Tecniche di Progettazione: Design Patterns

GoF: Command


These top secret drop boxes have revolutionized the spy industry. I just drop in my request and people disappear, governments change overnight and my dry cleaning gets done. I don't have to worry about when, where, or how; it just happens!
You Can Help
Throw It Here

Usual message/invocation

- When two objects communicate, often one object is sending a message to a receiver to perform a particular function
- The first object (the "sender") could hold a reference to the second (the "receiver")
  - or get it as a return value, or argument, or construct it
- The sender invokes a specific method of the receiver

The Command Pattern

- But what if the sender is not aware of, or does not care who the receiver is?
- The Command design pattern encapsulates the concept of a "Command" as an object
- The sender holds a reference to a Command object rather than to the specific receiver
  - The Command object encapsulates the receiver

The Command Pattern

- The sender sends a vanilla message (such as actionPerformed, execute, doit, or undo) to the Command object
- The Command object is then responsible for dispatching the correct messages to the specific receiver(s) to get the job done

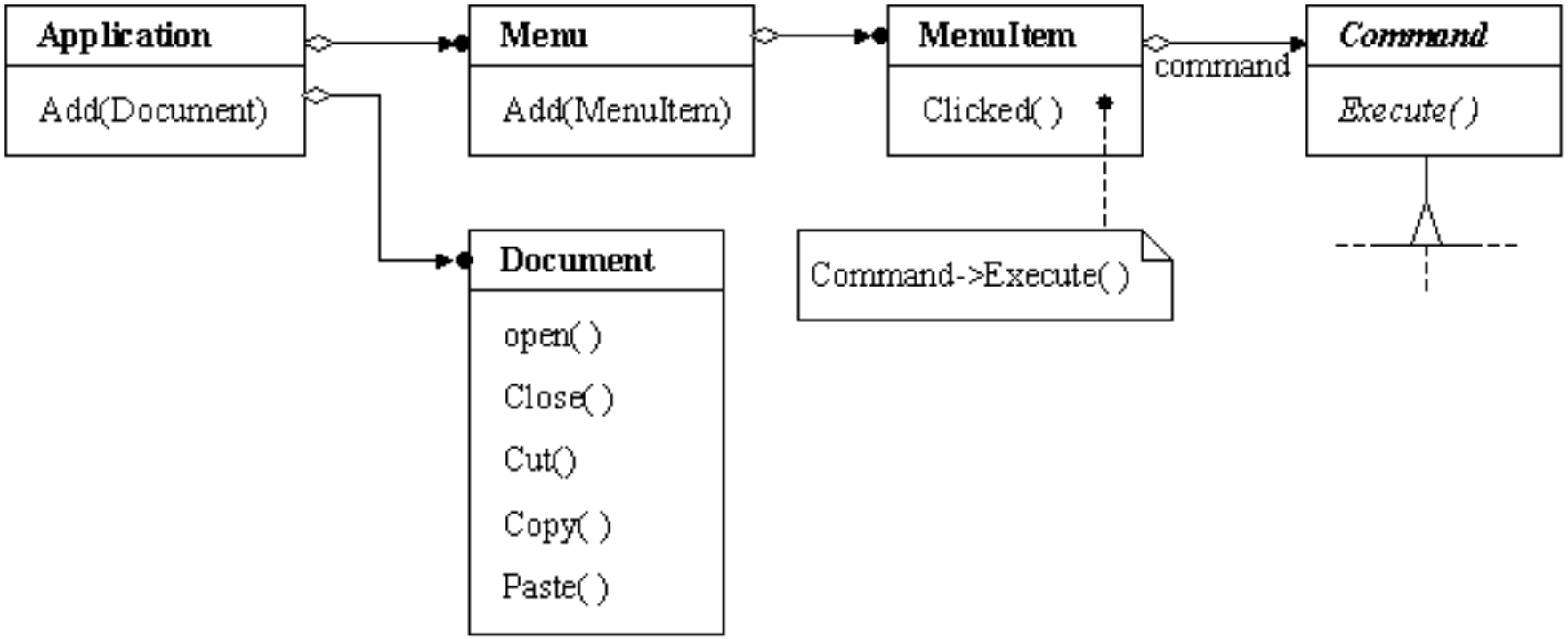
Command Pattern in Java

- One object can send messages to other objects without knowing anything about the actual operation or the type of object
- Polymorphism lets us encapsulate a request for services as an object
  - Establish a method signature name as an interface
  - Vary the algorithms in the called methods

