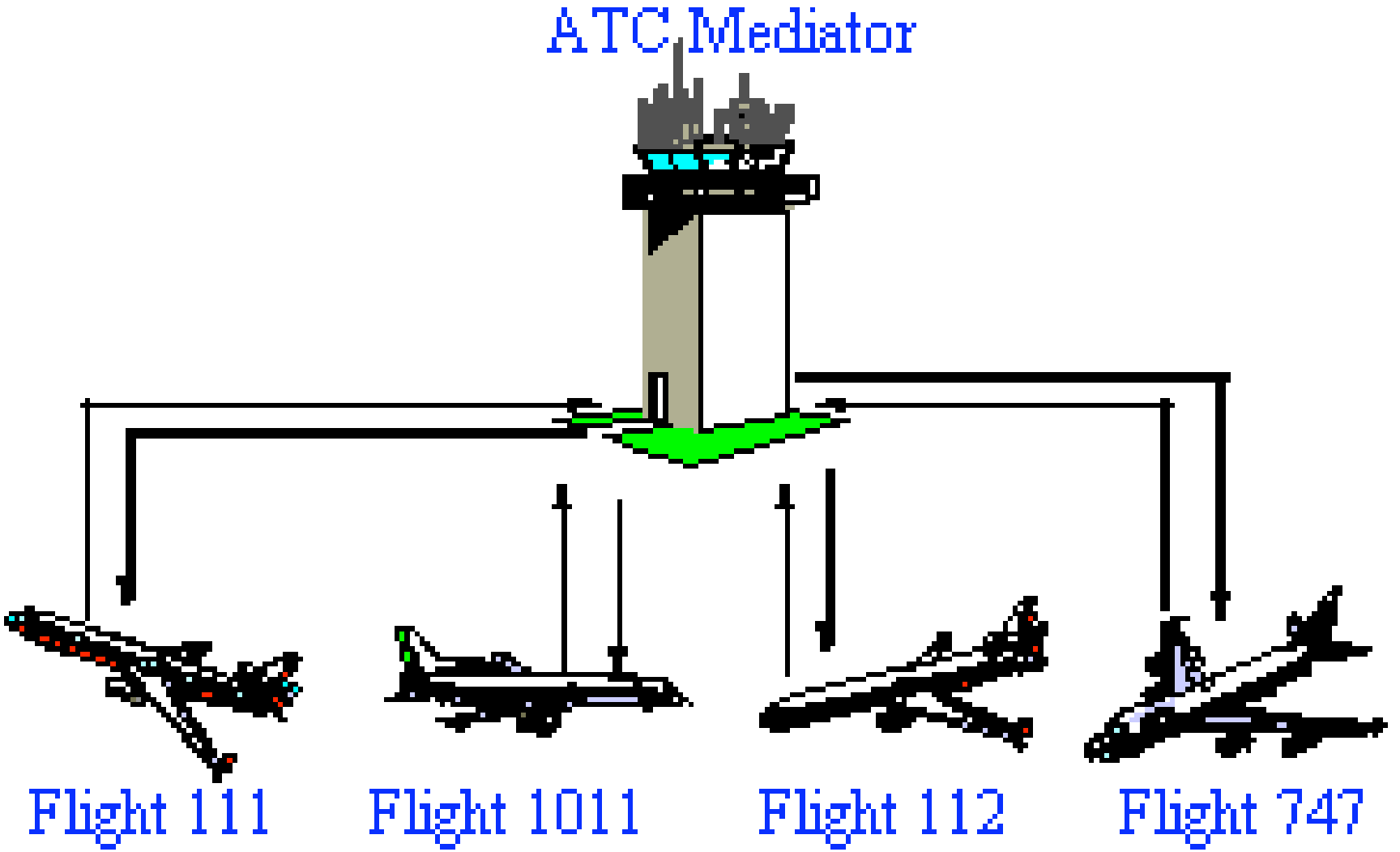
Tecniche di Progettazione: Design Patterns

