

CMSC 132:

Object-Oriented Programming II



Design Patterns II

Department of Computer Science
University of Maryland, College Park

Observer Pattern

- **Definition**

- Updates all dependents of object automatically once object changes state

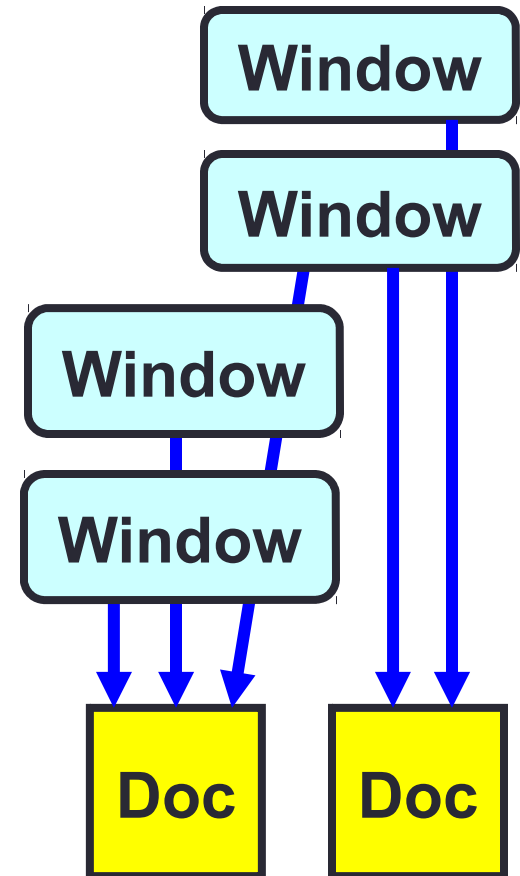
- **Where to use & benefits**

- 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  
    }  
}
```

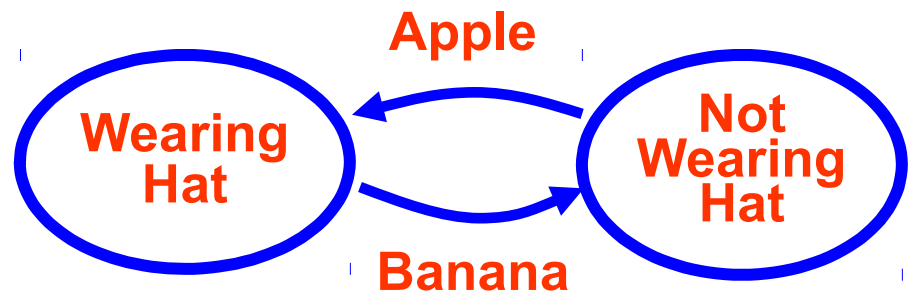
```
public class MyDoc extends Observable {  
    public void edit() {  
        ... // edit document  
        setChanged(); // mark change  
        notifyObservers(arg); // invokes update()  
    }  
}
```

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();
}

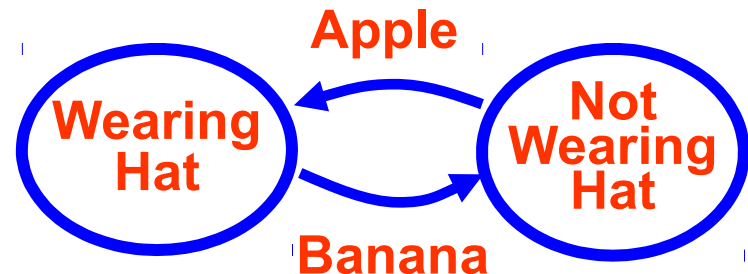
public class FickleFruitVendor {
    State wearingHat = new WearingHat();
    State notWearingHat = new NotWearingHat();

    // 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");
    }
}
```