Boundaries”
- “It simplifies Originator”

Consequences (bad)

- Might be expensive
- Difficulty defining interfaces to keep Originator encapsulated
- Hidden costs in caring for mementos
  - Caretaker could have to keep track of a lot of information for the memento

Storing Incremental Changes

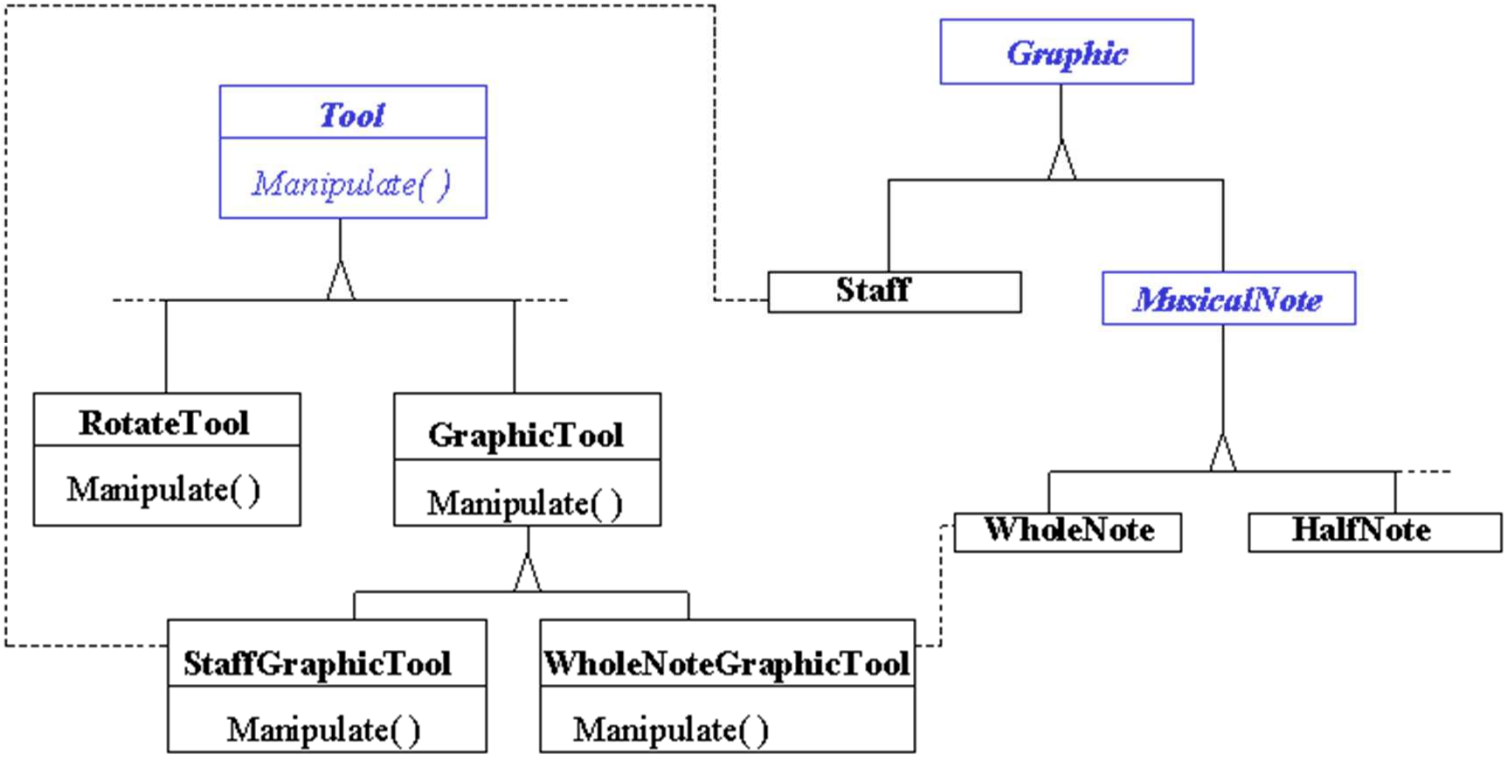
- If storing state happens incrementally, then we can just record the changes of what's happened in a new memento object.
- This helps with memory difficulties.