GoF: Mediator Memento Prototype

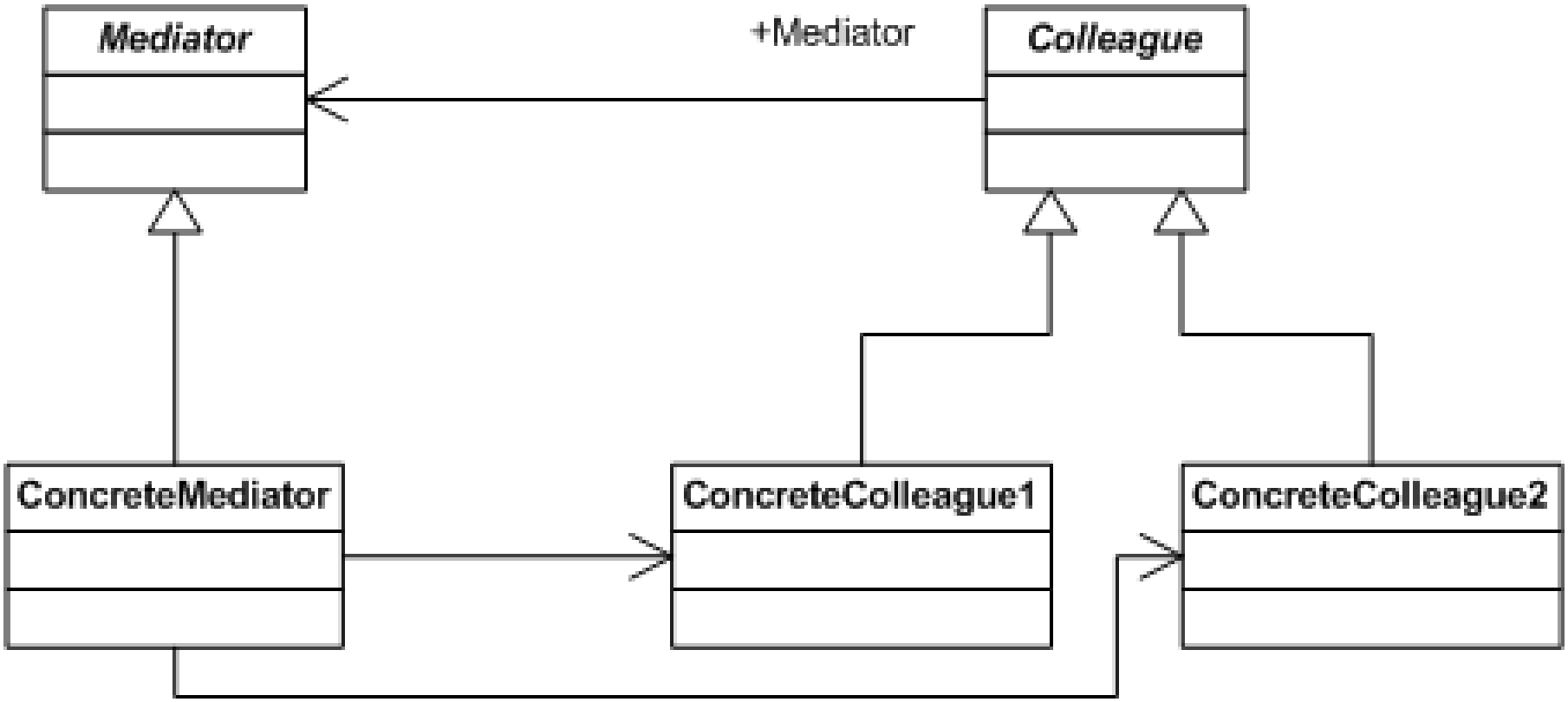
Mediator

Applicability

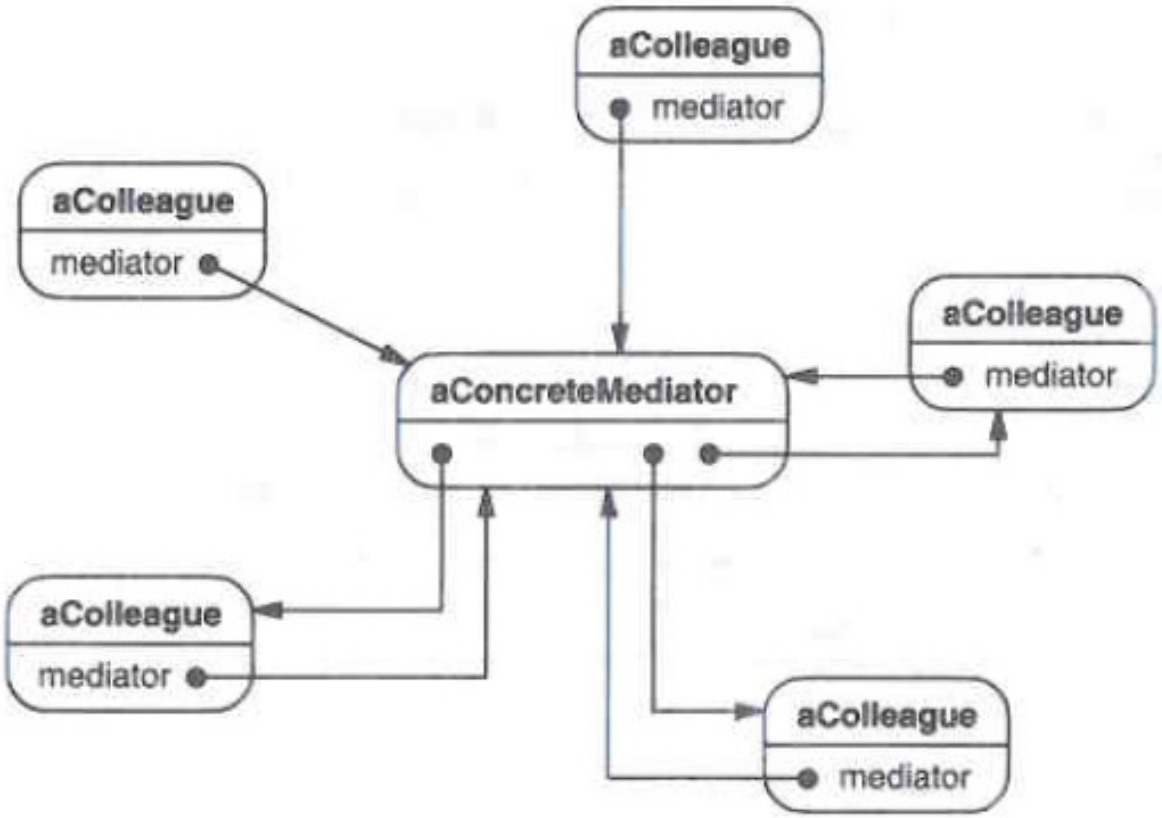
- When a set of objects communicates in a well-defined, but complex way
- When reusing an object is difficult because it refers to and communicates with many other objects (tight coupling)
- When a behavior that is distributed between several classes should be customizable without a lot of subclassing


ATC Mediator
Flight 111
Flight 1011
Flight 112
Flight 747

Mediator: structure



Structure


aColleague
mediator
aColleague
mediator
aColleague
mediator
aConcreteMediator
aColleague
mediator
aColleague
mediator

Mediator

- Encapsulates interconnects between objects
- Is the communications hub
- Is responsible for coordinating and conrolling colleague interaction
- Promotes loose coupling between classes
  - By preventing from referring to each other explicitly
- Arbitrates the message traffic

How to use Mediator

1. Identify a collection of interacting objects whose interaction needs simplification
2. Get a new abstract class that encapsulates that interaction
3. Create a instance of that class and redo the interaction with that class alone

Consequences

- Limits subclassing
  - Localizes behavior that would be otherwise distributed among many objects
  - Changes in behavior require changing only the Mediator class
- Decouples colleagues
  - 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
    - The colleagues are the subjects: any change in their state is notified to the coordinator that may notify other colleagues.
  - Pointer / other identifier to "self" passed from colleague to mediator, so that the mediator can identify the sender.

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 Languages

- "Mediator" constructs as language primitives:
  - Linda and tuple spaces: late 80's early 90's
    - Middleware acting as a coordinator
- BPEL (Business Process Execution Language) and web services (BPEL4WS o WS-BPEL)

Homework

- This exercise wants to demonstrate the Mediator pattern facilitating loosely coupled communication between different Participants registering with a Chatroom.
  - The Chatroom is the central hub through which all communication takes place.
  - Implement the Chatroom, having the following interface:

```
public interface AbstractChatroom  {
    public abstract void register(Participant participant);
    public abstract void send(String from, String to, String msg);
}
```

  - At this point only one-to-one communication is implemented in the Chatroom, optional: experiment with one-to-many.

