Flyweight

This lesson discusses how the flyweight pattern can be applied to reduce memory requirements.

What is it ?

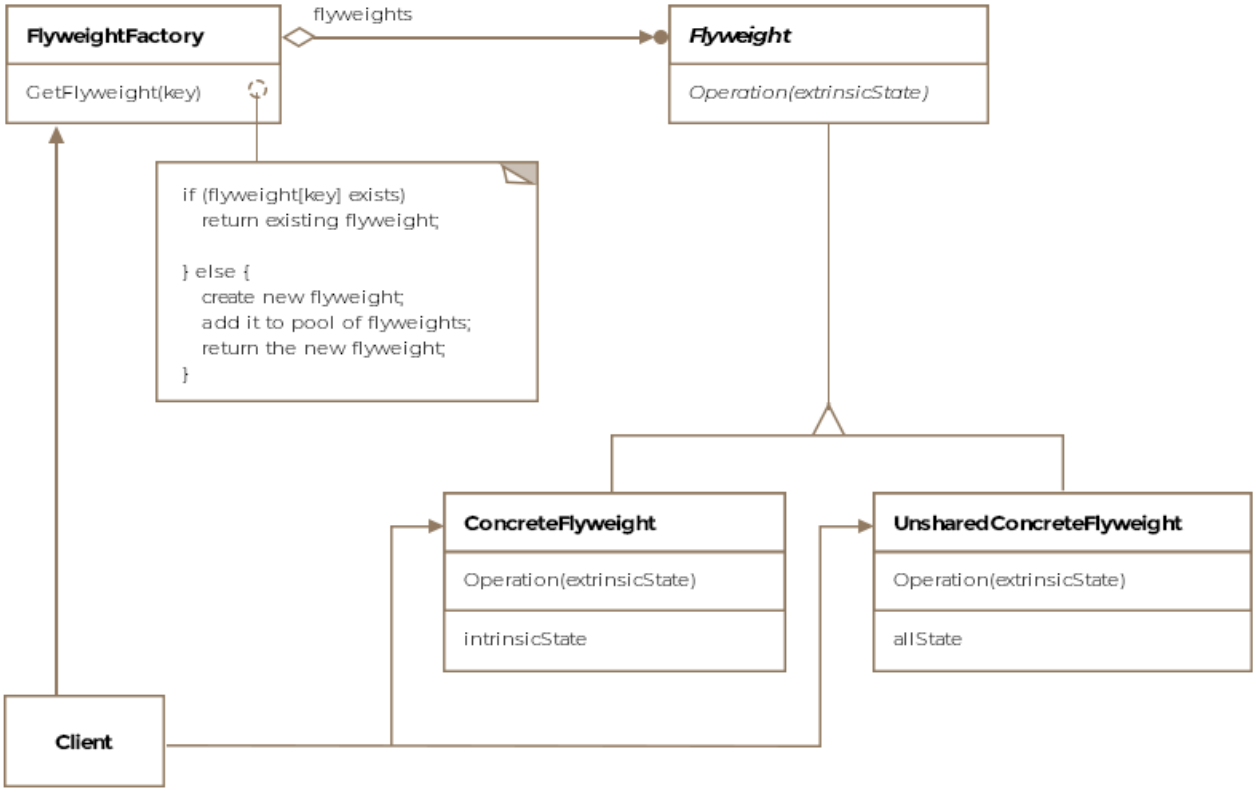
Flyweight is a category in boxing competitions for light weight boxers. The intent of the pattern is somewhat similar in that it tries to reduce bloated code to a more compact and lean representation, which uses less memory.

Formally, the pattern is defined as ***sharing state among a large number of fine-grained objects for efficiency***.

Class Diagram

The class diagram consists of the following entities

- **Flyweight**
- **Concrete Flyweight**
- **Unshared Concrete Flyweight**
- **Flyweight Factory**
- **Client**



Example

Following OO principles to the core may lead you to create too many objects in your application that have part of their state shared. For instance, continuing with our aircraft scenario, if you are designing a global radar that tracks all the planes currently airborne in the world at any time then your radar screen will show thousands of airplanes represented as objects in memory. If your hardware is limited in memory then you have a problem.

