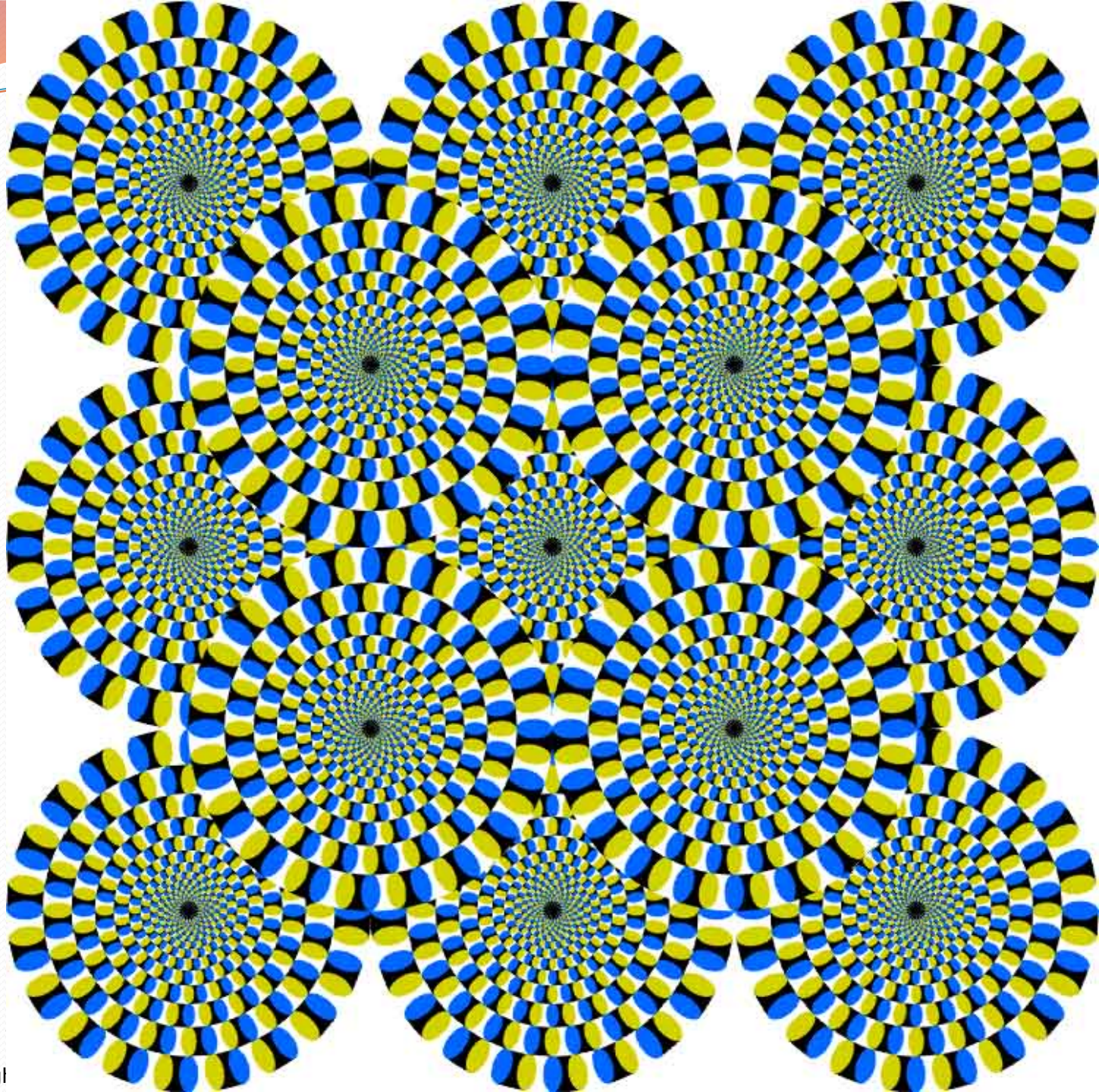


Building Java Programs

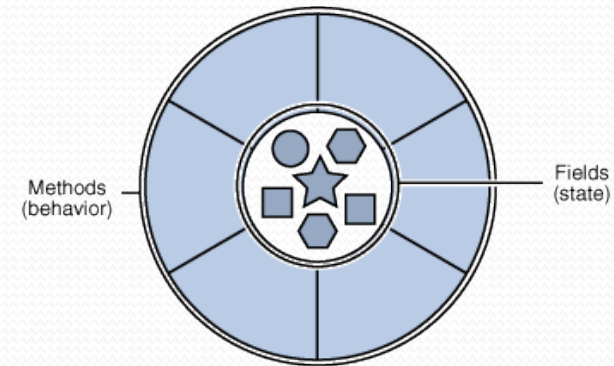
Graphics

Reading: Supplement 3G



Objects (usage)

- **object:** An entity that contains data and behavior.
 - *data:* variables inside the object
 - *behavior:* methods inside the object
 - You interact with the methods; the data is hidden in the object.
 - A **class** is a type of objects.

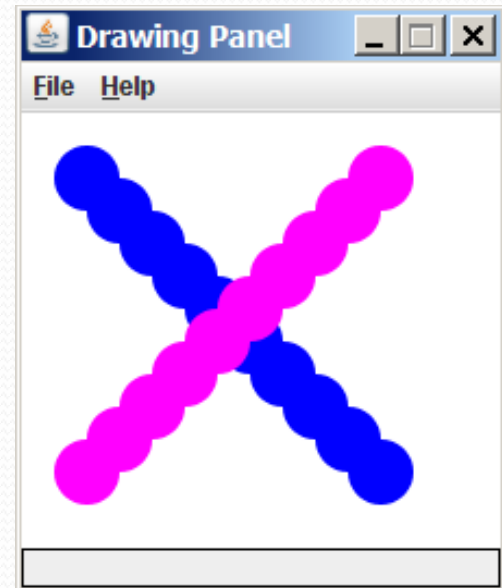


- Constructing (creating) an object:
Type objectName = `new` **Type** (**parameters**) ;
- Calling an object's method:
objectName.methodName (**parameters**) ;

