Object Oriented Programming and Design in Java

Session 7

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Announcements

- Homework 1 due now
- Homework 2 posted on website, due Mar. 3
- For fastest email queries, email all TAs and me
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Review

- Named ActionListeners
- Timers
- Interfaces and polymorphism
  - Examples: List, Comparator, Collection, Iterator

Today's Plan

- Introduction to **programming patterns**
- Patterns in GUI programming
  - Model/View/Controller, Observer, Composite, Decorator, Strategy

Programming Patterns

- Common design challenges have been solved over and over by others
- Many solutions are recorded as **patterns**, useable in your own design
- Higher level form of abstraction than more explicit, code-specific ideas (e.g., encapsulation)

Pattern Format

- Patterns are defined by a general **context**, the design challenge
- And a **solution**, which prescribes how to design your program in the context
- Since patterns are general, they will feature many interfaces

Iterator: Context

- An aggregate object contains element objects
- Clients need access to the elements
- The aggregate should not expose its internal structure
- There may be multiple clients that need simultaneous access

Iterator: Solution

- Define an iterator class that fetches on element at a time
- Each iterator object keeps track of the position of the next element to fetch
- If there are variations of the aggregate and iterator class, implement common interface types.

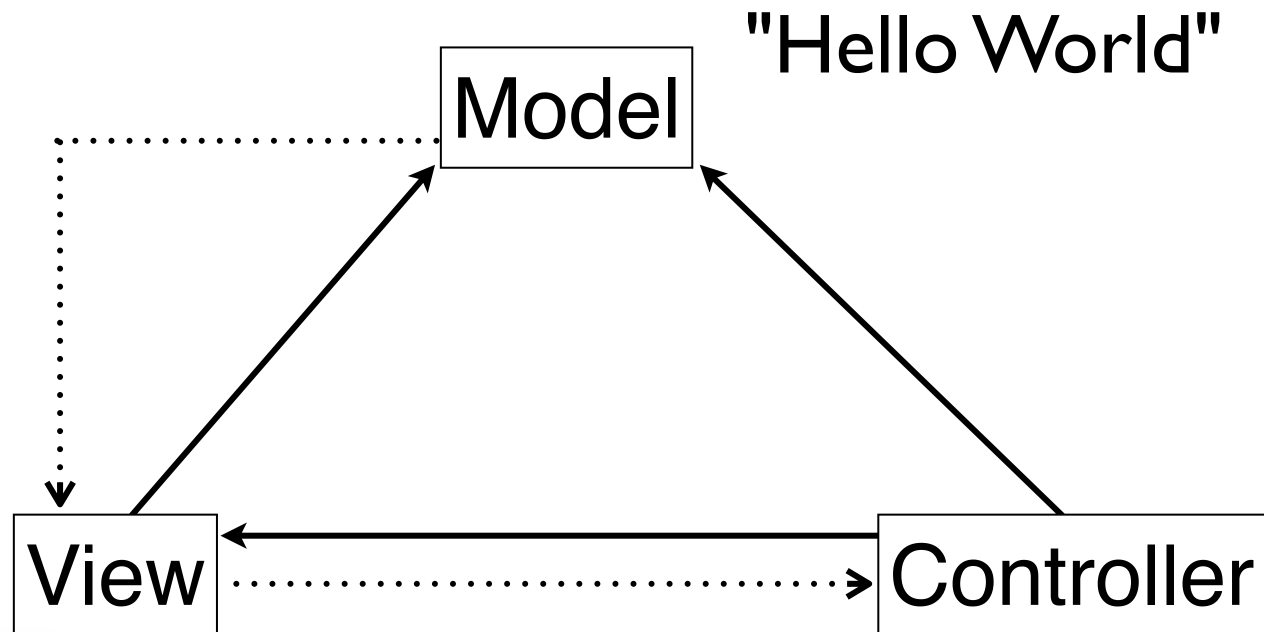
Patterns in GUI Programming

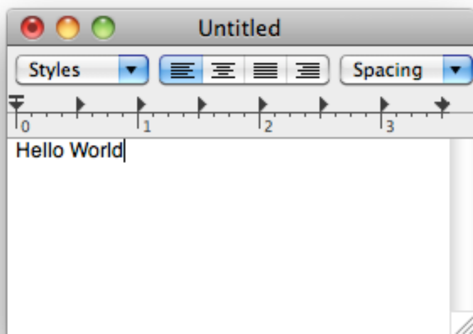
- We saw in our example GUI programs that GUI code can get messy
- Thus, there are many useful patterns people have established for GUIs

