Tecniche di Progettazione: Design Patterns

GoF: Command

The Command Pattern

- 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 senders sends a specific method to 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

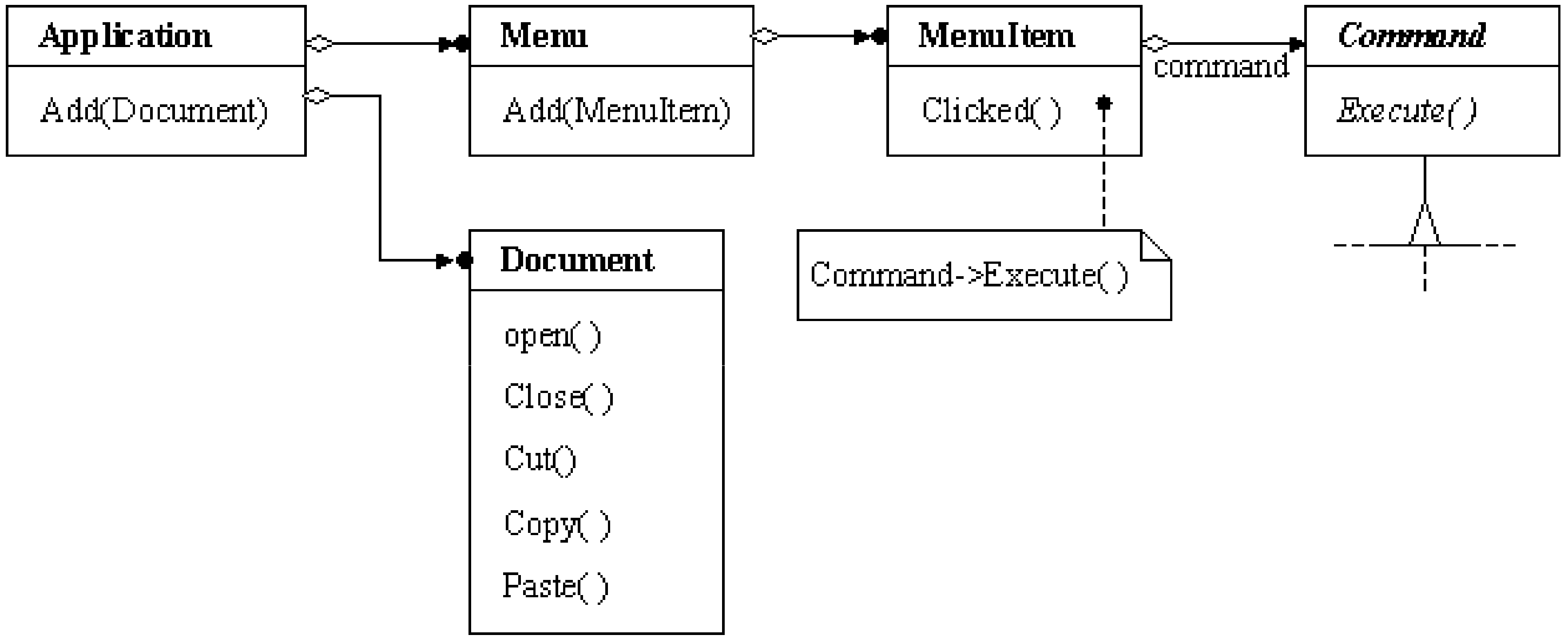
Command Pattern in Java

- 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

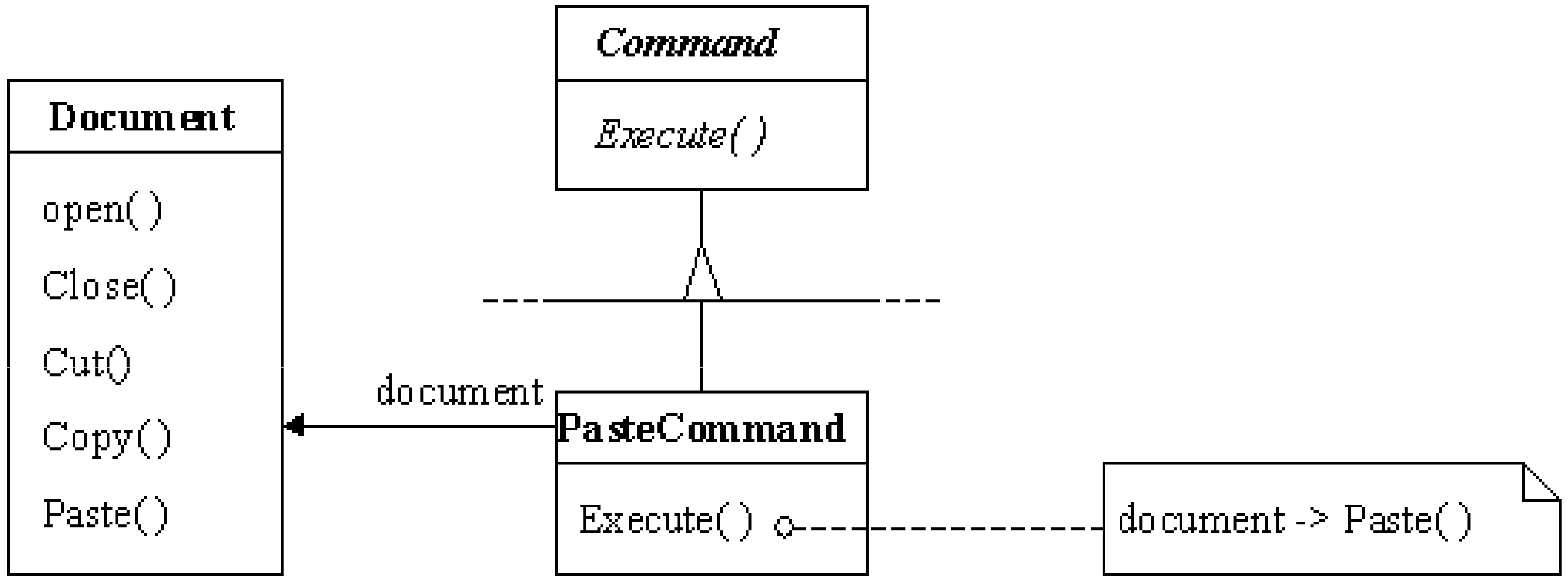
- The Command object can also be used when you need to tell the program to execute the command later.
  - In such cases, you are saving commands as objects to be executed later

