

CMSC 132:

Object-Oriented Programming II

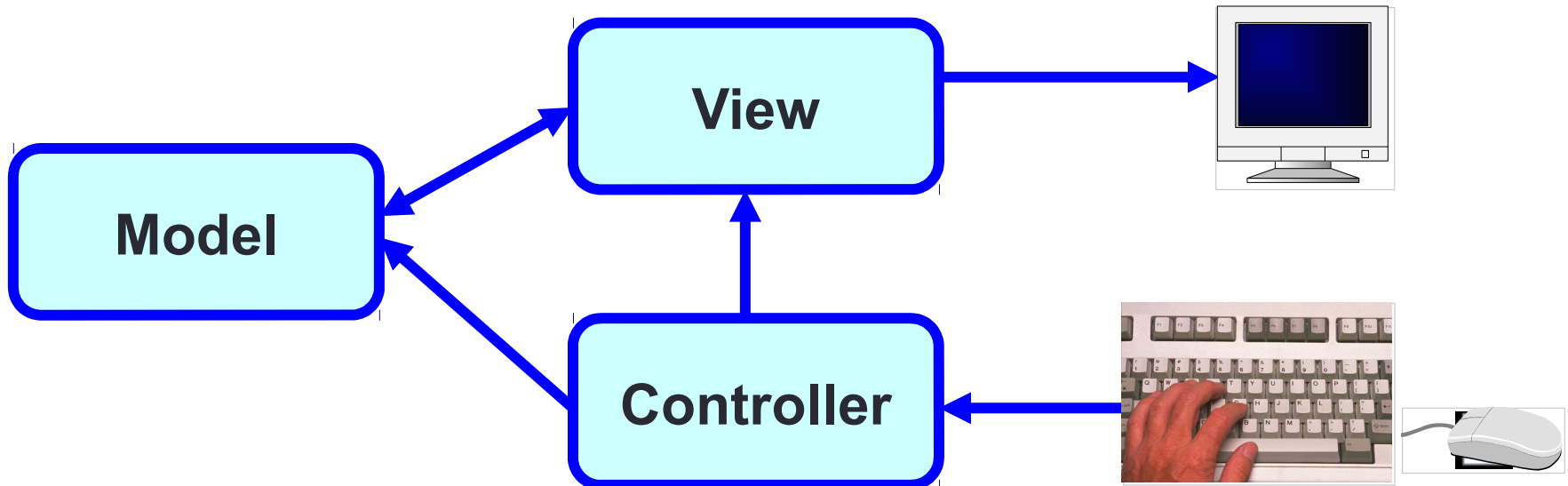


Graphical User Interfaces (GUIs)

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Model-View-Controller (MVC)

- Model for GUI programming (Xerox PARC '78)
- Separates GUI into 3 components
 - Model $\Rightarrow$ application data
 - View $\Rightarrow$ visual interface
 - Controller $\Rightarrow$ user interaction



