CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2006
Doc 7 Command & Command Processor
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References

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Pattern-Oriented Software Architecture: A System of Patterns, Buschman, Meunier, Rohnert, Sommerlad, Stal, 1996, pp. 277-290, Command Processor

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Command

Encapsulates a request as an object

For Example let
Invoker be a menu
Client be a word processing program
Receiver a document
Action be save
When to Use the Command Pattern

When you need an action as a parameter
Commands replace callback functions

When you need to specify, queue, and execute requests at different times

When you need to support undo

When you need to support logging changes

When you structure a system around high-level operations built on primitive operations

A transaction encapsulates a set of changes to data

Systems that use transaction often can use the command pattern

When you need to support a macro language
Consequences

Command decouples the object that invokes the operation from the one that knows how to perform it.

It is easy to add new commands, because you do not have to change existing classes.

You can assemble commands into a composite object.
abstract class Command {
    abstract public void execute();
}

class OpenCommand extends Command {
    private Application opener;

    public OpenCommand( Application theOpener ){
        opener = theOpener;
    }

    public void execute() {
        String documentName = AskUserSomeHow();

        if ( name != null ) {
            Document toOpen =
                new Document( documentName );
            opener.add( toOpen );
            opener.open();
        }
    }
}
Using Command

class Menu {
    private Hashtable menuActions = new Hashtable();

    public void addMenuItem( String displayString, Command itemAction ) {
        menuActions.put( displayString, itemAction );
    }

    public void handleEvent( String itemSelected ) {
        Command runMe;
        runMe = (Command) menuActions.get( itemSelected );
        runMe.execute();
    }

    // lots of stuff missing
}
class MacroCommand extends Command {
    private Vector commands = new Vector();

    public void add( Command toAdd ) {
        commands.addElement( toAdd );
    }

    public void remove( Command toRemove ) {
        commands.removeElement( toAdd );
    }

    public void execute() {
        Enumeration commandList = commands.elements();

        while ( commandList.hasMoreElements() )
        {
            Command nextCommand;
            nextCommand = (Command)
            commandList.nextElement();
            nextCommand.execute();
        }
    }
}
Prevayler

http://www.prevayler.org/wiki.jsp

Prevalence layer for Java

Database that
  Serializes object to save them to disk
  Uses commands when modifying objects
  Keeps log of commands

Ruby Version
  http://madeleine.sourceforge.net/
import java.util.*;
import org.prevayler.implementation.AbstractPrevalentSystem;

public class Restaurant extends AbstractPrevalentSystem {
    private String name;
    ArrayList ratings = new ArrayList();

    public Restaurant(String newName) { name = newName;}

    public String name() {return name;}

    public void addRating( int newRating) {
        ratings.add( new Integer(newRating));
    }

    public float getRating() {
        if (ratings.size() == 0 )
            return -1;
        int total = 0;
        for (int k =0; k < ratings.size();k++)
            total = total + ((Integer)ratings.get(k)).intValue();
        return total/ ratings.size();
    }
}
import java.io.Serializable;
import org.prevayler.Command;
import org.prevayler.PrevalentSystem;

public class AddRatingCommand implements Command {
    private final int newRating;

    public AddRatingCommand(int rating) {
        newRating = rating;
    }

    public Serializable execute(PrevalentSystem system) {
        ((Restaurant)system).addRating(newRating);
        return null;
    }

}
First Run

```java
import java.util.*;
import org.prevayler.implementation.SnapshotPrevayler;

public class PrevaylerExample {

    public static void main (String args[]) throws Exception {
        SnapshotPrevayler samsDinerData =
            new SnapshotPrevayler(new Restaurant("Sams Diner"), "food");

        System.out.println( "Start");
        Restaurant samsDiner = (Restaurant) samsDinerData.system();
        System.out.println( samsDiner.getRating() );
        samsDinerData.executeCommand( new AddRatingCommand( 5));
        System.out.println( samsDiner.getRating() );
    }
}
```

