Systems Programming

Graphical User Interfaces

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CONTENTS ARE MOSTLY BASED ON THE WORK BY:
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Systems Programming

GUIs based on Java Swing

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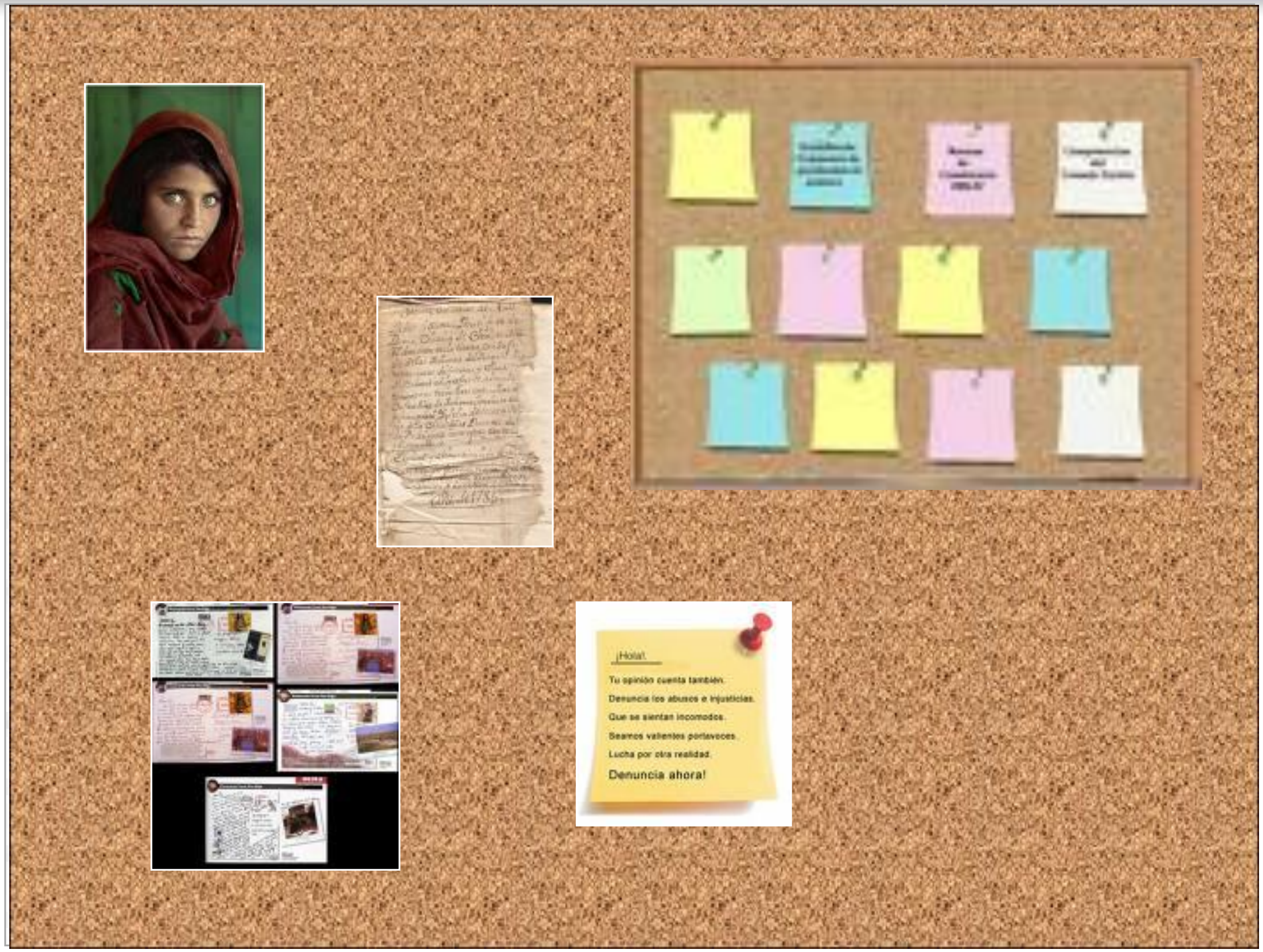
Introduction

- What are the GUIs?
- Well known examples…

Basic concepts

- Graphical application
- Containers
- Actions
- Events
- Graphical elements:
  - Menu bar
  - Title bar
  - Minimize and maximize buttons
  - Closing button
  - Scroll
  - Window frame
  - Icons
  - Buttons
  - Text areas

The wall metaphor



¡Hola!