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

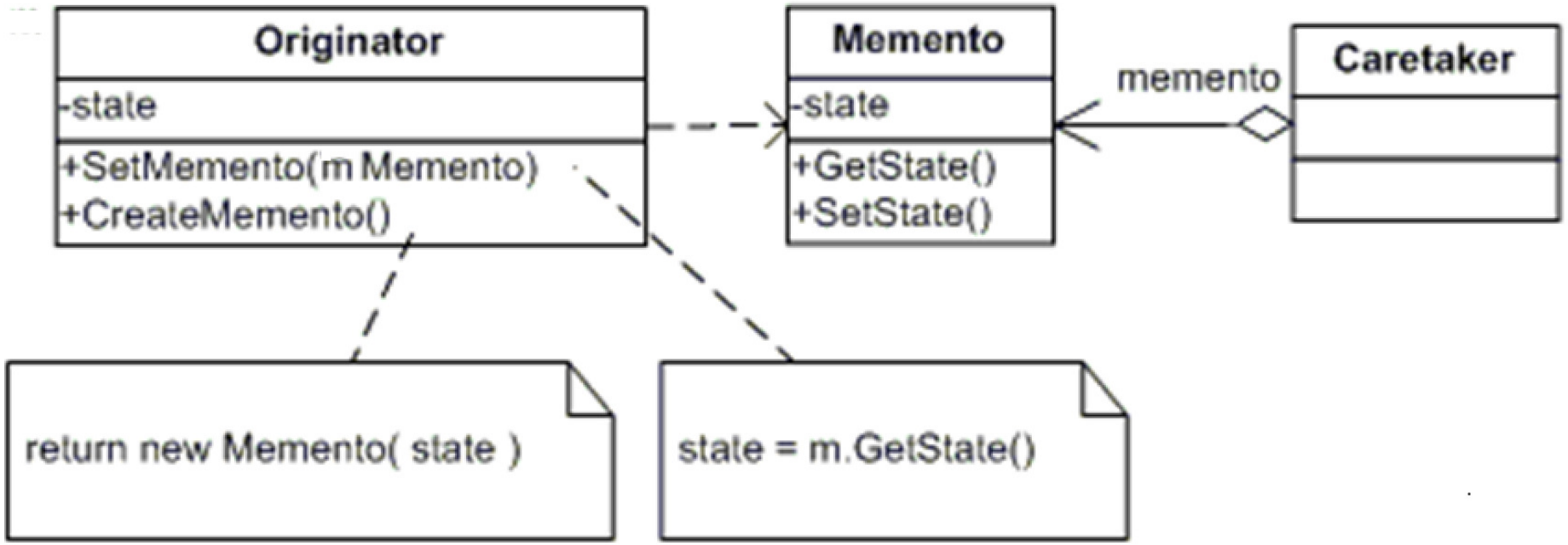
Memento pattern

- 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.