Graphical objects

We will draw graphics in Java using 3 kinds of objects:

- `DrawingPanel`: A window on the screen.
 - Not part of Java; provided by the authors. See class web site.
- `Graphics`: A "pen" to draw shapes and lines on a window.
- `Color`: Colors in which to draw shapes.



DrawingPanel

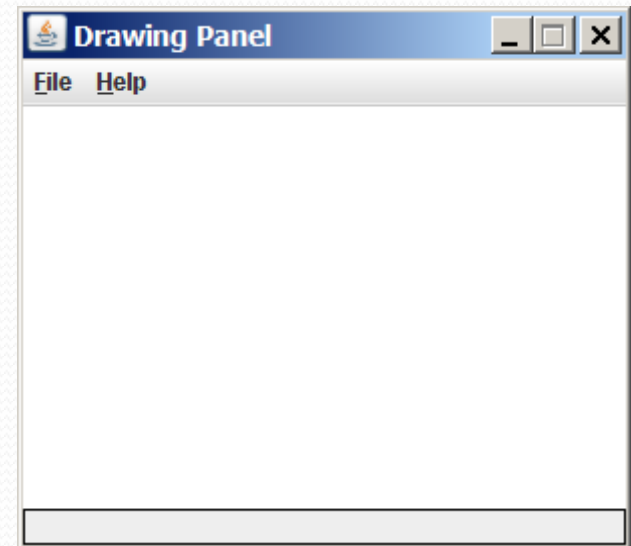
- To create a window:

```
DrawingPanel <name> = new DrawingPanel(<width>, <height>);
```

Example:

```
DrawingPanel panel = new DrawingPanel(300, 200);
```

- The window has nothing on it.
 - We can draw shapes and lines on it using another object of type `Graphics`.