GoF example

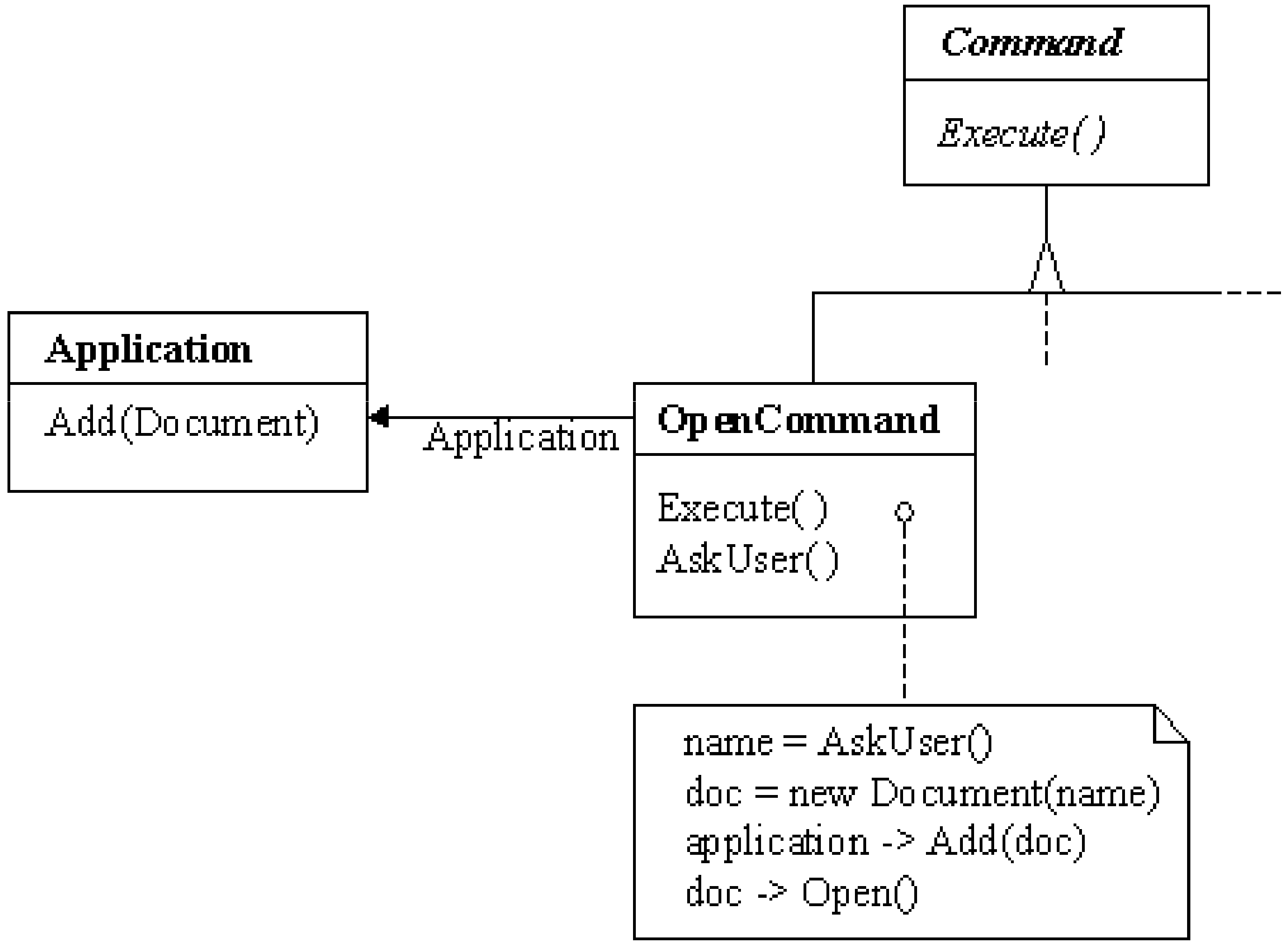


Application
Add(Document)
Menu
Add(MenuItem)
MenuItem
Clicked( )
command
Command
Execute( )
Document
open( )
Close( )
Cut()
Copy( )
Paste( )
Command->Execute( )