Each object would have some shared state that is independent of where the plane is flying in the world. This state which is independent of the *context* of the plane is called **intrinsic state** and can be factored out and shared amongst all similar planes. The state of the plane which changes with the context is called the **extrinsic state**. In this case, the coordinates of the plane will change for each plane and can be thought of as the extrinsic state. The remaining amount of fuel for each airplane is another piece of information that is extrinsic. However, the number of crew required to fly a particular variant of the F-16 would be the same across all the F-16s of that variant that are airborne. This would be an example

of **intrinsic state**. The crew number isn't dependent on the context, i.e. which part of the world is the plane flying in, which country does it belong to, is it on a patrolling mission or a combat mission etc - none of that affects or changes the number of people required to operate the aircraft.

Using the flyweight pattern, we can move the extrinsic state of the object outside of the class and only keep the intrinsic state within the class. This change would allow us to reuse the same F-16 object for all the F-16s that are currently airborne and show up on the radar. The number of objects required to represent the flying F-16s would drastically reduce. The extrinsic state of the planes can always be passed-in to the methods that use it.

The astute reader would immediately question where do we keep the *extrinsic state*? That can be kept in a separate ***context*** object. But then you may retort that it is like going back to square one, for now, we are creating more objects and the whole purpose of the pattern was to reduce the number of objects. Your observation is correct, however, note that the context object only contains that information which varies per instance of F-16. The information which is common across the F-16 instances is stored in a flyweight object. Earlier, we had a single *heavyweight* object that contained both kinds of information and was needed per instance of F-16. With the break-up, the single heavyweight object becomes a flyweight object used by all F-16s consisting of information that'll not change and an additional context object per F-16 instance consisting of information that'll change for each instance of the F-16. Since we are keeping a single copy of the non-varying information, we'll witness memory savings.

Let's see how the F-16 flyweight class would look like

```
public class F16 implements IAircraft {

    // Intrinsic state
    private final String name = "F16";
    private final int personnel = 2;
    private final String dimensions = "15m long 3m wide";
    private final String wingspan = "33 feet";
```

```
    // Extrinsic state includes the current position and current spee
d

    // of the aircraft that is being passed in for computing remainin
g
    // time to destination
    public double getTimeToDestination(int currX, int currY, int dest
X, int destY, int currSpeed) {

        // algorithm to calculate the remaining time to reach
        // destination.

        return 1;
    }
}
```

The client code can take advantage of the flyweight like so:

```
public class Client {

    public void main(int[][] coordsF16) {

        F16 flyweightF16 = new F16();

        for (int i = 0; i < coordsF16.length; i++) {
            int currX = coordsF16[i][0];
            int currY = coordsF16[i][1];

            // We are passing in the extrinsic state to the flyweigh
t object. Note we are storing the
            // extrinsic state of the airborne f16s in a 2-dimensiona
l array.
            System.out.println("time to destination = " +
                                flyweightF16.getTimeToDestination(curr
X, currY, 10, 10, 200));
        }

    }
}
```

Note, how the client is receiving the extrinsic state for each of the F-16 in a two-dimensional array. The flyweight F16 class has information specific to a F-16 plane that won't change. For brevity's sake the getters for the private fields are skipped.

Other Examples

- GoF discusses a text editor example. In the extreme case, each character can be represented as an object. However, any reasonably sized document would then become bloated with character objects. Each object would contain the font, style, color and the character encoding. For simplicity, if the document is limited to ASCII characters then we can have flyweight objects represent each character in the ASCII table.
- Methods `java.lang.Boolean.valueOf` and `java.lang.Integer.valueOf` both return flyweight objects.

Caveats

- Usually, we don't want the clients to creat the flyweight objects directly. A flyweight factory is used to manage the flywieght objects.
- It might appear that flyweight pattern is maybe similar to the singleton pattern, however there are some important differences. Flyweights are immutable whereas a singleton can undergo changes. Also, a singleton can only have a single copy whereas flyweights can have more than one object of their type.
- *State* and *Strategy* objects are often implemented as flyweights.
- In practice, composite pattern can be combined with flyweight to create a hierarchical structure, where the leaves are implemented as flyweight objects and are shared.
- Since flyweight objects are shared, identity tests for conceptually different objects would return true.

- Memory savings increase if the extrinsic state can be computed rather than being stored. However, the calculation or lookup of the extrinsic state trades execution time increase in lieu of memory savings.