Graphics

Object Orientated Programming in Java

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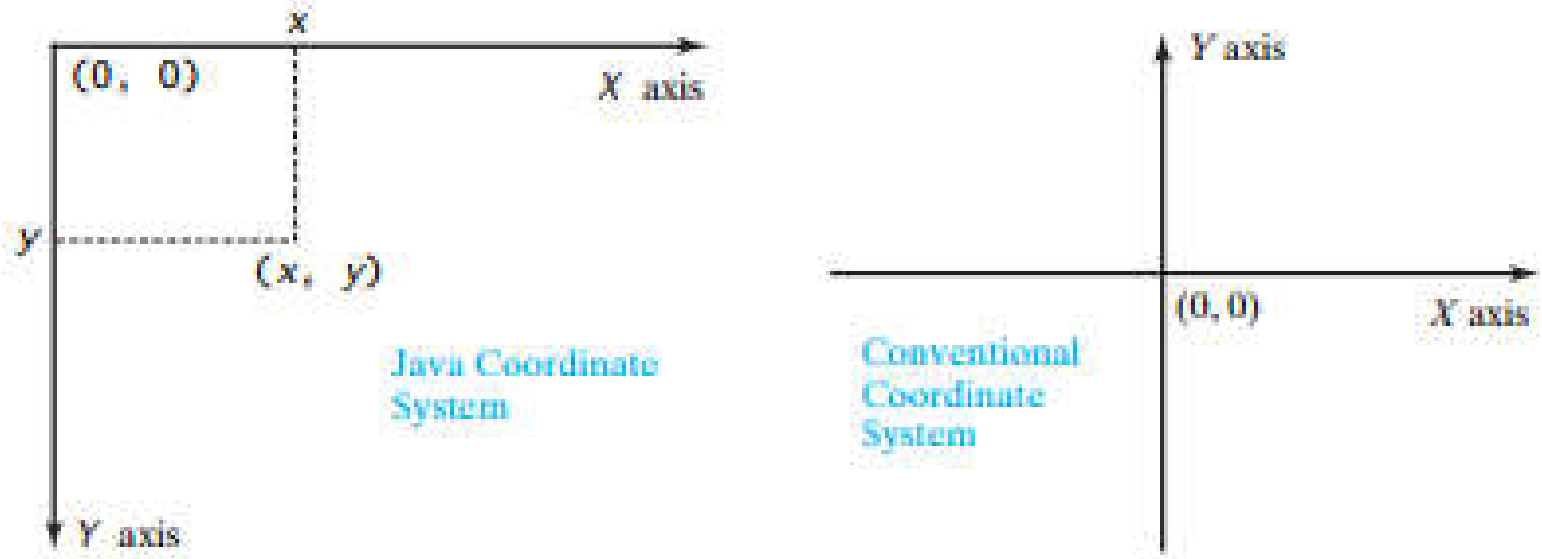
Outline

- Essential Graphical Principals
  - JFrame Window (Popup Windows)
  - Extending JFrame
  - Drawing from paintComponent
  - Drawing images/text/graphics
- Today's Practical
- Review/Discussion

Graphics

- How do you draw `complex' diagrams?
- Customize/control what is drawn on our windows
  - ▷Animated clocks, bar-charts, images,

Graphical Coordinate System



JFrame

- Simple GUI Window
  - Lets us perform simple drawing operations
- Basic Usage
  - Instantiate the JFrame and assign text for the title bar
    - JFrame frame = new Jframe('Title');
  - Specify size
    - frame.setSize(width, height)
  - Designate that closing the window ends the program
    - frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
  - Show the window
    - frame.setVisible(true);

Using JFrame

```
import javax.swing.*;

public class Popup1 {
  public static void main(String[] args) {
    JFrame frame = new JFrame("Simple Popup Window");
    frame.setSize(500,500);
    frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    frame.setVisible(true);
  }
}
```