Prototype

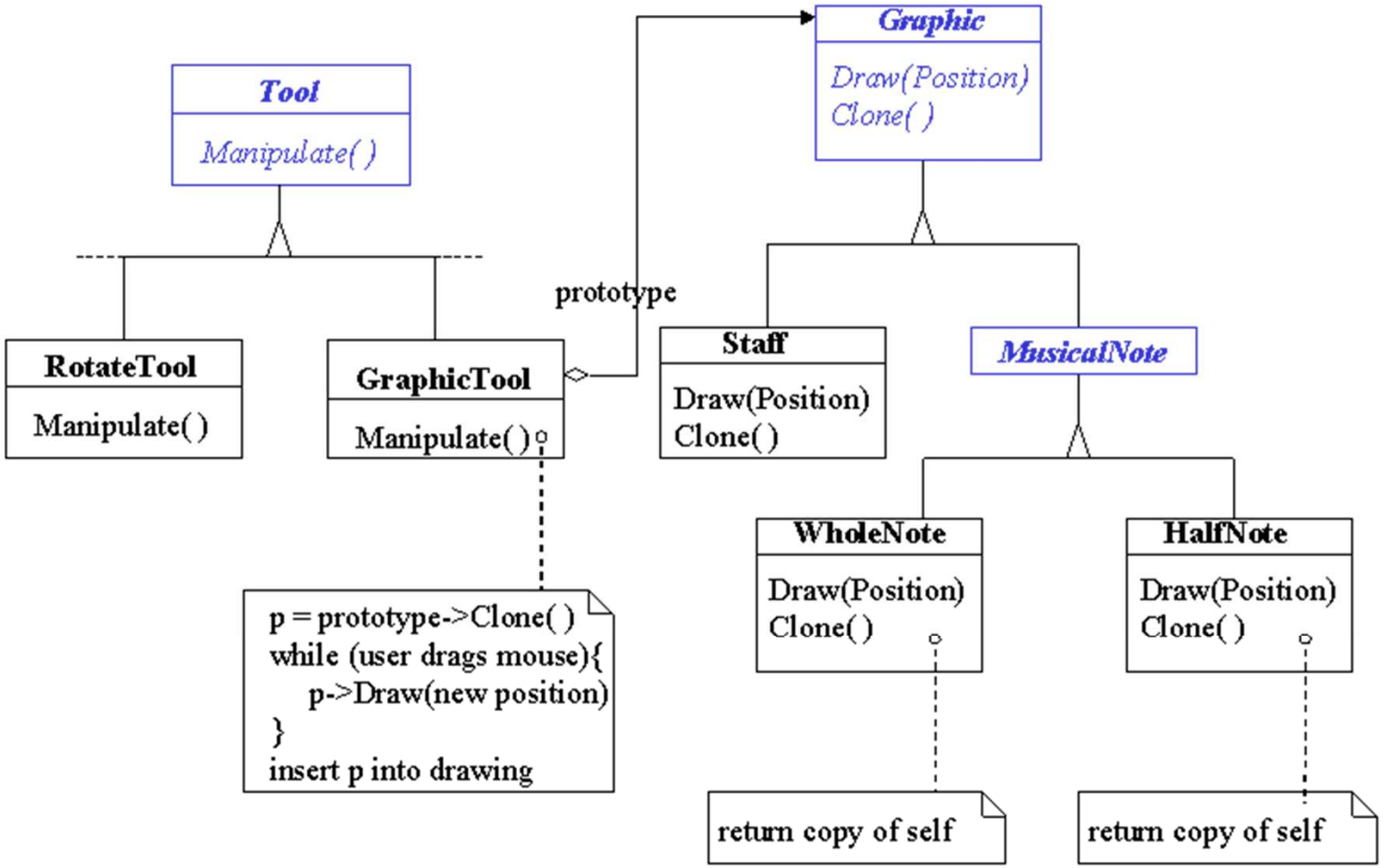
Prototype Pattern

- A creational pattern
- Specify the kinds of objects to create using a prototypical instance, and create new objects by copying this prototype