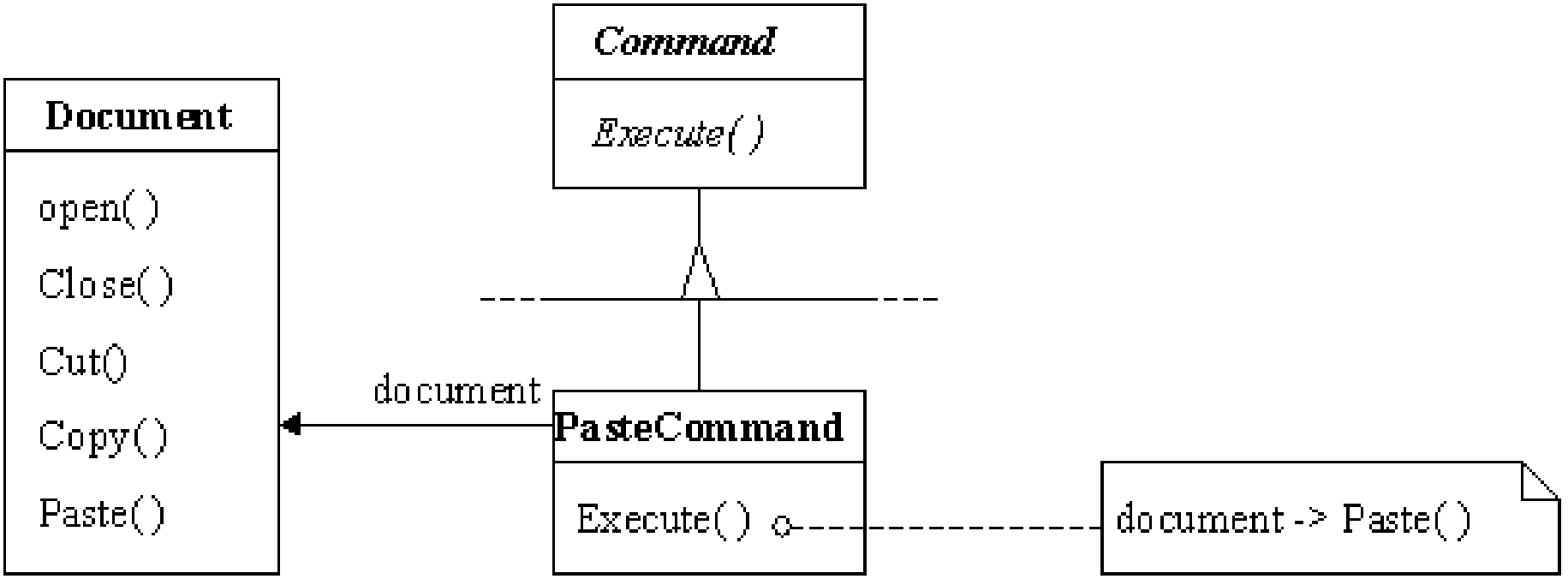
Uses

- The Command object can also be used when you need to tell the program to execute the command later.
  - In such cases, you are saving commands as objects to be executed later