Extending JFrame

```
public class Popup2 extends JFrame {
  public Popup2() {
    super("Simple Popup Window");
    setSize(500,500);
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    setVisible(true);
  }

  public static void main(String[] args) {
    new Popup2();
  }
}
```

Basic Drawing

Make a subclass of JPanel

```
public class MyPanel extends JPanel
```

Override the paintComponent method

```
@Override
protected void paintComponent(Graphics g) { ... }
```

Call super.paintComponent

```
super.paintComponent(g);
```

- Does default behavior like handling opacity

Use the supplied Graphics object to draw

```
g.drawLine(x1, y1, x2, y2);
```

- (0,0) is *top* left corner, x goes to right, y goes *down*

Assign the panel as the content of the frame

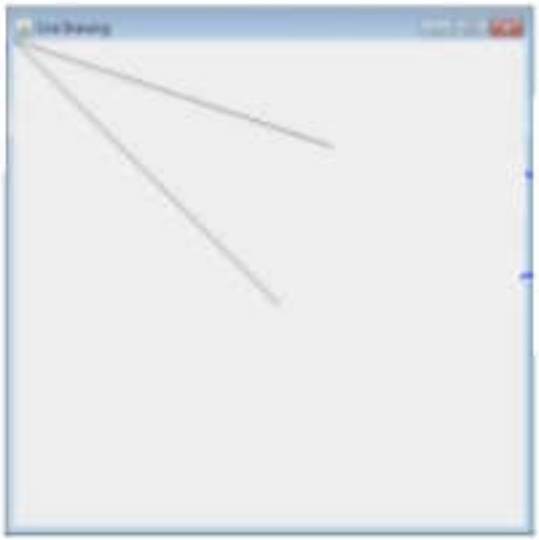
```
frame.setContentPane(new MyPanel());
```

Example JFrame

```
public class LineFrame extends JFrame {
  public LineFrame() {
    super("Line Drawing");
    setContentPane(new LinePanel());
    setSize(500,500);
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    setVisible(true);
  }

  public static void main(String[] args) {
    new LineFrame();
  }
}
```

Example JPanel

```
public class LinePanel extends JPanel {
  @Override
  protected void paintComponent(Graphics g) {
    super.paintComponent(g);
    g.drawLine(0, 0, 250, 250);
    g.drawLine(0, 0, 300, 100);
  }
}
```



Drawing Methods

Drawing lines and shapes

- Use supplied Graphics object
  - g.drawLine, not drawLine
- Understand coordinate system
  - (0,0) is top left corner, x goes to right, y goes down
- Make outlines or solid shapes
  - g.drawRect: outline, g:fillRect: solid

Setting default features of JPanel

- Do not use Graphics object
  - setBackground, setForeground, setFont, etc.
  - Usually called in constructor, not in paintComponent
- Remember to call super.paintComponent
  - Background colors have no effect unless window is opaque (default) and you call super.paintComponent

Graphics Class Methods

drawString(string, left, bottom)

Draws a string in the current font and color with the *bottom left* corner of the string at the specified location

One of the few methods where the y coordinate refers to the bottom of shape, not the top. But y values are still with respect to the *top left* corner of the applet window

drawRect(left, top, width, height)

Draws the outline of a rectangle (1-pixel border) in the current color

fillRect(left, top, width, height)

Draws a solid rectangle in the current color

drawLine(x1, y1, x2, y2)

Draws a 1-pixel-thick line from (x1, y1) to (x2, y2)

Graphics Class Methods

drawOval, fillOval

Draws an outlined or solid oval, where the arguments describe a rectangle that bounds the oval

drawPolygon, fillPolygon

Draws an outlined or solid polygon whose points are defined by arrays or a Polygon (a class that stores a series of points). By default, polygon is closed; to make an open polygon use the drawPolyline method

drawImage

Draws an image

Image usually created with Toolkit.getDefaultToolkit().getImage – see upcoming example