Problem


Tool
Manipulate( )
Graphic
Staff
MusicalNote
RotateTool
Manipulate( )
GraphicTool
Manipulate( )
WholeNote
HalfNote
StaffGraphicTool
Manipulate( )
WholeNoteGraphicTool
Manipulate( )

Prototype solution

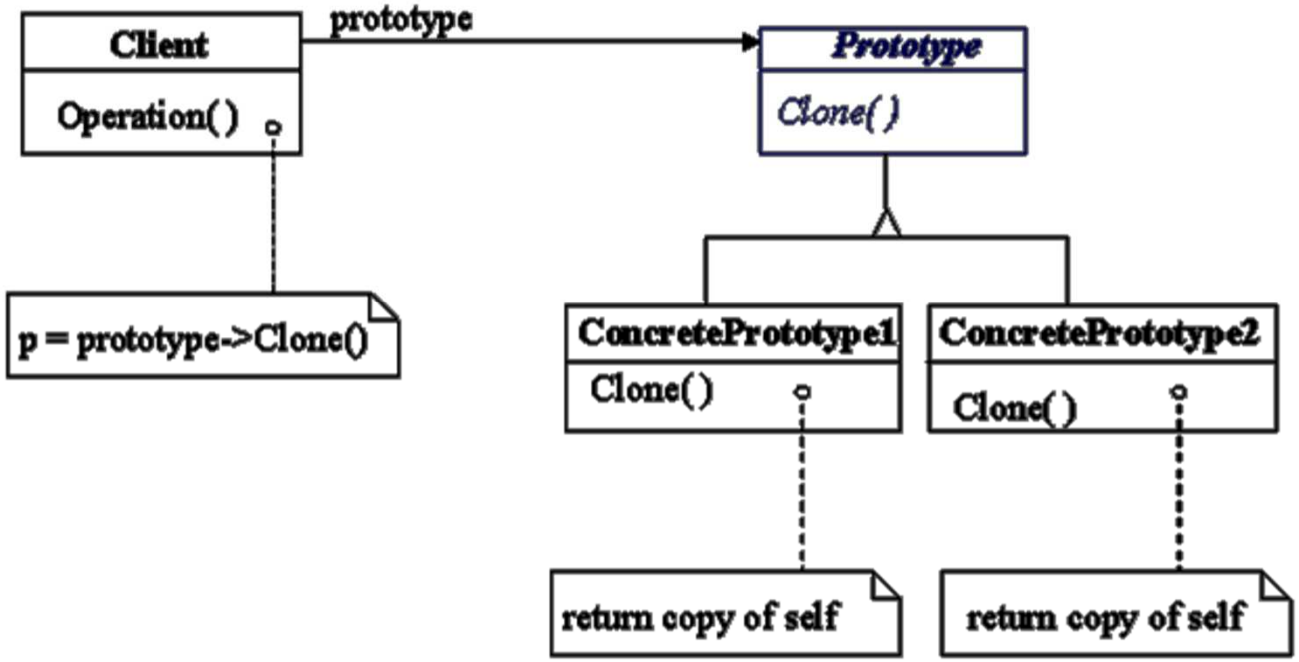


Structure & Participants

Prototype(Graphic)
-declares an interface for cloning itself.

ConcretePrototype (Staff, WholeNote, HalfNote)
-implements an operation for cloning itself.