Model-View-Controller

- Context: GUI displays some data that the user can affect via GUI
- Solution: separate objects into a model, a view and a controller
  - Model - stores the data
  - View - displays the data from Model
  - Controller - maps user actions to model updates

MVC Diagram





MVC Responsibilities

Model
Stores text and formatting markup (fonts, sizes, colors)
Notifies View to update when Model changes

View
Displays text with proper fonts and sizes
Displays toolbar
Notifies Controller when user edits text or clicks toolbar commands

Controller
Notifies model to change text when user inputs
Notifies model to perform special commands when toolbar buttons are clicked

Pattern: Observer

Context

- A *subject* object is the source of events
- One or more *observer* objects want to know when an event occurs

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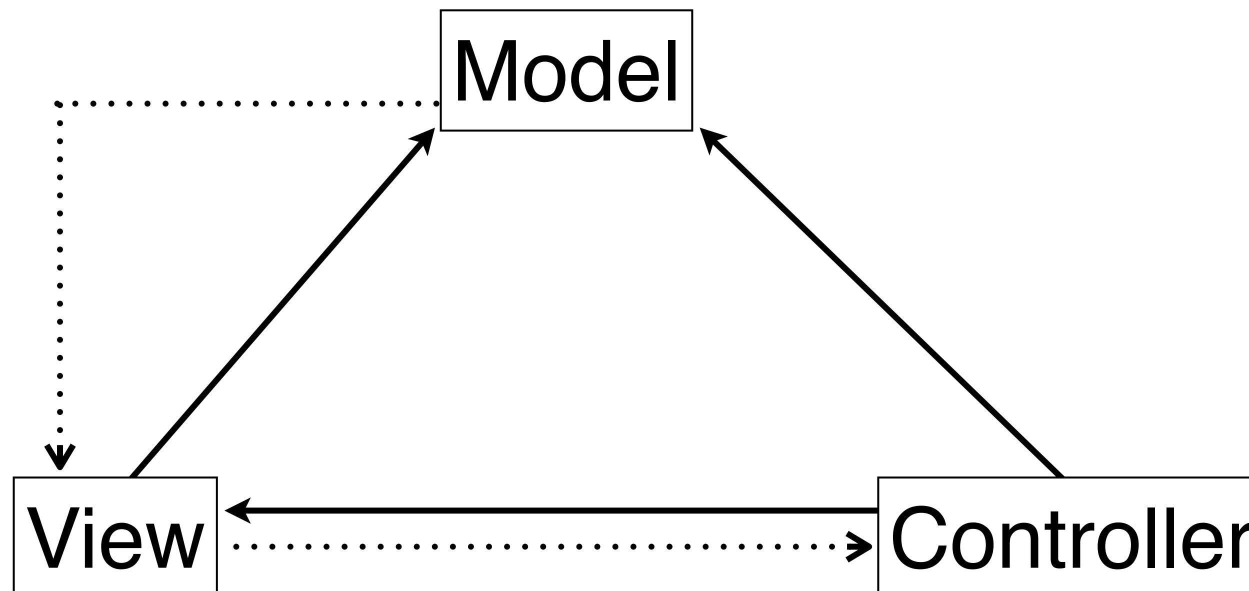
Solution

- Define an *observer* interface type
- The *subject* maintains collection of *observer* objects
- The *subject* provides methods for attaching *observers*
- Whenever an event occurs, the subject notifies all *observers*

Observers in MVC

- View observes Model; when Model changes, it notifies View
- Controller observes View; when user manipulates View, it notifies Controller