Tu opinion cuenta tambien.

Denuncia los abusos e injusticias.

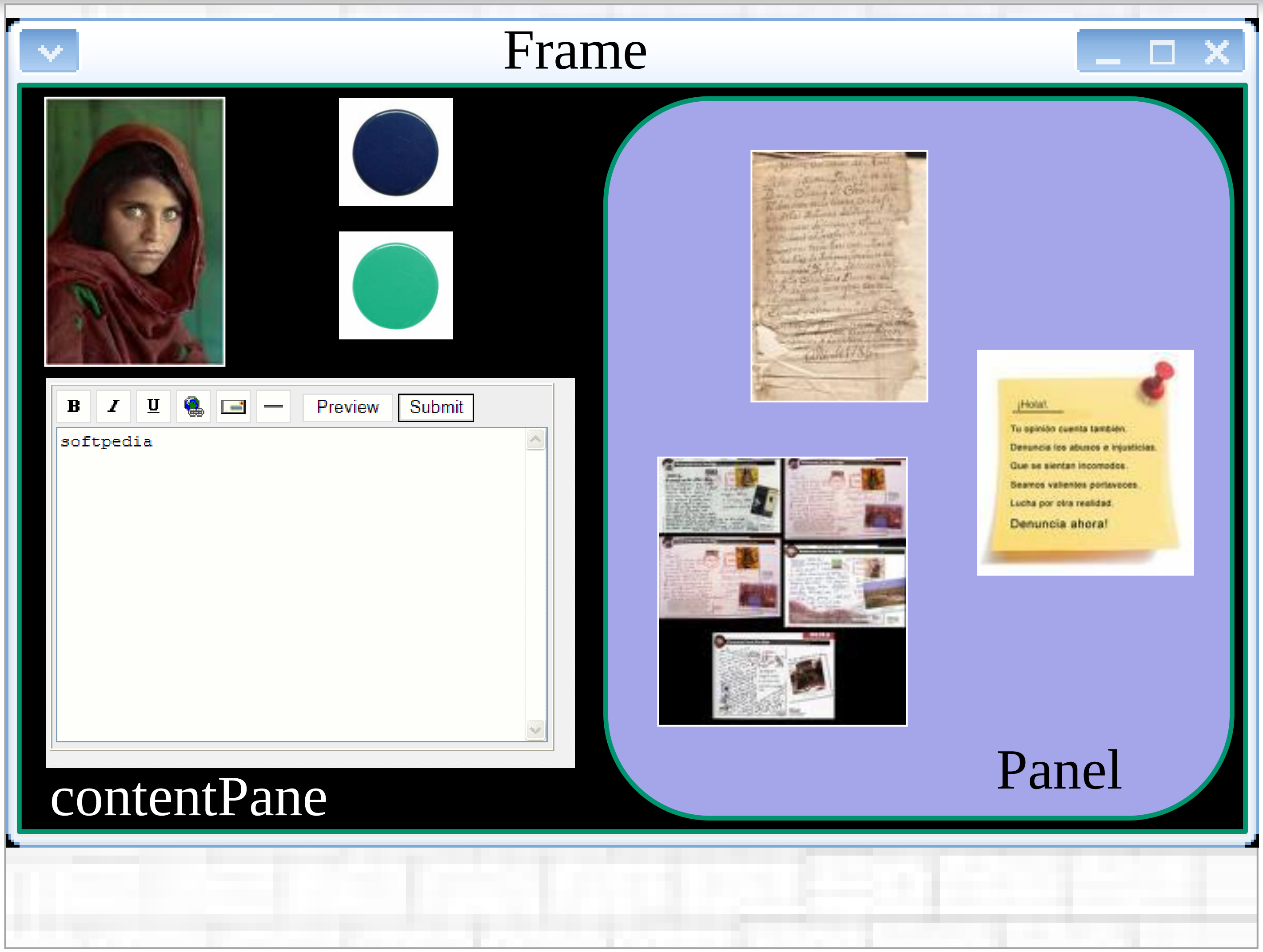
Que se sientan incomodos.

Seamos valientes portavoces.

Lucha por otra realidad.

Denuncia ahora!

