

CMSC 132:

OBJECT-ORIENTED PROGRAMMING II



Design Patterns II

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Observer Pattern

- **Definition**

- Updates all dependents of object automatically once object changes state

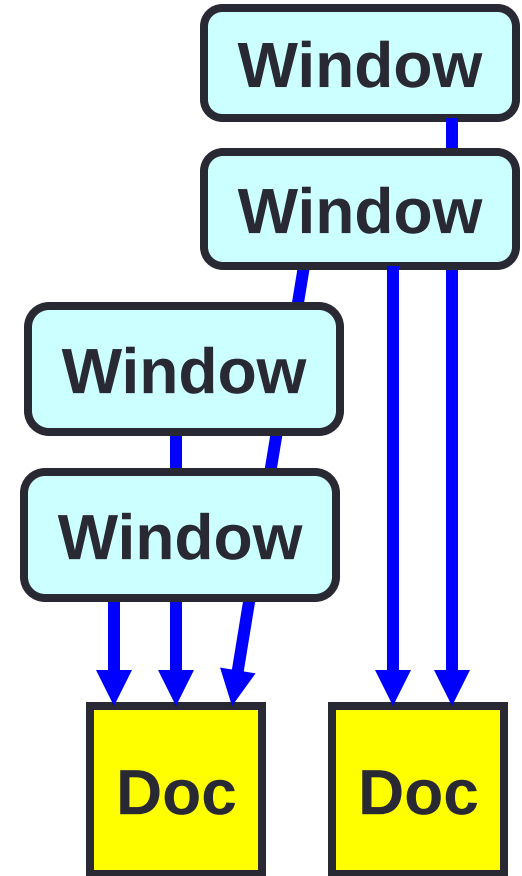
- **Where to use & benefits**

- One change affects one or many objects
- Many object behavior depends on one object state
- Need broadcast communication
- Maintain consistency between objects
- Observers do not need to constantly check for changes

Observer Pattern

- **Example**

- Multiple windows (views) for single document
- Original
 - Each window checks document
 - Window updates image if document changes
 - Think of window as asking “Are we there yet?”
- Using pattern
 - Each window registers as observer for document
 - Document notifies all of its observers when it changes



Observer Example

```
public interface Observer {  
    // called when observed object o changes  
    public void update(Observable o, Object a)  
}
```

```
public class Observable {  
    protected void setChanged()  
    protected void clearChanged()  
    boolean hasChanged()  
  
    void addObserver(Observer o)  
    void notifyObservers()  
    void notifyObservers(Object a)  
}
```

```
public class MyWindow implements Observer {  
    public openDoc(Observable doc) {  
        doc.addObservers(this); // add window to list  
    }  
    public void update(Observable doc, Object arg) {  
        redraw(doc); // display updated document  
    }  
}
```

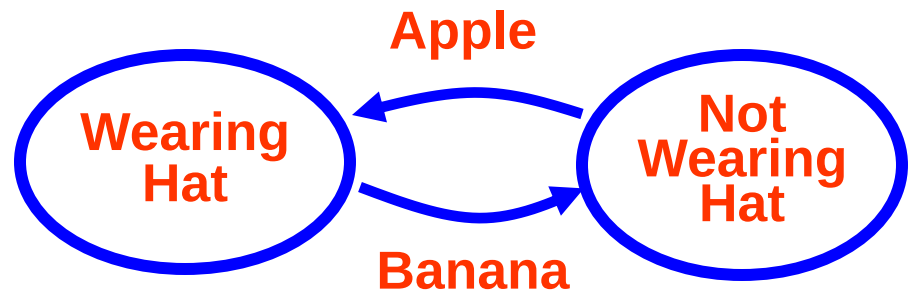
```
public class MyDoc extends Observable {  
    public void edit() {  
        ... // edit document  
        setChanged(); // mark change  
        notifyObservers(arg); // invokes update()  
    }  
}
```

State Pattern

- **Definition**
 - Represent change in an object's behavior using its member classes
- **Where to use & benefits**
 - Control states without many if-else statements
 - Represent states using classes
 - Every state has to act in a similar manner
 - Simplify and clarify the program
- **Example**
 - States representing finite state machine (FSM)
 - Original
 - Each method chooses action depending on state
 - Behavior may be confusing, state is implicit
 - Using pattern
 - State interface defines list of actions for state
 - Define inner classes implementing State interface
 - Finite state machine instantiates each state and tracks its current state
 - Current state used to choose action
- **Example:** StateCode