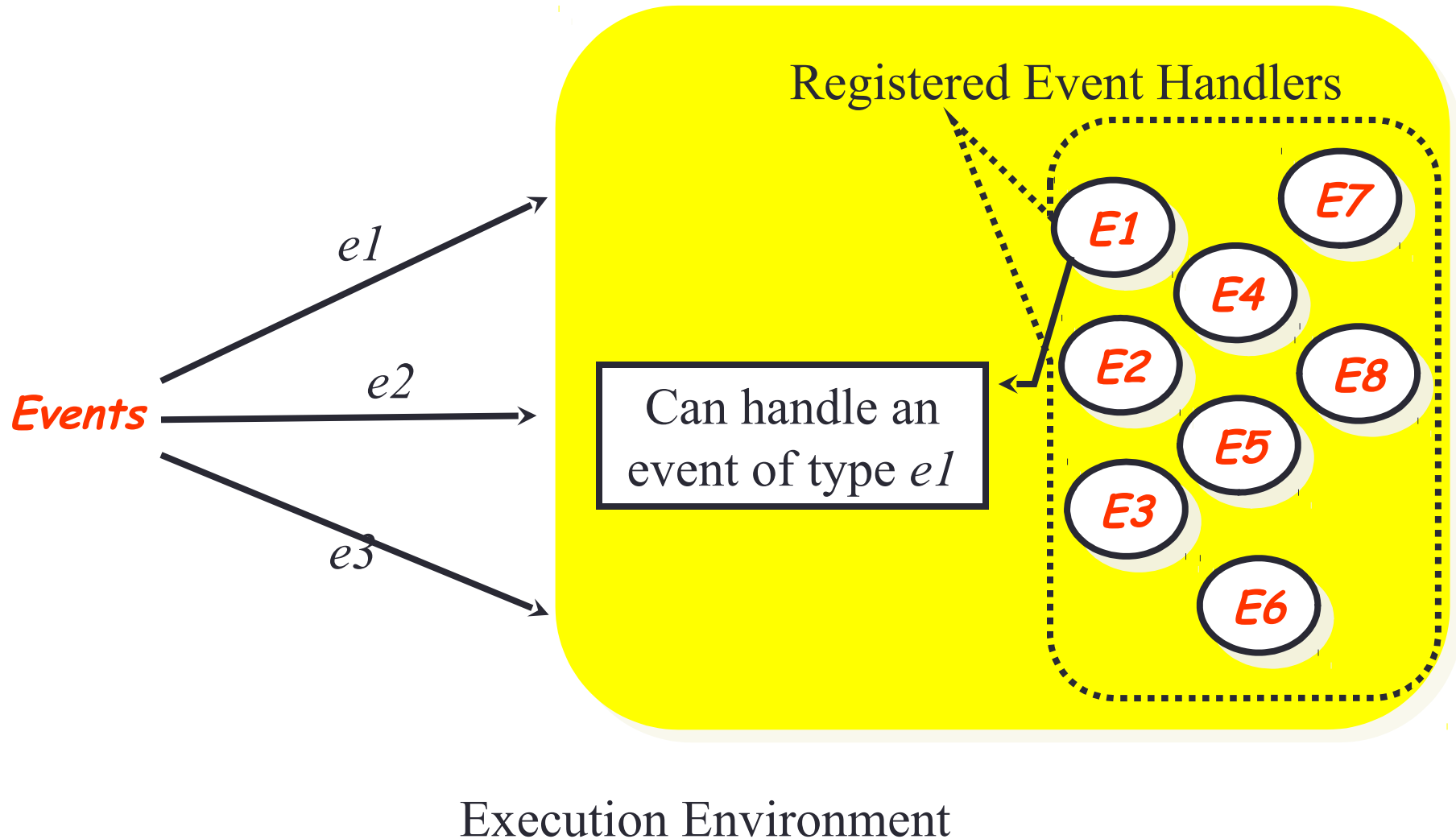
MVC Model of GUI Design

- Model
 - Should perform actual work
 - Should be independent of the GUI
 - But can provide access methods
- Controller
 - Lets user **control** what work the program is doing
 - Design of controller depends on model
- View
 - Lets user see what the program is doing
 - Should not display what controller **thinks** is happening (base display on model, not controller)