Client(GraphicalTool)
- creates a new object by asking a prototype to clone itself.



java.lang Class Object
protected Object **clone**() throws CloneNotSupportedException

Creates and returns a copy of this object. The precise meaning of "copy" may depend on the class of the object. The general intent is that, for any object x, the expression:

x.clone() != x

will be true, and that the expression:

x.clone().getClass() == x.getClass()

will be true, but these are not absolute requirements. While it is typically the case that:

x.clone().equals(x)

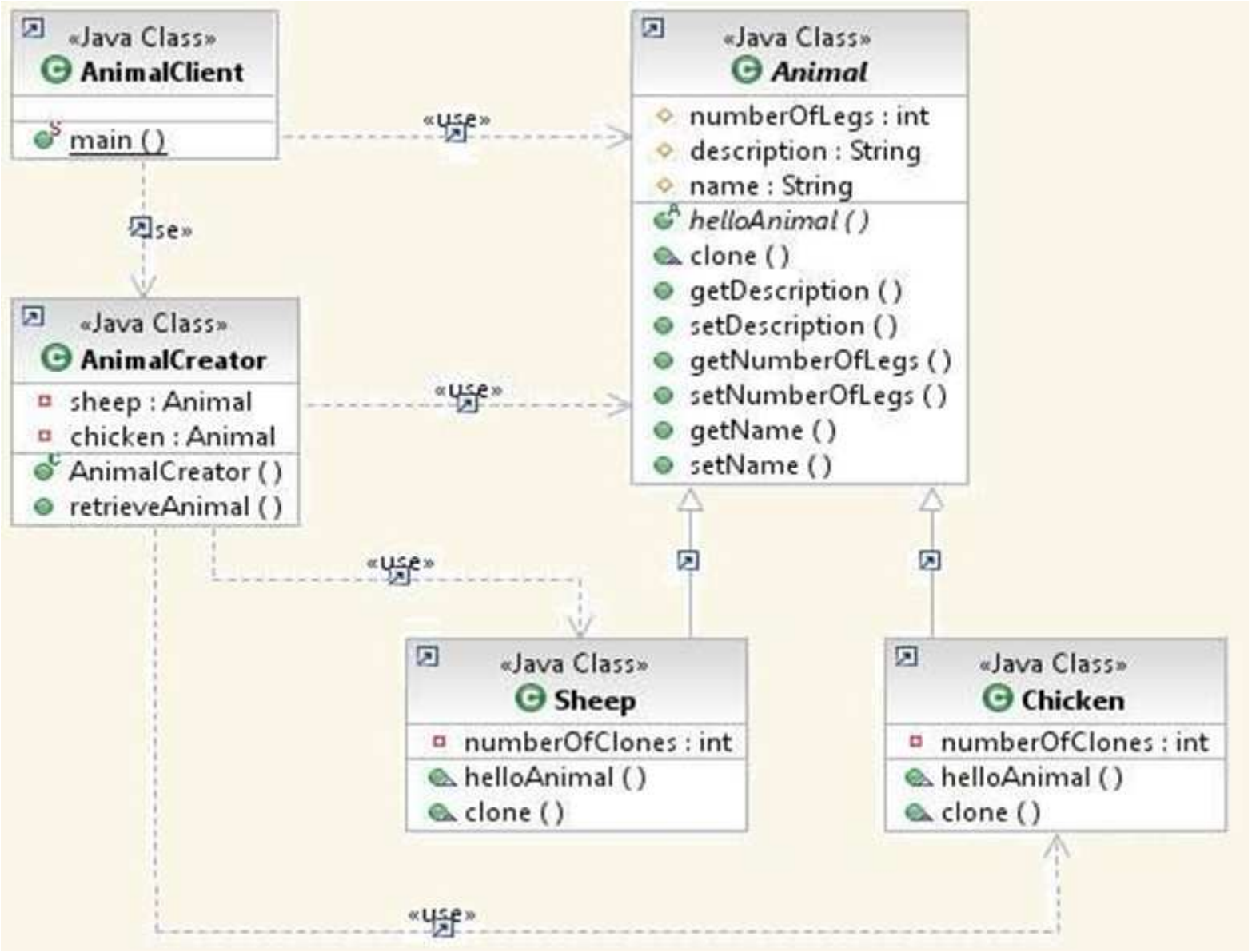
will be true, this is not an absolute requirement.