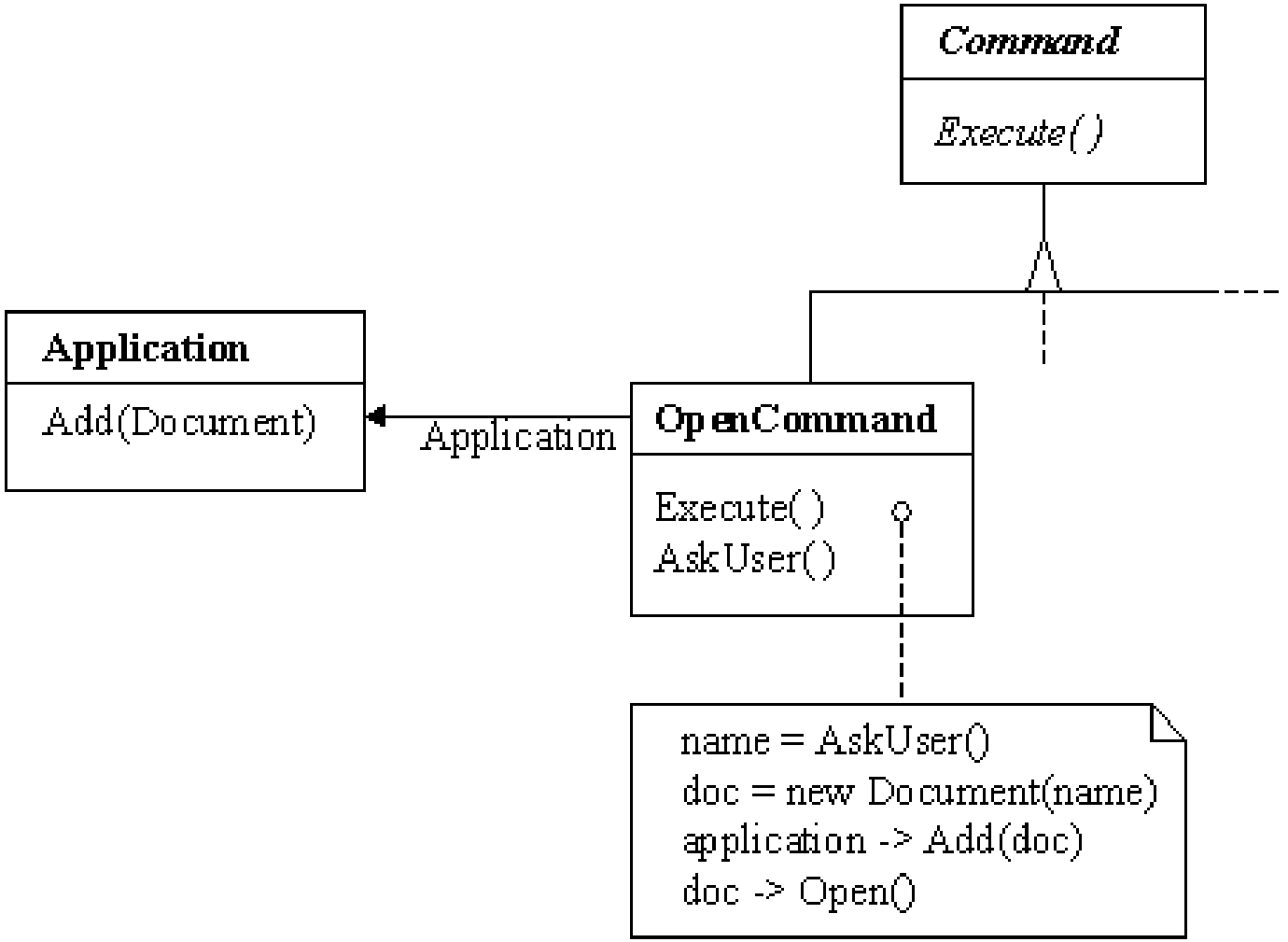
GoF example


Application
Add(Document)
Menu
Add(MenuItem)
MenuItem
Clicked( )
command
Command
Execute( )
Document
open( )
Close( )
Cut()
Copy( )
Paste( )
Command->Execute( )

