The AWT package

(and SWING…)

Abstract Windowing Toolkit

Java provides a package called
"Abstract Windowing Toolkit (AWT)" aimed at:

- developing *User-Friendly* graphical interfaces, built up using widget like buttons, element lists, areas for displaying objects and images,…
- Handling the interaction between the end-user and the program, relaying on an event-based programming model

Every action performed by the user on the graphical interface generates an *event*, which must be handled by the program:
if the user push that button,
then this code must be executed...

GUI (Graphical User Interface)

- AWT - Abstract Windowing Toolkit
  - Also referred to as "Awful Windowing Toolkit" (in Java 1.0)
  - It defines event-based framework for writing GUIs.
- Swing
  - Rich set of easy-to-use, easy-to-understand GUI Components (Java Beans) to allow you creating a GUI that you can be satisfied with.

AWT

- The large majority of objects used in building an interface derives from the class Component
- To build up a graphical interface (GUI), components are added to a special Component: a "Container"
- As a Container is also a Component, a Container can contain other Containers
- Each AWT component uses *native code* to make itself visualized on the screen
  - Whenever the application runs under MS Windows, buttons are ACTUALLY Windows' buttons!
  - Whenever the application runs on a Unix machine exploiting Motif, buttons are ACTUALLY Motif's buttons!

Creating a GUI

Whenever it is created either an application equipped with a GUI,

1. The GUI is built up adding Components to the Container objects
2. The proper event handlers are coded, in order to react to the user's actions
3. The interface is displayed (automatically done for applets)

As a GUI is displayed, the interpreter starts a new thread waiting for an event to be fired

Whenever a button is pressed, the mouse is moved, etc., such a thread executes the proper code in the event handler which is associated to the current action.

Because of the presence of such an auxiliary thread, the main() method can terminate just after the interface display.

Class Categories in Package AWT

Graphics Classes	classes that define colors, images, polygons, etc.
Components	GUI components such as *Button*, *Menu*, *List*, ...
Layout Managers	they control the layout of elements within their own container

The AWT package contains several sub-packages:

- java.awt.color
- java.awt.datatransfer
- java.awt.dnd
- java.awt.event
- java.awt.font
- java.awt.geom
- java.awt.print
- …

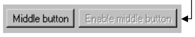
Components

- Declaration:
- Creation:

```
Button b1;
b1 = new Button(...);
```

Possible constructor parameters

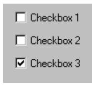
Button



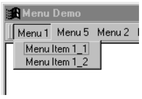
TextField

TextArea

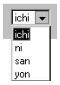
Checkbox



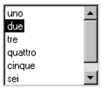
Menu



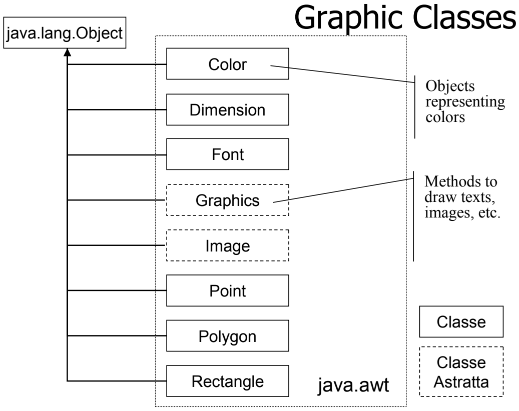
Choice



List



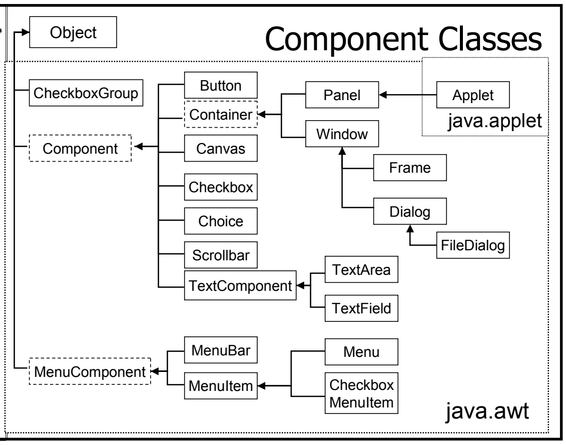
Graphic Classes



Objects representing colors

Methods to draw texts, images, etc.

