Program to Interface, Factories and Injection

Program to an Interface, Not an Implementation

Early in the **WeatherStation** constructor:

```
Barometer bar = new Barometer() ;
```

Why is this problematic:

- **`WeatherStation`** depends on a specific *implementation* of a **`Barometer`**.
- In particular, here a simulated **`Barometer`**!
- Each different type of **`Barometer`** makes us change the **`WeatherStation`**.
- Or jury-rig some sort of way of loading the "right" **`Barometer`**.
- Reduces the reusability of **`WeatherStation`** in different contexts.

Program to an Interface, Not an Implementation

Somewhere in the **WeatherStation** :

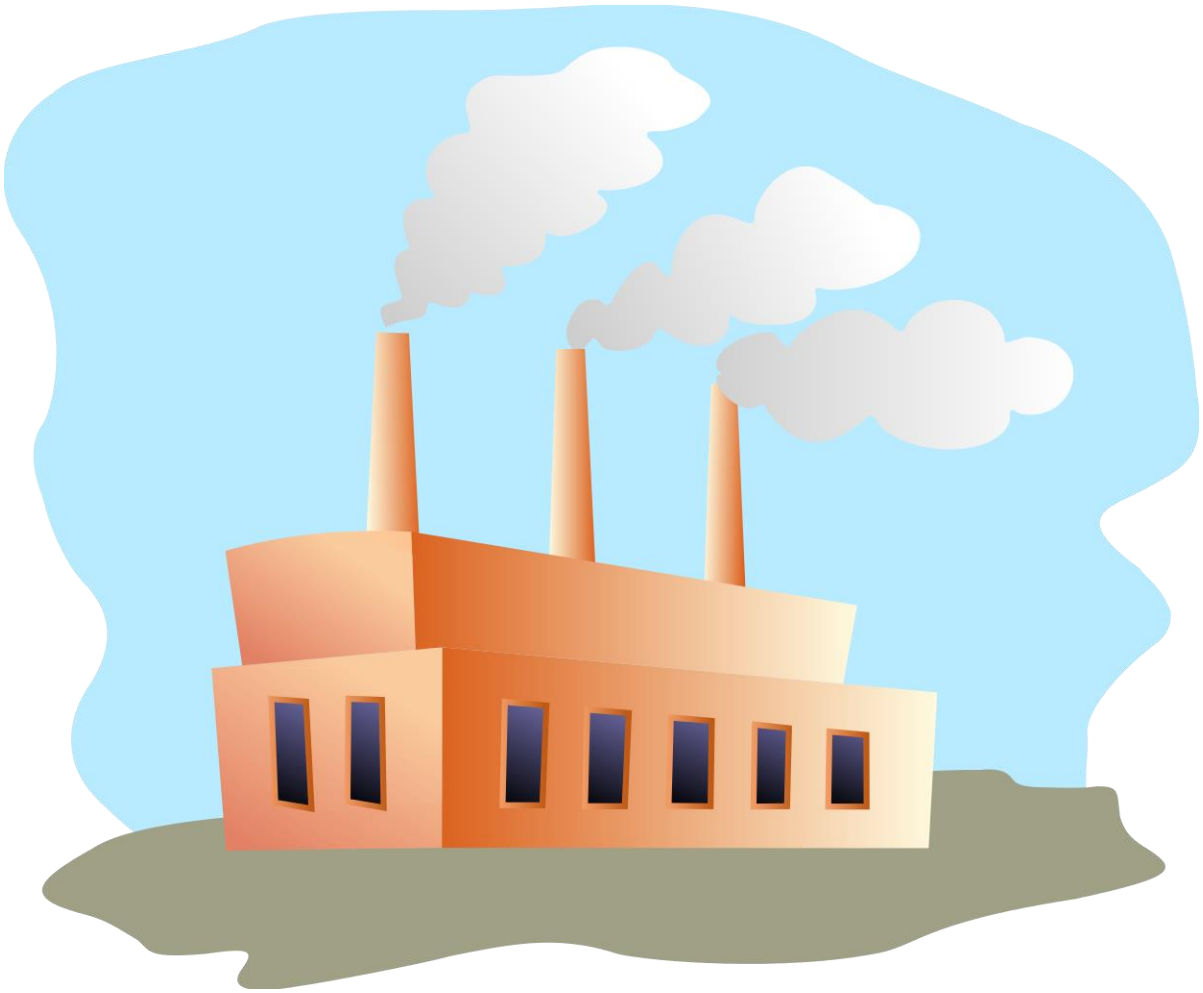
```
If (intBarometerType == 1) {
    barObj = new Barometer1() ;
}

If (intBarometerType == 2) {
    barObj = new Barometer2() ;
}
```

Issues:

***new* keyword gets used/abused**

Client is aware of all Barometer types

(need to recompile when you add a new type!)



