Programmazione grafica

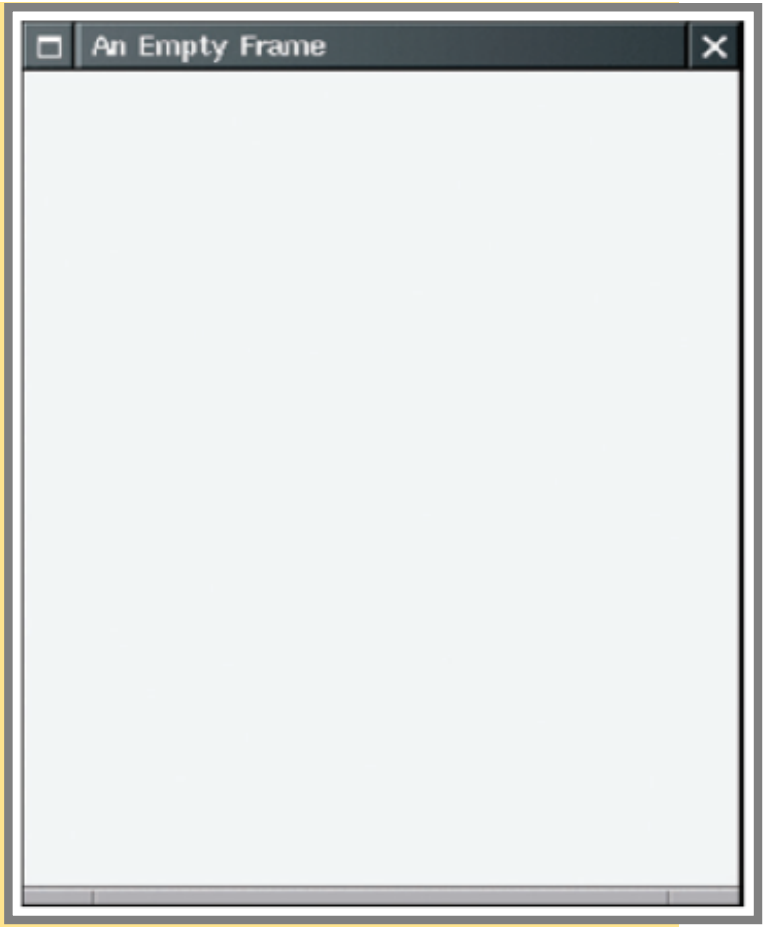
Applicazione grafica

- Visualizza informazioni all'interno di una finestra dotata di barra di titolo e cornice (**frame**)

- La Java Virtual Machine esegue ogni frame su un **thread** separato
  - la gestione del frame e delle operazioni che genera è affidata ad un thread
  - thread = flusso di esecuzione, processo, visione dinamica di un programma sequenziale

Finestre: classe **JFrame**

```
import javax.swing.*;

.....

.....

.....



JFrame frame = new JFrame();
frame.setSize(300, 400);
frame.setTitle("An Empty Frame");
frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
frame.setVisible(true);
```



File EmptyFrameViewer.java

```
01: import javax.swing.*;
02:
03: public class EmptyFrameViewer
04: {
05:    public static void main(String[] args)
06:    {
07:       JFrame frame = new JFrame();
08:
09:       final int FRAME_WIDTH = 300;
10:       final int FRAME_HEIGHT = 400;
11:
12:       frame.setSize(FRAME_WIDTH, FRAME_HEIGHT);
13:       frame.setTitle("An Empty Frame");
14:       frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
15:
16:       frame.setVisible(true);
17:    }
18: }
```

Disegnare figure

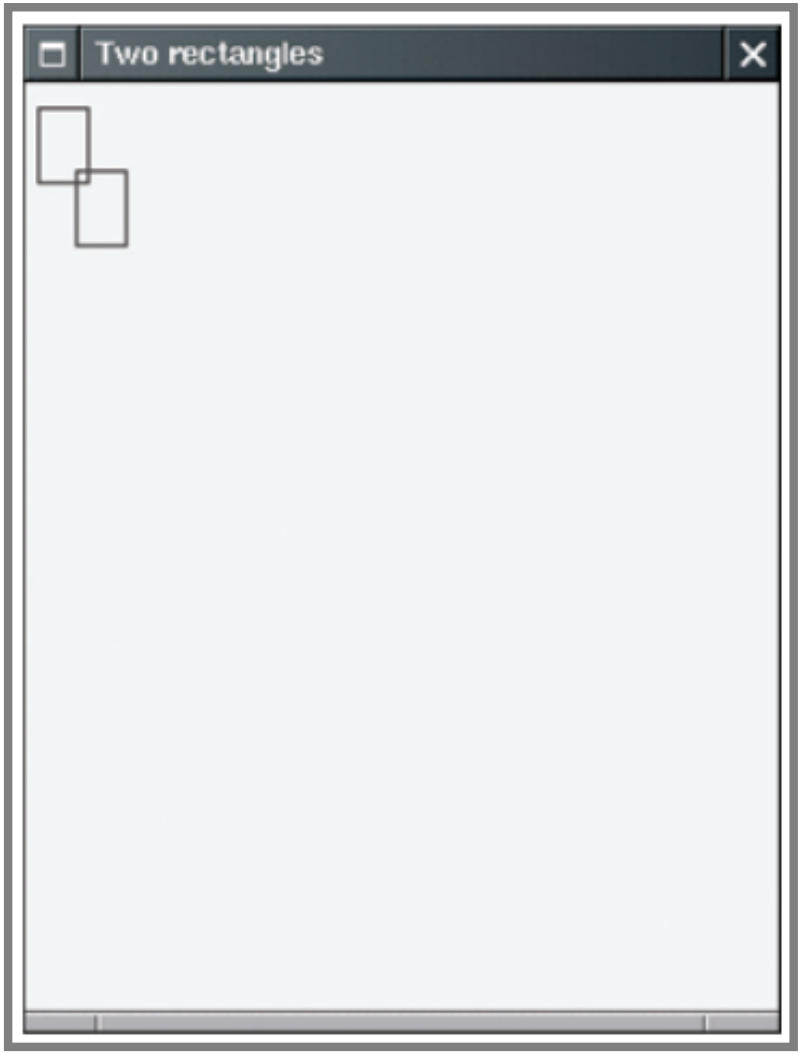
- per visualizzare qualcosa all'interno di un frame occorre definire un oggetto di tipo componente e aggiungerlo al frame
- si deve modificare (usando l'ereditarietà) la classe **JComponent**

```
public class RectangleComponent extends JComponent
{
  public void paintComponent(Graphics g)
   {
    // Recover Graphics2D
    Graphics2D g2 = (Graphics2D) g;
    . . .
   }
}
```