Component Classes



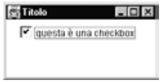
Components

Buttons

```
…
Button b=new Button("OK")
container.add(b);
…
```

Checkbox

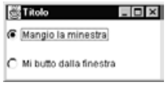
```
…
Checkbox c=new Checkbox("questa è una checkbox");
container.add(c);
boolean stato=c.getState();
c.setState(nuovo stato);
…
```



Components

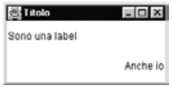
CheckboxGroup

```
CheckboxGroup cbg = new CheckboxGroup();
Checkbox cb1 =
        new Checkbox("Mangio la minestra", cbg, true);
Checkbox cb2 =
        new Checkbox("Mi butto dalla finestra", cbg, false);
container.add(cb1);
container.add(cb2);
```



Label

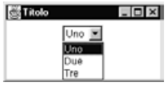
```
Label lab1=new Label("Sono una label");
Label lab2=new Label("Anche io", Label.RIGHT);
container.add(lab1);
container.add(lab2);
```



Components

Choice

```
Choice c=new Choice();
c.add("Uno");
c.add("Due");
c.add("Tre");
container.add(c);
String s=c.getSelectedItem();
```

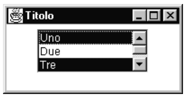


List

```
List c=new List(3, true);
l.add("Uno");
l.add("Due");
l.add("Tre");
l.add("Quattro");
container.add(l);
String[] s=l.getSelectedItems();
```

# of elements to display

Multiple choices allowed

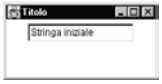


Components

TextField

Single-line text

```
TextField t=new TextField(“Stringa iniziale”);
t.setEditable(true);
String s=t.getText();
container.add(t);
```



Other methods:

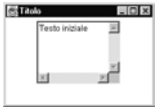
- void setText(String text)
- void setEchoChar(char c)
- void select(int start, int end)
- String getSelectedText()

Components

TextArea

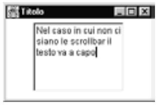
Multiple line text

```
TextArea t=new TextArea(“Testo iniziale”, 5, 15 );
t.setEditable(true);
String s=t.getText();
container.add(t);
```



Other methods and constructors:

- TextArea("Nel caso in cui non ci siano le "+
  "scrollbar il testo va a capo", 5, 15,
  TextArea.SCROLLBARS_NONE); →


Titolo
Nel caso in cui non ci siano le scrollbar il testo va a capo

- void setText(String text)
- void append(String s)
- void insert(String s, int pos)
- void select(int start, int end)
- String getSelectedText()

Container: Frame

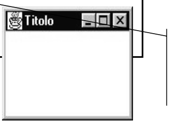
The objects Panel, Window (and their sub-classes Frame and Applet) are the only ones that can contain buttons, lists, etc.: the class Container is *abstract*

Frame is a resizable window with a title

```
public class MyFrame {
      public static void main (String[ ] args ) {
            Frame fr = new Frame ("Titolo");
            fr.setSize(150,180);
            fr.setBackground( Color.white);
            fr.show();
      }
}
```

Constructor for Frame

Methods of Frame, inherited from Component



The created object is not visible until the invocation of this method

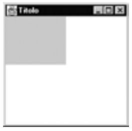
```
javac MyFrame.java
java MyFrame
```

Container: Panel

Like Window, it provides space for other components

To become visible, it must be placed onto a Window or Frame object (using method add() of class Container)

```
import java.awt.*;
public class MyFrame {
      public static void main (String[] args) {
            Frame fr = new Frame ("Titolo");
            Panel pnl = new Panel();
            fr.resize(200,200);
            fr.setBackground( Color.white);
            fr.setLayout(null);
            pnl.resize(100,100);
            pnl.setBackground( Color.cyan );
            fr.add(pnl);
            fr.show();
      }
}
```



Eliminates the default layout manager

Adds Panel onto Frame

Redraws the Frame and all the contained Components

Layout Manager

Every Container (Panel, Frame, …)
is assigned a default LayoutManager object

A LayoutManager is in charge of placing components onto a Container
according to its own rules.

