Command

You have probably heard of **behavioral patterns** by now. These are the type of patterns concerned with the interaction of objects. While there are about 12 design patterns that belong to behavioral patterns, the **command pattern** has a special place among them as it's the most commonly used. The purpose of the command pattern is to **decouple** the logic between a command and its consumers.

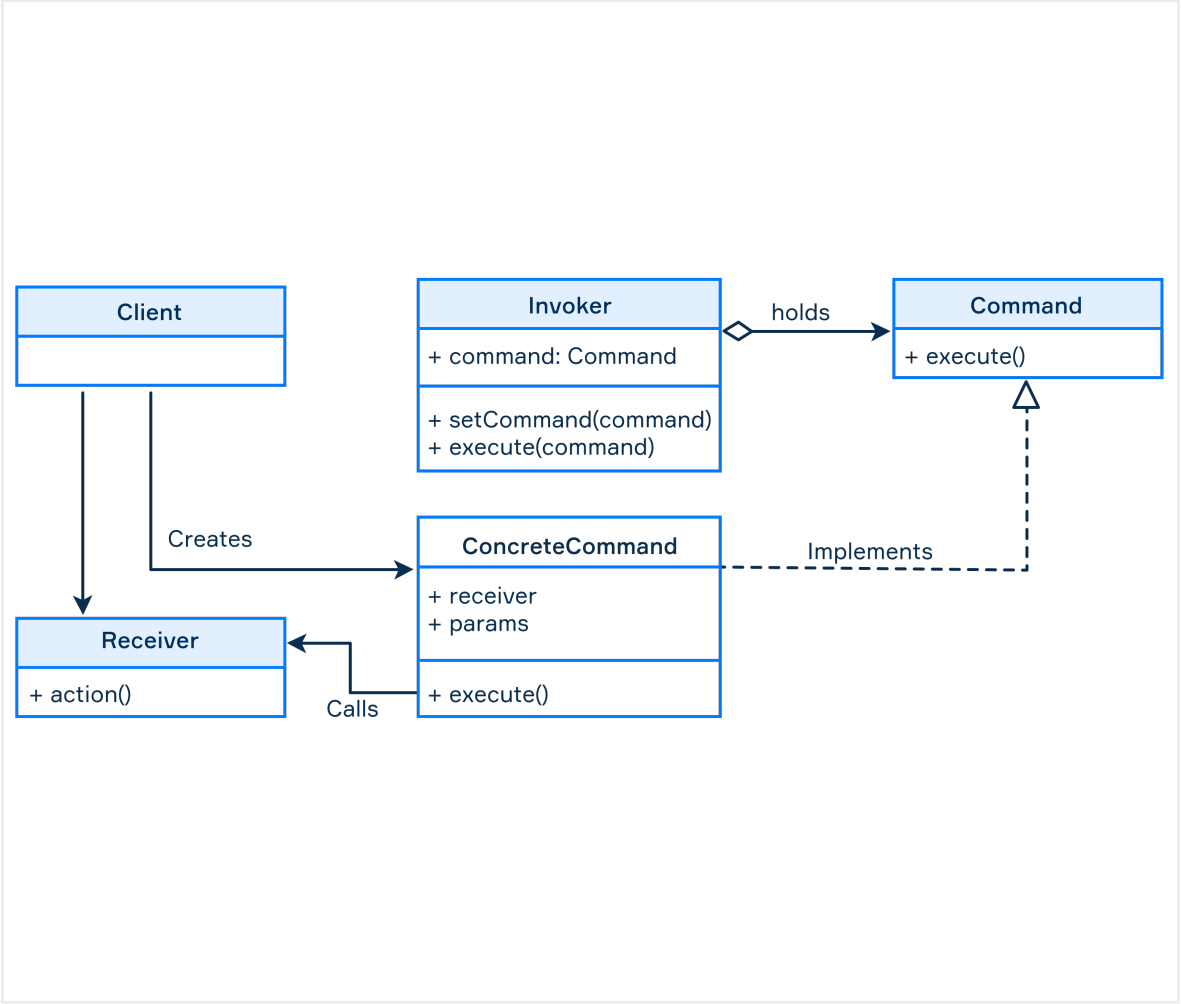
In a nutshell, a command pattern encapsulates all the data related to a command in one object. Usually, this data consists of a set of methods, their parameters, and one or more objects these methods belong to. We call this object Receiver. So, an important advantage of decoupling is that if you have to change any of these values, you only have to change one class.
In its classic version, implementing the command pattern involves five steps. Let's see what they are.

The classic version

The classic version of the command pattern has the following elements:

- The Command interface usually declares just a single method for executing the command.
- The ConcreteCommand is an operation with parameters that pass the call to the receiver; in the classic approach, a command only invokes one or more methods of a Receiver rather than performing business logic.
- The Receiver performs the action.
- The Invoker asks the command to carry out the request.
- The Client creates the ConcreteCommand object and sets the Receiver.