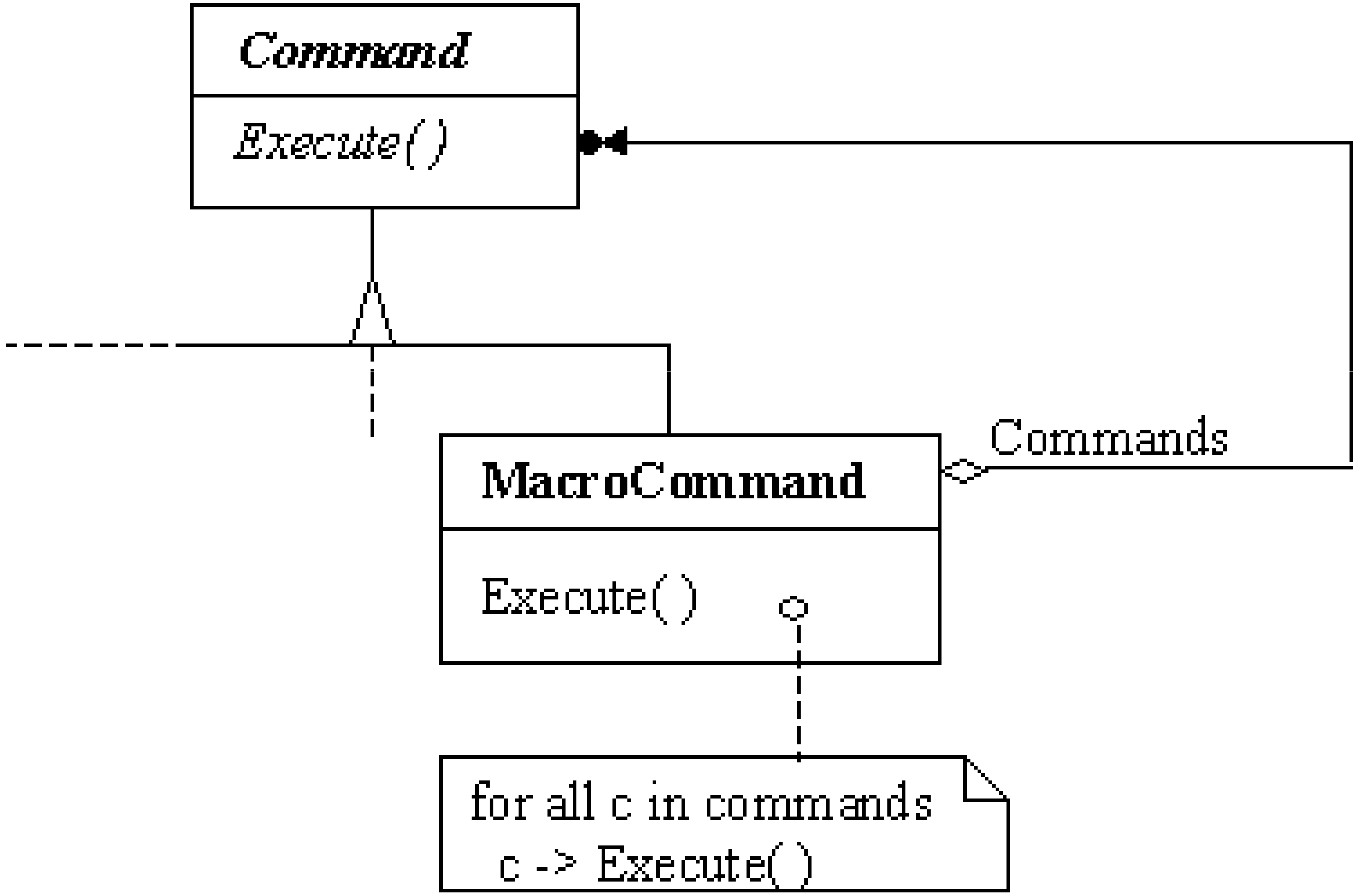
PasteCommand is a concrete Command that implements paste function.