The LayoutManager associated to a Container
can be substituted by the programmer
using the method setLayout() of class Container

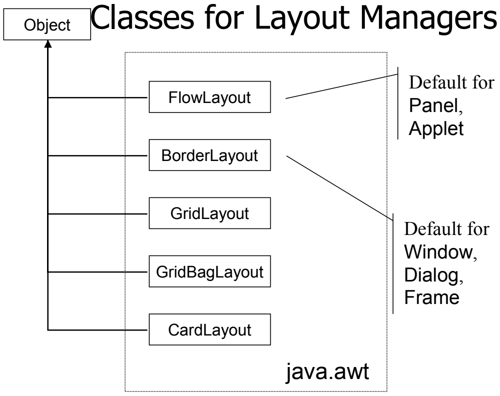
```
Frame fr = new Frame ();
fr.setLayout( lm );
...
fr.show();
```

Object of type LayoutManager

Layout Managers

- **null** – Each component has specific place and size.
- **FlowLayout** – Components are added from left to right, top to bottom, by the order they are added to the container (components are sized according to preferred size)
- **GridLayout** – Table-like order.
- **BorderLayout** – 5 regions subdivision.
- **GridbagLayout** – The most robust and complicated one.
- **BoxLayout** – Order by *y* or *x* axis

Classes for Layout Managers



Object

FlowLayout

BorderLayout

GridLayout

GridBagLayout

CardLayout

java.awt

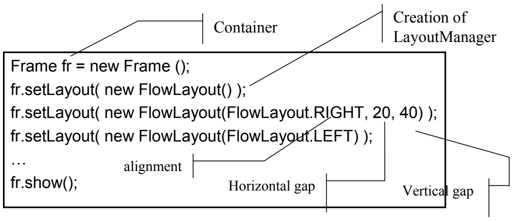
Default for Panel, Applet

Default for Window, Dialog, Frame

FlowLayout Manager (I)

Every object added to a Container with a FlowLayout manager follows the previous one, as in an horizontal line

The list of objects can be aligned (LEFT, CENTER, RIGHT), and the distance between components can be specified



Container

Creation of LayoutManager

```
Frame fr = new Frame ();
fr.setLayout( new FlowLayout() );
fr.setLayout( new FlowLayout(FlowLayout.RIGHT, 20, 40) );
fr.setLayout( new FlowLayout(FlowLayout.LEFT) );
…
fr.show();
```

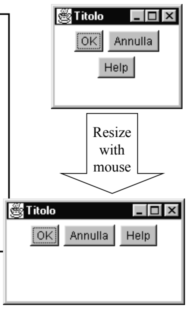
alignment

Horizontal gap

Vertical gap

FlowLayout Manager (II)

```
public class HorizFlow {
        public static void main (String[] args) {
                Frame fr = new Frame ("Titolo");
                fr.setLayout( new FlowLayout() );
                fr.add( new Button("OK") );
                fr.add( new Button("Annulla") );
                fr.add( new Button("Help") );
                fr.show();
        }
}
```



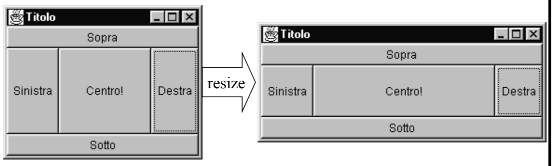
The components' size is not modified

Their position changes, according to the Frame size

BorderLayout Manager (I)

It defines five areas on a Container:

North (up) South (down) East(right) West (left) Center



The relative position of elements remains the same; but their size is modified

BorderLayout Manager (II)

Code for the window in the previous slide:

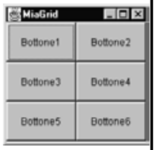
```
public class Test {
        public static void main (String[] args) {
                Frame fr = new Frame ("Titolo");
                fr.add( "East", new Button("Destra") );
                fr.add( "North", new Button("Sopra") );
                fr.add( "West", new Button("Sinistra") );
                fr.add( "South", new Button("Sotto") );
                fr.add( "Center", new Button("Centro!") );
                fr.show();
        }
}
```