The wall metaphor


Frame
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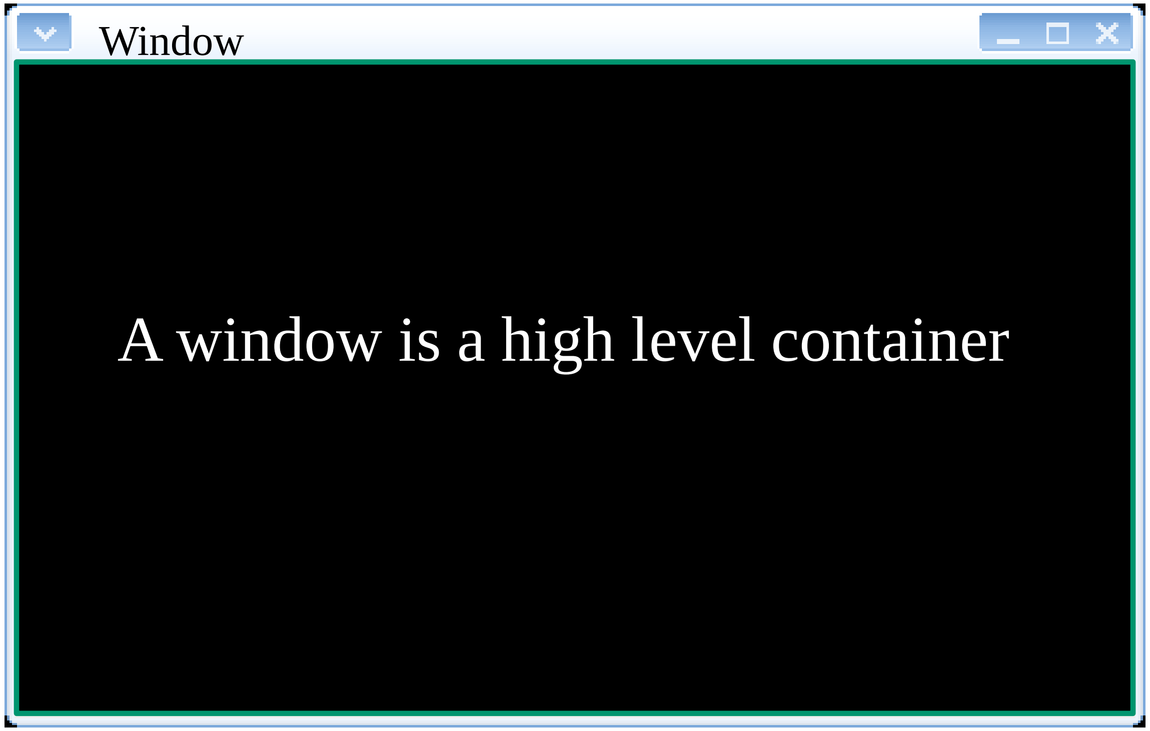
Panel
contentPane

Creating the wall

- How to create a window in Java?



How to create a window in Java?

```
import javax.swing.* ;

public class Example extends JFrame {

              ethods starts everything*/
              atic void main (String argv[]) {

            Example window= new Example();

            window.setSize (400, 400);
            window.setVisible(true);

      }
}
```

A window in Java is just a class extending Jframe, the generic window.

The classes needed to build GUIs are included in the Swing package

The window must be made visible explicitly

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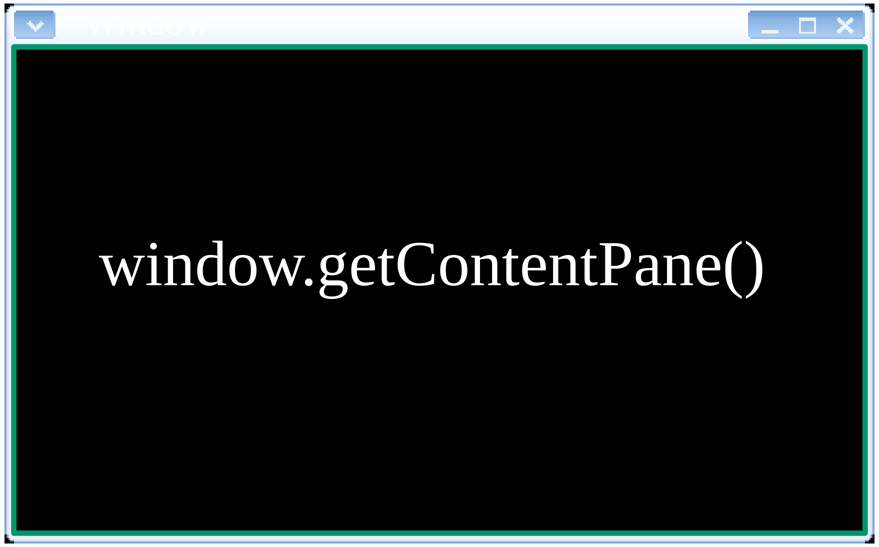
Covering the wall with cork