P2I: Factories

Go ask someone else for what we need:

- Some other *known* class (static factories):

  java.util.System:

  `public Console console() ;`

  - Get object to read and write to the application's console.
  - How this is done is inherently system dependent.
  - Different on Windows, Linux, Mac

P2I: Factories

Go ask someone else for what we need:

- Some other *known* class (static factories)
- Some other *known* object (dynamic factories)

java.util.Runtime:

```
Runtime rt = Runtime.getRuntime() ;

. . .

Process p = rt.exec("some system command") ;
```

- Processes are inherently system dependent.
- As is how to create one to execute a command.

Factory Method Pattern

Often we have related, parallel hierarchies.

Factory method uses an object in one hierarchy to retrieve an appropriate object from the other hierarchy.

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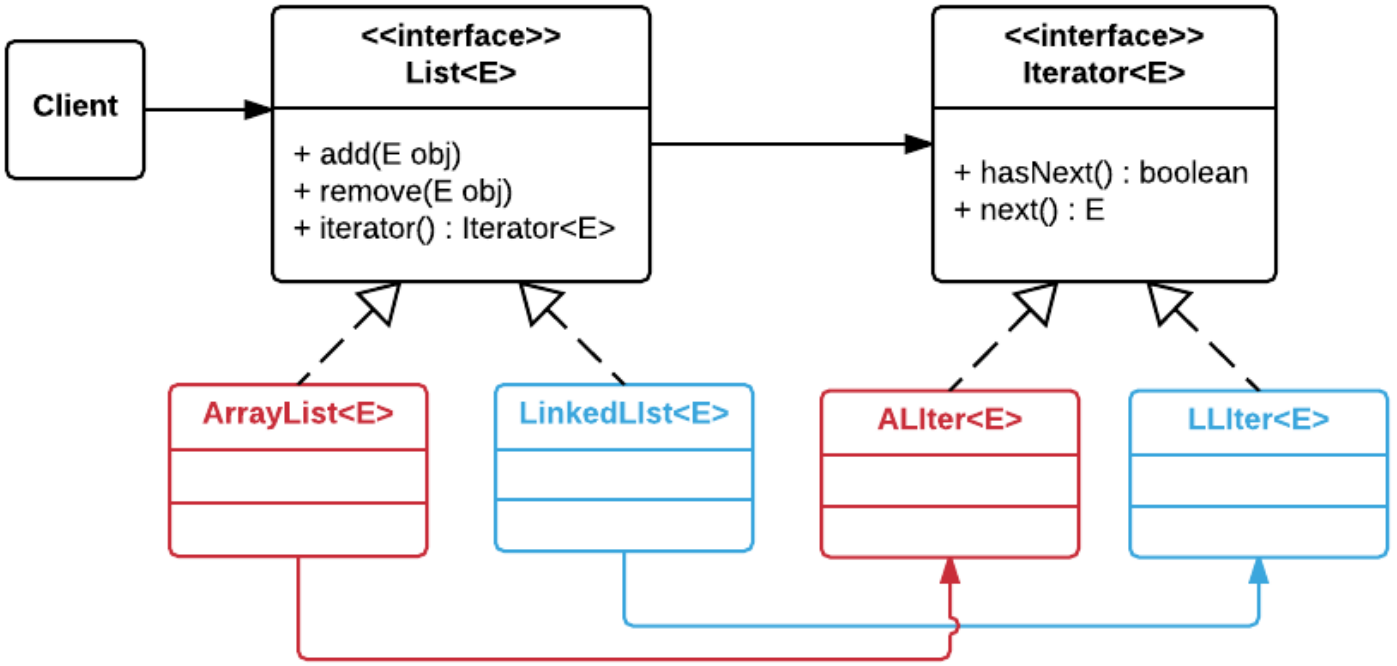
Example: Java Collections and their Iterators.