The invocation fr.setLayout(new BorderLayout()); is missing, as it is the default Layout Manager for Frame

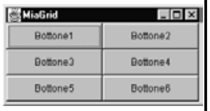
GridLayout Manager

A GridLayout manager is created with a certain number of rows and columns

Components are added just filling a row after the other



```
public class Test {
      public static void main (String[] args) {
            Frame fr = new Frame ("MiaGrid");
            fr.setLayout( new GridLayout(3,2));
            for (int i=1; i<7; i++)
                  fr.add(new Button("Bottone"+i) );
            fr.show();
      }
}
```



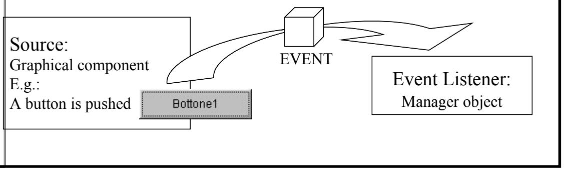
As for BorderLayout only the components' size is changed

Events (I)

- Graphical objects (Button …) "fire events" as a consequence of the user's actions:
  - A mouse click on an element;
  - A window resizing;
  - Selection of an element;
  - etc…
- Each event type is represented by a specific class
- Firing an event means creating an object (I.e. an instance of the class which describes the event)

Events (II)

- The event, after its firing, is cached by one or more "listener"
- The listeners react to the event by executing some methods
- The point (in the code!) where an event takes place, and the location where it is handled can be separate



Source:
Graphical component
E.g.:
A button is pushed

EVENT

Event Listener:
Manager object

Event Listener

It's an object of a class that implements a particular interface

```
public interface XXXListener {
      public abstract void actionPerformed( XXXEvent e);
}
```

```
class MioListener implements XXXListener {
      public void actionPerformed( XXXEvent e) {
            // code for managing the event
      }
}
```

This method is executed as the event is fired

Many interfaces of type *XXX*Listener have the only method actionPerformed(*XXX*Event)
where *XXX* is the event name: Action, Mouse, ...

"Registration" of an Event Listener

The "registration" is the operation to let the event producers know who they have to send a fired event to.
The registration is done by the methods addXXXListener()

The programmer is required to:

1. Define the graphical elements:
   Button b1 = new Button("Ok");

2. Create the *event listener* (an instance of the class that handles the event)
   XXXListener ml = new XXXListener();

3. Register it to the object that produces such an event
   b1.addXXXListener(ml);

Event Management

```
Button b1;                              //Declaration of a graphical object
…
b1=new Button("ClickOnMe")              //Creation of the graphical object
                                        //not visible yet
MyButtListener mngr=new MyButtListener();   //Creation of an obj
                                        //able to handle the event types
                                        //I'm interested in (types are specified
                                        //by interfaces)

b1.addActionListener(mngr);             //Association of an event manager
                                        //to the event producer
```

When the user push the button:

- an instance of ActionEvent is created
- the method actionPerformed() is executed, with such an object as the parameter

Event Listener: Use of *Inner Classes*

```
import java.awt.*;
import java.awt.event.*;
public class MyEvent {
      Frame fr;     // visible from inside class MyEvent
      Button b1;    // thus also from the INNER class MyButtListener
      public static void main(String[] args) {
            MyEvent e = new MyEvent();
            e.myOpen();
      }
      void myOpen() {
            fr = new Frame("My Event");
            fr.setLayout( new FlowLayout() );
            b1 = new Button("On");
            b1.addActionListener( new MyButtListener() );
            fr.add( b1 );     // add button to Frame
            fr.show();
      }
      class MyButtListener implements ActionListener {
            public void actionPerformed( ActionEvent e) {
                  if ( b1.getLabel().equals("On") )    b1.setLabel("Off");
                  else                                 b1.setLabel("On");
            }
      }
}
```

Add for the event management

Pushing the button, the label switches from On to Off and back.