Supports JPEG, GIF (including animated GIF), or PNG

Graphics Class Methods

setColor, getColor

- Specifies the foreground color prior to drawing operation
- By default, the graphics object receives the foreground color of the window
  - As set via setForeground from the constructor
- Java has 16 predefined colors (Color.RED, Color.BLUE, etc.) or create your own color: new Color(r, g, b)
- Changing the color of the Graphics object affects only the drawing that explicitly uses that Graphics object
  - To make permanent changes, call the *panel's* setForeground method

Question

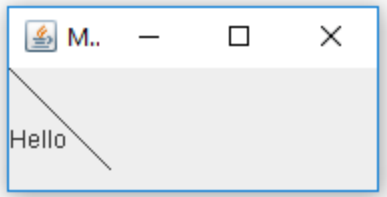
```java
import javax.swing.*;
import java.awt.Graphics;

public class MyPaint extends JFrame {
    public static void main(String[] args) {
        MyPaint frame = new MyPaint();
        frame.setTitle("MyPaint");
        frame.setContentPane(new MyPanel());
        frame.setSize(200, 100);
        frame.setLocationRelativeTo(null); // Center the frame
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
    }
}

class MyPanel extends JPanel
{
    @Override
    protected void paintComponent(Graphics g) {
        super.paintComponent(g);
        g.drawString("Hello", 0, 40);
        g.drawLine(0, 0, 50, 50);
    }
}
```

What would be the output of this program?

Sketch on paper what the output would look like

Answer

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

public class MyPaint extends JFrame {
    public static void main(String[] args) {
        MyPaint frame = new MyPaint();
        frame.setTitle("MyPaint");
        frame.setContentPane(new MyPanel());
        frame.setSize(200, 100);
        frame.setLocationRelativeTo(null); // Center the frame
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
    }
}

class MyPanel extends JPanel
{
    @Override
    protected void paintComponent(Graphics g) {
        super.paintComponent(g);
        g.drawString("Hello", 0, 40);
        g.drawLine(0, 0, 50, 50);
    }
}
```



javac MyPaint.java
java –cp . MyPaint

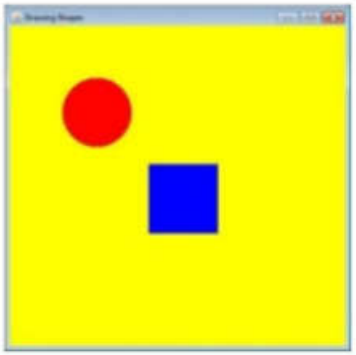
Example

```
public class ShapeFrame extends JFrame {
  public ShapeFrame() {
    super("Drawing Shapes");
    setContentPane(new ShapePanel(Color.YELLOW));
    setSize(500,500);
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    setVisible(true);
  }

  public static void main(String[] args) {
    new ShapeFrame();
  }
}
```

1

```
public class ShapePanel extends JPanel {
  public ShapePanel(Color bgColor) {
    setBackground(bgColor);
  }