Abstract Factory Method

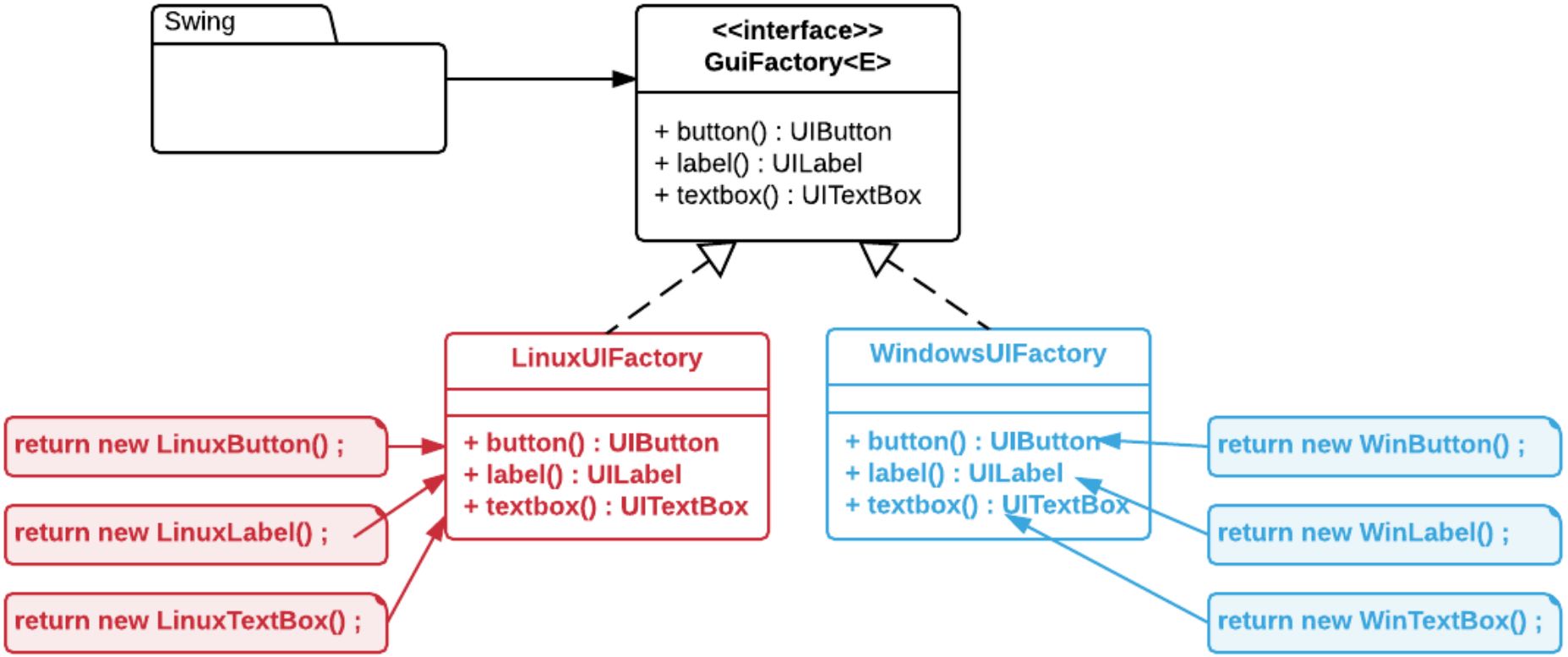
Sometimes we have different implementations of a set of related objects.

Implementations are not interchangeable.

Example: Swing

- Swing provides system independent classes for system dependent UI elements.
- That is, JButtons look like X-Windows buttons on Linux and Windows buttons on Windows.
- Same from frames, text boxes, etc.
- Configure runtime with an object that returns the correct type of button, frame, etc. for the system we run on.

Swing Windowing Abstract Factory



Barometer & Factory - 1

First, use an abstract barometer class:

```
public abstract class Barometer {
    public static Barometer createBarometer() { ... }

    abstract public double pressure() ;
}
```

Next, change the simulated barometer class and all other barometer classes to

1.Have a different name, and
2.Extend the abstract class above

```
public class SimBarometer extends Barometer { ... }

public class RealBarometer extends Barometer { ... }
```

Barometer & Factory - 2

Change the factory **`createBarometer()`** method to return the desired specific, concrete barometer object.

```
public static Barometer createBarometer() {
    return new SimBarometer() ; // or something else
}
```

Inside the **`WeatherStation`**, use the factory to get the **Barometer** to use:

```
public WeatherStation {

    private final Barometer bar ;

    public WeatherStation() {
        bar = Barometer.createBarometer() ;
    }

    . . .
```

P2I: Factory Pattern Points

Factory Approach Advantages

- Decouple the class needing an object from the creation of a concrete object.
- Always get compatible objects (esp. with Abstract Factory).