Non-static access to the *InnerClass*

Creation and registration of EventListener

Event management

EventListeners:
Interfaces with Multiple Methods

- Interface ActionListener has the only method actionPerformed()
- Some other interfaces have more methods, in addition to actionPerformed()

  The classes that extend such interfaces must implement ALL the methods, regardless of their actual use
- This can be boring. A possible trick is the use of *adapter classes*:
  - They implement such interfaces,
  - And define ALL the methods, but empty

  The programmer can:
  - Write an event listener as a class that extends the *adapter class*
  - *override* only the useful methods

Event Types and Syntax

Al the AWT components have the methods:

- addXXXListener()
- removeXXXListener()

XXX represents the event type, and it is present in:

- The method name: addXXXListener()
- The name of the class describing the event: class XXXEvent
- The interface to be implemented by the listener class interface: XXXListener

Events and Listeners (1)

Event types and their generator components

event type	component	event description
ActionEvent	Button, List, TextField,...	*button push, element selection in list, writing inTextField*
AdjustmentEvent	Scrollbar, ...	*scrollbar movement*
ComponentEvent	Component and sub-cl	*movement and resizing*
KeyEvent	Component and sub-cl	*key push*
MouseEvent	Component and sub-cl	*pointer movement, click, double click....*

Events and Listeners (2)

- Each component supports only some event types
- To know what the events associated to a component are, we can read the API documentation for that component:

e.g. Button has method addActionListener()

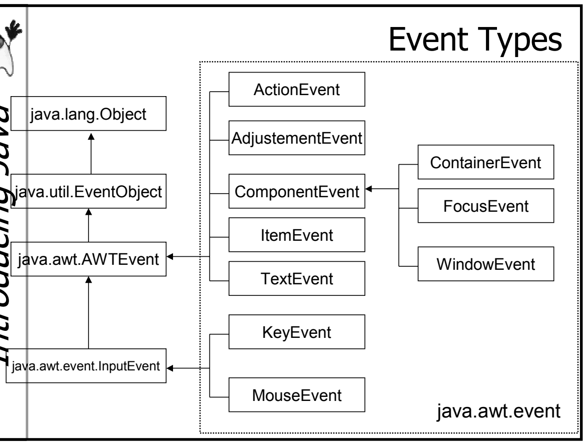
⇨ Button can fire an ActionEvent

Button derives from Component

Component has methods: addFocusListener, addKeyListener, addMouseListener, ...

⇨ Button can fire: FocusEvent, KeyEvent, MouseEvent, ...

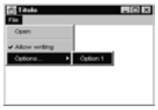
Event Types



Menu

Menus can be added to objects of class Frame, or its subclasses

1. Create a MenuBar object
   MenuBar mb=new MenuBar();
2. Create a Menu object
   Menu m=new Menu("File");
3. Create MenuItem objects, and add them to the menu
   m.add(new MenuItem("Open"));
   m. addSeparator(); // add a separator
   m.add(new CheckboxMenuItem("Allow writing")); // Checkbox
   Menu sub = new Menu("Options..."); //Create a submenu
   sub.add(new MenuItem("Option 1"));
   m.add(sub); // add submenu
4. Adds Menu to MenuBar (rightward)
   mb.add(m);
5. Add MenuBar to window by the proper method
   frame.setMenuBar(mb);



Example 1

Create a window with three buttons, and handle the event fired as they are pushed.

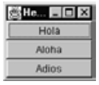
```
public class Activator {
  public static void main(String[] args) {
    Button b;
    ActionListener al = new MyActionListener();
    Frame f = new Frame("Hello Java");
    f.add(b = new Button("Hola"), BorderLayout.NORTH);
    b.setActionCommand("Hello");
    b.addActionListener(al);
    f.add(b = new Button("Aloha"), BorderLayout.CENTER);
    b.addActionListener(al);
    f.add(b = new Button("Adios"), BorderLayout.SOUTH);
    b.setActionCommand("Quit");
    b.addActionListener(al);
    f.pack();
    f.show();
  }
}
```

The command associated to buttons could be different to the one visualized on it

(internationalization)

Example 1

```
class MyActionListener implements ActionListener {
  public void actionPerformed(ActionEvent e) {
  String s = e.getActionCommand();
  if (s.equals("Quit")) {
    System.exit(0);
  } else if (s.equals("Hello")) {
    System.out.println("Bon Jour");
  } else {
    System.out.println(s + " selected");
  }
 }
}
```