Note that the Command interface is not necessarily an interface in terms of language. It can be a simple or an abstract class. The main point is that it represents an abstract command that is inherited by concrete commands.
The following diagram illustrates all the elements of the pattern and how they are related.



The Client creates an object of Receiver and ConcreteCommand, then sets up the Invoker to execute the command. Each type of ConcreteCommand (CreateFileCommand, RemoveFileCommand) has a set of fields which represent the parameters. A command calls one or more methods of Receiver to execute concrete actions and change the state of the application.

Example of the command pattern

Suppose you are going to build a home automation system where you need to turn the light on and off. Here we have two commands which are quite similar. So first, we will create the Command interface. It will have only one method – execute().

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

Then we will create two classes that will implement the Command interface. These concrete classes encapsulate data needed for the command. So you have to create concrete classes for each command. We will be creating two concrete classes as our application has two commands, LightOn and LightOff. First. LightOnCommand will implement the Command interface.

```
public class LightOnCommand implements Command {
```

```
    private Light light;

    public LightOnCommand(Light light) {
        this.light = light;
    }

    @Override
    public void execute() {
        light.lightOn();
    }
}
```

Next, LightOffCommand will implement
the Command interface. LightOffCommand basically has the same code
as LightOnCommand.

```
public class LightOffCommand implements Command {

    private Light light;

    public LightOffCommand(Light light) {
        this.light = light;
    }

    @Override
    public void execute() {
        light.lightOff();
    }
}
```

We haven't created the Light class yet, which is our Receiver. We'll do that
next:

```
public class Light {

    public void lightOn() {
        System.out.println("Turn on Light");
    }

    public void lightOff() {
        System.out.println("Turn off Light");
    }
}
```

Sometimes learning design patterns with simple examples is difficult because these examples don't represent the complexity of real-world applications. For example, someone may ask, why create a separate Light class when we only need two methods and both of them can be implemented on the command

classes itself? Well, in a real-world application, the Light class can be more complex with more fields and methods command classes have nothing to do with.
Next, we need to create the Invoker class. The invoker class decides how the commands are executed. For example, Invoker can keep a list of commands that need to be executed in a specific order. Please note that Invoker is just a default term we use to call the class that decides how commands are executed. You can name it any way you like, depending on the application you're developing.
We will name the invoker class Controller here.

```
public class Controller {

    private Command command;

    public void setCommand(Command command) {
        this.command = command;
    }

    public void executeCommand() {
        command.execute();
    }
}
```

Finally, our client or the main method will use the invoker to execute the command.

```
public class HomeAutomationDemo {

    public static void main(String[] args) {

        Controller controller = new Controller();
        Light light = new Light();

        Command lightsOn = new LightOnCommand(light);
        Command lightsOff = new LightOffCommand(light);

        controller.setCommand(lightsOn);
        controller.executeCommand();

        controller.setCommand(lightsOff);
        controller.executeCommand();
    }
}
```

What happens here is quite straightforward. There are three significant steps in the main method:

1. Creating an object from the invoker class, which is called Controller in our application.
2. Creating objects from commands that we are going to execute.
3. Executing commands using invokers.

There could be other steps necessary for the completion of these three main steps. For example, the main() method has created a Light object because a Light object has to be passed to create Command objects. When you execute this code, the following output will be produced:

```
Turn on Light
Turn off Light
```

Additional options

The command pattern can also be used for the following purposes:

- adding commands to a queue to execute them later;
- supporting undo/redo operations;
- storing a history of commands;
- serializing commands to store them on a disk;
- assembling a set of commands into a single composite command known as **macros.**

These options are not essential to the pattern but are often used in practice. Sometimes, a command performs all the work by itself instead of invoking the Receiver object to do the action. This option is somewhat simpler and also used in practice.

Applicability

Possible applications of this pattern include:

- **GUI buttons and menu items.** In Swing programming, an Action is a command object. In addition to the ability to perform the desired command, an Action may have an associated icon, a keyboard shortcut, tooltip text, and so on.
- **Networking.** It is possible to send whole command objects across the network to be executed on other machines: for example, player actions in computer games.
- **Transactional behavior.** Similar to undo, a database engine or software installer may keep a list of operations that have been or will be performed. Should one of them fail, all others can be reversed or discarded (this is usually called **rollback**).
- **Asynchronous method invocation.** In multithreading programming, this pattern makes it possible to run commands asynchronously in the 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 and send them to the receiver while it finishes running them.

Conclusion

The main advantage of the command pattern is that it decouples the object that invokes the operation from the one that knows how to perform it. Various modifications of this pattern can be used to keep a history of requests, implement the undo functionality and create macro commands. However, keep in mind that your application can become more complex because this pattern adds another layer of abstraction instead of simply invoking methods.