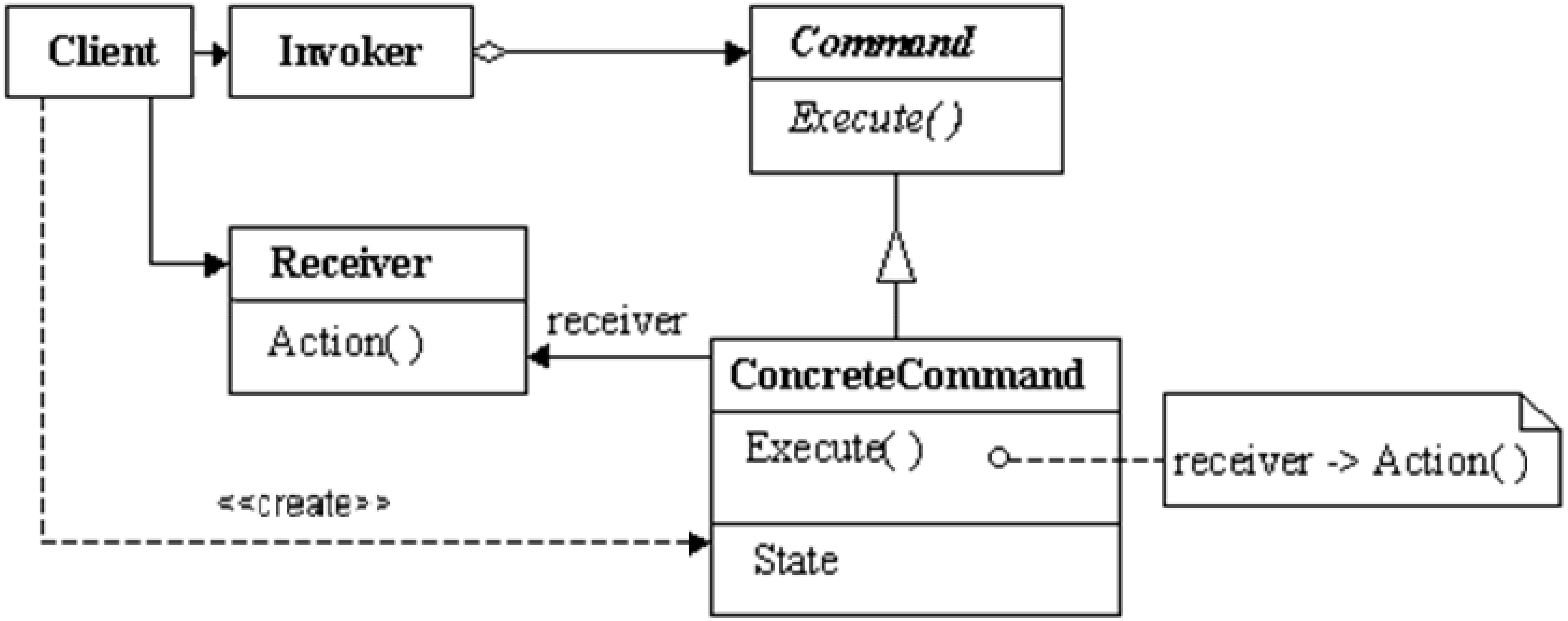
OpenCommand is a concrete Command that implements open function.



