COMP2511
Observer Pattern

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Observer Pattern

These lecture notes use material from the wikipedia page at: https://en.wikipedia.org/wiki/Observer_pattern

and

the reference book "Head First Design Patterns".

Observer Pattern

- The **Observer Pattern** is used to implement distributed **event handling** systems, in "event driven" programming.
- In the observer pattern
  - an object, called the ***subject*** **(**or ***observable*** or ***publisher*** **)** , maintains a list of its dependents, called ***observers (***or ***subscribers)***, and
  - **notifies** the *observers* **automatically** of **any** state **changes** in the ***subject***, usually by calling one of their methods.
- Many programming languages support the observer pattern,
  Graphical User Interface libraries use the observer pattern extensively.

Observer Pattern

- The Observer Pattern defines a **one-to-many** dependency between objects so that when one object (*subject*) changes state, all of its dependents (*observers*) are notified and updated automatically.
- The aim should be to,
  - define a one-to-many dependency between objects **without** making the objects **tightly coupled**.
  - **automatically** notify/update an **open-ended** number of *observers* (dependent objects) when the *subject* changes state
  - be able to **dynamically** add and remove *observers*

Observer Pattern: Possible Solution

- Define *Subject* and *Observer* **interfaces**, such that when a subject changes state, all registered observers are notified and updated automatically.
- The responsibility of,
  - a ***subject*** is to maintain a list of observers and to notify them of state changes by calling their `update()` operation.
  - ***observers*** is to register (and unregister) themselves on a subject (to get notified of state changes) and to update their state when they are notified.
- This makes subject and observers **loosely** coupled.
- Observers can be **added** and **removed** independently **at run-time**.
- This notification-registration interaction is also known as **publish-subscribe**.

Java Observer and Observable : Deprecated

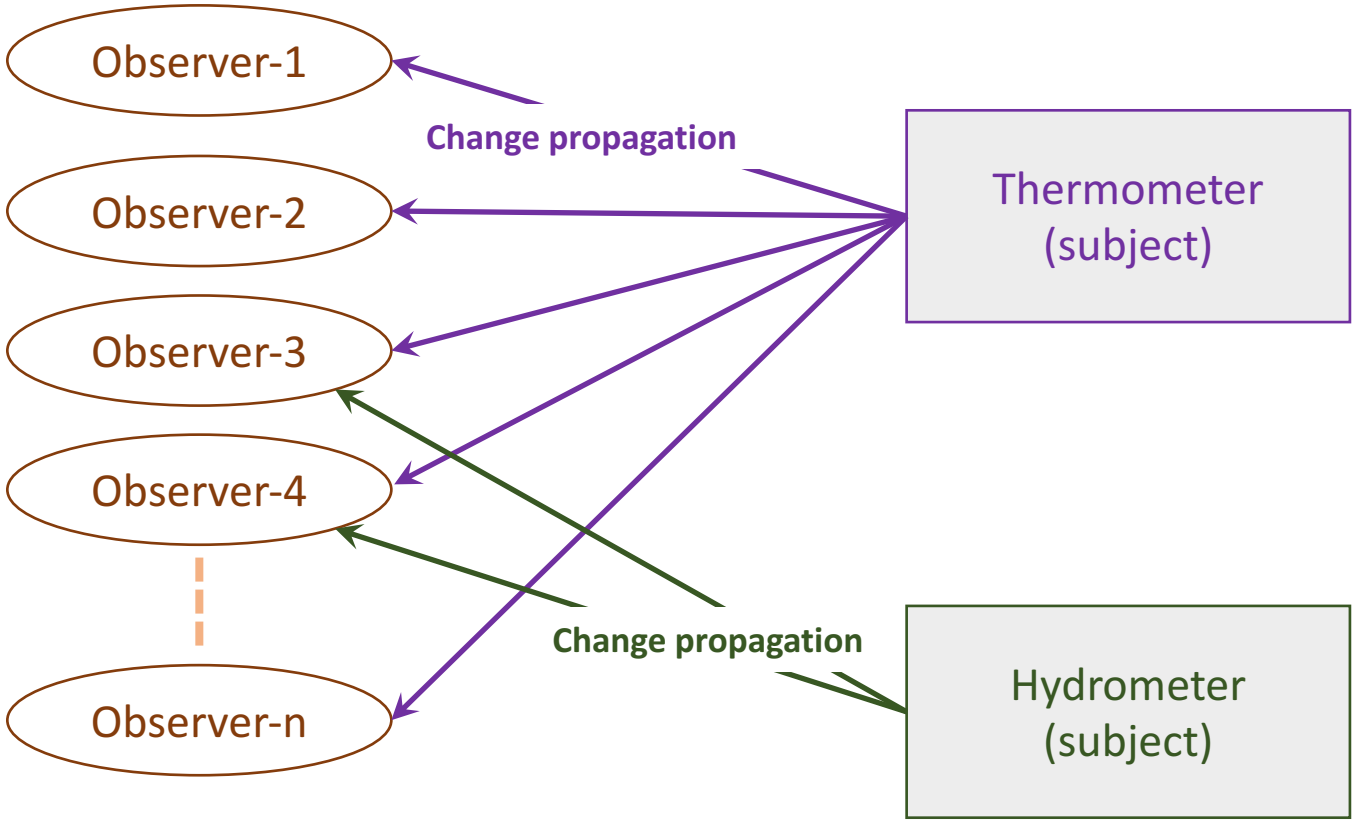
The following java library classes have been **deprecated** in **Java 9** because the model implemented was quite **limited**.

