CS 635 Advanced Object-Oriented Design & Programming
Spring Semester, 2005
Doc 16 Model-View-Controller

Contents

References

Pattern-Oriented Software Architecture: A System of Patterns v1, Buschman, Meunier, Rohnert, Sommerlad, Stal, 1996, pp 125-143

Domain-Driven Design, Eric Evans, 2004, Addison-Wesley

Model-View-Controller (MVC) Pattern Context

Interactive application with human-computer interface

Forces

- Same data may be displayed differently
- Display & application must reflect data changes immediately
- UI changes should be easy and even possible at runtime
- UI changes & additions should not affect core application code
- Changing look & feel or port to other platforms should not affect core application code

Solution

Divide application into three parts:

- Model (core application)
- View (display, output)
- Controller (user input)

Model

Core application code

Contains a list of observers (view & controller)

Has a broadcast mechanism to inform views of a change

Same mechanism as subject in Observer pattern

View

Creates & initializes its controller

Displays information to user

Implements the update procedure

Obtains data from model

Controller

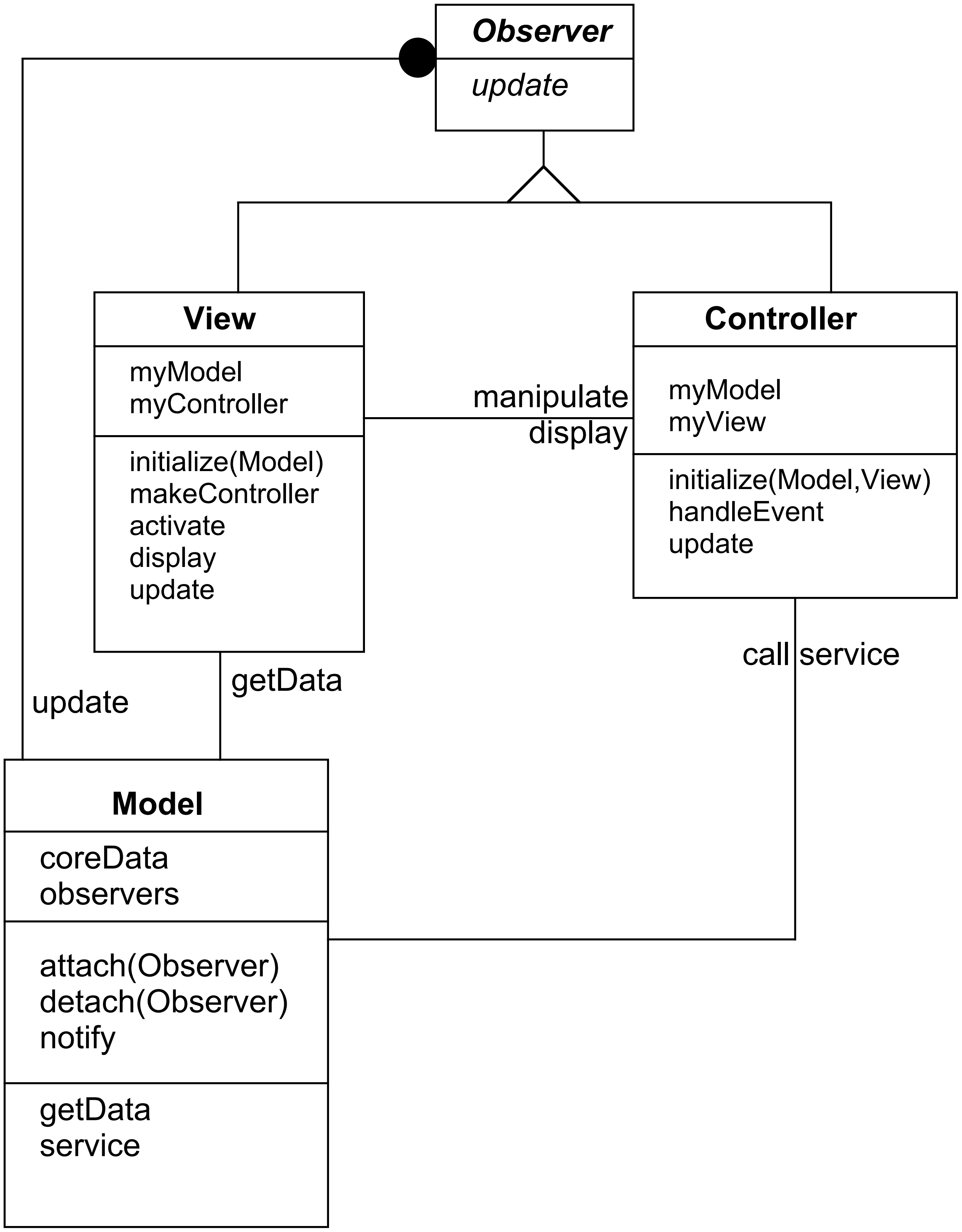
Handles input from user as events

- Keystrokes
- Mouse clicks
- Mouse movements

Maps each event to proper action on model and/or view

Many people misinterpret what a controller does

MVC Class Structure



Controller

Make up the user interface

Most (all?) GUI frameworks combine these

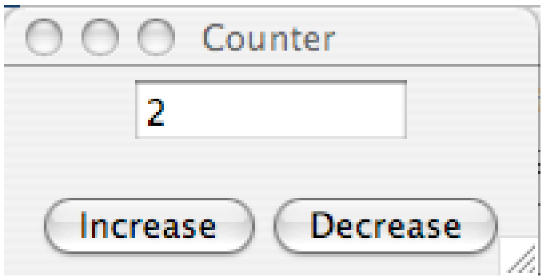
VW Smalltalk contains both, but hides controller from programmer

Some Existing Smalltalk Controllers & Views	
Controllers	**Views**
ApplicationDialogController	ActionButtonView
BasicButtonController	AutoScrollingView
ClickWidgetController	BasicButtonView
ColoredAreaController	BooleanWidgetView
ComboBoxButtonController	CheckButtonView
ComboBoxInputBoxController	ClickWidget
ComboBoxListController	ComboBoxButtonView
ControllerWithMenu	ComboBoxInputFieldView
ControllerWithSelectMenu	ComboBoxListView
DataSetController	ComposedTextView
DataSetControllerProxy	DataSetView
DelayingWidgetController	DefaultLookCheckButtonView