- Every high level container in Swing (windows, for instance) will be “covered” with a “contentPane”
- The rest of the graphical components will be placed on it
  - Including other containers



Adding it to the code

```
import javax.swing.* ;

public class Example extends JFrame {

      /* This methods starts everything*/
      public static void main (String argv[]) {

            Example window = new Example();

            window.getContentPane().add(…);

            window.setSize (400, 400);
            window.setVisible(true);

      }
}
```

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What elements can I “attach to the cork”?

- In the **`contentPane`** you can put elements from the Swing package:
  - Labels: `JLabel`
  - Buttons: `JButton`
  - Text boxes: `JTextField`, `JTextArea`
  - Checkboxes: `JCheckBox`
  - Option buttons: `JRadioButton`
  - Lists: `JList`
  - Scroll bars: `JScrollBar`
- All the Swing components extend `JComponent`

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And how can I attach them?

```
JButton button;
JLabel label;

public Example() {

      label = new JLabel(“A label");
      button = new JButton(“A button");
      button.setSize(100, 70);
      getContentPane().add(button);
      getContentPane().add(label);

}
```

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LITTLE PAUSE

... A good time to take a look at the Java API, in order to get to know where to find information on the different graphical components and how to use them...

And how can I attach “corks to the cork”?

- We will use CONTENT PANELS:
  `JPanel`
- They are medium level containers:
  - They simplify the window organization
- A panel may contain other panels

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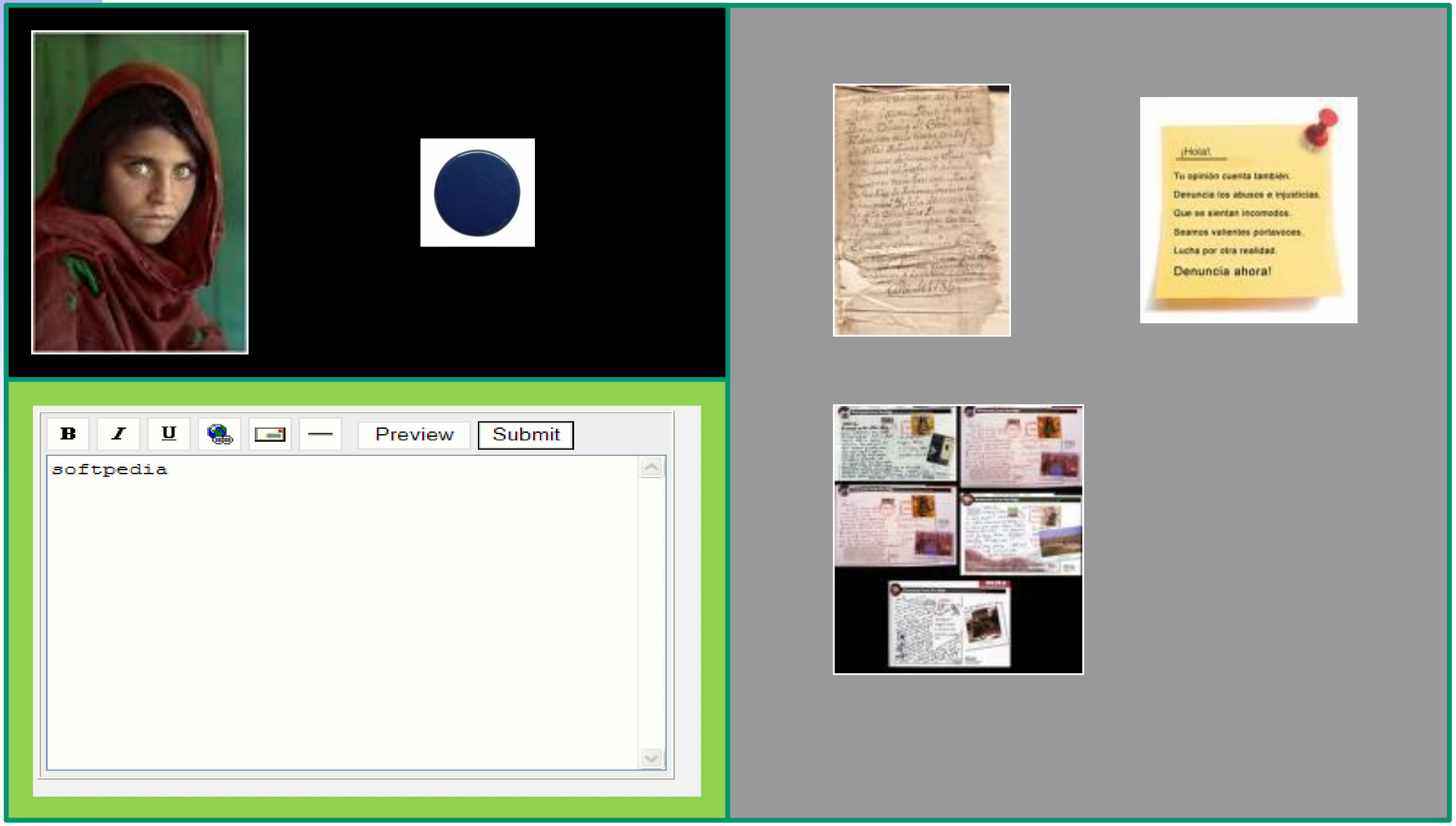
Panel hierarchy