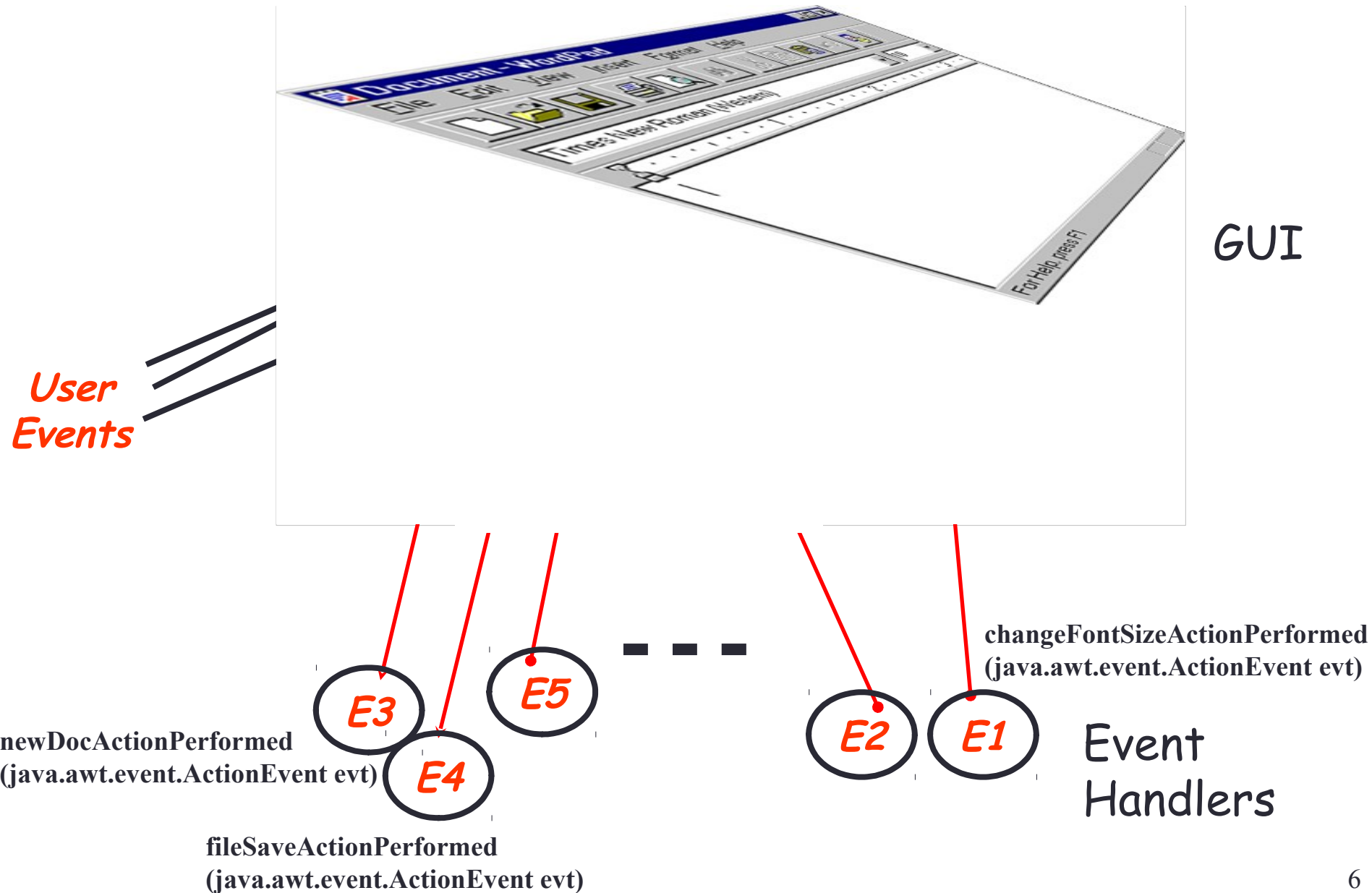
Programming Models

- Normal (control flow-based) Programming
 - Approach
 - Start at main()
 - Continue until end of program or exit()
- Event-driven Programming
 - Event □ Action or condition occurring outside normal flow of control of program (e.g., mouse clicks, keyboard input, etc.)
 - Unable to predict time & occurrence of event
 - Approach
 - Start with main()
 - Define system elements and register event listeners
 - Await events (& perform associated computation)

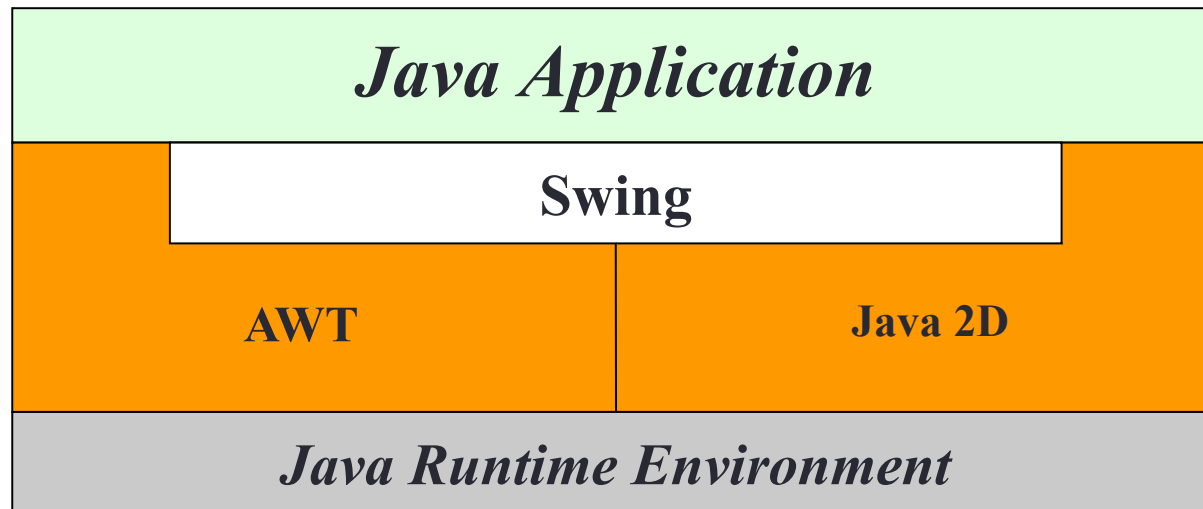
Event Handling in Action



GUIs are Event-Driven Software



GUIs in Java



Desktop Java Graphics APIs: From “Filthy Rich Clients”
by Chet Haase and Romain Guy, Chap1, Page 12
ISBN-978-0-13-241393-0
Book Web Site: <http://www.filthyrichclients.org/>