DrawingController	DefaultLookRadioButtonView
DropDownListController	EmulationScrollBar
EmulatedDataSetController	GeneralSelectionTableView
EmulatedSequenceController	HierarchicalSequenceView
EmulationScrollBarController	HorizontalTabBarView
HierarchicalSequenceController	HorizontalTopTabBarView
InputBoxController	InputFieldView

Example Counter & View

```
public class Counter
  {
  private int count = 0;

  public void increase() { count++;}
  public void decrease() { count--;}
  public String toString() { return String.valueOf(count);}
  }
```

Create a view like:



First Attempt

```
import java.awt.Button;
import java.awt.FlowLayout;
import java.awt.Frame;
import java.awt.GridLayout;
import java.awt.Panel;
import java.awt.TextField;
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class Counter extends Frame implements ActionListener
  {
  private static final int NUMBER_OF_COLUMNS = 10;

  private TextField value = new TextField(NUMBER_OF_COLUMNS);
  private Button increase = new Button("Increase");
  private Button decrease = new Button("Decrease");

  private int count = 0;

  public static void main(String[] args)
    {
    new Counter(200, 100);
    }

  public Counter(int widthInPixels, int heightInPixels)
    {
    configureWindowFrame(widthInPixels, heightInPixels);

    add(textPanel());
    add(buttonPanel());
    initializeGuiWidgets();

    show();
    }
```

First Attempt Continued

```
private void configureWindowFrame(
      int widthInPixels, int heightInPixels)
   {
   setTitle("Counter");
   setSize(widthInPixels, heightInPixels);
   setLayout(new GridLayout(2, 1));
   }

private void initializeGuiWidgets()
   {
   // Make Model observer of GUI widgets?
   increase.addActionListener(this);
   decrease.addActionListener(this);
   value.addActionListener(this);
   value.setText(this.toString());
   }

private Panel buttonPanel()
   {
   Panel buttons = new Panel(new FlowLayout());
   buttons.add(increase);
   buttons.add(decrease);
   return buttons;
   }

private Panel textPanel()
   {
   Panel text = new Panel(new FlowLayout());
   text.add(value);
   value.setText(toString());
   return text;
   }
```