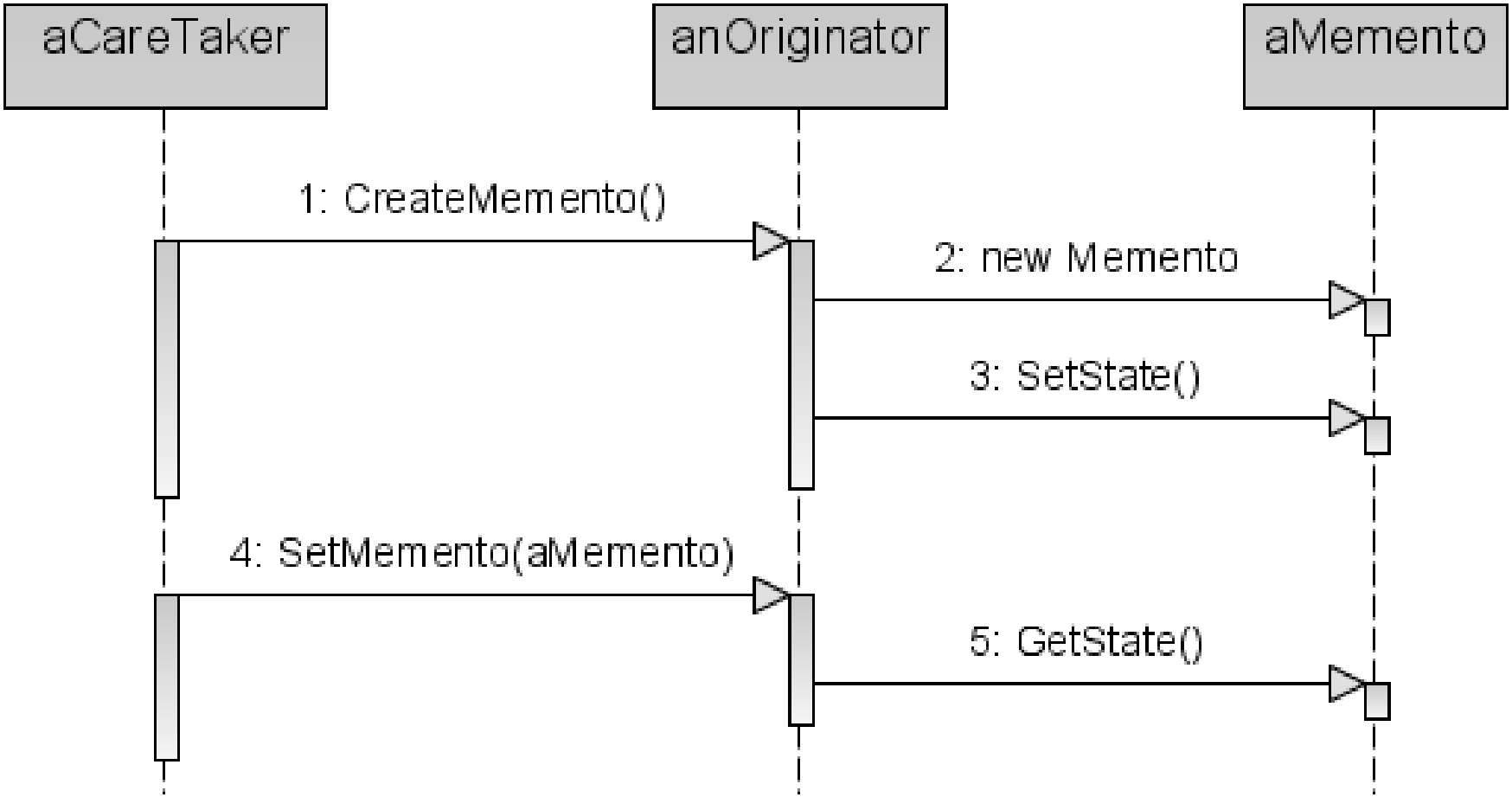
Structure


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



Collaboration

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

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.