By convention, the returned object should be obtained by calling super.clone. If a class and all of its superclasses (except Object) obey this convention, it will be the case that x.clone().getClass() == x.getClass().

java.lang Class Object
protected Object **clone**() throws CloneNotSupportedException

- By convention, the object returned by this method should be independent of this object (which is being cloned).
- To achieve this independence, it may be necessary to modify one or more fields of the object returned by super.clone before returning it.
  - Typically, this means copying any mutable objects that comprise the internal "deep structure" of the object being cloned and replacing the references to these objects with references to the copies.
  - If a class contains only primitive fields or references to immutable objects, then it is usually the case that no fields in the object returned by super.clone need to be modified.

Ex. Animal farm



Prototype Pattern Example code

```
public abstract class Animal implements Cloneable {
        protected int numberOfLegs = 0;
        protected String description = "";
        protected String name = "";

        public abstract String helloAnimal();

        public Animal clone() {
                Animal clonedAnimal = null;
                clonedAnimal = (Animal) super.clone();
                clonedAnimal.setName(name);
                return clonedAnimal;
        } // method clone

        public String getName() {
                return name;
        }

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

Prototype Pattern Example code

```
public class Chicken extends Animal {
    private int numberOfClones = 0;

    public String helloAnimal() {
        StringBuffer chickenTalk = new StringBuffer();
        chickenTalk.append("Cluck cluck World. I am ");
        chickenTalk.append(name);
        return chickenTalk.toString();
     } // helloAnimal

     public Chicken clone() {
        Chicken clonedChicken = (Chicken) super.clone();
        String chickenName = clonedChicken.getName();
        numberOfClones++;
        clonedChicken.setName(chickenName + numberOfClones);
        return clonedChicken;
     } // method clone
}
```

Prototype Pattern Example code

```
public class Sheep extends Animal {
    private int numberOfClones = 0;

    public String helloAnimal() {
        StringBuffer sheepTalk = new StringBuffer();
        sheepTalk.append("Meeeeeee World. I am ");
        sheepTalk.append(name);
        return sheepTalk.toString();
    } // helloAnimal

    public Sheep clone() {
        Sheep clonedSheep = (Sheep) super.clone();
        String sheepName = clonedSheep.getName();
        numberOfClones++;
        clonedSheep.setName(sheepName + numberOfClones);
        return clonedSheep;
     } // method clone
}
```

Prototype Pattern Example code

```
public class AnimalCreator {
        private Animal sheep = new Sheep();
        private Animal chicken = new Chicken();

        public AnimalCreator() {
                sheep.setName("Sheep");
                chicken.setName("Chicken");
        } // no-arg constructor

        public Animal retrieveAnimal(String kindOfAnimal) {
                if ("Chicken".equals(kindOfAnimal)) {
                        return (Animal) chicken.clone();
                }
                else if ("Sheep".equals(kindOfAnimal)) {
                        return (Animal) sheep.clone();
                } // if
                return null;
        } // method retrieveAnimal
} // class AnimalCreator
```

Prototype Pattern Example code