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Denuncia ahora!

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Example of panel

```
JButton button;
JLabel label;
JPanel panel;

public Example() {

      panel = new JPanel();
      getContentPane().add(panel);

      label = new JLabel("A label");
      button = new JButton("A button");
      button.setSize(100, 70);
      panel.add(button);
      panel.add(label);

}
```

How can I put together all those components?

- You can use either coordinates…

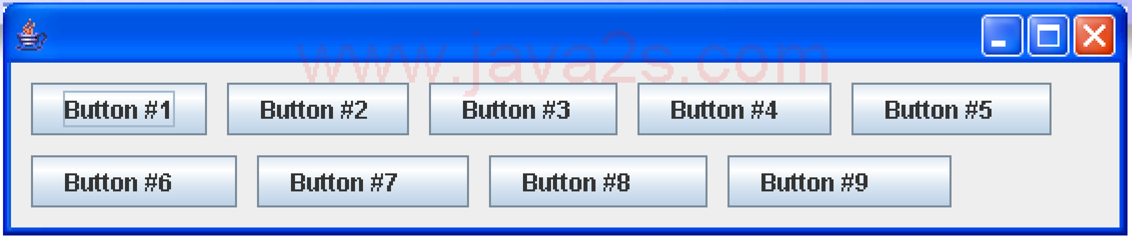
```
label.setBounds(100, 70, 50, 50);
```

- …or LAYOUTS:
  - These are like templates to organize graphical components.
  - They are associated to panels.
  - We'll see three types here.
- To use coordinates you have to neutralize the layout first:

```
panel.setLayout(null)
```

- You need to import `java.awt.*` in order to use layouts!

Example using FlowLayout



```
JButton button;
JLabel label;
JButton otherButton;
JPanel panel;

public Example() {
  panel = new JPanel();
  getContentPane().add(panel);

  label = new JLabel("A label");
  button = new JButton("A button");
  otherButton = new JButton("Other button");
  panel.add(button);
  panel.add(label);
  panel.add(otherButton);
}
```

It places the elements in a row, one after the other

FlowLayout is the default! (in panels)