- java.util.Observer and
- java.util.Observable

Limitations

- *Observable* is a **class**, not an interface !
- Observable **protects** crucial methods, the `setChanged()` method is protected.
- we can't call `setChanged()` unless we subclass *Observable*! Inheritance is must, bad design ☺
- we can't add on the *Observable* behavior to an existing class that already extends another superclass.
- there isn't an *Observable* interface, for a proper custom implementation

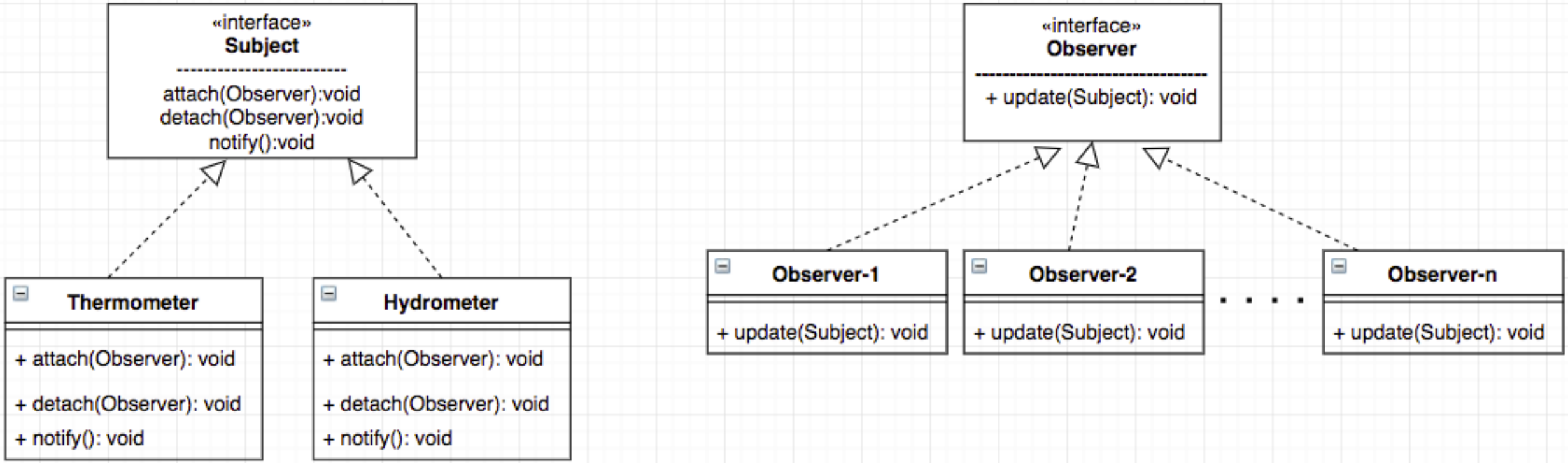
Multiple Observers and Subjects



Observers / Subscribers / Listeners

Observables / Subjects / Publishers

Observer Pattern: Possible Solution




```
ArrayList<Observer> listObservers = new ArrayList<Observer>();
```

```
public void notifyObservers() {
    for( Observer obs : listObservers) {
        obs.update(this);
    }
}
```