Disegnare forme

- `paintComponent`
  - chiamato ogni volta che una componente necessita di essere ridisegnata
  - le istruzioni di disegno sono inserite in questo metodo
- `Graphics` ci consente di manipolare lo stato grafico (ad es. colore). Classe astratta.
- `Graphics2D`: astratta, estende `Graphics`, ha metodi per tracciare forme grafiche
- Cast a `Graphics2D` del parametro `Graphics` serve per usare il metodo `draw`
- `Graphics` e `Graphics2D` sono in `java.awt`

Esempio: disegnare rettangoli in un frame



Classi del programma

- **`RectangleComponent`**: contiene metodo **`paintComponent`** che esegue il disegno

- **`RectangleViewer`**:
  - contiene il metodo **`main`** che costruisce un frame
  - aggiunge una componente al frame e rende il frame visibile

File RectangleComponent.java

```
01: import java.awt.Graphics; import java.awt.Graphics2D;
02: import java.awt.Rectangle; import javax.swing.JPanel;
03: import javax.swing.JComponent;
04:
05: //  A component that draws two rectangles.
06: public class RectangleComponent extends JComponent
07: {
08:    public void paintComponent(Graphics g)
09:    {
10:       // Recover Graphics2D
11:       Graphics2D g2 = (Graphics2D) g;
12:
13:       // Construct a rectangle and draw it
14:       Rectangle box = new Rectangle(5, 10, 20, 30);
15:       g2.draw(box);
16:
17:       // Move rectangle 15 units to the right and 25 units down
18:       box.translate(15, 25);
19:
20:       // Draw moved rectangle
21:       g2.draw(box);
22:    }
23: }
```

File RectangleViewer.java

```
01: import javax.swing.JFrame;
02:
03: public class RectangleViewer
04: {
05:    public static void main(String[] args)
06:    {
07:       JFrame frame = new JFrame();
08:
09:       final int FRAME_WIDTH = 300;
10:       final int FRAME_HEIGHT = 400;
11:
12:       frame.setSize(FRAME_WIDTH, FRAME_HEIGHT);
13:       frame.setTitle("Two rectangles");
14:       frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
15:
16:       RectangleComponent component = new RectangleComponent();
17:       frame.add(component);
18:
19:       frame.setVisible(true);
20:    }
21: }
```

Ricapitoliamo i passi

1. Costruire un frame
2. Costruire una componente:

```
RectangleComponent component = new RectangleComponent();
```

3. Aggiungi la componente al frame

```
frame.add(component);
```

Se si usa una versione precedente Java 5.0:

```
frame.getContentPane().add(component);
```

4. Rendi il frame visibile

Applet

- Le applet sono programmi che vengono eseguiti in un web browser
- Per implementare un'applet:

```
import javax.swing.JApplet;
public class MyApplet extends JApplet
{
  public void paint(Graphics g)
  {
   // Recover Graphics2D
   Graphics2D g2 = (Graphics2D) g;
   // Drawing instructions go here
   . . .
  }
}
```

Applet

- Rispetto alle componenti:
  1. Si estende `JApplet` invece di `JComponent`
  2. Il codice per tracciare il disegno viene messo nel metodo `paint` anziché `paintComponent`

- Per eseguire un'applet, si deve scrivere un file HTML con un tag `applet`

File RectangleApplet.java

```
01: import java.awt.Graphics;
02: import java.awt.Graphics2D;
03: import java.awt.Rectangle;
04: import javax.swing.JApplet;
05:
06: /**
07:    An applet that draws two rectangles.
08: */
09: public class RectangleApplet extends JApplet
10: {
11:    public void paint(Graphics g)
12:    {
13:       // Prepare for extended graphics
14:       Graphics2D g2 = (Graphics2D) g;
```

File RectangleApplet.java

```
15:
16:         // Construct a rectangle and draw it
17:         Rectangle box = new Rectangle(5, 10, 20, 30);
18:         g2.draw(box);
19:
20:         // Move rectangle 15 units to the right and 25 units down
21:         box.translate(15, 25);
22:
23:         // Draw moved rectangle
24:         g2.draw(box);
25:     }
26: }
27:
```