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



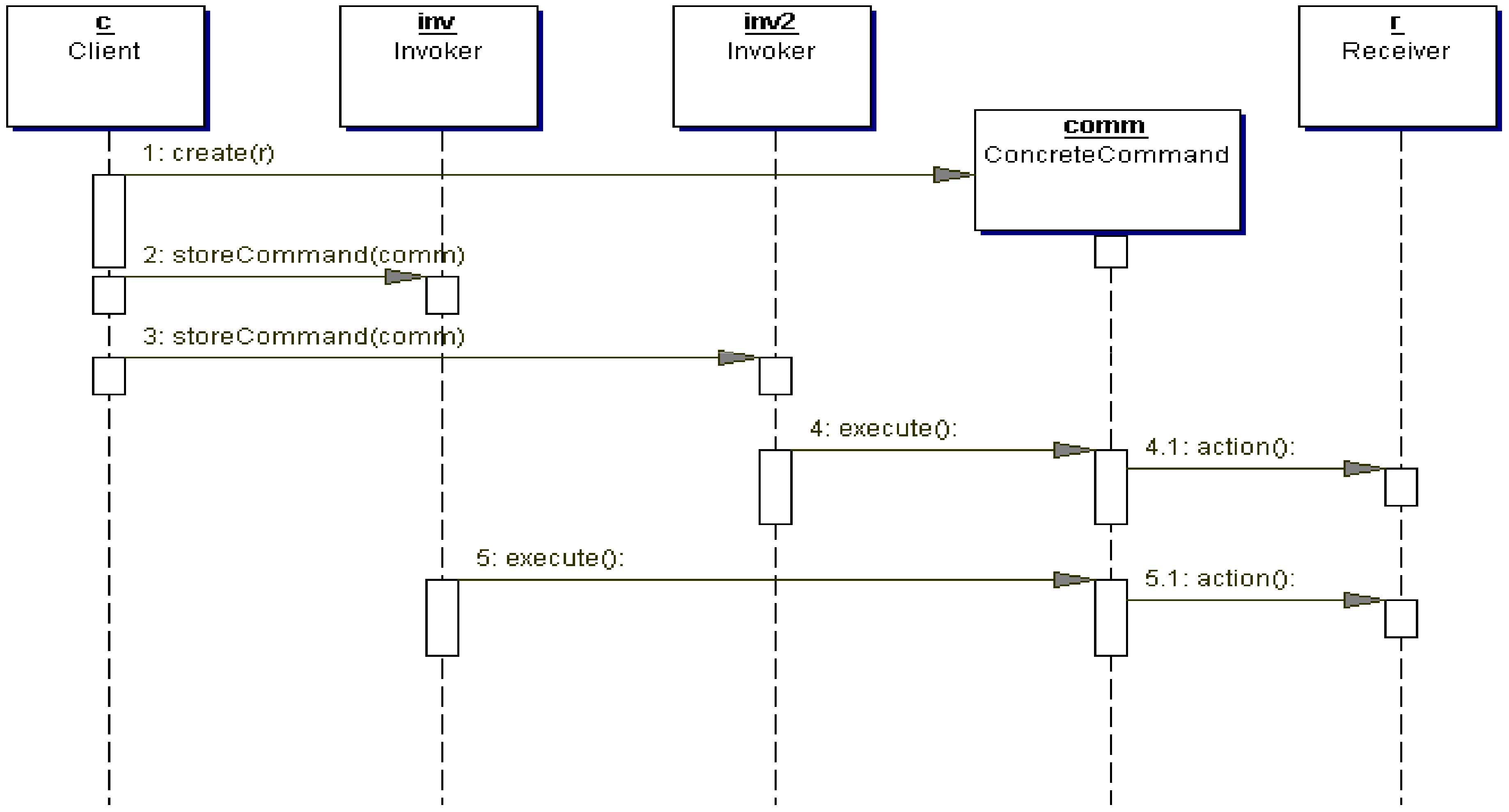
The Command Pattern structure



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

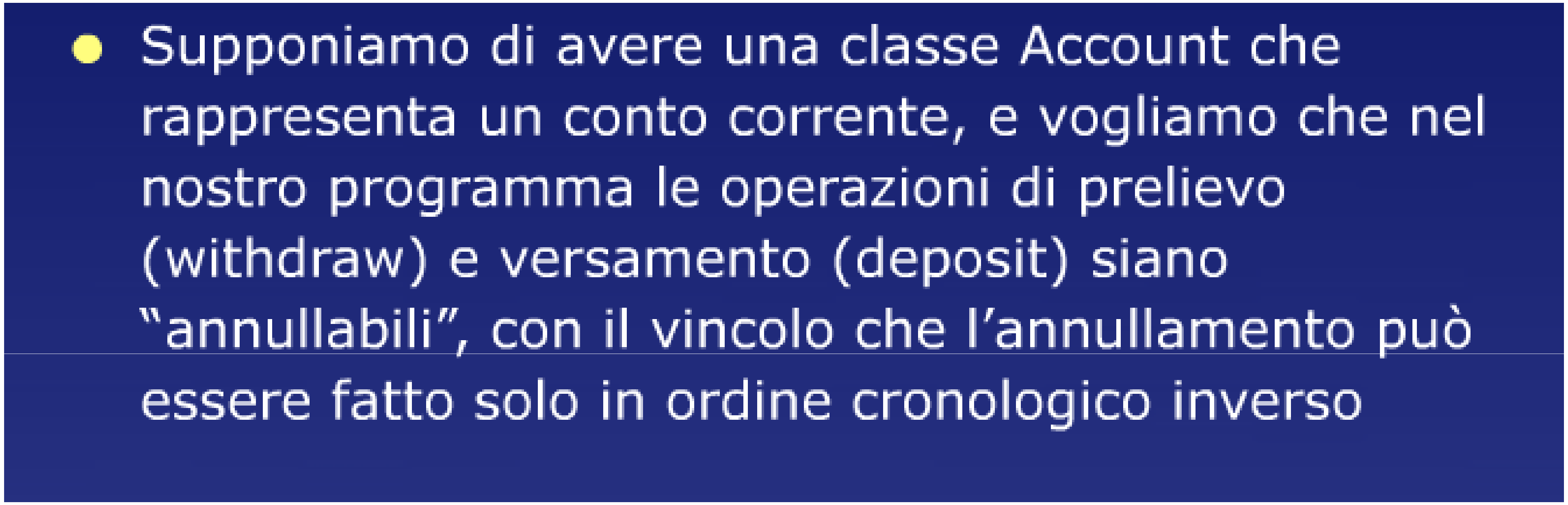
- You can undo/redo any Command
  - Each Command stores what it needs to restore state
- You can store Commands in a stack or queue
  - Command processor pattern maintains a history
- It is easy to add new Commands, because you do not have to change existing classes
  - Command is an abstract class, 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 command asynchronously.

