

11 Graphical User Interfaces

Overview

- Java API for GUIs
- Constructing GUIs
- Interface components
- Event handling
- *Example: image viewer*

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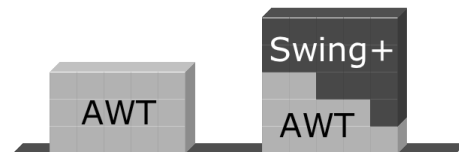
GUI Principles

- Components: GUI building blocks.
 - Buttons, menus, sliders, etc.
- Events: reacting to user input.
 - Button presses, menu selections, etc.
- Layout: arranging components to form a usable GUI.
 - Using layout *managers*.

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AWT and Swing



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Creating a frame

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

public class ImageViewer
{
    private JFrame frame;

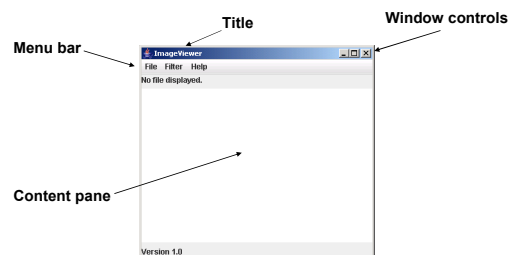
    /**
     * Create an ImageViewer show it on screen.
     */
    public ImageViewer()
    {
        makeFrame();
    }

    // rest of class omitted.
}
```

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Elements of a frame



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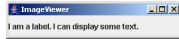
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The content pane

```
/**
 * Create the Swing frame and its content.
 */
private void makeFrame()
{
    JFrame frame = new JFrame("ImageViewer");
    Container contentPane = frame.getContentPane();

    JLabel label = new JLabel("I am a label.");
    contentPane.add(label);

    frame.pack();
    frame.setVisible(true);
}
```



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Adding menus

- JMenuBar
 - Displayed below the title.
 - Contains the menus.
- JMenu
 - e.g. *File*. Contains the menu items.
- JMenuItem
 - e.g. *Open*. Individual items.

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```
private void makeMenuBar(JFrame frame)
{
    JMenuBar menubar = new JMenuBar();
    frame.setJMenuBar(menubar);

    // create the File menu
    JMenu fileMenu = new JMenu("File");
    menubar.add(fileMenu);

    JMenuItem openItem = new JMenuItem("Open");
    fileMenu.add(openItem);

    JMenuItem quitItem = new JMenuItem("Quit");
    fileMenu.add(quitItem);
}
```

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Event handling

- Events correspond to user interactions with components.
- Components are associated with different event types.
 - Frames are associated with `WindowEvent`.
 - Menus are associated with `ActionEvent`.
- Objects can be notified when an event occurs.
 - Such objects are called *listeners*.

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Centralized event receipt

- A single object handles all events.
 - Implements the `ActionListener` interface.
 - Defines an `actionPerformed` method.
- It registers as a listener with each component.
 - `item.addActionListener(this)`
- It has to work out which component has dispatched the event.

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```
public class ImageViewer implements ActionListener
{
    ...
    public void actionPerformed(ActionEvent e)
    {
        String command = e.getActionCommand();
        if (command.equals("Open")) {
            ...
        }
        else if (command.equals("Quit")) {
            ...
        }
    }
    ...
    private void makeMenuBar(JFrame frame)
    {
        ...
        openItem.addActionListener(this);
        ...
    }
}
```

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Centralized event handling

- The approach works.
- It is used, so you should be aware of it.
- However ...
 - It does not scale well.
 - Identifying components by their text is fragile.
- An alternative approach is preferred.

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Nested class syntax

- Class definitions may be nested.

```
- public class Enclosing
{
    ...
    private class Inner
    {
        ...
    }
}
```

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Inner classes

- Instances of the inner class are localized within the enclosing class.
- Instances of the inner class have access to the private members of the enclosing class.

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Anonymous inner classes

- Obey the rules of inner classes.
- Used to create one-off objects for which a class name is not required.
- Use a special syntax.
- The instance is always referenced via its supertype, as it has no subtype name.

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Anonymous action listener

```
JMenuItem openItem = new JMenuItem("Open");

openItem.addActionListener(new ActionListener() {
    public void actionPerformed(ActionEvent e) {
        openFile();
    }
});
```

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Anonymous class elements

```
openItem.addActionListener(
    new ActionListener() {
        public void actionPerformed(ActionEvent e) {
            openFile();
        }
    }
);
```

Annotations in the diagram:

- Anonymous object creation**: points to the `new ActionListener()` expression.
- Class definition**: points to the inner class body (the curly braces containing the `actionPerformed` method).
- Actual parameter**: points to the closing parenthesis of the `addActionListener` call.

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Exit on window close

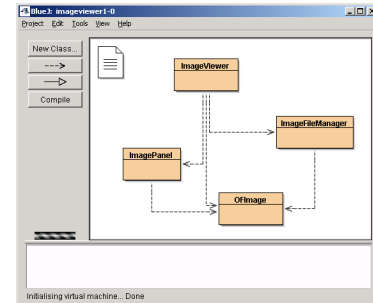
```
frame.addWindowListener(new WindowAdapter() {  
    public void windowClosing(WindowEvent e)  
    {  
        System.exit(0);  
    }  
});
```

WindowAdapter provides a no-op implementation of the WindowListener interface.

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The imageviewer project



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Image processing



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Class responsibilities

- ImageViewer
 - Sets up the GUI structure.
- ImageFileManager
 - Static methods for image file loading and saving.
- ImagePanel
 - Displays the image within the GUI.
- OFImage
 - Models a 2D image.

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OFImage

- Our subclass of BufferedImage.
- Represents a 2D array of pixels.
- Important methods:
 - getPixel, setPixel
 - getWidth, getHeight
- Each pixel has a color.
 - We use java.awt.Color.

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Adding an ImagePanel

```
public class ImageViewer  
{  
    private JFrame frame;  
    private ImagePanel imagePanel;  
  
    ...  
  
    private void makeFrame()  
    {  
        Container contentPane = frame.getContentPane();  
        imagePanel = new ImagePanel();  
        contentPane.add(imagePanel);  
    }  
  
    ...  
}
```

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Loading an image

```
public class ImageViewer
{
    private JFrame frame;
    private ImagePanel imagePanel;

    ...

    private void openFile()
    {
        File selectedFile = ...;
        OFImage image =
            ImageFileManager.loadImage(selectedFile);
        imagePanel.setImage(image);
        frame.pack();
    }

    ...
}
```

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Review

- Aim for clean application structures.
 - *Keep GUI elements separate from application functionality!*
- Pre-defined components simplify creation of sophisticated GUIs.
- Many components recognize user interactions with them.
- Reactive components deliver events to listeners.

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