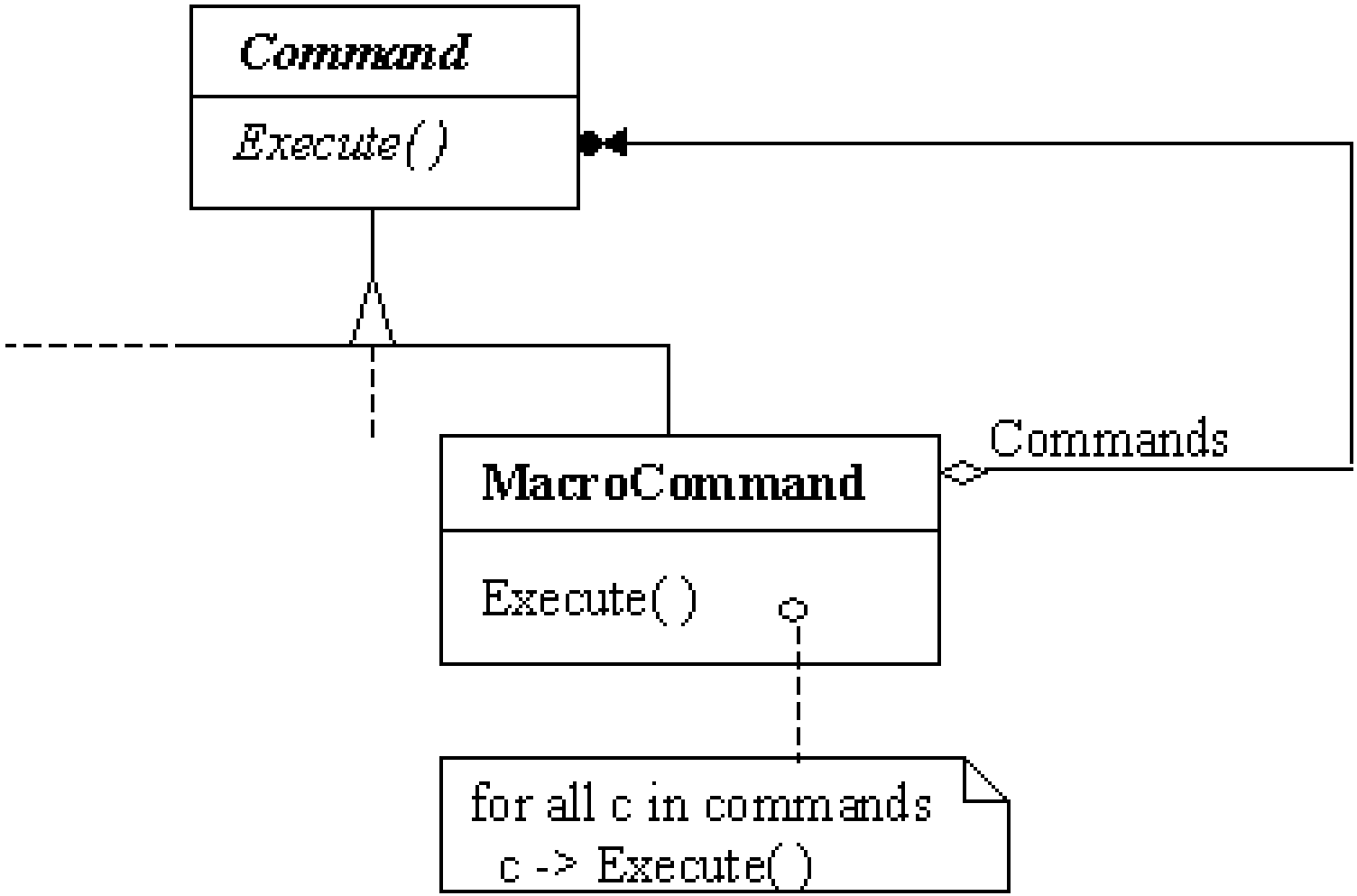
PasteCommand is a concrete Command that implements paste function.