First Attempt Continued

```
public void increase()
   {
   count++;
   }

public void decrease()
   {
   count--;
   }

public String toString()
   {
   return String.valueOf(count);
   }

public void actionPerformed(ActionEvent event)
   {
   Object source = event.getSource();
   if (source == increase)
      increase();
   else if (source == decrease)
      decrease();
   value.setText(toString());

   }
}
```

First Attempt Summary

What was model

- Now is listener (observer) to GUI widgets
- Knows about each GUI widget
- Adding more GUI widgets requires changing class

Not an example of MVC

Second Example
Model

```
import java.util.Observable;

public class Counter extends Observable
  {
  private int count = 0;

  public void increase()
     {
     count++;
     changed();
     }

  public void decrease()
     {
     count--;
     changed();
     }

  public String toString()
     {
     return String.valueOf(count);
     }

  private void changed()
     {
     setChanged();
     notifyObservers();
     }
  }
```

View

```
import java.awt.*;
import java.awt.event.*;

public class CounterView extends Frame implements Observer
  {
  private static final int NUMBER_OF_COLUMNS = 10;

  private TextField value = new TextField(NUMBER_OF_COLUMNS);
  private Button increase = new Button("Increase");
  private Button decrease = new Button("Decrease");

  private Counter model;

  public CounterView(
          int widthInPixels, int heightInPixels, Counter count)
    {
    model = count;
    model.addObserver(this);

    configureWindowFrame(widthInPixels, heightInPixels);

    add(textPanel());
    add(buttonPanel());
    initializeGuiWidgets();

    show();
    }

  public void update(Observable arg0, Object arg1)
    {
    value.setText(model.toString());
    }
```

View Continued

```
   private void configureWindowFrame(
         int widthInPixels, int heightInPixels)
      {
      setTitle("Counter");
      setSize(widthInPixels, heightInPixels);
      setLayout(new GridLayout(2, 1));
      }

   private void initializeGuiWidgets()
      {
      increase.addActionListener(new ActionListener() {
         public void actionPerformed( ActionEvent event) {
            model.increase();
         }
      });

      decrease.addActionListener(new ActionListener() {
         public void actionPerformed( ActionEvent event) {
            model.decrease();
         }
      });
      }

   private Panel buttonPanel()
      {
      Panel buttons = new Panel(new FlowLayout());
      buttons.add(increase);
      buttons.add(decrease);
      return buttons;
      }
```

View Continued

```
    private Panel textPanel()
        {
        Panel text = new Panel(new FlowLayout());
        text.add(value);
        value.setText(model.toString());
        return text;
        }
    }
```

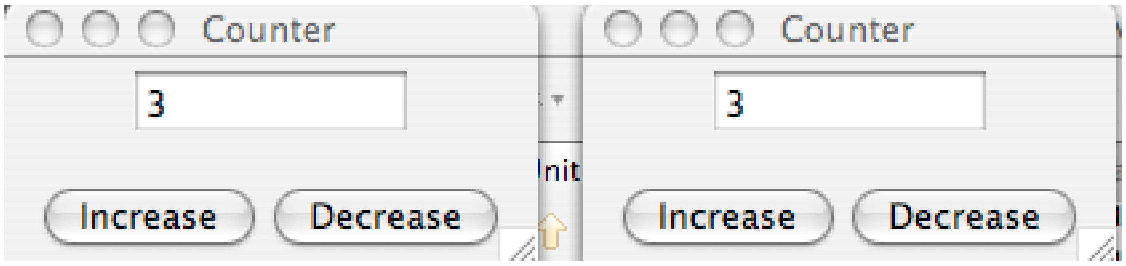
Running an Example

One View

```
public static void main(String [] args)
   {
   Counter sampleModel = new Counter();
   new CounterView(200, 100, sampleModel);
   }
```

Two Views - Same Model

```
public static void main(String [] args)
   {
   Counter sampleModel = new Counter();
   new CounterView(200, 100, sampleModel);
   new CounterView(200, 100, sampleModel);
   }
```