Graphics

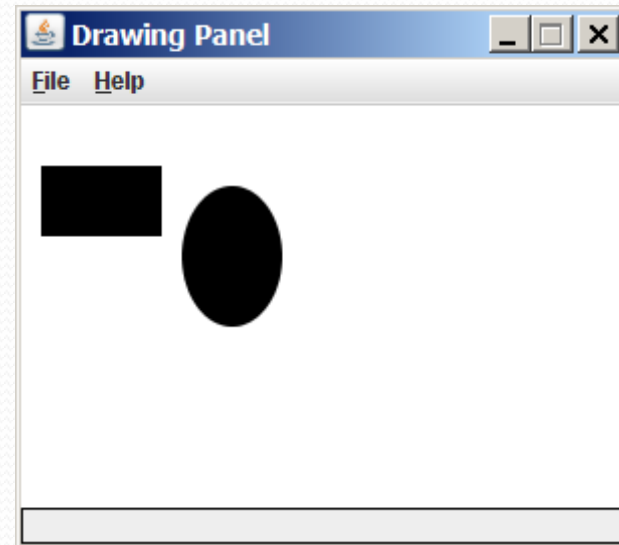
- Shapes are drawn using an object of class `Graphics`.
 - You must place an import declaration in your program:
`import java.awt.*;`
 - Access it by calling `getGraphics` on your `DrawingPanel`.

```
Graphics g = panel.getGraphics();
```

- Draw shapes by calling methods on the `Graphics` object.

```
g.fillRect(10, 30, 60, 35);
```

```
g.fillOval(80, 40, 50, 70);
```

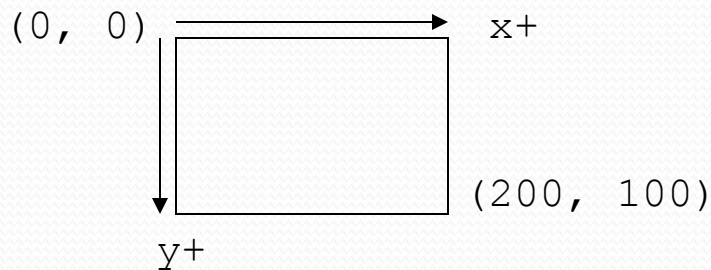


Graphics methods

Method name	Description
<code>g.drawLine(x1, y1, x2, y2);</code>	line between points (x1, y1), (x2, y2)
<code>g.drawOval(x, y, width, height);</code>	outline largest oval that fits in a box of size <i>width</i> * <i>height</i> with top-left at (x, y)
<code>g.drawRect(x, y, width, height);</code>	outline of rectangle of size <i>width</i> * <i>height</i> with top-left at (x, y)
<code>g.drawString(text, x, y);</code>	text with bottom-left at (x, y)
<code>g.fillOval(x, y, width, height);</code>	fill largest oval that fits in a box of size <i>width</i> * <i>height</i> with top-left at (x,y)
<code>g.fillRect(x, y, width, height);</code>	fill rectangle of size <i>width</i> * <i>height</i> with top-left at (x, y)
<code>g.setColor(Color);</code>	set Graphics to paint any following shapes in the given color

Coordinate system

- Each (x, y) position is a *pixel* ("picture element").
- $(0, 0)$ is at the window's top-left corner.
 - x increases rightward and the y increases downward.
- The rectangle from $(0, 0)$ to $(200, 100)$ looks like this:

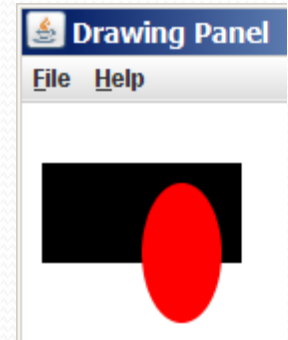


Colors

- Colors are specified by `Color` class constants named: `BLACK`, `BLUE`, `CYAN`, `DARK_GRAY`, `GRAY`, `GREEN`, `LIGHT_GRAY`, `MAGENTA`, `ORANGE`, `PINK`, `RED`, `WHITE`, `YELLOW`

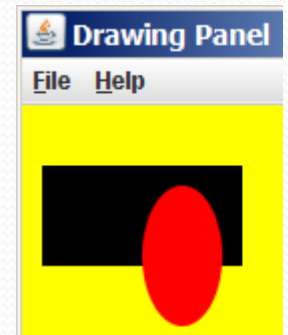
- Pass to Graphics object's `setColor` method:

```
g.setColor(Color.BLACK);  
g.fillRect(10, 30, 100, 50);  
g.setColor(Color.RED);  
g.fillOval(60, 40, 40, 70);
```