  @Override
  protected void paintComponent(Graphics g) {
    super.paintComponent(g);
    g.setColor(Color.RED);
    g.fillOval(75, 75, 100, 100);
    g.setColor(Color.BLUE);
    g.fillRect(200, 200, 100, 100);
  }
}
```

2



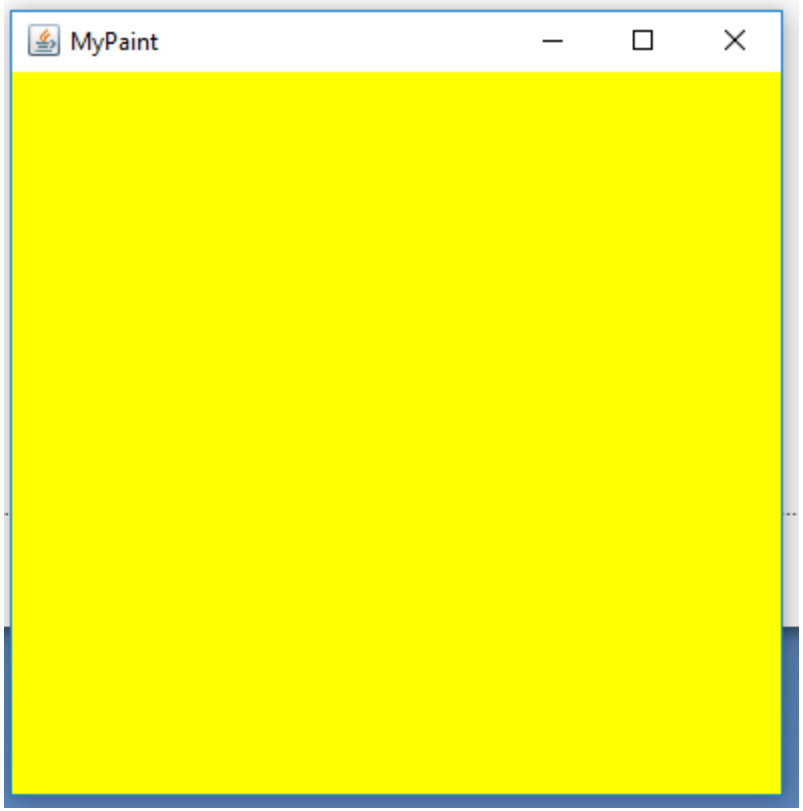
Question

What will the output for the following program?

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

public class MyPaint extends JFrame {
    public static void main(String[] args) {
        MyPaint frame = new MyPaint();
        frame.setTitle("MyPaint");
        frame.setContentPane(new MyPanel());
        frame.setSize(400, 400);
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
    }
}

class MyPanel extends JPanel {
    public MyPanel(){
        setBackground(Color.YELLOW);
    }
    protected void paintcomponent(Graphics g) {
        super.paintComponent(g);
        g.setColor(Color.RED);
        g.fillOval(75,75,100,100);
        g.setColor(Color.BLUE);
        g.fillRect(200,200,100,100);
    }
}
```

Answer

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

public class MyPaint extends JFrame {
    public static void main(String[] args) {
        MyPaint frame = new MyPaint();
        frame.setTitle("MyPaint");
        frame.setContentPane(new MyPanel());
        frame.setSize(400, 400);
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
    }
}

class MyPanel extends JPanel {
    public MyPanel(){
        setBackground(Color.YELLOW);
    }
    protected void paintcomponent(Graphics g) {
        super.paintComponent(g);
        g.setColor(Color.RED);
        g.fillOval(75,75,100,100);
        g.setColor(Color.BLUE);
        g.fillRect(200,200,100,100);
    }
}
```



Fixing Problems

Fix 1: Use @Override

```
@Override
protected void paintcomponent(Graphics g) { ... }
```

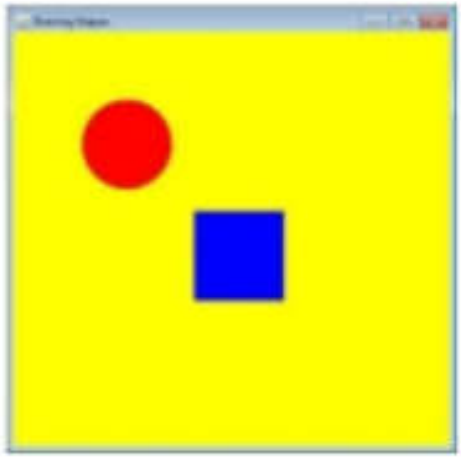
Code will fail at compile time, not work oddly at run time

"The method paintcomponent(Graphics) of type ShapePanel must override or implement a supertype method"

Fix 2: call it paintComponent