Applet

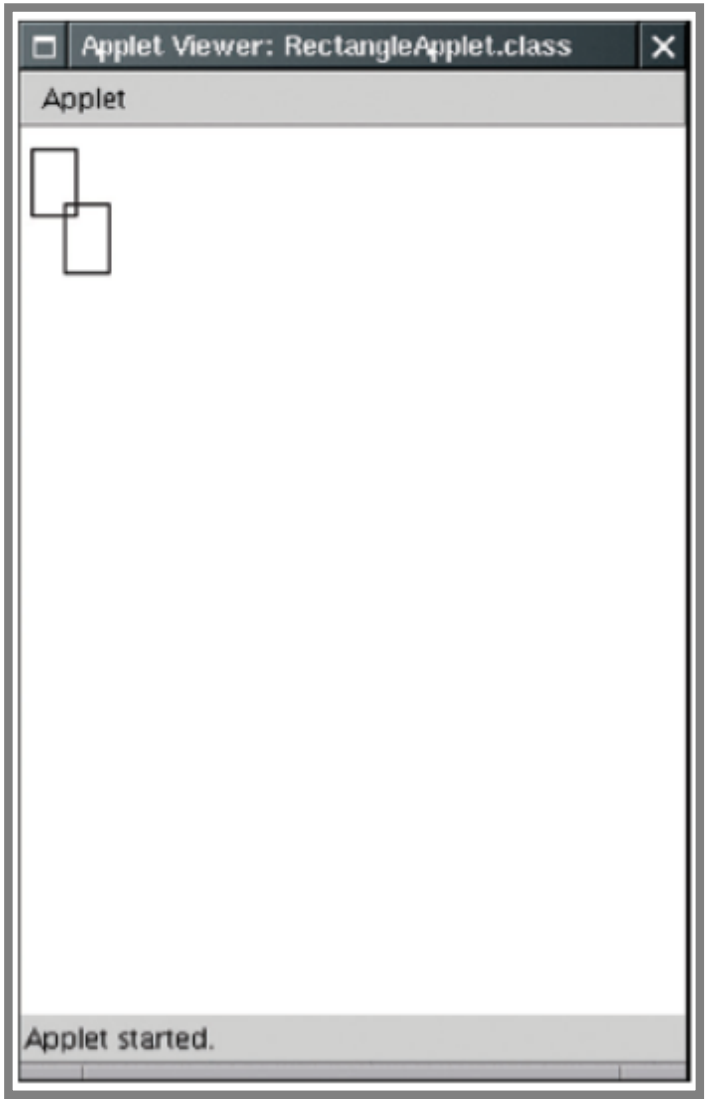
- Un file HTML può avere applet multiple
  - si aggiunge un tag **`applet`** per ogni applet
- Si possono visualizzare le applet con un **`applet`** viewer o con un browser con Java abilitato

```
appletviewer RectangleApplet.html
```

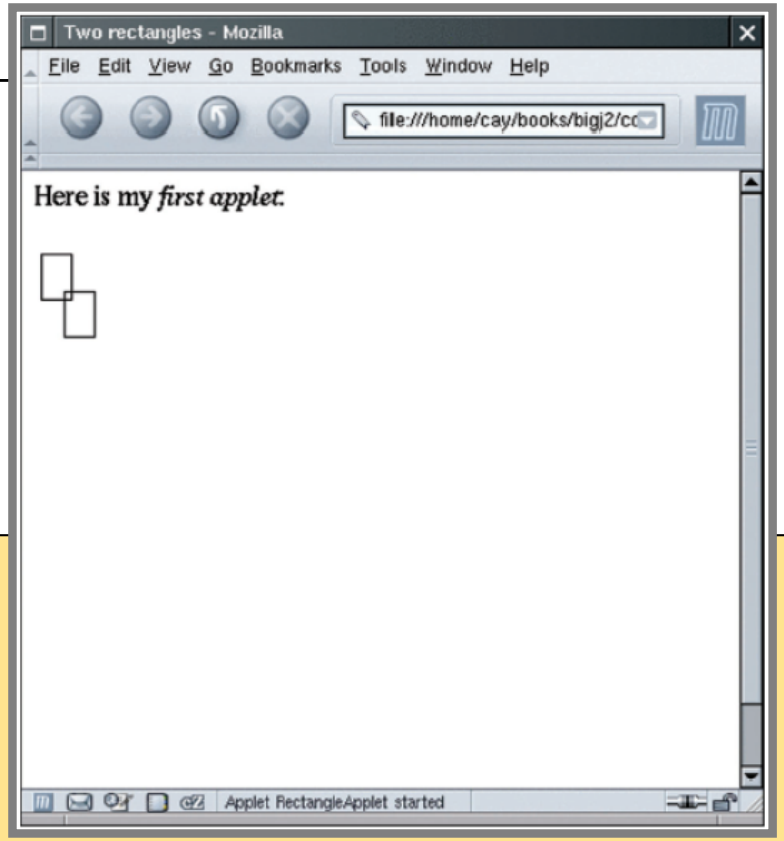
File RectangleApplet.html:

```
<applet code="RectangleApplet.class" width="300" height="400">
</applet>
```

Output con appletviewer



Applet con browser



File RAppletExplained.html:

```
<html>
   <head>
      <title>Two rectangles</title>
   </head>
   <body>
      <p>Here is my <i>first applet</i>:</p>
      <applet code="RectangleApplet.class" width="300" height="400">
      </applet>
   </body>
</html>
```