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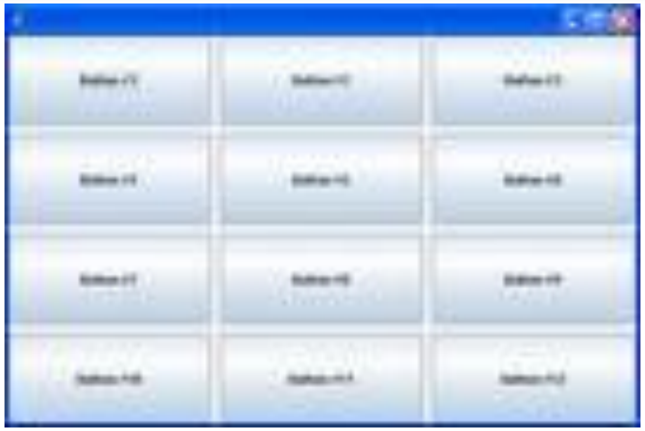
Example using GridLayout

```
public Example() {

   panel = new JPanel();
   panel.setLayout(new GridLayout(2, 2));
   getContentPane().add(panel);

   label = new JLabel(“A label");
   button = new JButton(“A button");
   otherButton = new JButton(“Other button");
   panel.add(button);
   panel.add(label);
   panel.add(otherButton);

}
```



It places the elements in a grid

Example with BorderLayout

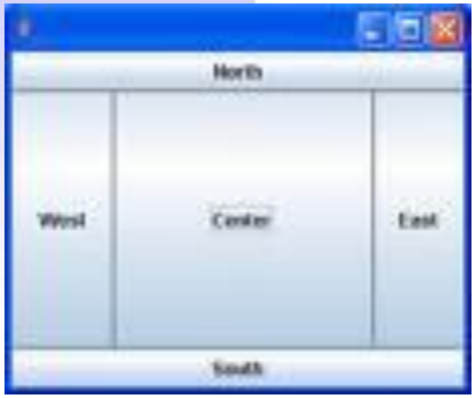
It is the default in high level containers

```
public Example() {

   panel = new JPanel();
   panel.setLayout(new BorderLayout());
   getContentPane().add(panel);

   label = new JLabel(“A label");
   button = new JButton(“A button");
   otherButton = new JButton(“Other button");
   panel.add(button, BorderLayout.SOUTH);
   panel.add(label, BorderLayout.WEST);
   panel.add(otrobutton, BorderLayout.NORTH);

}
```



It divides the container in five sections:
North, south, east, west and center

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Events

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Session objectives

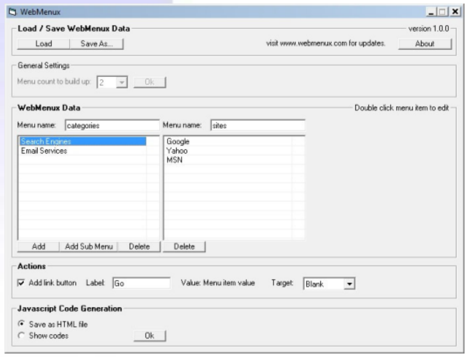
- Being able to add behaviour to the graphical elements in the interface…
- …modifying those elements as a result of the actions on them
- In other words, to cover the whole cycle:
  1. Receiving events that take place on the graphical elements
  2. Processing them
  3. Showing feedback on the screen