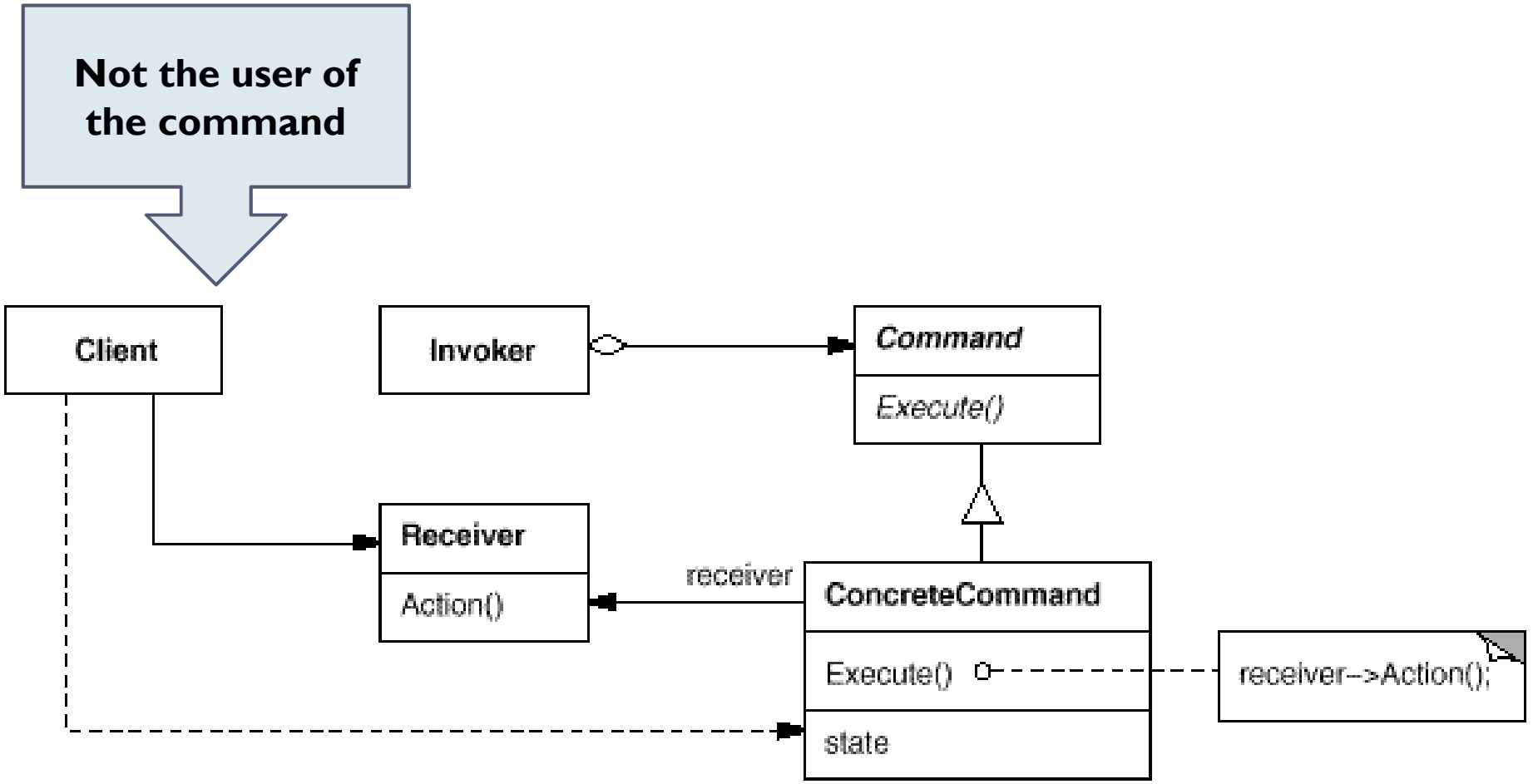
OpenCommand is a concrete Command that implements open function.



MacroCommand is a concrete Command that executes a sequence of commands.