Homework

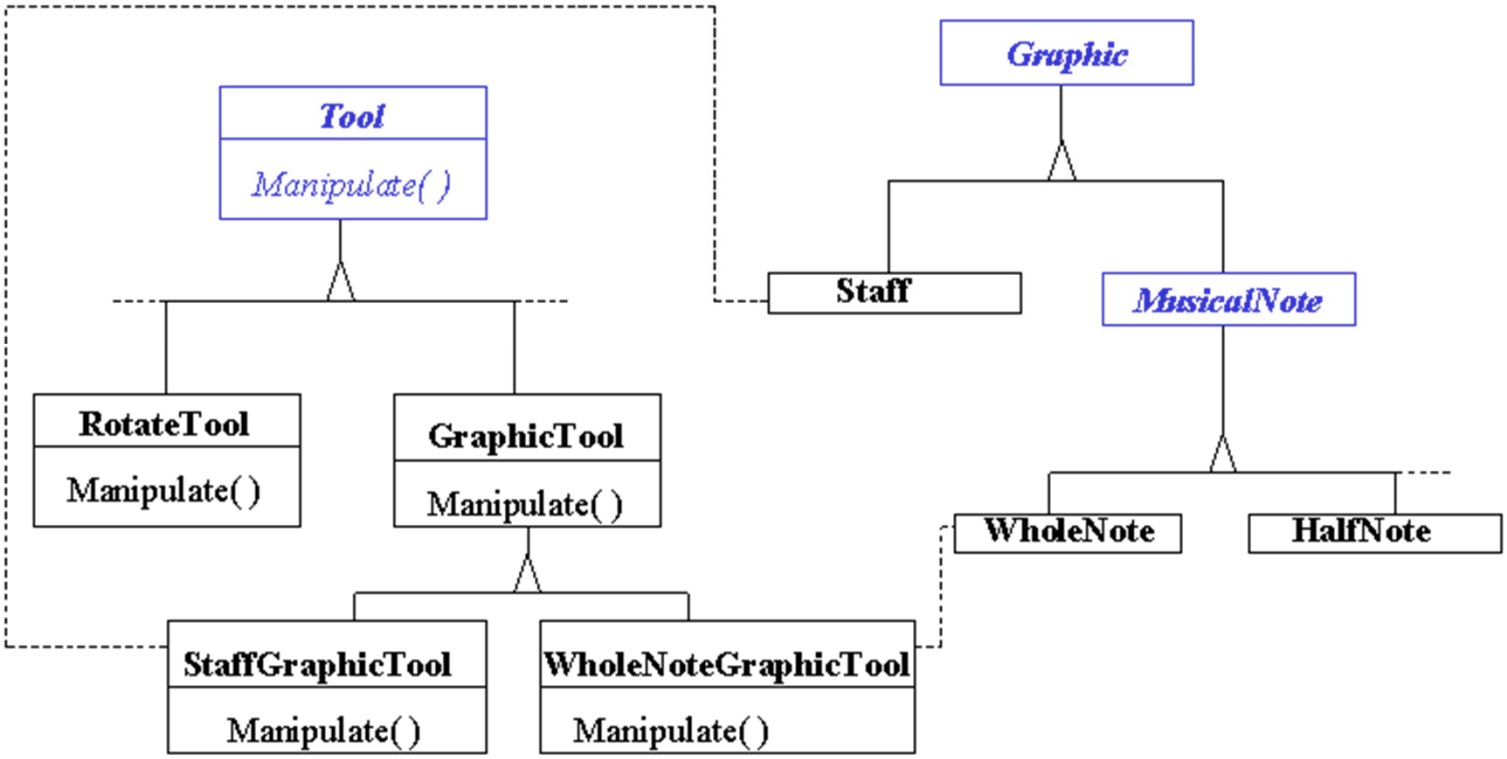
- Change the calculator example using memento instead of undo to restore an old state.