State Example – Original Code

```
public class FickleFruitVendor {  
    boolean wearingHat;  
    boolean isHatOn() { return wearingHat; }  
    String requestFruit() {  
        if (wearingHat) {  
            wearingHat = false;  
            return "Banana";  
        }  
        else {  
            wearingHat = true;  
            return "Apple";  
        }  
    }  
}
```



State Example

```
public interface State {  
    boolean isHatOn();  
    String requestFruit();  
}
```

```
public class FickleFruitVendor {  
    State wearingHat = new WearingHat();  
    State notWearingHat = new NotWearingHat();  
}
```

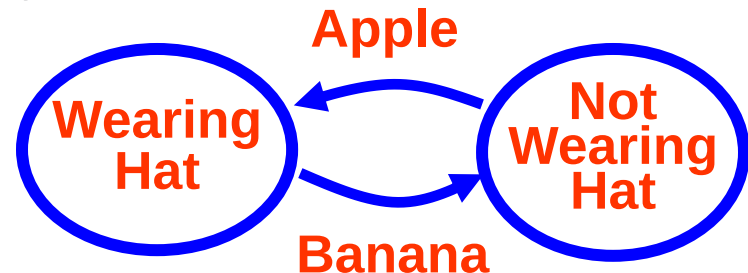
```
// explicitly track current state of Vendor  
State currentState = wearingHat;
```

```
// behavior of Vendor depends on current  
state
```

```
public boolean isHatOn() {  
    return currentState.isHatOn();  
}  
public String requestFruit() {  
    return currentState.requestFruit();  
}  
}
```

```
public class WearingHat implements State {  
    boolean isHatOn() { return true; }  
    String requestFruit() {  
        // change state  
        currentState = notWearingHat;  
        return "Banana";  
    }  
}
```

```
public class NotWearingHat implements State {  
    boolean isHatOn() { return false; }  
    String requestFruit() {  
        // change state  
        currentState = wearingHat;  
        return "Apple";  
    }  
}
```



Visitor Pattern

- **Definition**

- Define operations on elements of data structures without changing their classes

- **Where to use & benefits**

- Add operations to classes with different interfaces
 - Can modify operations on data structure easily
 - Encapsulate operations on elements of data structure
 - Decouples classes for data structure and algorithms

- **Example**

- Print elements in collection of objects
 - Original
 - Iterator chooses action based on type of object
 - Many if-else statements
 - Using pattern
 - Visitor interface defines actions during visit
 - Visitable interface allow objects to **accept** visit
 - Action automatically selected by polymorphic functions through **double dispatch**

- **Example:** VisitorCode

Visitor Example – Original Code

```
public void messyPrintCollection(Collection c) {  
    for (Object o : c) {  
        if (o instanceof String)  
            System.out.println("{"+o.toString()+"}"); // add { }  
        else if (o instanceof Float)  
            System.out.println(o.toString()+"f");      // add f  
        else  
            System.out.println(o.toString());  
    }  
}
```

Visitor Example

```
public interface Visitor {
    public void visit(VisitableString s);
    public void visit(VisitableFloat f);
}

public interface Visitable{
    public void accept(Visitor v);
}

public class VisitableString implements Visitable {
    private String value;
    public VisitableString(String s) { value = s; }
    public String toString() { return value.toString(); }
    public void accept(Visitor v) { v.visit(this); }
}

public class VisitableFloat implements Visitable {
    private Float value;
    public VisitableFloat(Float f) { value = f; }
    public String toString() { return value.toString(); }
    public void accept(Visitor v) { v.visit(this); }
}
```

```
public class PrintVisitor implements Visitor {
    public void visitCollection(Collection c) {
        for (Object o : c) {
            if (o instanceof Visitable)
                ((Visitable) o).accept(this);
            else
                System.out.println(o.toString());
        }
    }

    public void visit(VisitableString s) {
        System.out.println("{"+s.toString()+"}");
    }

    public void visit (VisitableFloat f) {
        System.out.println(f.toString()+"f");
    }
}
```