Another View

A view that shows how many times a counter calls increase

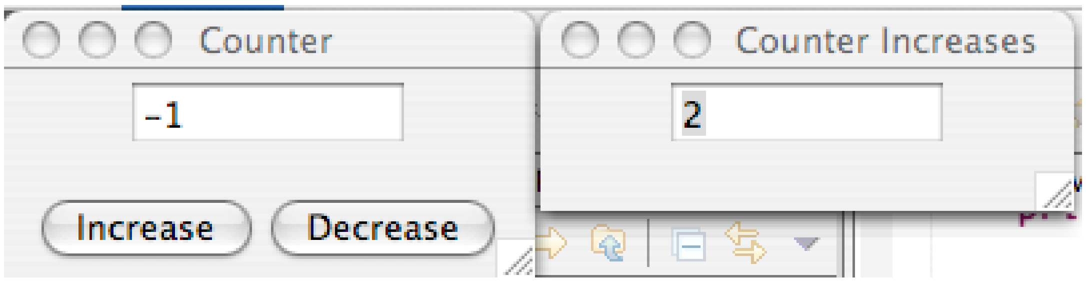
```
import java.awt.FlowLayout;
import java.awt.Frame;
import java.awt.TextField;
import java.util.Observable;
import java.util.Observer;

public class IncreaseCountView extends Frame implements Observer
  {
  private TextField value = new TextField(10);
  private int increases = 0;

  public IncreaseCountView( Counter count)
    {
    count.addObserver(this);
    setTitle("Counter Increases");
    setSize(100, 50);
    setLayout(new FlowLayout());

    add(value);
    value.setText(String.valueOf(increases));
    show();
    }

  public void update(Observable subject, Object changeType)
    {
    if (changeType.equals("INCREASE"))
      {
      increases++;
      value.setText(String.valueOf(increases));
      }
    }
  }
```

Changes Needed in the Model

```
public class Counter extends Observable
  {
  private int count = 0;

  public void increase()
     {
     count++;
     changed("INCREASE");        //Note change
     }

  public void decrease()
     {
     count--;
     changed("DECREASE");        //Note change
     }

  public String toString()
     {
     return String.valueOf(count);
     }

  private void changed(String type)      //Note change
     {
     setChanged();
     notifyObservers(type);              //Note change
     }
  }
```

Running an Example
Two Views - Same Model

```
public static void main(String [] args)
   {
   Counter sampleModel = new Counter();
   new CounterView(200, 100, sampleModel);
   new IncreaseCountView( sampleModel);
   }
```



Comments

Model had to be changed to:
- Notify observers
- Indicate type of change

Model is not completely independent of the views

View
- Is observer of model
- Is observer of GUI widgets

Aspect-Oriented Programming

Allows models to be completely independent of views

More on Aspects

- AspectJ - aspects for Java
- AspectS - aspects for Smalltalk

Smart UI Pattern

“the separation of UI and domain is so often attempted and so seldom accomplished that its negation deserves a discussion”

Eric Evans, Domain-Driven Design

The Pattern

Put all business logic into user interface

Divide the application into different small user interfaces

Use relational databases as back end

Use automated UI building and visual programming tools

Advantages

- High and immediate productivity for simple applications
- Little training need by the developer
- Short development time for small modules

Disadvantages

- No reuse – code gets duplicated
- Integration of applications difficult
- Very difficult to add new functionality to existing application
- Difficult to build complex applications

MVC & Web Applications

Server pages embeds code into the veiw

Server Pages
Java

```
<html>
<body>
<%! int x = 1; %>
<%! int y = 2; %>
If we add <%= x %> to <%= y %> we will get <%= x + y %>
</body>
</html>
```

Smalltalk

```
<HTML>
<BODY>
<%
  x :=1.
  y :=2.
%>
<p>
When we add <%= x %> to <%= y %> we get <%= x + y %>
</p>
</BODY>
</HTML>
```

Servlets

Embed the view in code

Java

```
import java.io.*;
import javax.servlet.*;
import javax.servlet.http.*;

public class HelloWorld extends HttpServlet {

    public void doGet(HttpServletRequest request,
         HttpServletResponse response)
         throws IOException, ServletException
    {
        response.setContentType("text/html");
        PrintWriter out = response.getWriter();
        out.println("<html>");
        out.println("<body>");
        out.println("<head>");
        out.println("<title>Hello World!</title>");
        out.println("</head>");
        out.println("<body>");
        out.println("<h1>Hello World!</h1>");
        out.println("</body>");
        out.println("</html>");
    }
}
```

Some New Web Frameworks Using MVC

- Seaside
- Cocoon
- Ruby on Rails