Prototype

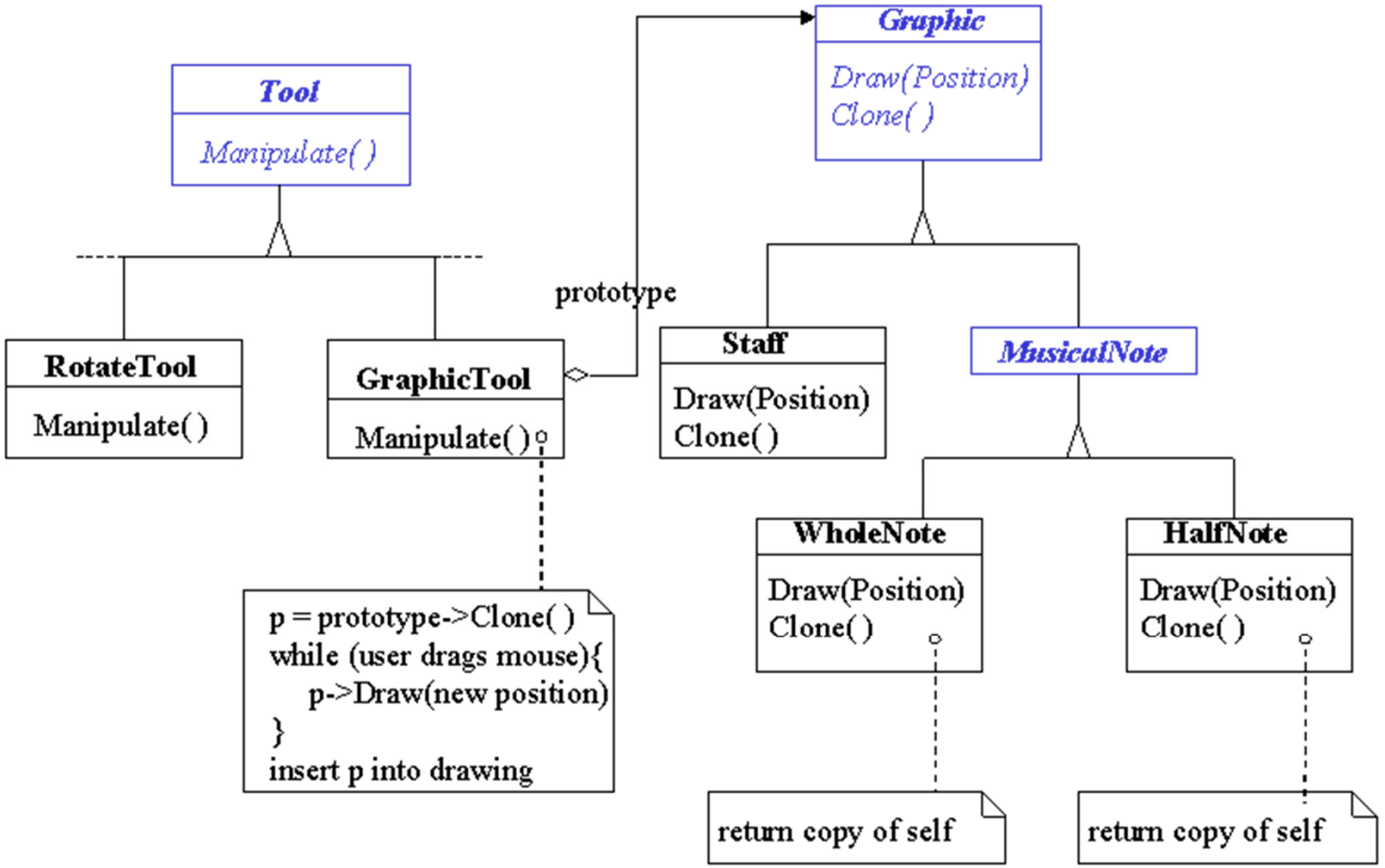
Prototype Pattern

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

Problem


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

Prototype solution

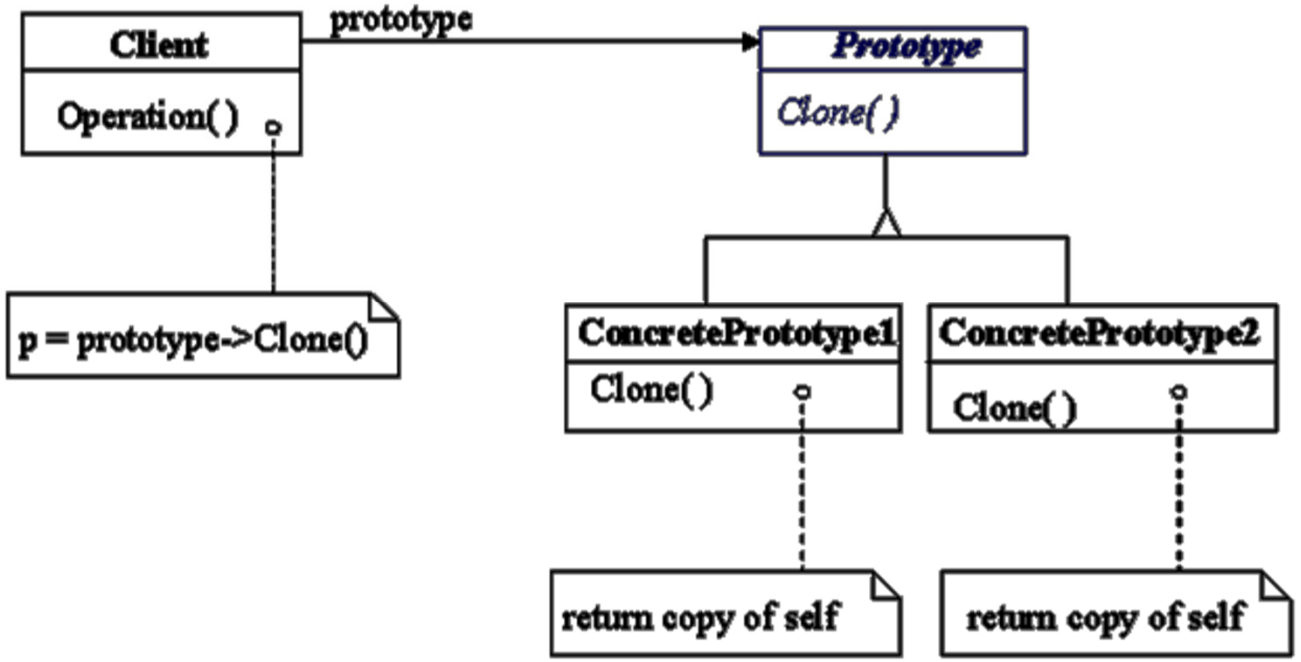


Structure & Participants

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)

