Template Method

This lesson discusses how algorithms with multiple steps can be made configurable by allowing subclasses to provide behavior for some of the steps.

What is it ?

A template can be thought of as a general or abstract structure that can be customized for specific situations. You may have used a *template* for writing your resume. The template would define the overall structure of the document and leave the details to be added in by the template user. The template method pattern is similar, it defines the skeleton or steps of an algorithm but leaves opportunities for subclasses to override some of the steps with their own implementations.

Formally, the pattern is defined as ***allowing subclasses to define parts of an algorithm without modifying the overall structure of the algorithm.***

The template method pattern factors out the common code among its subclasses and puts them into the abstract class. The variable parts of the algorithm are left for the subclasses to override. These parts are template methods. A ***template method*** defines an algorithm in terms of abstract operations that subclasses override to provide concrete behavior. The ordering of the steps is fixed by the abstract class. Usually, the algorithm is represented as a series of methods which are then invoked in the desired sequence in another method. Note that the classes may choose to ignore overriding certain steps or choose to rely on the default implementation provided by the abstract class. The abstract class may want to forbid the subclasses from overriding behavior for some steps, it can enforce this constraint by marking the methods implementing those steps as `final`.

The opportunity afforded to subclasses for overriding some steps of the algorithm is through methods called **hooks**. A hook denotes an optional step for the subclass to override whereas a method marked as `abstract` forces the subclasses to provide an implementation for the step.

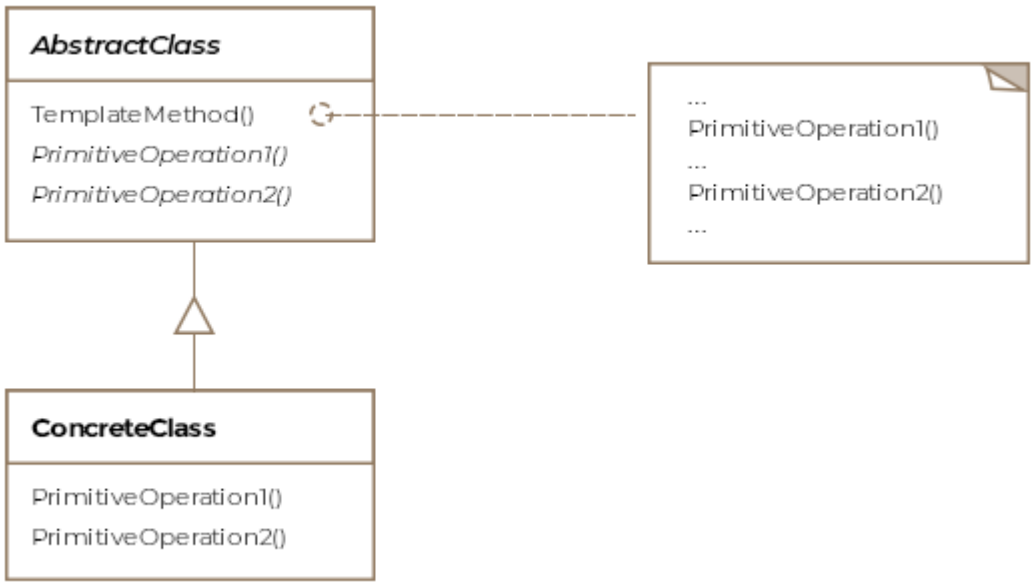
The template pattern method is very suitable for frameworks. A framework generally defines the application control flow and gives developers the opportunity to override certain methods to customize the flow of their application needs. For instance, the very popular message queuing framework Kafka allows developers to set the `UncaughtExceptionHandler` method and give their application a chance to react to an uncaught exception. The developer can choose to ignore and not set any handler. The template method pattern doesn't need to follow the textbook description of the pattern and can deviate to fit in the given context but the underlying spirit should conform to the intent of the pattern description.

One of the benefits apart from code reuse of the template method pattern is that the higher level components don't depend on lower level components and call the lower level components as and when required. When entities at various levels depend horizontally and vertically on various other entities, it becomes what is called a **Dependency Rot**. The pattern helps avoid the dependency rot by making the lower level components (subclasses) depend on the higher level abstract class.

Class Diagram

The class diagram consists of the following entities

- **Abstract Class**
- **Concrete Class**



Example

Let's take our aircraft example. Before each flight there's a list of tasks the pilots must go through that is called the "pre-flight checklist". You can well imagine that for most of the aircrafts this list would have a lot of commonalities. Therefore, it makes sense to model an abstract class that captures all the tasks in the preflight checklist in the order they should be performed.

```
public abstract class AbstractPreFlightCheckList {

    // This method captures the template or the skeleton
    // of the algorithm for the pre-flight checklist.
    final public void runChecklist() {

        // Check fuel guage
        IsFuelEnough();

        // Check doors are locked
        doorsLocked();

        // Check air pressure
        checkAirPressure();
    }

    // Don't let subclasses override this method, this is a
    // mandatory check
    final protected void IsFuelEnough() {
        System.out.println("check fuel gauge");
    }

    // Some airplanes may or may not have doors so allow this
    // method to be overridden by subclasses
    protected boolean doorsLocked() {
        return true;
    }

    // Force subclasses to provide their own way of checking for
    // cabin or cockpit air pressure
    abstract void checkAirPressure();
}
```

The F-16 preflight checklist would then look like

```
public class F16PreFlightCheckList extends AbstractPreFlightCheckList {

    @Override
    void checkAirPressure() {
        // Implement the custom logic for checking cockpit
        // air pressure for F-16
    }

    @Override
    protected boolean doorsLocked() {
        // F-16 unlike a Boeing-747 has no doors
        // so always return true;
        return true;
    }
}
```

Since an F-16 doesn't have doors that need to be locked, it conveniently ignores providing an implementation for the method `doorsLocked` and relies on the default implementation of the abstract class to take the right action.

Other Examples

- Java's applets have gone down in popularity but the applet framework exposed a number of hooks for the developers. For instance, the `start` method gave the application a chance to take action before the applet just got displayed in the browser.
- The java.io package has an abstract `read()` method in `InputStream` that subclasses must implement and is in turn invoked by the method `read(byte arg1[], int offet, int length)`.
- The class `javax.servlet.http.HttpServlet` has a bunch of methods `doGet`, `doPost` and `doPut` etc, that can be overriden by implementing classes.

Caveats

- Don't confuse the template method pattern with the *strategy pattern*. Strategy pattern uses composition by accepting objects that define the entire algorithm, whereas the template pattern method uses inheritance to vary parts of the algorithm by subclasses but the outline and structure of the algorithm is still the realm of the abstract class.
- Factory method pattern is a specialization of the template method pattern.
- Ideally, the number of methods for which the subclasses need to provide implementation should be minimized when applying the template method pattern.

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