```
@Override
protected void paintComponent(Graphics g) {
   ...
}
```

@Override has no effect other than documentation on *correct* code, but with *incorrect* code it helps catch errors at compile time



Drawing Images

Basic syntax

Define instance variable of type Image

```
private Image image;
```

Use Toolkit to get the image (usually in constructor)

```
image = Toolkit.getDefaultToolkit().getImage(...)
```

- You can supply either a path relative to root of the code, or a URL
- Resource can be JPEG, GIF, or PNG

Draw the image in paintComponent

```
g.drawImage(image, left, top, windowImageDrawnOn);
```

Special notes

getImage returns immediately; the image is downloaded in a background thread

If image is incomplete when paintComponent is called, paintComponent is automatically called again later

If you use a URL for the image location, you need a try/catch block

Images

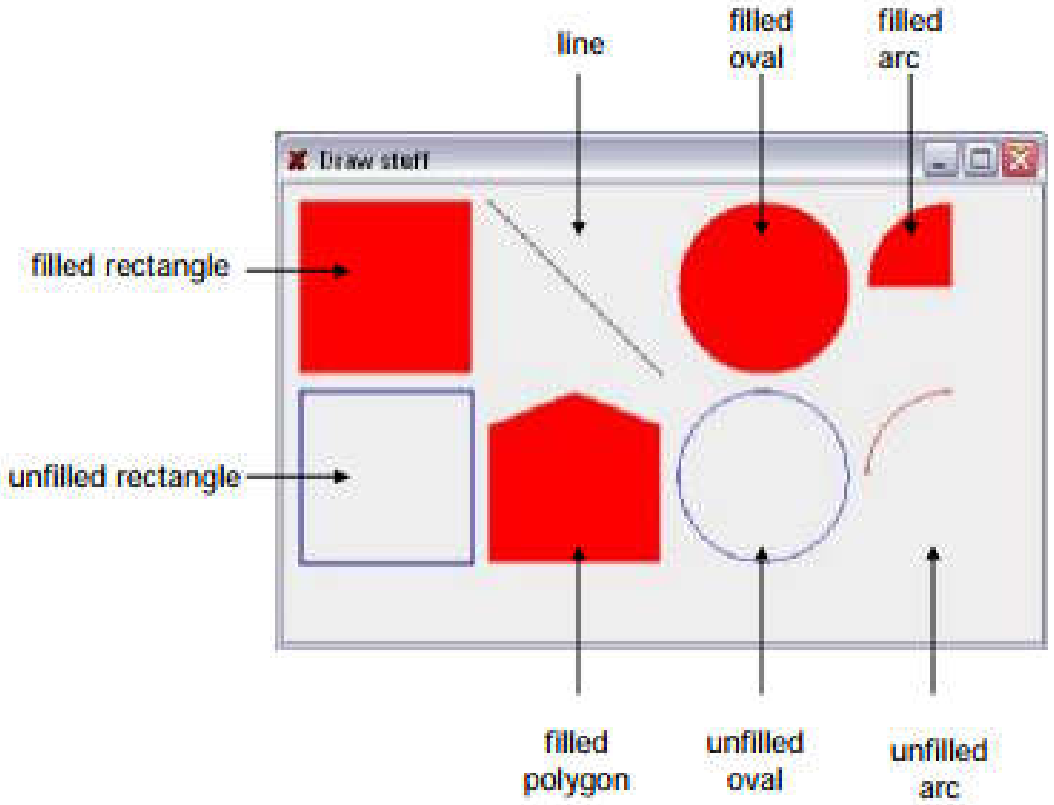
```
public class ImageFrame1 extends JFrame {
  public ImageFrame1(String relativePath) {
    super("Image Drawing");
    setContentPane(new ImagePanel1(relativePath));
    setSize(400,400);
    setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
    setVisible(true);
  }