A different ActionListener can be associated to each button, so that we don't have to check what button generated the event (IDE)

Example 2

```
public class Draw extends Frame{
  public void init() {
    addMouseListener(
      new MouseAdapter() {
          int savedX, savedY;
          public void mousePressed(MouseEvent e) {
            savedX = e.getX();
            savedY = e.getY();
          }
          public void mouseReleased(MouseEvent e) {
            Graphics g = Draw.this.getGraphics();
            g.drawRect(savedX, savedY,
                        e.getX()-savedX,
                        e.getY()-savedY);
          }
      }
    );
}
```

Usare una classe adapter come classe interna anonima per disegnare rettangoli all'interno di una finestra: pressione del bottone per l'angolo in alto a sx, rilascio del bottone del mouse per l'angolo in basso a dx

```
  public static void main (String[] args){
              Draw d=new Draw();
              d.init();
              d.show();
  }
}
```

Swing

- Il package swing estende le capacità grafiche di Java introducendo un nuovo insieme di componenti che affiancano quelli di AWT
- In molti casi i widget di swing sono analoghi a quelli di AWT, ma con una differenza sostanziale
  - I widget di AWT sono realizzati usando i widget nativi del sistema operativo sottostante (peer-based components)
  - I widget di swing possono esistere anche senza che esista un corrispondente nel sistema operativo sottostante (lightweight components)
- Per questo motivo una interfaccia swing ha un "look and feel" che è indipendente dal sistema operativo e può essere cambiato dinamicamente (il "look and feel" di defaul è detto *Metal*)
- Swing introduce anche alcuni nuovi componenti

Swing: Some Components

- JPanel

è un oggetto simile a Panel (ligthweight) con il supporto per il double-buffering

- Icon

non è un componente ma può essere usata con quasi tutti i componenti (è possibile inserire icone all'interno di bottoni ed altri componenti)

Oggetti che agiscono da icone implementano l'interfaccia Icon:

```
public interface Icon {
  void paintIcon( Component c, Graphics g, int x, int y);
  int getIconWidth();
  int getIconHeight();
}
```

La classe ImageIcon implementa l'interfaccia Icon e può essere usata per rappresentare immagini

```
Icon tinyPicture = new ImageIcon("TinyPicture.gif");
```

Swing: Some Components

Esistono costruttori di ImageIcon che accettano come parametro un URL o un byte array

E' possibile creare icone implementando l'interfaccia ad es. nel seguente modo:

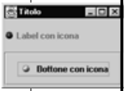
```
public class RedOval implements Icon {
  public void paintIcon (Component c, Graphics g, int x, int y) {
    g.setColor(Color.red);
    g.drawOval (x, y, getIconWidth(), getIconHeight());
  }
  public int getIconWidth() { return 10; }
  public int getIconHeight() { return 10; }
}
```

Swing: Some Components

- JLabel similar to Label, but with the additional capability to add icons to text
- JButton similar to Button, plus icons

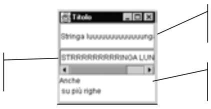
Example:

```
public class Example {
  public static void main(String[] args) {
              JFrame f=new JFrame("Titolo");
              Container c=f.getContentPane();
              c.setLayout(new GridLayout(2,1));
              Icon ic1=new ImageIcon("redball.gif");
              Icon ic2=new ImageIcon("greenball.gif");
              JLabel lab=new JLabel("Label con icona");
              lab.setIcon(ic1);
              JButton b=new JButton("Bottone con icona",ic2);
              c.add(lab);
              c.add(b);
              f.show();
  }
}
```



Swing: JTextComponents

- Classe JTextComponent is the superclass of components used for visualization and for text manipulation:
  - JTextField
  - JTextArea
  - JTextPane
  - JPasswordField
  - JEditorPane
- JTextField and JTextArea are similat to their AWT counterparts, but they must be eventually placed inside a JScrollPane



JTextField

JTextField inside a JScrollPane

JTextArea

Swing: JTextPane

JTextPane is a text editor that supports text formatting, word-wrapping and visualization of pictures