```
public class AnimalClient {
    public static void main(String[] args) {
        AnimalCreator animalCreator = new AnimalCreator();
        Animal[] animalFarm = new Animal[8];

        animalFarm[0] = animalCreator.retrieveAnimal("Chicken");
        animalFarm[1] = animalCreator.retrieveAnimal("Chicken");
        animalFarm[2] = animalCreator.retrieveAnimal("Chicken");
        animalFarm[3] = animalCreator.retrieveAnimal("Chicken");
        animalFarm[4] = animalCreator.retrieveAnimal("Sheep");
        animalFarm[5] = animalCreator.retrieveAnimal("Sheep");
        animalFarm[6] = animalCreator.retrieveAnimal("Sheep");
        animalFarm[7] = animalCreator.retrieveAnimal("Sheep");

        for (int i= 0; i<=7; i++) {
                System.out.println(animalFarm[i].helloAnimal());
        } // for
    } // main method
} // class AnimalClient
```

```
Cluck cluck World.  I am Chicken1.
Cluck cluck World.  I am Chicken2.
Cluck cluck World.  I am Chicken3.
Cluck cluck World.  I am Chicken4.
Meeeeeee World.  I am Sheep1.
Meeeeeee World.  I am Sheep2.
Meeeeeee World.  I am Sheep3.
Meeeeeee World.  I am Sheep4.
```

Prototype Pattern

- When to Use
  - When product creation should be decoupled from system behavior
  - When to avoid subclasses of an object creator in the client application