Graphical application architecture

Interface

Processing

Persistence



WebMenux

Load / Save WebMenux Data — version 1.0.0

Load | Save As... — visit www.webmenux.com for updates. — About

General Settings

Menu count to build up: 2 — Ok

WebMenux Data — Double click menu item to edit

Menu name: categories — Menu name: sites

Search Engines	Google
Email Services	Yahoo
	MSN

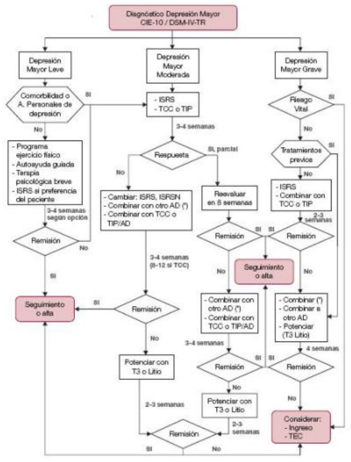
Add | Add Sub Menu | Delete — Delete

Actions

[✓] Add link button — Label: Go — Value: Menu item value — Target: Blank

Javascript Code Generation

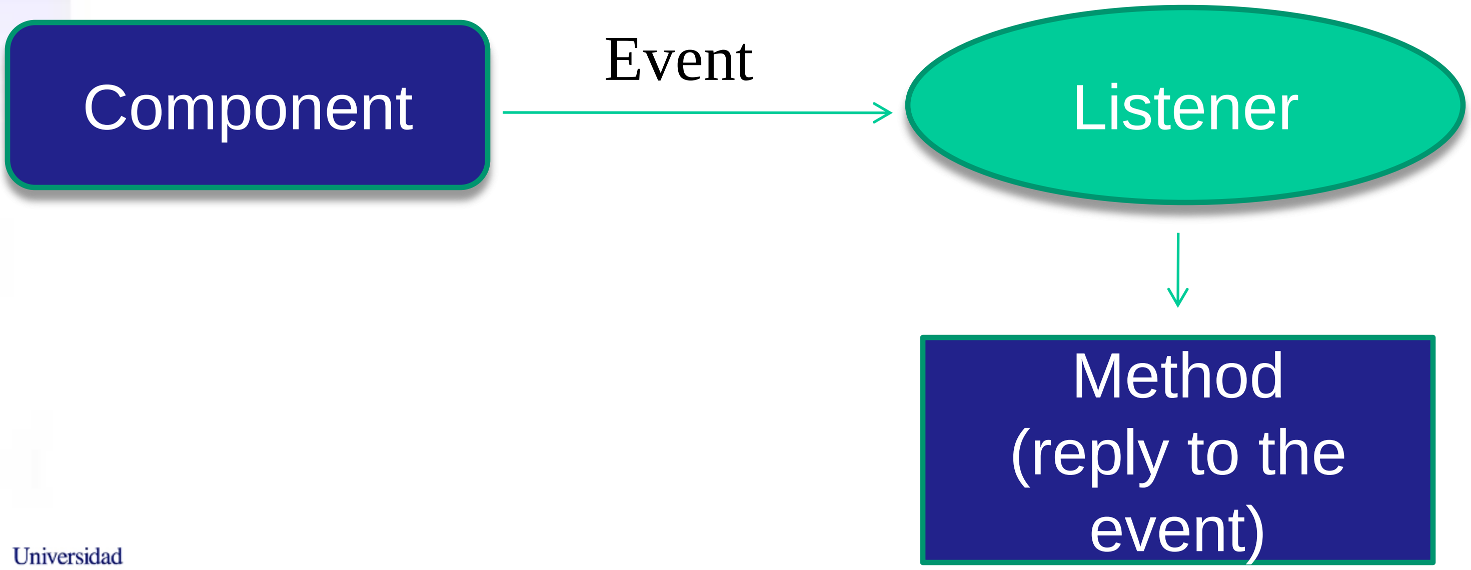
[✓ Save as HTML file] Show codes — Ok



How is this link created?

Anybody listening?

- When users act on the interface, something should happen.
- For being so, we will have to program **events managers** (listeners)



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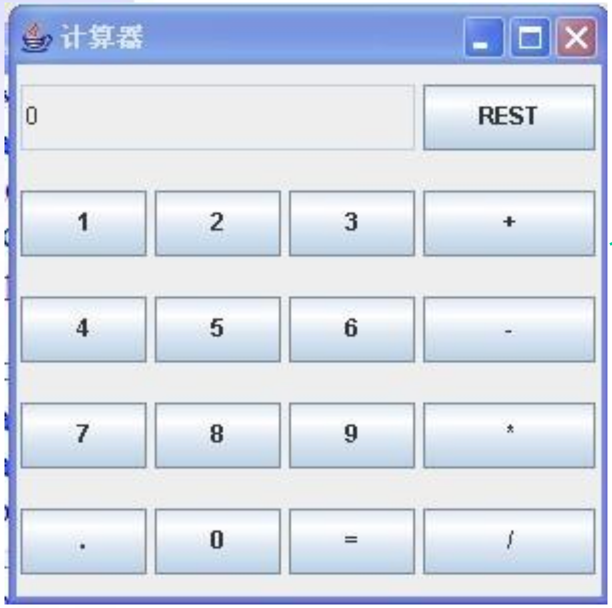
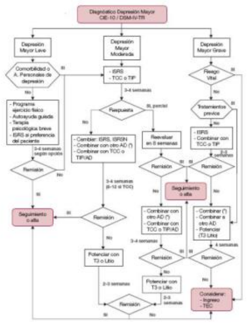
Examples of listeners

- **`WindowListener`**
  - For managing window events
- **`ActionListener`**
  - For managing buttons and other simple components events
- You will have to consult the API constantly!