GUIs in Java

- **AWT (Abstract Window Toolkit) (`java.awt.*`)**
 - First graphical user interface toolkit for Java
 - Old GUI framework for Java (Java 1.1)
 - Reliance on native system libraries
 - Platform independence problems
 - Responsible for input event mechanisms
- **Java 2D**
 - Graphics Library of Java
 - Introduced in JDK 1.2
 - Basics and advance drawing operation, image manipulation, and drawing
 - Handles Swing's Rendering operations
- **Swing (`javax.swing.*`)**
 - GUI framework first introduced in JDK 1.2
 - Includes AWT features plus many enhancements
 - Pure Java components (no reliance on native code)
 - Pluggable look and feel architecture

Some of this material is from “Filthy Rich Clients” (see reference in previous slide).

Steps for Creating a GUI in Java

- (Step 1) Define a **container** to hold components (e.g., JFrame, JApplet)
- (Step 2) Add GUI **components** to the container (JButton, JTextField, ...)
 - Use layout manager to determine positions
- (Step 3) Add actions to GUI
 - Add (register) event listeners to GUI components
 - Usually one event listener class per widget (item user sees)
 - Inner class usually utilized to implement listener
 - Example of Java listeners & Actions Causing Event
 - ActionListener □ clicking button in GUI
 - At run time
 - Java generates **event object** when events occur
 - Java then passes event object to event listener
- (Step 4) Schedule the GUI processing in the EDT (Event-Dispatching Thread)

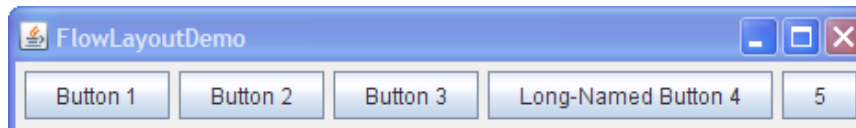
Schedule GUI Processing in EDT

- What is a thread?
- Event Dispatching Thread (EDT) is a background thread to process GUI events
- These events are mainly **updates** that
 - Cause components to redraw themselves
 - Represent input events
- Swing uses a single-threaded painting model
 - Event Dispatching Thread is the only valid thread for updating GUI components
 - **Avoid updating GUI components from other threads** (a source of bugs)
- Java Code that allows current thread to execute GUI code in dispatching thread

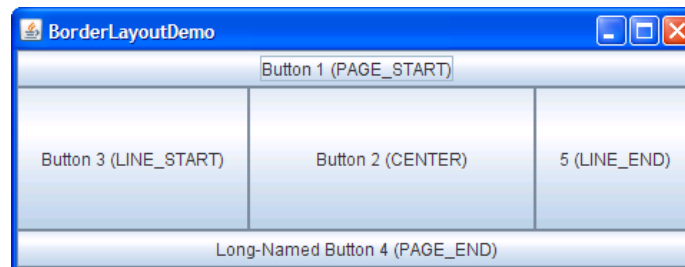
```
public static void main(String[] args) {  
    javax.swing.SwingUtilities.invokeLater(new Runnable() {  
        public void run() {  
            createAndDisplayGUI(); // actually creates GUI  
        }  
    });  
}
```

Java Layout Manager

- Definition
 - Arrangement of GUI components in container
- Layout manager
 - Entity translating layout specifications into actual coordinates at runtime, depending on conditions
- Examples
 - FlowLayout (lays out component from left to right)



- BorderLayout (designates portions of the container as North, South, East, West, and Center)



Examples

- Main Examples
 - eventHandlingIntro
 - singleClassBorderLayout
 - timer
 - textFileReaderSingleClass (illustrates MVC)
- Additional Examples
 - textFileReaderFont
 - textFilerReaderFontSlider
 - textFileReaderFont
 - tables

Beware of Long Computations in Swing

- Swing uses a single-threaded model
- Long computations in the EDT freezes the GUI
- Usually you place the computation in a separate thread
- We will talk about this matter once we have covered threads

Additional Resources

- Javadoc from the JDK
- Swing tutorial
<http://java.sun.com/docs/books/tutorial/uiswing/components/>
- Filthy Rich Clients
<http://filthyrichclients.org/>