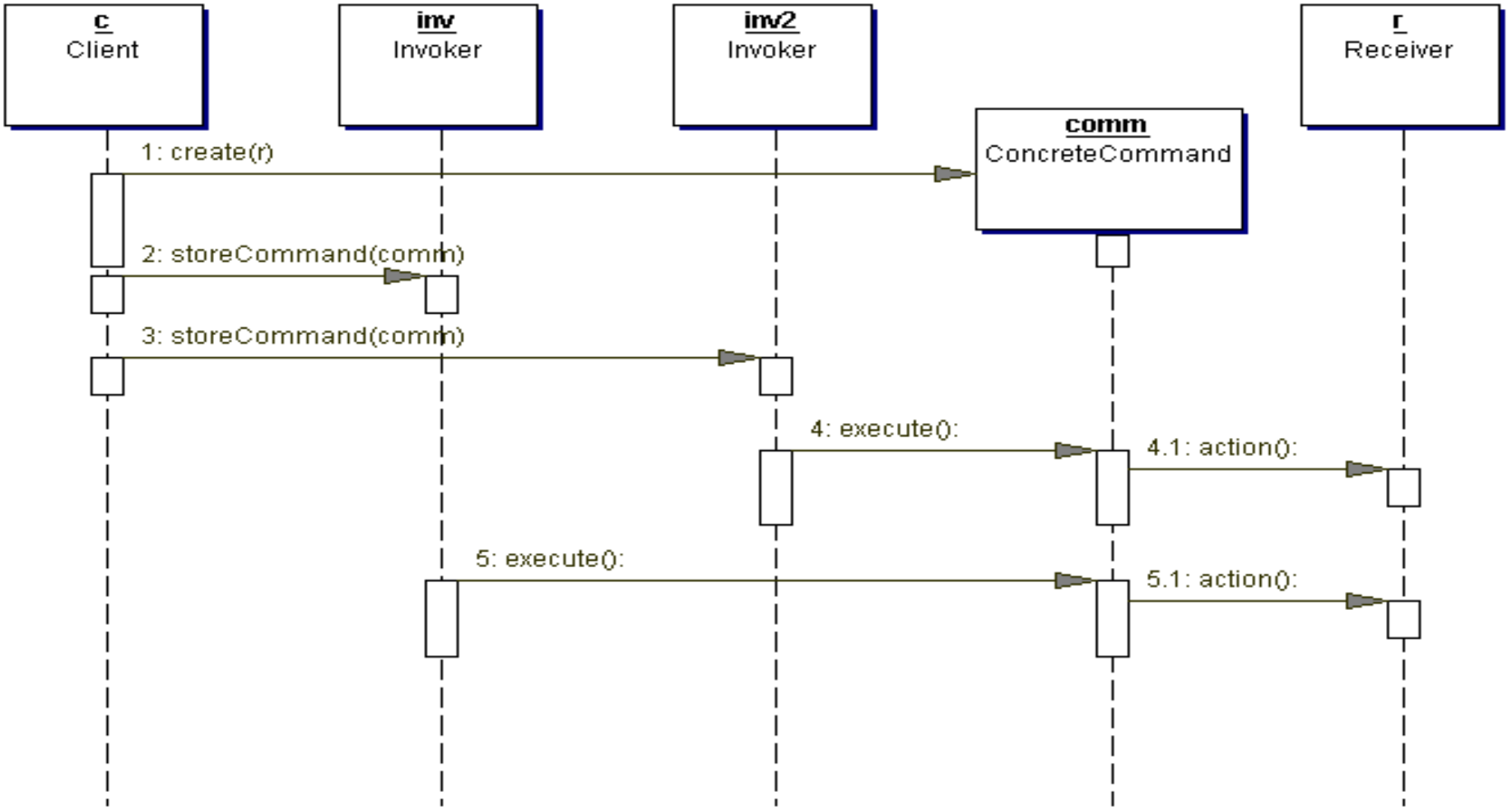
The Command Pattern structure



Command: Participants

- **Command**: declares an interface for executing an operation.
- **ConcreteCommand**: defines a binding between a Receiver object and an action, and implements Execute.
- **Client**: creates a ConcreteCommand object and sets its receiver.
- **Invoker**: asks the command to carry out the request.
- **Receiver**: knows how to perform the operations.