  public static void main(String[] args) {
    new ImageFrame1("images/Java-Man.gif");
  }
}
```

Review Basic Graphic Methods

Method Name	Description
`g.drawLine(x1,y1,x2,y2);`	Line between points (x1,y1) and (x2,y2)
`g.drawOval(x,y,width,height);`	Outline largest oval that fits in a box of size width*height with top-left at (x,y)
`g.drawRect(x,y,width,height);`	Outline rectangle of size width*height with top-left at (x,y)
`g.drawString(text,x,y);`	text with bottom-left at (x,y)
`g.fillOval(x,y,width,height);`	Fill largest oval that fits in a box of size width*height with top-left at (x,y)
`g.fillRect(x,y,width,height);`	Fill rectangle of size width*height with top-left at (x,y)
`g.setColor(Color);`	Set `Graphics` to paint any following shapes in the given color.

Question

- Write down the graphics methods you'd use to draw the following output:



Question

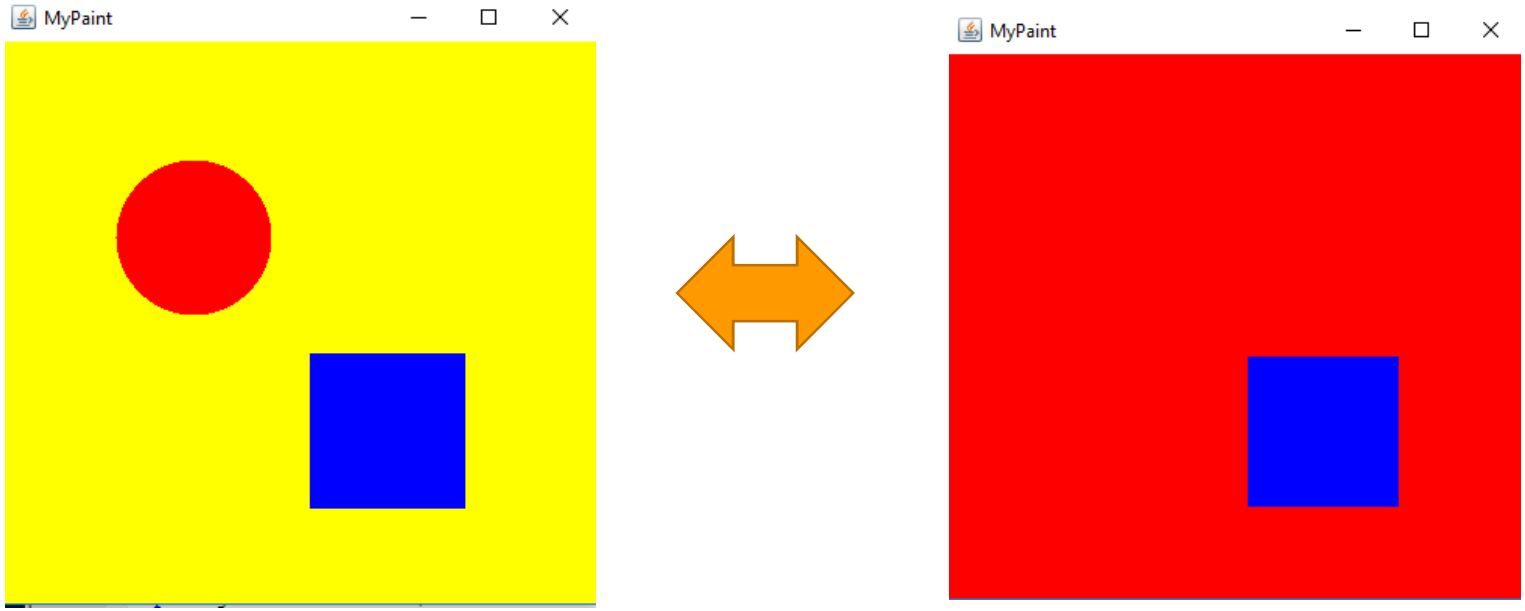
```
import javax.swing.*;
import java.awt.*;
import java.awt.event.*;