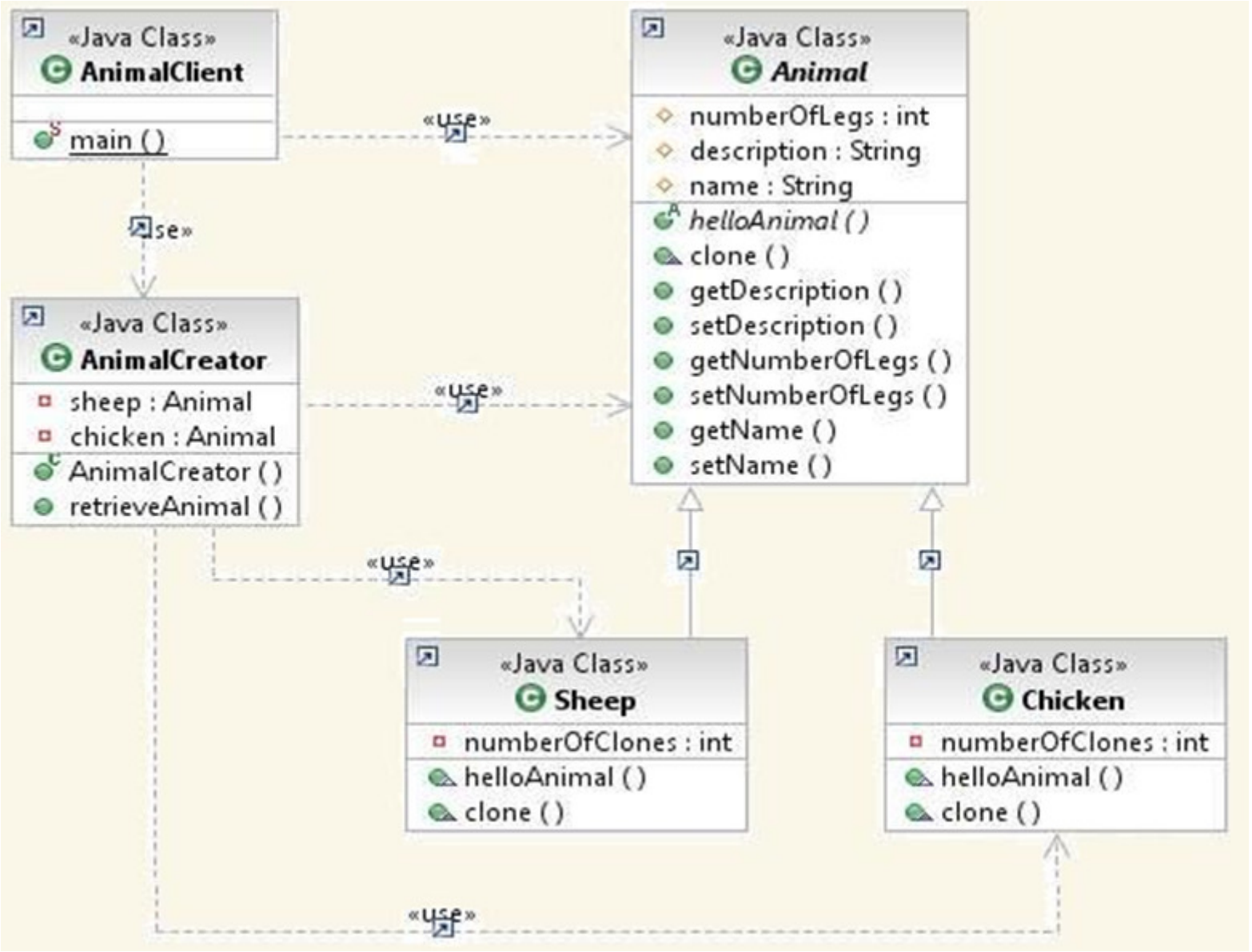
will be true, this is not an absolute requirement.

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

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.