1. Create a DefaultStyledDocument:
   DefaultStyledDocument doc=new DefaultStyledDocument();
2. Create a JTextPane passing the DefaultStyleDocument
   JTextPane pane=new JTextPane(doc);
3. Insert the JTextPane upon a JScrollPane: JScrollPane scrollPane=new JScrollPane(pane);
4. Define styles and associate them to document portions

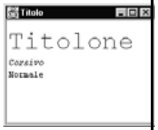
Swing: JTextPane

```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;
import javax.swing.text.*;
public class Esempio2 {
    public static void main(String[] args) {
              JFrame f=new JFrame("Titolo");
              Container c=f.getContentPane();
              DefaultStyledDocument doc=new DefaultStyledDocument();
              JTextPane tp=new JTextPane(doc);
              c.add(new JScrollPane(tp));

              SimpleAttributeSet normal=new SimpleAttributeSet();

              SimpleAttributeSet italic=new SimpleAttributeSet();
              StyleConstants.setItalic(italic, true);

              SimpleAttributeSet big=new SimpleAttributeSet();
              StyleConstants.setFontSize(big, 36);
              …
              doc.insertString(doc.getLength(), "Titolone\n", big);
              doc.insertString(doc.getLength(), "Corsivo\n", italic);
              doc.insertString(doc.getLength(), "Normale", normal);
              …
              f.show();
    }
}
```

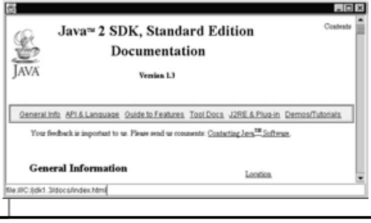


```
Titolone
Corsivo
Normale
```

Swing: JEditorPane

JEditorPane è un editor di testo che supporta testi in formato RTF e HTML

Non è un browser completo, ma può essere usato per visualizzare help in formato HTML



Java™ 2 SDK, Standard Edition
Documentation
Version 1.3

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JAVA

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General Information

Location

file:///C:/jdk1.3/docs/index.html

Example: a Browser (1)

L'immagine del lucido precedente è stata realizzata con la seguente classe

```
import java.awt.*;
import java.awt.event.*;
import java.io.*;
import java.net.*;
import javax.swing.*;
import javax.swing.event.*;
import javax.swing.text.*;
public class Browser extends JPanel{
  public Browser(){
            setLayout(new BorderLayout());
            final JEditorPane jt = new JEditorPane();
            final JTextField input = new JTextField("http://www.unipi.it");
            // Il JEditorPanel non è modificabile
            jt.setEditable(false);
            //CONTINUA
```

Example: a Browser (2)

```
// Per seguire i link
jt.addHyperlinkListener(new HyperlinkListener () {
        public void hyperlinkUpdate(final HyperlinkEvent e) {
                if (e.getEventType() == HyperlinkEvent.EventType.ACTIVATED) {

                        // Salva il vecchio doc
                        Document doc = jt.getDocument();
                        try {
                            URL url = e.getURL();
                            jt.setPage(url);
                            input.setText (url.toString());
                        } catch (IOException io) {
                            JOptionPane.showMessageDialog (
                            Browser.this, “Link non valido",
                            "Input non valido",
                            JOptionPane.ERROR_MESSAGE);
                            jt.setDocument (doc);
                        }
                }
        }
 });
//CONTINUA
```

Example: a Browser (3)

```
            JScrollPane pane = new JScrollPane();
            pane.getViewport().add(jt);
            add(pane, BorderLayout.CENTER);

            input.addActionListener (new ActionListener() {
                public void actionPerformed (ActionEvent e) {
                      try {
                        jt.setPage (input.getText());
                      } catch (IOException ex) {
                        JOptionPane.showMessageDialog (
                        Browser.this, “URL non valido",
                        "Input non valido",
                        JOptionPane.ERROR_MESSAGE);
                      }
                }
            });
  add (input, BorderLayout.SOUTH);
 }
 //CONTINUA
```

Example: a Browser (4)

```
public static void main(String[] args) {
                        JFrame fr=new JFrame();
                        Container c=fr.getContentPane();

                        Browser b=new Browser();
                        c.add(b);
                        fr.show();
            }
}
```