public class MyPaint extends JFrame {
    public static void main(String[] args) {
        MyPaint frame = new MyPaint();
        frame.setTitle("MyPaint");
        frame.setContentPane(new MyPanel());
        frame.setSize(400, 400);
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setVisible(true);
}   }

class MyPanel extends JPanel {
    Color[] colors     = new Color[]{Color.YELLOW, Color.RED};
    int     colorIndex = 0;

    public MyPanel() {
        addMouseListener(new MouseAdapter() {
            public void mousePressed(MouseEvent me) {
                    colorIndex = (colorIndex+1)%2;
                    repaint();
    } } ); }

    @Override
    protected void paintComponent(Graphics g) {
        super.paintComponent(g);
        setBackground(colors[colorIndex]);
        g.setColor(Color.RED);
        g.fillOval(75,75,100,100);
        g.setColor(Color.BLUE);
        g.fillRect(200,200,100,100);
}   }
```

What would the following program output?

javac MyPaint.java
java –cp . MyPaint

Answer

- Left mouse button is pressed



Force Redraw

- To notify Java to redraw our window (i.e., call paintComponent)
  - ▷call ‘repaint()’
- For example, add new graphics each time the mouse button is pressed

Review

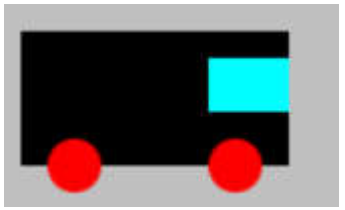
- Graphics can be drawn using a class which extends JPanel
- Swing will call the paintComponent method to draw:
  - protected void paintComponent(Graphics g);
- There are a variety of drawing methods:
  - drawLine(int x1, int y1, int x2, int y2);
  - drawRect(int x, int y, int w, int h);
  - drawOval(int x, int y, int w, int h);
  - drawPolygon(int[] xpoints, int[] ypoints, int npoints);

Other Graphics Capabilities

- Lots of GUI Controls
  - Buttons, sliders, checkboxes, tables, etc
    - which you can override and improve
- Rich 2D drawing
  - Line properties, translucent drawing, rotating, scaling images, coordinate transforms, ...
- Animation
  - Double-buffering, combining drawing with threads, ..

Examples

```
setBackground(Color.LIGHT_GRAY);
g.setColor(Color.BLACK);
g.fillRect(10,30,100,50);

g.setColor(Color.RED);
g.fillOval(20,70,20,20);
g.fillOval(80,70,20,20);