Output

```
Recovering system state...
Start
-1.0
5.0
```
public class PrevaylerExample {

    public static void main (String args[]) throws Exception {
        SnapshotPrevayler samsDinerData =
            new SnapshotPrevayler(new Restaurant("Sams Diner"), "food");

        System.out.println( "Start");
        Restaurant samsDiner = (Restaurant) samsDinerData.system();
        System.out.println( samsDiner.getRating() );
        samsDinerData.executeCommand( new AddRatingCommand( 10));
        System.out.println( samsDiner.getRating() );

    }
}

**Output**

Recovering system state...
Reading food/000000000000000000001.commandLog...
Start
5.0
7.0
Pluggable Commands

Can create one general Command using reflection

Don’t hard code the method called in the command

Pass the method to call an argument
import java.util.*;
import java.lang.reflect.*;

public class Command
{
    private Object receiver;
    private Method command;
    private Object[] arguments;

    public Command(Object receiver, Method command, 
                   Object[] arguments )
    {
        this.receiver = receiver;
        this.command = command;
        this.arguments = arguments;
    }

    public void execute() throws InvocationTargetException, 
                               IllegalAccessException
    {
        command.invoke( receiver, arguments );
    }
}
public class Test {
    public static void main(String[] args) throws Exception {
        Vector sample = new Vector();
        Class[] argumentTypes = {Object.class};
        Method add =
                Vector.class.getMethod("addElement", argumentTypes);
        Object[] arguments = {"cat"};

        Command test = new Command(sample, add, arguments);
        test.execute();
        System.out.println(sample.elementAt(0));
    }
}
Smalltalk Pluggable Command

Object subclass: #PluggableCommand
  instanceVariableNames: 'receiver selector arguments '
  classVariableNames: '
  poolDictionaries: '
  category: 'Whitney-Examples'

Class Methods
receiver: anObject selector: aSymbol arguments: anArrayOrNil
  ^super new
    setReceiver: anObject
    selector: aSymbol
    arguments: anArrayOrNil

Instance Methods
setReceiver: anObject selector: aSymbol arguments: anArrayOrNil
  receiver := anObject.
  selector := aSymbol.
  arguments := anArrayOrNil isNil
    ifTrue:[#( )]
    ifFalse: [anArrayOrNil]
  execute
    ^receiver
      perform: selector
      withArguments: arguments
Using the Pluggable Command

| sample command |
sample := OrderedCollection new.
command := PluggableCommand
  receiver: sample
  selector: #add:
  arguments: #( 5 ).
command execute.
^sample at: 1
Command Processor Pattern

Command Processor manages the command objects

The command processor:

- Contains all command objects
- Schedules the execution of commands
- May store the commands for later unto
- May log the sequence of commands for testing purposes
- Uses singleton to insure only one instance
Structure

Command Processor
- `dolit(command)`
- `undolit()`
- `commandStack`

Command
- `execute()`

Receiver
- `action()`

ConcreteCommand
- `execute()`
- `receiver`

Client

Diagram:
- Client creates transfer command
- Command Processor performs stores
- ConcreteCommand performs
- Command performs stores
- Receiver performs
- Client performs
Benefits

Flexibility in the way requests are activated

   Different user interface elements can generate the same kind of command object
   Allows the user to configure commands performed by a user interface element

Flexibility in the number and functionality of requests

   Adding new commands and providing for a macro language comes easy

Programming execution-related services

   Commands can be stored for later replay
   Commands can be logged
   Commands can be rolled back

Testability at application level

Concurrency

   Allows for the execution of commands in separate threads
Liabilities

Efficiency loss

Potential for an excessive number of command classes

Try reducing the number of command classes by:

- Grouping commands around abstractions
- Unifying simple commands classes by passing the receiver object as a parameter

Complexity

How do commands get additional parameters they need?