Forme grafiche

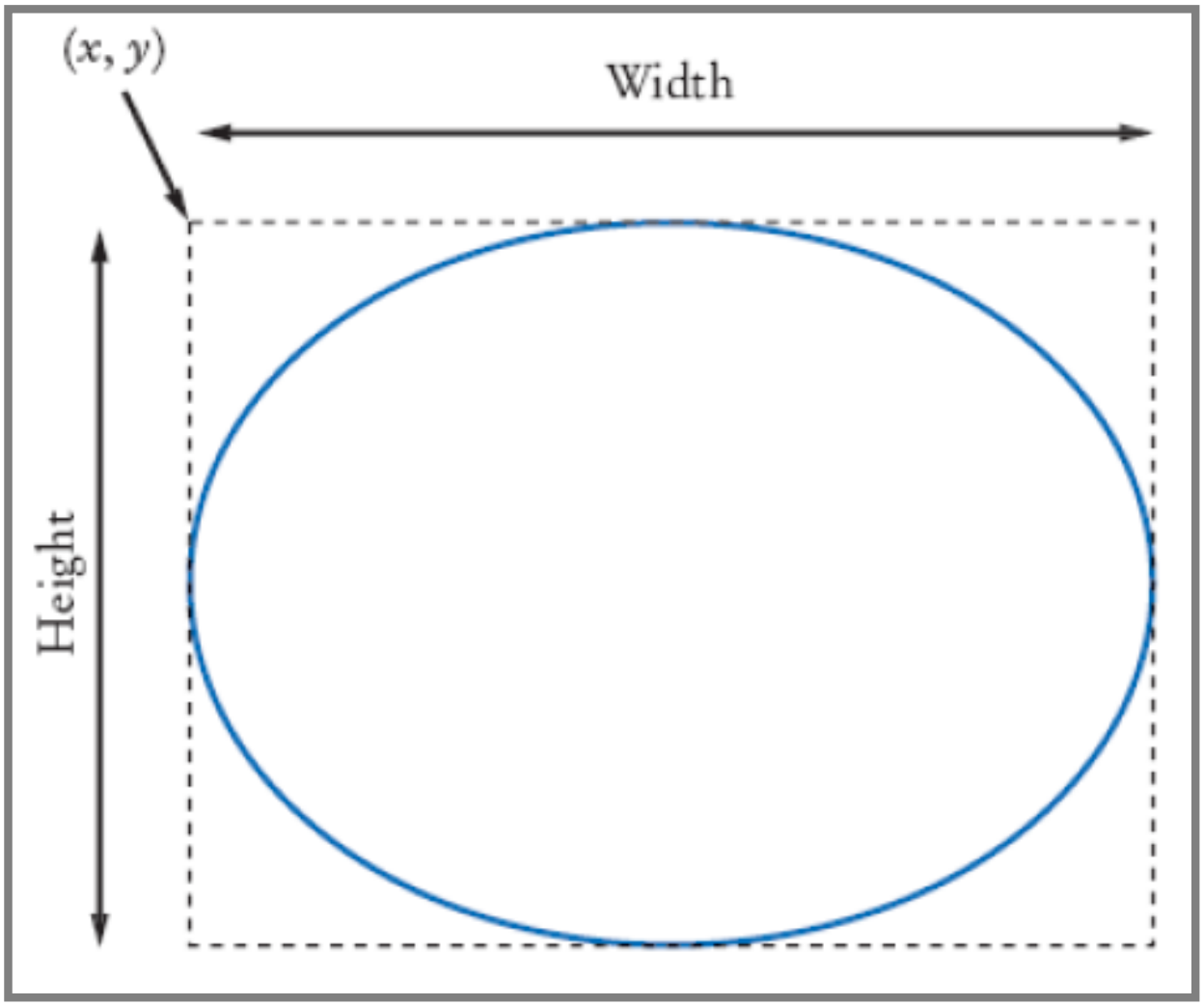
- Le classi `Rectangle`, `Ellipse2D.Double`, e `Line2D.Double` descrivono forme grafiche
  - Classi `.Float` esprimono coordinate in float
- Queste classi `.Double` e `.Float` sono classi interne di `Ellipse2D` e `Line2D`
  - fare attenzione con l'istruzione `import`:

```
import java.awt.geom.Ellipse2D; // no .Double
```

- Una forma deve essere istanziata e tracciata

```
Ellipse2D.Double ellipse = new Ellipse2D.Double(x, y, width, height);
g2.draw(ellipse);
```

Significato dei parametri ellisse



Istanziare oggetti Line2D

- Passiamo coordinate estremi:

```
Line2D.Double segment = new Line2D.Double(x1, y1, x2, y2);
```

- oppure gli estremi stessi:

```
Point2D.Double from = new Point2D.Double(x1, y1);
Point2D.Double to = new Point2D.Double(x2, y2);
Line2D.Double segment = new Line2D.Double(from, to);
```

Tracciare oggetti di tipo String

Coordinate punto base

```
g2.drawString("Message", 50, 100);
```

Colori

- Colori standard `Color.BLUE`, `Color.RED`, `Color.PINK`, etc. (costanti)
- Altri colori si possono ottenere combinando rosso, verde e blu dando per ognuno dei valori compresi tra `0.0F` e `1.0F`
- Ad es.:

```
Color magenta = new Color(1.0F, 0.0F, 1.0F);
```