Active waiting

- Once the GUI is “painted” on the screen…
- … the program stays in a “stand-by” mode, not running any active code





When something happens on the interface, the associated listener wakes up

And translated into code?

This package includes the listeners

Listeners are interfaces, usually

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

public class ListenerExample implements ActionListener {

    public void actionPerformed (ActionEvent e) {

        System.out.println(“Inside the listener");

    }

}
```

This method is awaken automatically

Who listens to whom?

- If we have several graphical components…
- …and we can create as many listeners as we wish…
- Who listens to whom?

- We'll have to associate, explicitly, the listeners to the components
- Multiple combinations are possible:
  - Several listeners associated to the same component.
  - One listener associated to several components.

How to set up the association?

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

public class Example2 extends JFrame {

   JButton myButton = new JButton ("Click here");
   ListenerExample myListener = new ListenerExample();

   public Example2 () {
         getContentPane().add(myButton);
         myButton.addActionListener(myListener);
   }

   public static void main (String[] arg) {
         Example2 window = new Example2();
         window.setSize(200, 200);
         window.setVisible(true);
      }
}
```

Creating an instance of the corresponding listener

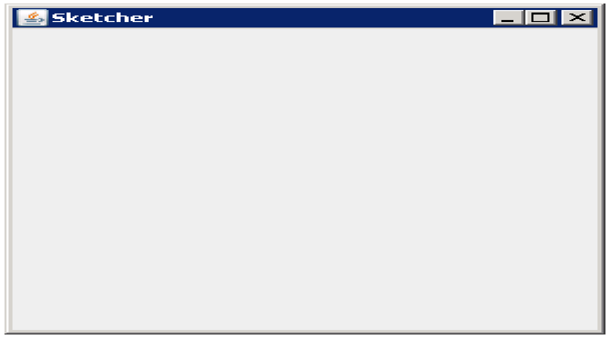
Associating the listener to the component

Which part of the listener is awaken?

- Listeners have **different methods** to listen to different events.
- Java **automatically** invokes the suitable method, depending on the event.
- The body of these methods will be programmed by us. We can invoke other methods from these.
- When the method running is over, the program moves on to stand-by again, awaiting for new events.
- These methods receive an **event** object as argument.

Example: WindowListener

- Among its methods we find:
  - `void windowClosing (WindowEvent evt)`
  - `void windowOpened (WindowEvent evt)`
  - `void windowClosed (WindowEvent evt)`
  - `void windowIconified (WindowEvent evt)`
  - `void windowDeiconified (WindowEvent evt)`
  - `void windowActivated (WindowEvent evt)`
  - `void windowDeactivated (WindowEvent evt)`



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May I get more information about an event?

- The event received as an argument by the listeners' methods is provided automatically by Java
- "**Asking**" to that event object we can find out more things about what really happened
- Asking, as always, is done by invoking methods of the event object

Example

Argument provided by Java automatically

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

public class ListenerExample implements ActionListener {

    public void actionPerformed (ActionEvent e) {

        String source = e.getActionCommand();
        System.out.println("Button: " + source);

    }

}
```

It gives back the label of the component that started the event

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Event oriented programming

- GUIs in Java is just an example of a more general and very important programming technique: Events Oriented Programming
- In a program everything is sequential: the time when each action is going to happen is predictable…
- …How can we take into account those events in the world outside our program that we don't know exactly when will happen?
  - When will that door open?
  - When will this pot of water boil?
  - When will the user push this button?
- Programs have mechanisms to react ("wake up") when specific events take place outside the program

Code organization

- Everything explained about GUIs is under the principles and rules of the OO programming paradigm…
- …so everything we know about OO up to now is perfectly valid here
- We have just added new pieces to the meccano…
  - …that can be mixed with the rest in the way we consider most suitable.
- Examples:
  - Creating the listeners as independent classes
  - Creating the listeners as inner classes
  - Making the graphical components themselves act as listeners
  - Associating a listener to more than one graphical component

Adapters

- Some listeners interfaces have lots of methods…
- …and we will have to implement them all (listeners are interfaces)
- Adapters are classes that implement all the methods of a specific listener
- Being classes, we just have to extend them rewriting the methods we need
- For every Listener interface, there is an Adapter class:
  - `WindowListener` → `WindowAdapter`
  - `KeyListener` → `KeyAdapter`
  - `MouseListener` → `MouseAdapter`

"We're all ears!"