g.setColor(Color.CYAN);
g.fillRect(80,40,30,20);
```



```
g.setColor(Color.GREEN);
Polygon poly = new Polygon();
poly.addPoint(10, 90);
poly.addPoint(50, 10);
poly.addPoint(90, 90);
g.fillPolygon(poly);
```

Experiment

- Only scratched the surface of Graphics
  - Very simple windows and graphics
- Combine the graphics with GUI components
  - Buttons/menus
- Custom ‘interfaces’ components
  - e.g., Override default draw method for a button to create a new improved button look
- Events
  - Mouse button presses (drawing program)
  - Timing (animations)

This Week

- Read Associated Chapters
  - Comprehensive Edition (Additional Chapters)
- Review Slides
- Java Exercises
- Online Quizzes

Summary

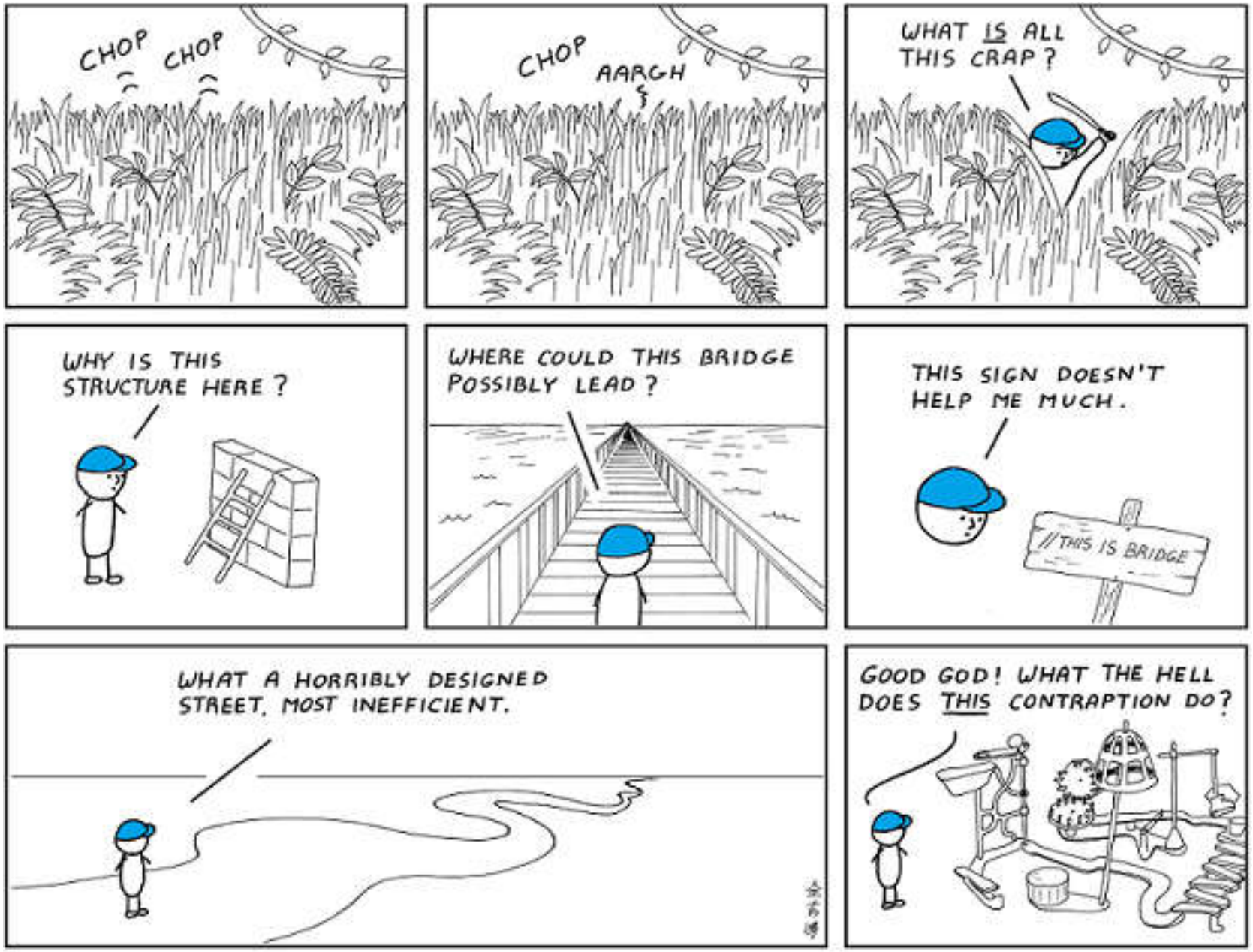
- Overview Essential Graphical Principles
  - JFrame, JPanel, paintComponent, @Override (Checking)
- Hands-On/Practical
- Today is about Graphics with Java
  - Drawing

Exercises

- Chapter exercises 15.1-15.3

- Comment your code
- Remember to zip the files together
  - The name of the .zip file should be your student number
  - (e.g., 39293923923.zip)

Questions/Discussion



I hate reading
other people's code.