- Stabilire i colori in un contesto grafico

```
g2.setColor(magenta);
```

- `Color` è usato quando si tracciano e riempiono forme grafiche

```
g2.fill(rectangle); // riempe con il colore corrente
```

Disegnare figure complesse

- Consiglio: definire una classe per ogni forma

```
class Car
{
   . . .
   public void draw(Graphics2D g2)
   {
      // Drawing instructions
      . . .
   }
}
```

- Per figure complesse determinare le coordinate con disegni su foglio quadrettato

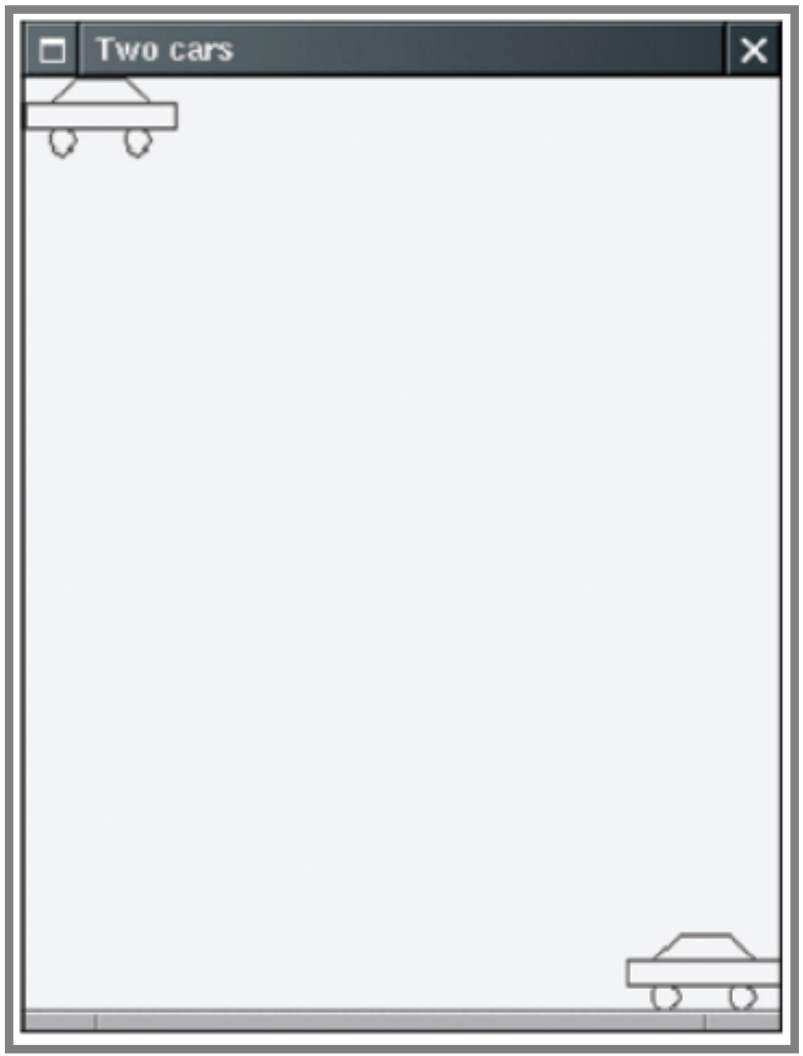
Disegnare oggetti Car

- Disegna due auto:
  - una nell'angolo in alto a sinistra
  - l'altra nell'angolo in basso a destra
- Calcola la posizione in basso a destra nel metodo `paintComponent`:

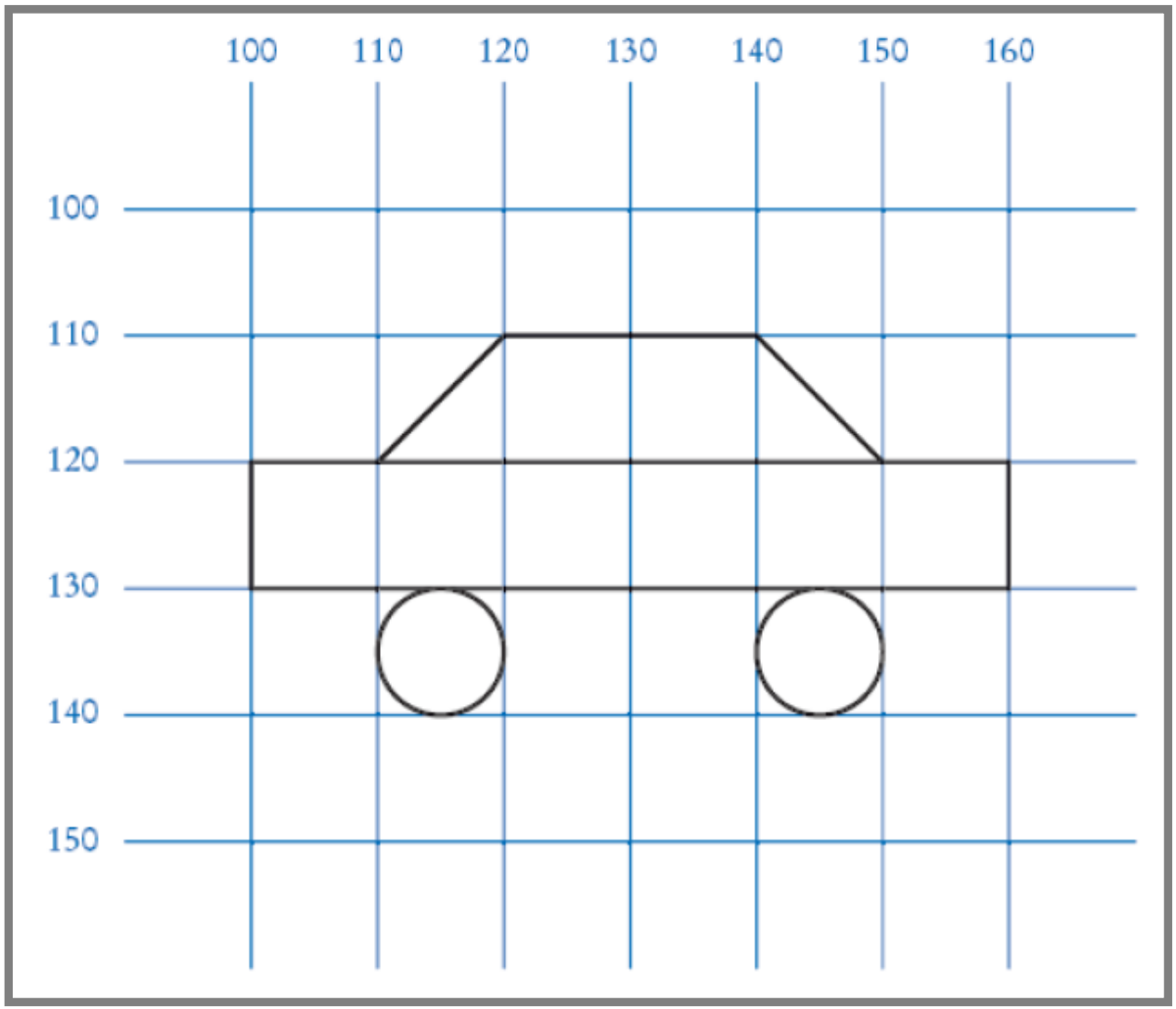
```
int x = getWidth() - 60;
int y = getHeight() - 30;
Car car2 = new Car(x, y)
```

- `getWidth` e `getHeight` sono invocate sull'oggetto che esegue `paintComponent`
- se la taglia della finestra è modificata, `paintComponent` è invocata e la posizione delle auto è ricalcolata

Esempio: output



Coordinate per disegnare auto



File CarComponent.java

```
01: import java.awt.Graphics;
02: import java.awt.Graphics2D;
03: import javax.swing.JComponent;
04:
05: /**
06:    This component draws two car shapes.
07: */
08: public class CarComponent extends JComponent
09: {
10:    public void paintComponent(Graphics g)
11:    {
12:       Graphics2D g2 = (Graphics2D) g;
13:
14:       Car car1 = new Car(0, 0);
15:
16:       int x = getWidth() - Car.WIDTH;
17:       int y = getHeight() - Car.HEIGHT;
18:
19:       Car car2 = new Car(x, y);
20:
21:       car1.draw(g2);
22:       car2.draw(g2);
23:    }
24: }
```

File Car.java

```
01: import java.awt.Graphics2D;
02: import java.awt.Rectangle;
03: import java.awt.geom.Ellipse2D;
04: import java.awt.geom.Line2D;
05: import java.awt.geom.Point2D;
06:
07: /**
08:    A car shape that can be positioned anywhere on the screen.
09: */
10: public class Car
11: {
12:    /**
13:       Constructs a car with a given top left corner
14:       @param x the x coordinate of the top left corner
15:       @param y the y coordinate of the top left corner
16:    */
```

File Car.java

```
17:    public Car(int x, int y)
18:    {
19:       xLeft = x;
20:       yTop = y;
21:    }
22:
23:    /**
24:       Draws the car.
25:       @param g2 the graphics context
26:    */
27:    public void draw(Graphics2D g2)
28:    {
29:       Rectangle body
30:             = new Rectangle(xLeft, yTop + 10, 60, 10);
31:       Ellipse2D.Double frontTire
32:             = new Ellipse2D.Double(xLeft + 10, yTop
                     + 20, 10, 10);
```

File Car.java

```
33:         Ellipse2D.Double rearTire
34:               = new Ellipse2D.Double(xLeft + 40, yTop
                        + 20, 10, 10);
35:
36:         // The bottom of the front windshield
37:         Point2D.Double r1
38:               = new Point2D.Double(xLeft + 10, yTop + 10);
39:         // The front of the roof
40:         Point2D.Double r2
41:               = new Point2D.Double(xLeft + 20, yTop);
42:         // The rear of the roof
43:         Point2D.Double r3
44:               = new Point2D.Double(xLeft + 40, yTop);
45:         // The bottom of the rear windshield
46:         Point2D.Double r4
47:               = new Point2D.Double(xLeft + 50, yTop + 10);
48:
49:         Line2D.Double frontWindshield
50:               = new Line2D.Double(r1, r2);
```