- The background color can be set by calling `setBackground` on the `DrawingPanel`:

```
panel.setBackground(Color.YELLOW);
```



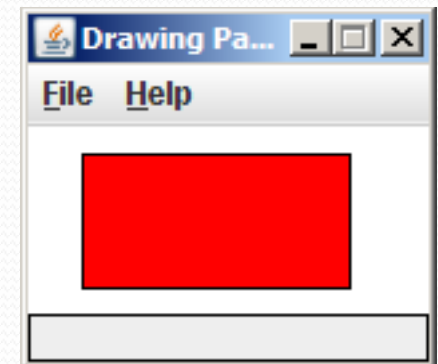
Outlined shapes

- To draw a shape with a fill and outline, first *fill* it in the fill color and then *draw* the same shape in the outline color.

```
import java.awt.*; // so I can use Graphics
public class DrawOutline {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(150, 70);
        Graphics g = panel.getGraphics();

        // inner red fill
        g.setColor(Color.RED);
        g.fillRect(20, 10, 100, 50);

        // black outline
        g.setColor(Color.BLACK);
        g.drawRect(20, 10, 100, 50);
    }
}
```



Superimposing shapes

- When two shapes occupy the same pixels, the last one drawn is seen.

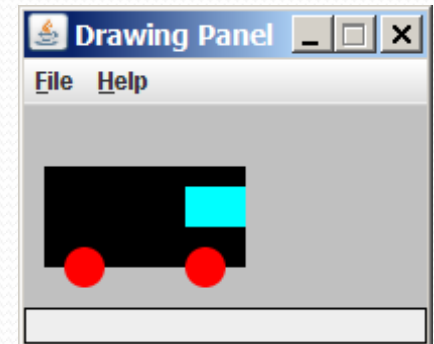
```
import java.awt.*;

public class DrawCar {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(200, 100);
        panel.setBackground(Color.LIGHT_GRAY);
        Graphics g = panel.getGraphics();

        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);
    }
}
```

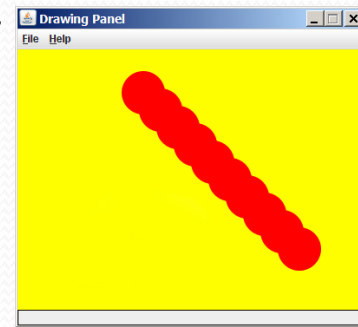


Drawing with loops

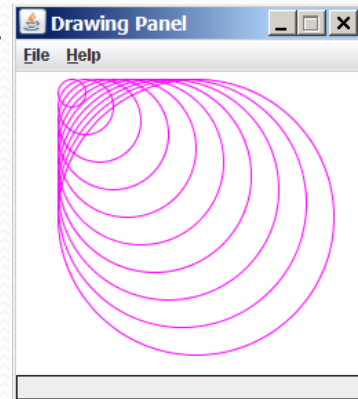
- The x, y, w, h expression can contain the loop counter, i .

```
DrawingPanel panel = new DrawingPanel(400, 300);
panel.setBackground(Color.YELLOW);
Graphics g = panel.getGraphics();

g.setColor(Color.RED);
for (int i = 1; i <= 10; i++) {
    g.fillOval(100 + 20 * i, 5 + 20 * i, 50, 50);
}
```



```
DrawingPanel panel = new DrawingPanel(250, 220);
Graphics g = panel.getGraphics();
g.setColor(Color.MAGENTA);
for (int i = 1; i <= 10; i++) {
    g.drawOval(30, 5, 20 * i, 20 * i);
}
```

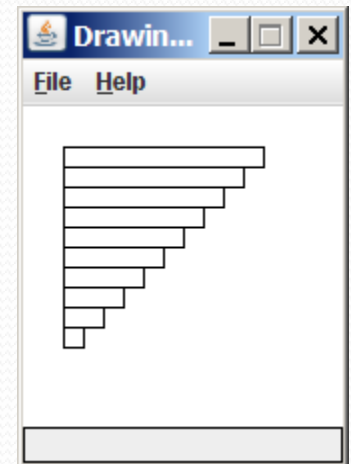


Loops that begin at 0

- Beginning a loop at 0 and using `<` can make coordinates easier to compute.
- Example:
 - Draw ten stacked rectangles starting at (20, 20), height 10, width starting at 100 and decreasing by 10 each time:

```
DrawingPanel panel = new DrawingPanel(160, 160);  
Graphics g = panel.getGraphics();
```

```
for (int i = 0; i < 10; i++) {  
    g.drawRect(20, 20 + 10 * i,  
              100 - 10 * i, 10);  
}
```