Read the example code discussed/developed in the lectures, and also provided for this week

Passing data: Push or Pull

The *Subject* needs to pass (change) data while notifying a change to an *Observer.* Two possible options,

Push data

- *Subject* passes the changed data to its observers, for example:

```
update(data1,data2,…)
```

- All *observers* must implement the above update method.

Pull data

- *Subject* passes reference to itself to its observers, and the observers need to get (pull) the required data from the subject, for example:

```
update(this)
```

- Subject needs to provide the required access methods for its observers. For example, `public double getTemperature() ;`

```java
public interface Subject {

    public void registerObserver(Observer o);
    public void removeObserver(Observer o);
    public void notifyObservers();

}
```

```java
public class Thermometer implements Subject {

    ArrayList<Observer> listObservers = new ArrayList<Observer>();
    double temperatureC = 0.0;

    @Override
    public void registerObserver(Observer o) {
        if(! listObservers.contains(o)) { listObservers.add(o); }
    }

    @Override
    public void removeObserver(Observer o) {
        listObservers.remove(o);
    }

    @Override
    public void notifyObservers() {
        for( Observer obs : listObservers) {
            obs.update(this);
        }
    }

    public double getTemperatureC() {
        return temperatureC;
    }

    public void setTemperatureC(double temperatureC) {
        this.temperatureC = temperatureC;
        notifyObservers();
    }
}
```

Read the example code discussed/developed in the lectures, and also provided for this week

Notify Observers after every update

```java
public interface Observer {

    public void update(Subject obj);

}
```

Update for Multiple Subjects

Display after an update

```java
public class DisplayUSA implements Observer {
    Subject subject;
    double temperatureC = 0.0;
    double humidity = 0.0;

    @Override
    public void update(Subject obj) {

        if(obj instanceof Thermometer) {
            update( (Thermometer) obj);
        }
        else if(obj instanceof Hygrometer) {
            update((Hygrometer)obj);
        }
    }

    public void update(Thermometer obj) {
            this.temperatureC = obj.getTemperatureC();
            display();
    }
    public void update(Hygrometer obj) {
            this.humidity = obj.getHumidity();
            display();
    }

    public void display() {
        System.out.printf("From DisplayUSA: Temperature is %.2f F, "
                + "Humidity is %.2f\n", convertToF(), humidity);
    }

    public double convertToF() {
        return (temperatureC *(9.0/5.0) + 32);
    }
}
```

Read the example code discussed/developed in the lectures, and also provided for this week

```java
public class Test1 {

    public static void main(String[] args) {
        // TODO Auto-generated method stub

        Thermometer thermo = new Thermometer();
        Observer usaDisplay = new DisplayUSA();
        thermo.registerObserver(usaDisplay);

        Observer ausDisplay = new DisplayAustralia();
        thermo.registerObserver(ausDisplay);

        System.out.println("\n---------------- thermo.setTemperatureC(30) ------------ ");
        thermo.setTemperatureC(30);
        System.out.println("\n---------------- thermo.setTemperatureC(12) ------------ ");
        thermo.setTemperatureC(12);


        Hygrometer hyg = new Hygrometer();
        hyg.registerObserver(usaDisplay);

        System.out.println("\n---------------- hyg.setHumidity(77) ------------ ");
        hyg.setHumidity(77);
        System.out.println("\n---------------- hyg.setHumidity(96) ------------ ");
        hyg.setHumidity(96);
        System.out.println("\n---------------- thermo.setTemperatureC(35) ------------ ");
        thermo.setTemperatureC(35);

        thermo.removeObserver(usaDisplay);
        System.out.println("\n---------------- thermo.removeObserver(usaDisplay)  ------------ ");

        System.out.println("\n---------------- thermo.setTemperatureC(41) ------------ ");
        thermo.setTemperatureC(41);
        System.out.println("\n---------------- ------------ ");

    }
```