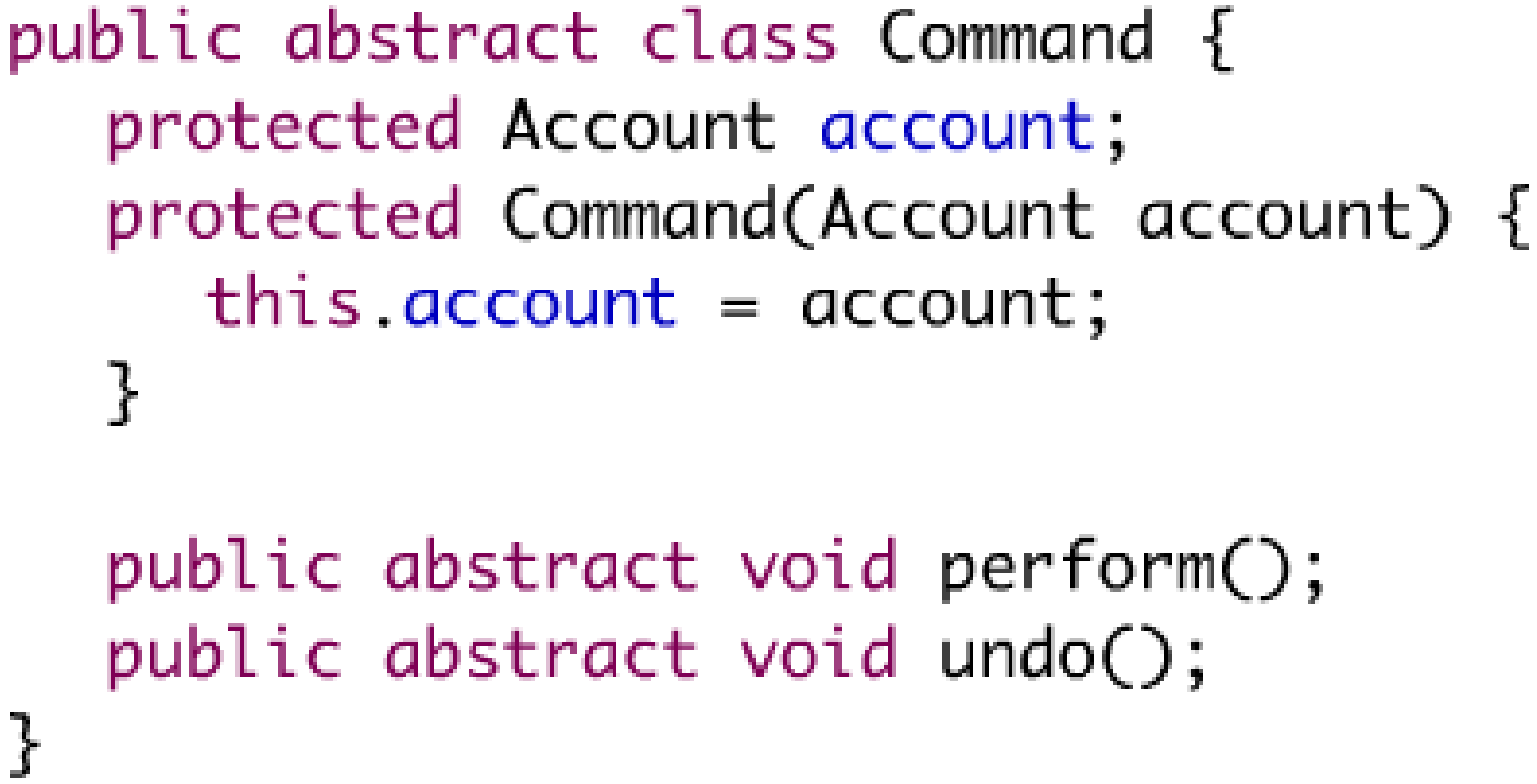
Summary

- 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.