Factory Approach Disadvantages

- Still have to know where the factory is.
- Coupled to the factory class or object.

Can we decouple even more? Yes - *dependency injection*.

Dependency Inversion Principle (DIP)

- Low-level components should depend on high-level components, not the other way around.

- OR -

- High-level components should not depend on low-level components. **Both should depend on abstractions**.

- Abstractions should not depend on details (of low level entities). Details should depend on abstractions.

- OR -

- High-level components control the interface to low-level components.

One use of DIP is through dependency **injection** pattern

P2I: Dependency Injection Pattern

Dependency Injection - target object (e.g., **`WeatherStation`**) is given the objects it needs (e.g., barometer and temperature sensor) from the surrounding environment:

- Via **constructor** arguments.
- Via specific **injection methods**.

In fact, we've already seen this:

P2I: Dependency Injection Pattern

Dependency Injection - target object (here WeatherStation) is given the object it needs from the surrounding environment:

- Via constructor arguments.
- Via specific injection methods.

In fact, we've already seen this:

Anything compatible with **WeatherStation** can be substituted.

```
public class TextUI implements Observer {

    private final WeatherStation station ;

    public TextUI(WeatherStation station) {
        this.station = station ;
        this.station.addObserver(this) ;
    }
```

Dependency Injection & Barometer - 1

First, define a barometer *interface*:

```
public interface Barometer {
    public double pressure() ;
}
```

Next, change the simulated barometer class and all other barometer classes to

1.Have a different name, and
2.Implement the interface above

```
public class SimBarometer implements Barometer { ... }
public class RealBarometer implements Barometer { ... }
```

Dependency Injection & Barometer - 2

Change the **`public static void main()`** method to inject whichever concrete barometer we want:

```
public static void main(String[] args) {
    . . .
    WeatherStation ws =
        new WeatherStation( new SimBarometer() );
}
```

In the **`WeatherStation`** constructor, save the injected **`Barometer`**:

```
public WeatherStation {
    private final Barometer bar ;
    public WeatherStation(Barometer bar) {
        this.bar = bar ;
    }
    . . .
```

Now To The Temperature Sensor

Early in the **`WeatherStation`** constructor

```
KelvinTempSensor sensor = new KelvinTempSensor() ;
```

On the surface this looks exactly like **`Barometer`**:

- We create a concrete sensor object in the weather station.
- This limits weather station reusability with different sensors.
- So:
  - Define an interface, say **`IKelvinTempSensor`**.
  - Implement the interface for all real & simulated sensor classes.
  - Create the desired concrete sensor in main or other driver method.
  - Inject this object into the **`WeatherStation`** constructor.

But there is more here than meets the eye!

Problems With The Temperature Sensor

- The interface represents an "odd" notion of what temperature looks like:
  - Scaled integer from 0 to 65535?
  - Measures up to 655.35 °K?
  - That's a weird upper bound - why is it there?
- The designers thought the problem was selecting an integrating the best sensor.

Problems With The Temperature Sensor

- The interface represents an "odd" notion of what temperature looks like:
  - Scaled integer from 0 to 65535?
  - Measures up to 655.35 °K?
  - That's a weird upper bound - why is it there?
- The designers thought the problem was selecting an integrating the best sensor.
- The designers were **WRONG**!
- The **real problem** is how to hide the details of specific sensor used from the weather station.
- All the weather station needs is a general value representing the temperature in some reasonable form.

Design Caveats (Uncle Bob Martin)

- Woe is the designer who prematurely decides on a database, and then finds that flat files would have been sufficient.
- Woe is the designer who prematurely decides upon a web-server, only to find that all the team really needed was a simple socket interface.
- Woe is the team whose designers prematurely impose a framework upon them, only to find that the framework provides powers they don't need and adds constraints they can't live with.
- Blessed is the team whose designers have provided the means by which all these decisions can be deferred until there is enough information to make them.
- Blessed is the team whose designers have so isolated them from slow and resource hungry IO devices and frameworks that they can create fast and lightweight test environments.
- Blessed is the team whose designers care about what really matters and defer those things that don't.