add / register

change state

remove

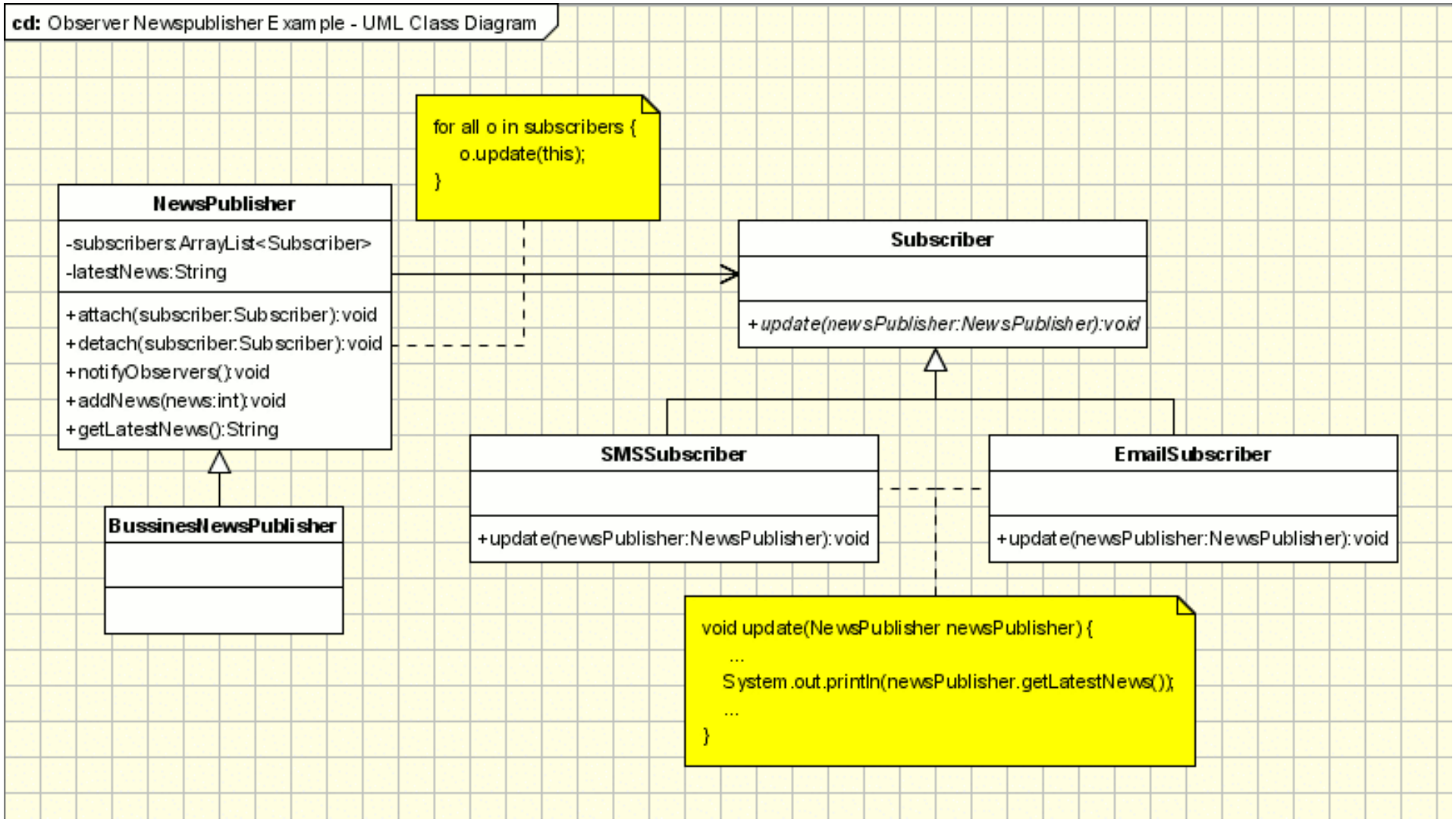
Read the example code discussed/developed in the lectures, and also provided for this week