Pattern: Composite

JPanel

```
frame1.add(new JButton("JComponents added"));
frame1.add(new JLabel("to this JFrame"));
frame1.add(new JTextField("are laid out"));
frame1.add(new JButton("by FlowLayout"));

JPanel panel = new JPanel();
panel.setLayout(new GridLayout(0,1));

panel.add(new JButton("JComponents added"));
panel.add(new JLabel("to this JPanel"));
panel.add(new JTextField("are laid out"));
panel.add(new JButton("by GridLayout"));

frame1.add(panel);
```

Pattern: Composite

- Primitive objects can be combined into composite objects
- Clients treat a composite object as a primitive object

- Define an interface type that abstracts primitive objects
- Composite object contains a collection of primitive objects
- Both primitive and composite classes implement interface
- When implementing methods from the interface, composite class applies method to its primitive objects and combines the results

Pattern: Decorator

JScrollPane

```
public static void main(String[] args)
{
   JFrame frame = new JFrame();

   JPanel panel = new JPanel();

   panel.setLayout(new GridLayout(10,10));

   for (int i=0; i<ROWS; i++)
      for (int j=0; j<COLS; j++)
         panel.add(new JButton("Button (" + i + "," + j + ")"));

   frame.add(new JScrollPane(panel), BorderLayout.CENTER);
   frame.pack();
   frame.setVisible(true);
}
```

Pattern: Decorator

- You want to enhance the behavior of a component class
- A decorated component can be used in the same way as a plain component
- The component class shouldn't be responsible for the decoration
- There may be an open-ended set of possible decorations

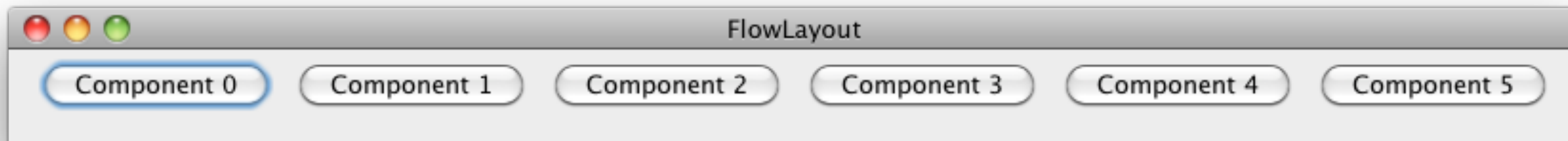
- Define an interface type that abstracts the component
- Concrete component classes implement this interface
- Decorator classes also implement this interface
- Decorator objects manage the component that it decorates

Pattern: Strategy

LayoutManager

- BoxLayout - draws components in a row or a column
- BorderLayout - lets you specify where to draw component (north, south, east, west, center)
- GridLayout - draws components in a grid pattern

Different Layouts



```
JFrame flowFrame = new JFrame("FlowLayout");
JFrame boxFrame = new JFrame("BoxLayout");
JFrame gridFrame = new JFrame("GridLayout");

flowFrame.setLayout(new FlowLayout());
boxFrame.setLayout(new BoxLayout(boxFrame.getContentPane(),
     BoxLayout.Y_AXIS));
gridFrame.setLayout(new GridLayout(2,3));

for (int i=0; i<6; i++)
{
   flowFrame.add(new JButton("Component "+i));
   boxFrame.add(new JButton("Component "+i));
   gridFrame.add(new JButton("Component "+i));
}
```

Pattern: Strategy

- A *context* class benefits from different variants of an algorithm
- Clients of the *context* class sometimes want to supply custom versions of the algorithm

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- Define an interface type, called a *strategy,* that abstracts the algorithm
- Each concrete *strategy* class implements a version of the algorithm
- The client supplies a concrete strategy object to the context class
- Whenever the algorithm needs to be executed, the context class calls the appropriate methods of the strategy object

Using Patterns

- Lots of established, useful patterns
- Make sure the context applies to situation before trying solution
- Understand why pattern solves the problem before applying solution

Reading

- Horstmann Ch. 5
  - Download and try code example(s)
- Next week, we’ll go over some off-book Java GUI material