  - When creating an instance of a class is time-consuming or complex in some way.

Consequences of Prototype Pattern

- Hides the concrete product classes from the client
- Adding/removing of prototypes at run-time
- Allows specifying new objects by varying values or structure
- Reducing the need for sub-classing
  - no need of a sub-class of the factory per each product
  - Just clone each product

Drawbacks of Prototype Pattern

- It is built on the method .clone(), which could be complicated sometimes in terms of
  - shallow copy and
  - deep copy.
- Moreover, classes that have circular references to other classes cannot really be cloned.

Visitor

Visitor Pattern

- Intent
  - Lets you define a new operation without changing the classes on which they operate.
- Motivation
  - Allows for increased functionality of a class(es) while simplifying base classes.
  - A primary goal of designs should be to ensure that base classes maintain a minimal set of operations.
  - Encapsulates common functionality in a class framework.

Visitor Pattern

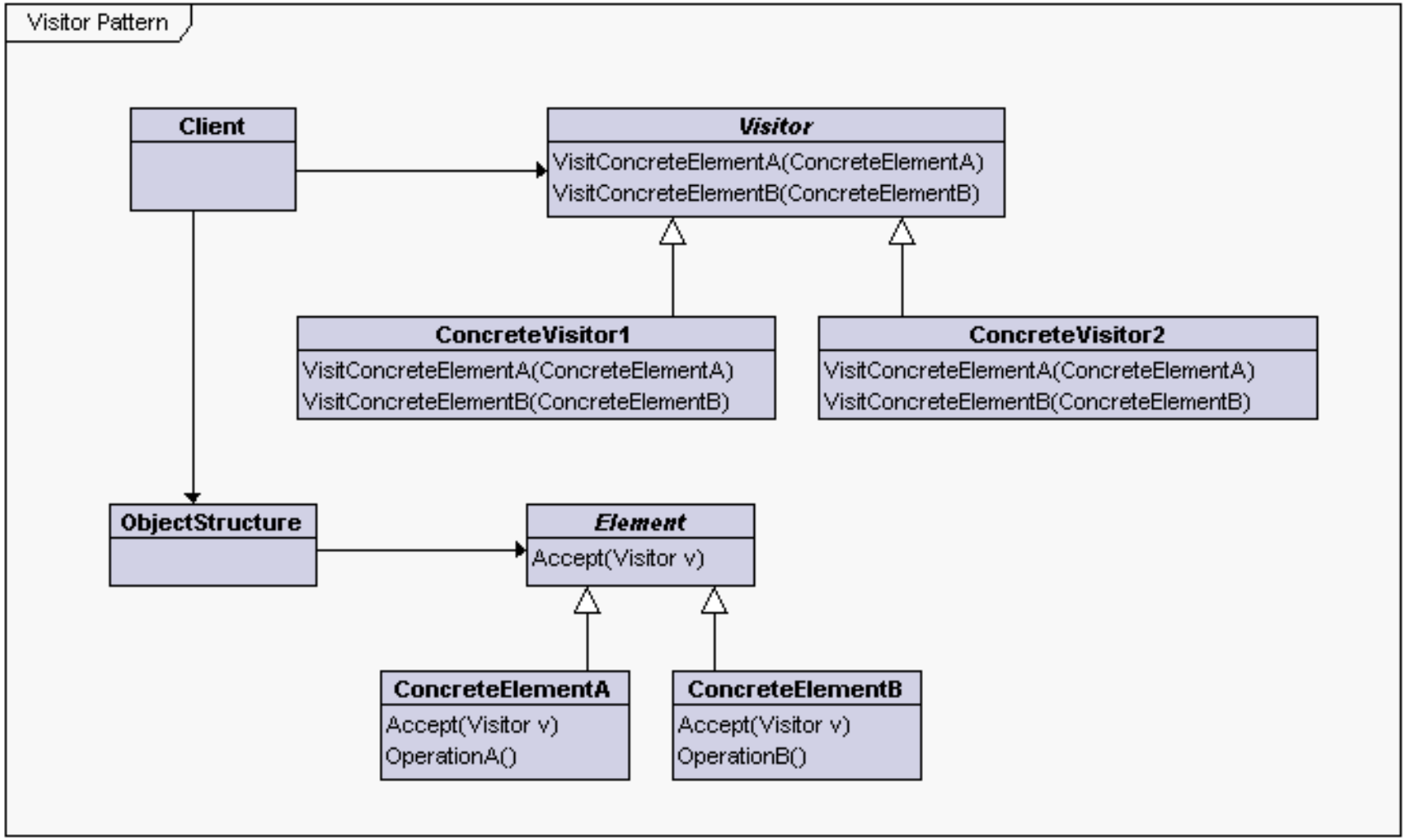
- Motivation (cont)
  - Visitors avoid type casting that is required by methods that pass base class pointers as arguments. The following code describes how a typical class could expand the functionality of an existing composite.