- Supponiamo di avere una classe Account che rappresenta un conto corrente, e vogliamo che nel nostro programma le operazioni di prelievo (withdraw) e versamento (deposit) siano "annullabili", con il vincolo che l'annullamento può essere fatto solo in ordine cronologico inverso

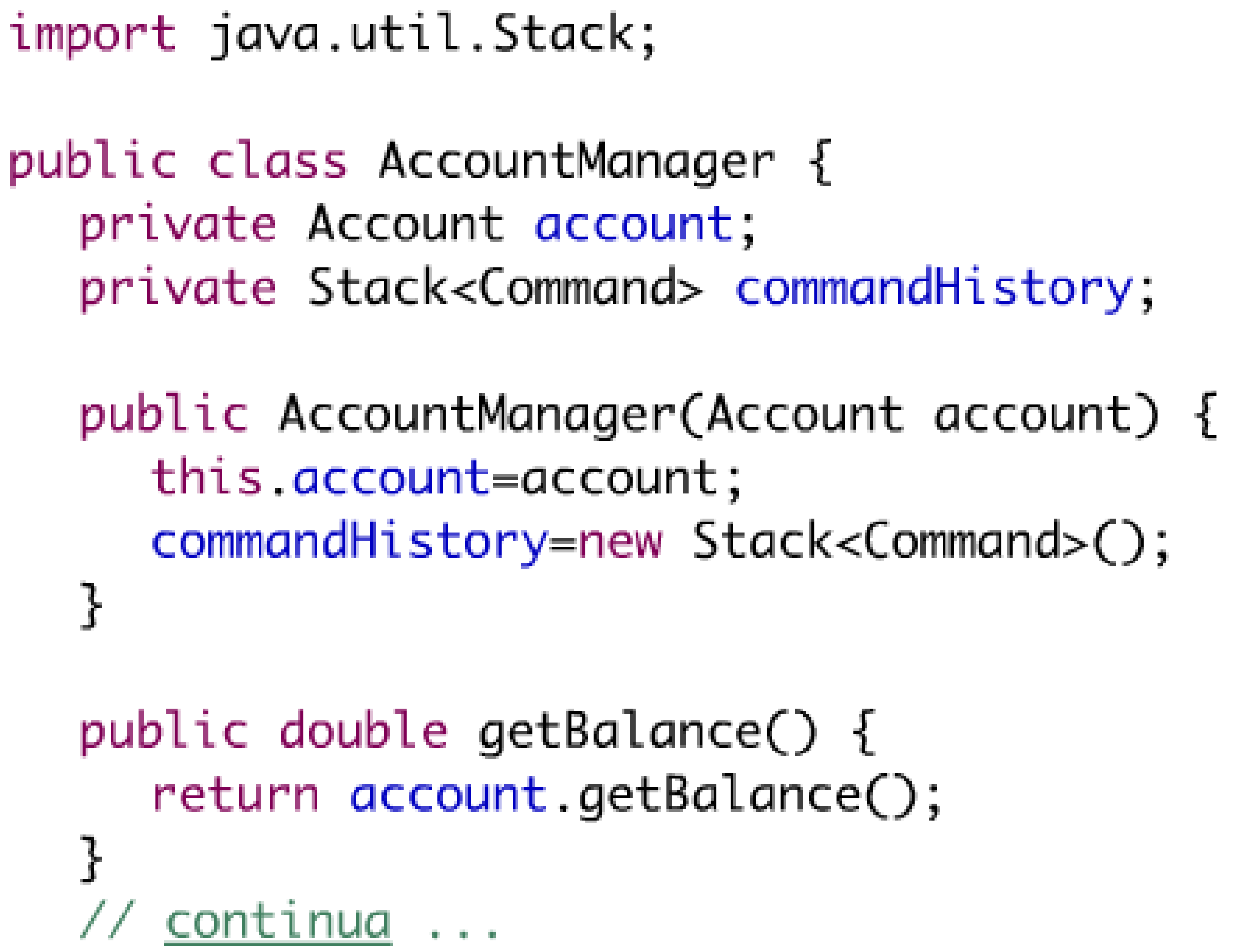
```java
public class Account {
    private double balance; // Saldo del conto

    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();
}
```

```java
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);
   }
}
```

```java
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();
  }
}
```

Implementation issues (cont'd)

- In programming languages like C, there are the *function pointers*.
- Java doesn't have function pointers, we can use the Command pattern to implement callbacks.
- One might be tempted to use the Method objects of the Reflection API. Better not to use the Reflection API when other tools more natural to the Java programming language will suffice