Command Pattern

This lesson discusses how actions and requests can be encapsulated as objects to act as callbacks and in the process allow logging, queueing and undo of commands.

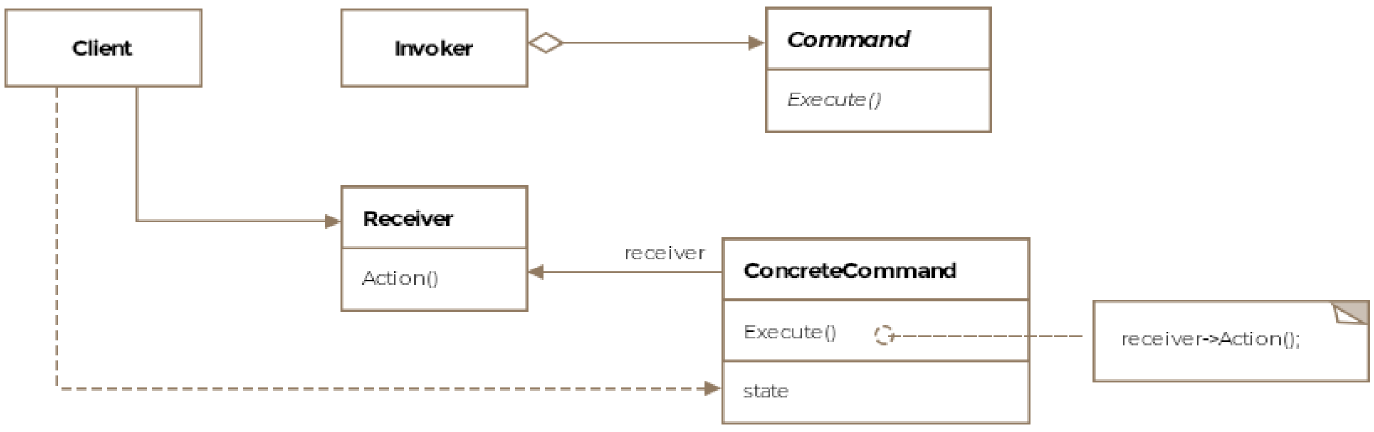
What is it ?

> The command pattern's intention is to decouple the consumers of an action and the object which knows how to perform the action. Let me present an example for clarity. Suppose you are designing a framework for UI, and you add the ability for the users of the framework to add a menu bar. The menu bar will consist of menu-items. When someone clicks on the menu-item some action will be performed. Since you are only building the framework, you don't know what actions the users of the framework can have the menu-item perform. It may vary from opening a document to restarting the application. The command pattern allows us to encapsulate the desired action in an object and the object becomes responsible for invoking the action with the appropriate arguments.
>
> Formally, the pattern is defined as ***representing an action or a request as an object that can then be passed to other objects as parameters, allowing parameterization of clients with requests or actions. The requests can be queued for later execution or logged. Logging requests enables undo operations***.

Class Diagram

> The class diagram consists of the following entities
>
> - **Command**

- **Concrete Command**
- **Client**
- **Invoker**
- **Receiver**



Class Diagram

Example

Going back to our aircraft example, imagine the cockpit of the Boeing-747. It has a multitude of instrument panels with knobs and buttons. For simplicity's sake let's say the plane has a button for the landing gear (https://en.wikipedia.org/wiki/Landing_gear) (the wheels of the aircraft), which allows the landing gear to be lowered or retracted. **The button shouldn't need to know *how* the landing gear works, it just needs to know *who* has the knowledge to operate the landing gear**. The *who* part will implement the `Command` interface and the button will know it needs to invoke the `execute` method on the *who* object.

Let's look at the code implementation of our simplistic scenario. First up is the command interface:

```
public interface Command {
    void execute();
}
```

When the button is pressed to say lower the landing gear. The button code should only have to deal with a command object that implements the **`Command`** interface. The button code simply calls **`execute`** on the command object. Let's look at the **`LandingGearDownCommand`** class.

```
public class LandingGearDownCommand implements Command {

    // This is called the receiver of the request and
    // actually has the logic to perform the action
    LandingGear landingGear;

    public LandingGearDownCommand(LandingGear landingGear) {
        this.landingGear = landingGear;
    }

    @Override
    public void execute() {
        landingGear.up();
    }
}
```

You'll see the variable `landingGear` in the **`LandingGearDownCommand`** class. This is called the **Receiver**. It is the object that actually knows how to lower the landing gear and does the job, which is why it is called the receiver because it *receives* the request and processes it. The LandingGearDownCommand is the **Command** in pattern-speak. **The command is composed with the receiver that actually contains the logic to perform the requested action**

You must be wondering that **`LandingGearDownCommand`** object needs to be instantiated somewhere in the code. The **Invoker** takes on the responsibility of creating the command object and invoking it. In our case, we can imagine a class representing the instrument panel which holds all the commands for the physical buttons on the panel. It may look something like:

```
public class InstrumentPanel {

    // Only two commands for now
    Command[] commands = new Command[2];

    public InstrumentPanel() {

    }

    public void setCommand(int i, Command command) {
        commands[i] = command;
    }

    public void lowerLandingGear() {
        // Assuming that the client correctly sets the first
        // index to be the landing gear lower command
        commands[0].execute();
    }

    public void retractLandingGear() {
        commands[1].execute();
    }
}
```

Notice how the Invoker is simply setting up the commands and then invoking the `execute` method on the command objects. We can very well replace the command object with an instance of a different implementation and the invoker would still work correctly. This allows decoupling between the invoker and the receivers. The Command pattern decouples the object that invokes the operation from the one having the knowledge to perform it.

The last piece to the command pattern is the client which sets up the invoker with the right commands and the commands with the right receiver objects.

```
    public void main() {

        LandingGear landingGear = new LandingGear();
        LandingGearDownCommand landingGearDownCommand = new LandingGearDow
nCommand(landingGear);
        LandingGearUpCommand landingGearUpCommand = new LandingGearUpComma
nd(landingGear);

        // Create the instrument panel
        InstrumentPanel instrumentPanel = new InstrumentPanel();

        // Assign the commands
        instrumentPanel.setCommand(0, landingGearUpCommand);
        instrumentPanel.setCommand(1, landingGearDownCommand);

        // Lower the landing gear
        instrumentPanel.lowerLandingGear();

        // Retract the landing gear
        instrumentPanel.retractLandingGear();
    }
```

Macro Command

A series of commands can be strung together and executed in a sequence by another command object, sometimes called a *macro command*. It has no explicit receiver as the commands it sequences define their own receivers. The macro command is an example of the *composite pattern*.

Other Examples

- `java.lang.Runnable` defines the interface implemented by classes whose instances are executed by threads.

- Implementations of `javax.swing.Action` also conform to the command pattern.

Caveats

- The command pattern is equivalent of a callback function in procedural languages as we parametrize objects with an action to perform
- The command objects can also be queued for later execution.
- The command interface can introduce an `unexecute` method, which reverses the actions of the `execute` method. The executed commands can then be stored in a list and traversing the list forwards and backwards while invoking execute or unexecute can support redo and undo respectively. The *memento pattern* can be helpful in storing the state a command needs to undo its effects.
- The command interface can add methods to save and read from disk allowing logging of commands. In case of a crash the log can be read and the commands re-executed in the same sequence to get the system back to the state just before the crash.
- The command pattern offers a way to model *transactions*. A transaction consists of finer grained operations applied to data.

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