```
Void MyAddition::execute( Base* basePtr) {
        if( dynamic_cast<ChildA*>(basePtr)){
                        // Perform task for child type A.
        } else if ( dynamic_cast<ChildB*>(basePtr)){
                        // Perform task for child type B.
        } else if( dynamic_cast<ChildC*>(basePtr)){
                        // Perform task for child type C.
        }
}
```

Visitor Pattern: Applicability

- The following situations are prime examples for use of the visitor pattern.
  - When an object structure contains many classes of objects with different interfaces and you want to perform functions on these objects that depend on their concrete classes.
  - When you want to keep related operations together by defining them in one class.
  - When the class structure rarely change but you need to define new operations on the structure.

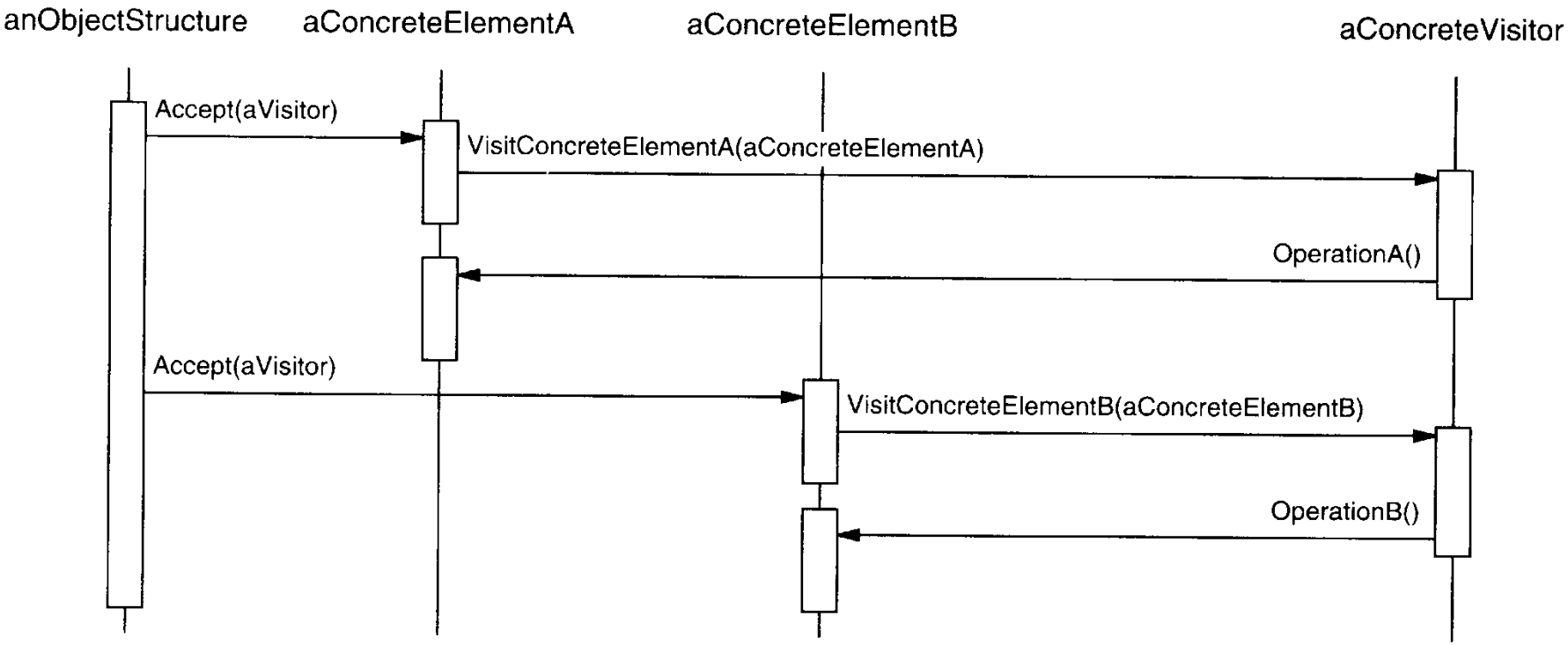
Structure


Visitor Pattern
Client
Visitor
VisitConcreteElementA(ConcreteElementA)
VisitConcreteElementB(ConcreteElementB)
ConcreteVisitor1
VisitConcreteElementA(ConcreteElementA)
VisitConcreteElementB(ConcreteElementB)
ConcreteVisitor2
VisitConcreteElementA(ConcreteElementA)
VisitConcreteElementB(ConcreteElementB)
ObjectStructure
Element
Accept(Visitor v)
ConcreteElementA
Accept(Visitor v)
OperationA()
ConcreteElementB
Accept(Visitor v)
OperationB()

Visitor Pattern: Participants

- Visitor
  - Declares a Visit Operation for each class of Concrete Elements in the object structure.
- Concrete Visitor
  - Implements each operation declared by Visitor.
- Element
  - Defines an Accept operation that takes the visitor as an argument.
- Concrete Element
  - Implements an accept operation that takes the visitor as an argument.
- Object Structure
  - Can enumerate its elements.
  - May provide a high level interface to all the visitor to visit its elements.
  - May either be a composite or a collection.

Visitor Pattern: Collaborations



Visitor Pattern: Consequences

- Makes adding new operations easier.
- Collects related functionality.
- Adding new Concrete Element classes is difficult.
- Can "visit" across class types, unlike iterators.
- Accumulates states as they visit elements.
- May require breaking object encapsulation to support the implementation.

Visitor: Related Patterns

- Composites
  - Visitors can be used to apply an operation over an object structure defined by the composite pattern.
- Interpreter
  - Visitors may be applied to do the interpretation.