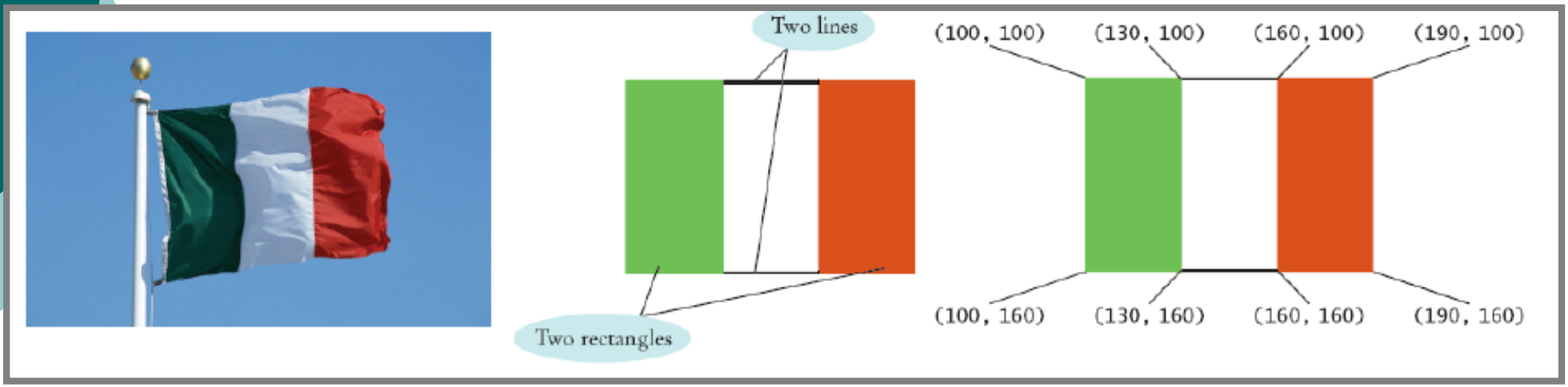
File Car.java

```
51:         Line2D.Double roofTop
52:               = new Line2D.Double(r2, r3);
53:         Line2D.Double rearWindshield
54:               = new Line2D.Double(r3, r4);
55:
56:         g2.draw(body);
57:         g2.draw(frontTire);
58:         g2.draw(rearTire);
59:         g2.draw(frontWindshield);
60:         g2.draw(roofTop);
61:         g2.draw(rearWindshield);
62:      }
63:
64:      public static int WIDTH = 60;
65:      public static int HEIGHT = 30;
66:      private int xLeft;
67:      private int yTop;
68: }
```

File CarViewer.java

```
01: import javax.swing.JFrame;
02:
03: public class CarViewer
04: {
05:    public static void main(String[] args)
06:    {
07:       JFrame frame = new JFrame();
08:
09:       final int FRAME_WIDTH = 300;
10:       final int FRAME_HEIGHT = 400;
11:
12:       frame.setSize(FRAME_WIDTH, FRAME_HEIGHT);
13:       frame.setTitle("Two cars");
14:       frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
15:
16:       CarComponent component = new CarComponent();
17:       frame.add(component);
18:
19:       frame.setVisible(true);
20:    }
21: }
```

Disegnare forme grafiche

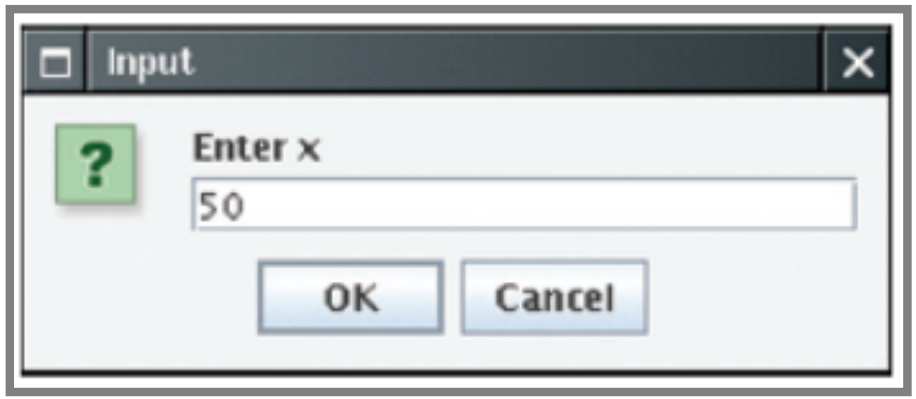



```
Rectangle leftRectangle = new Rectangle(100, 100, 30, 60);
Rectangle rightRectangle = new Rectangle(160, 100, 30, 60);
Line2D.Double topLine
   = new Line2D.Double(130, 100, 160, 100);
Line2D.Double bottomLine
   = new Line2D.Double(130, 160, 160, 160);
```