Command: collaboration (with two invokers for a command)



Implementation issues

- How intelligent should a command be?
  - one extreme: A command only defines a binding between a receiver and the actions that carry out the request.
  - the other extreme: A command implements everything itself without delegating to a receiver at all.
- Supporting undo and redo. A ConcreteCommand class might need to store some additional states:
  - the Receiver object
  - the arguments to the operation performed on the receiver
  - any original values in the receiver that may change as a result of handling the request

Command pattern: Consequences

- You can undo/redo any Command
  - Each Command stores what it needs to restore state
- You can store Commands in a stack or queue
  - Command processor pattern maintains a history
- It is easy to add new Commands, because you do not have to change existing classes
  - Command is an abstract class, from which you derive new classes
  - execute(), undo() and redo() are polymorphic functions

Asynchronous Method Invocation

- Another usage for Command is to run commands asynchronously in background of an application.
  - In this case the invoker is running in the main thread and sends the requests to the receiver which is running in a separate thread.
  - The invoker will keep a queue of commands to be run and will send them to the receiver while it finishes running them.
- Instead of using one thread in which the receiver is running more threads can be created for this. The invoker will use a pool of receiver threads to run commands asynchronously.

Summary

- The Command design pattern encapsulates the concept of a command into an object.

- A command object could be sent across a network to be executed elsewhere or it could be saved as a log of operations.

Example for Undo

- For assume we have a class Account representing a bank account.

- Operations
  - withdraw( )
  - deposit( )

- We want to undo them
  - In inverse chronological order

```java
public class Account {
    private double balance; // Saldo del conto

    public Account(double initialBalance) {
        balance=initialBalance;
    }
    // Restituisce il saldo
    public double getBalance() {
        return balance;
    }
    // Esegue un versamento
    public void deposit(double amount) {
        balance += amount;
    }
    // Esegue un prelievo
    public void withdraw(double amount) {
        balance -= amount;
    }
}
```

```
public abstract class Command {
    protected Account account;
    protected Command(Account account) {
        this.account = account;
    }

    public abstract void perform();
    public abstract void undo();
}
```

```
public class DepositCommand extends Command {
   private double amount;
   public DepositCommand(Account account, double amount) {
      super(account);
      this.amount=amount;
   }

   public void perform() {
      account.deposit(amount);
   }

   public void undo() {
      account.withdraw(amount);
   }
}
```

```
public class WithdrawCommand extends Command {
   private double amount;
   public WithdrawCommand(Account account, double amount) {
      super(account);
      this.amount=amount;
   }

   public void perform() {
      account.withdraw(amount);
   }

   public void undo() {
      account.deposit(amount);
   }
}
```

```java
import java.util.Stack;

public class AccountManager {
   private Account account;
   private Stack<Command> commandHistory;

   public AccountManager(Account account) {
      this.account=account;
      commandHistory=new Stack<Command>();
   }

   public double getBalance() {
      return account.getBalance();
   }
   // continua ...
```

```
    // ... continua
    public void deposit(double amount) {
        Command cmd=new DepositCommand(account, amount);
        commandHistory.push(cmd);
        cmd.perform();
    }
    public void withdraw(double amount) {
        Command cmd=new WithdrawCommand(account, amount);
        commandHistory.push(cmd);
        cmd.perform();
    }
    public void undo() {
        Command last=commandHistory.pop();
        last.undo();
    }
}
```

Homework

- A company has set up a network crisis center to quickly respond to problems that may arise on any of its dozens of Web servers. E.g., if a major problem arises at its Denver server, someone might need to shut down that server by
  - connecting to it, issuing multiple shutdown commands (backing up files, rerouting network connectivity around the server, performing system diagnostics, etc.), and ultimately disconnecting.
- If a less severe problem arises at the Miami server, crisis center personnel might need to reboot that server by
  - connecting to it, issuing multiple reboot commands (transmitting warnings to connected servers, loading appropriate boot code, confirming proper restart, etc.), and then disconnecting.

Homework (cont'd)

- Currently, personnel must issue long sequences of commands to one of many servers whenever a problem arises.
- This could easily lead to commands being issued in the wrong sequence or to the wrong destination.
- By encapsulating the individual commands needed to handle a particular problem into a single Command object and then binding that object to a specific receiver, the potential for miscommunication is reduced.

- Permit undo.