Demos …

- Live Demos …

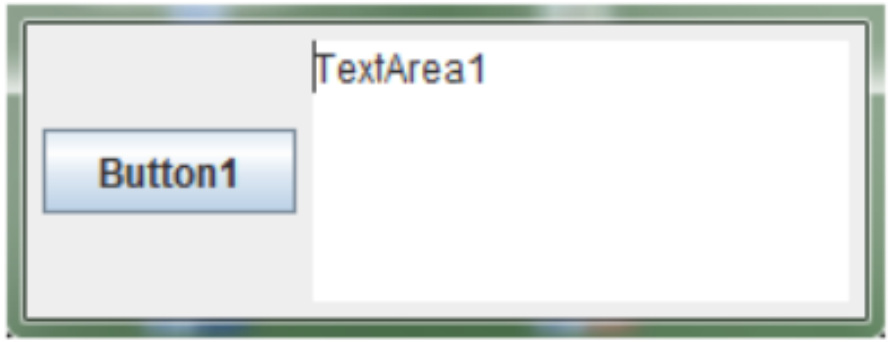
- Make sure you **properly understand the demo example code** available for this week.

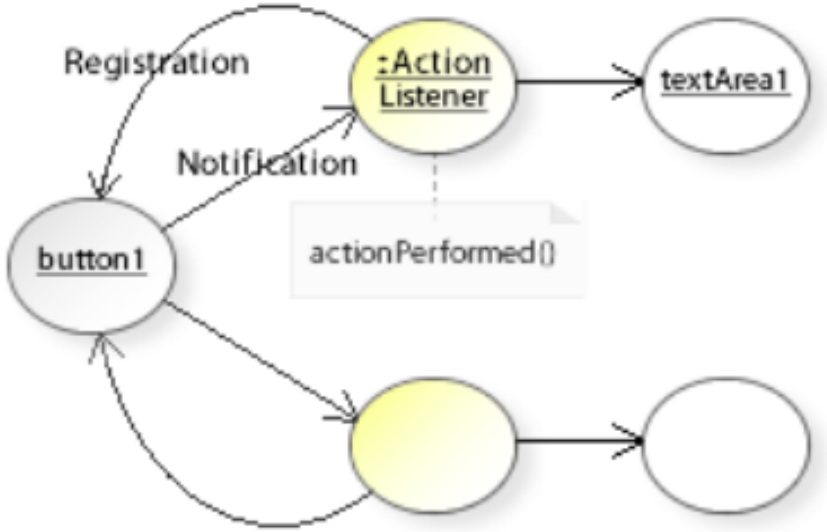
Observer Pattern: Example



The above image is from https://www.oodesign.com/observer-pattern.html

Observer Pattern: UI Example





Summary

Advantages:

- Avoids tight coupling between *Subject* and its *Observers*.
- This allows the *Subject* and its *Observers* to be at different levels of abstractions in a system.
- **Loosely coupled** objects are easier to maintain and reuse.
- Allows **dynamic** registration and deregistration.

Be careful:

- A change in the subject may result in a chain of updates to its observers and in turn their dependent objects – resulting in a **complex update behaviour**.
- Need to properly manage such dependencies.

Summary

BULLET POINTS

- The Observer Pattern defines a one-to-many relationship between objects.
- Subjects, or as we also know them, Observables, update Observers using a common interface.
- Observers are loosely coupled in that the Observable knows nothing about them, other than that they implement the Observer interface.
- You can push or pull data from the Observable when using the pattern (pull is considered more "correct").
- Don't depend on a specific order of notification for your Observers.
- Java has several implementations of the Observer Pattern, including the general purpose java.util.Observable.
- Watch out for issues with the java.util.Observable implementation.
- Don't be afraid to create your own Observable implementation if needed.
- Swing makes heavy use of the Observer Pattern, as do many GUI frameworks.
- You'll also find the pattern in many other places, including JavaBeans and RMI.

From the reference book: "Head First Design Pattern"