Ricevere testo in input

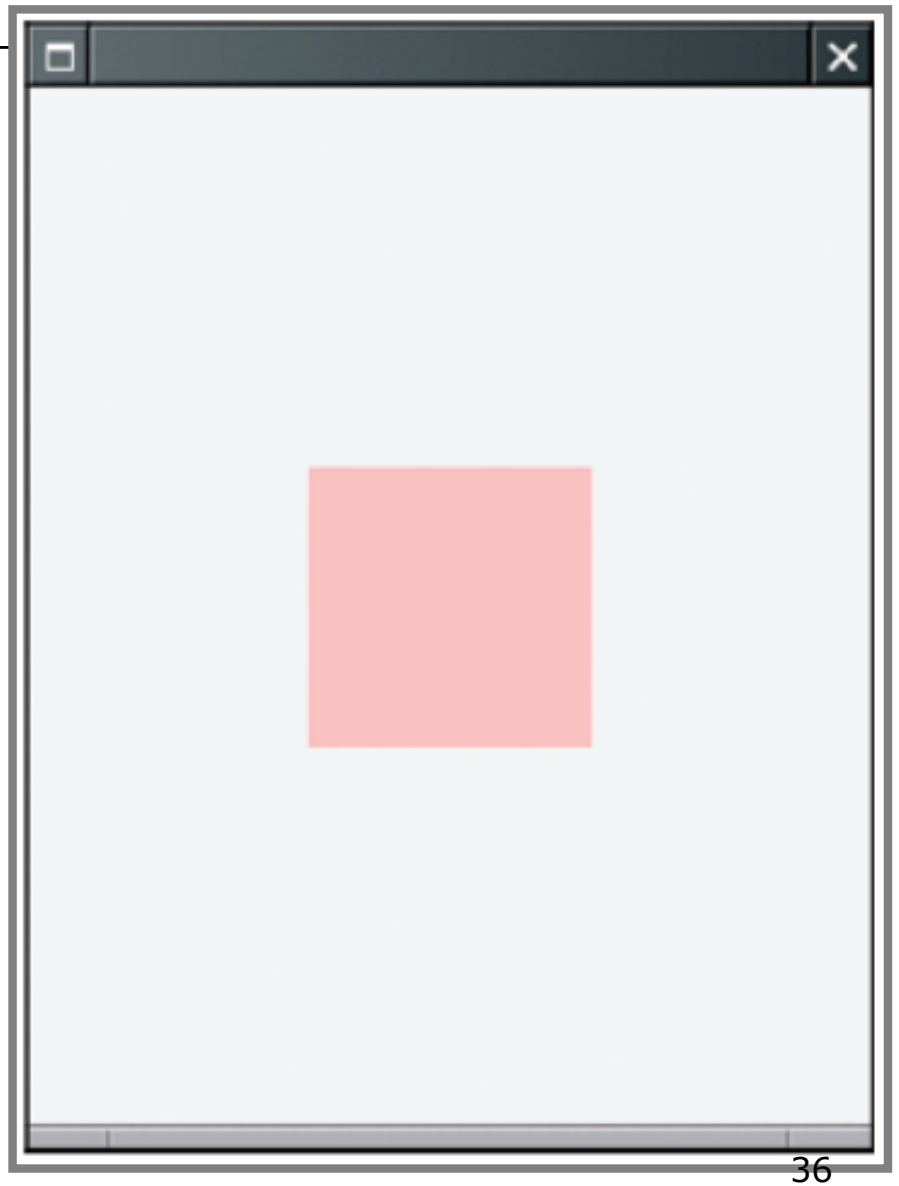
- Un'applicazione grafica può ricevere testo in input lanciando un oggetto `JOptionPane`
- Il metodo `showInputDialog`
  - visualizza un prompt e attende l'input dall'utente
  - restituisce la stringa digitata dall'utente

```
String input = JOptionPane.showInputDialog("Enter x");
double x = Double.parseDouble(input);
```



Esercizio

Si vuole generare un quadrato del colore specificato dall'utente al centro del frame



File ColorViewer.java

```
01: import java.awt.Color;
02: import javax.swing.JFrame;
03: import javax.swing.JOptionPane;
04:
05: public class ColorViewer
06: {
07:    public static void main(String[] args)
08:    {
09:       JFrame frame = new JFrame();
10:
11:       final int FRAME_WIDTH = 300;
12:       final int FRAME_HEIGHT = 400;
13:
14:       frame.setSize(FRAME_WIDTH, FRAME_HEIGHT);
15:       frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
16:
17:       String input;
18:
```

File ColorViewer.java

```
19:         // Ask the user for red, green, blue values
20:
21:         input = JOptionPane.showInputDialog("red:");
22:         double red = Double.parseDouble(input);
23:
24:         input = JOptionPane.showInputDialog("green:");
25:         double green = Double.parseDouble(input);
26:
27:         input = JOptionPane.showInputDialog("blue:");
28:         double blue = Double.parseDouble(input);
29:
30:         Color fillColor = new Color(
31:               (float) red, (float) green, (float) blue);
32:         ColoredSquareComponent component
33:               = new ColoredSquareComponent(fillColor);
34:         frame.add(component);
35:
36:         frame.setVisible(true);
37:    }
38: }
```

File ColoredSquareComponent.java

```
01: import java.awt.Color;
02: import java.awt.Graphics;
03: import java.awt.Graphics2D;
04: import java.awt.Rectangle;
05: import javax.swing.JComponent;
06:
07: /**
08:    A component that shows a colored square.
09: */
10: public class ColoredSquareComponent extends JComponent
11: {
12:    /**
13:       Constructs a component that shows a colored square.
14:       @param aColor the fill color for the square
15:    */
16:    public ColoredSquareComponent(Color aColor)
```

File ColoredSquareComponent.java

```
17:     {
18:        fillColor = aColor;
19:     }
20:
21:     public void paintComponent(Graphics g)
22:     {
23:        Graphics2D g2 = (Graphics2D) g;
24:
25:        // Select color into graphics context
26:
27:        g2.setColor(fillColor);
28:
29:        // Construct and fill a square whose center is
30:        // the center of the window
31:
```

File ColoredSquareComponent.java

```
32:         final int SQUARE_LENGTH = 100;
33:
34:         Rectangle square = new Rectangle(
35:               (getWidth() - SQUARE_LENGTH) / 2,
36:               (getHeight() - SQUARE_LENGTH) / 2,
37:               SQUARE_LENGTH,
38:               SQUARE_LENGTH);
39:
40:         g2.fill(square);
41:      }
42:
43:      private Color fillColor;
44: }
```