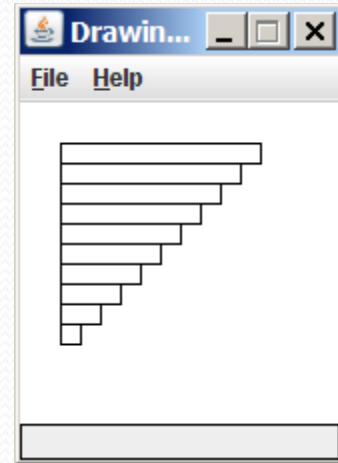


Drawing w/ loops questions

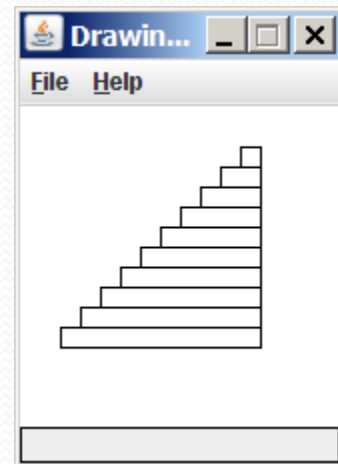
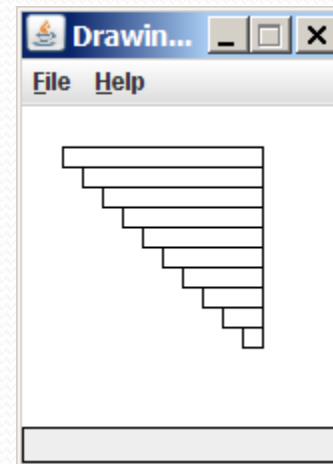
- Code from previous slide:

```
DrawingPanel panel = new DrawingPanel(160, 160);  
Graphics g = panel.getGraphics();
```

```
for (int i = 0; i < 10; i++) {  
    g.drawRect(20, 20 + 10 * i,  
              100 - 10 * i, 10);  
}
```



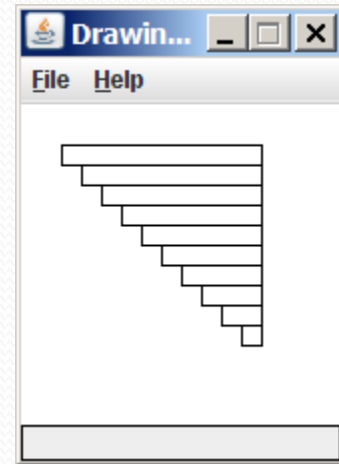
- Write variations of the above program that draw the figures at right as output.



Drawing w/ loops answers

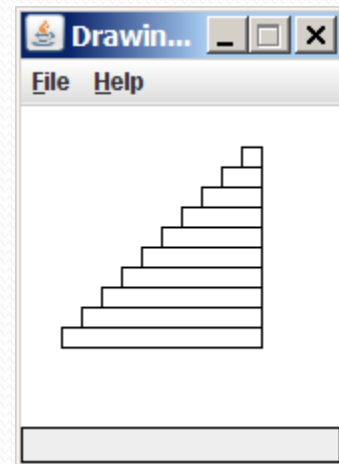
- Solution #1:

```
Graphics g = panel.getGraphics();  
for (int i = 0; i < 10; i++) {  
    g.drawRect(20 + 10 * i, 20 + 10 * i,  
               100 - 10 * i, 10);  
}
```



- Solution #2:

```
Graphics g = panel.getGraphics();  
for (int i = 0; i < 10; i++) {  
    g.drawRect(110 - 10 * i, 20 + 10 * i,  
               10 + 10 * i, 10);  
}
```



Drawing with methods

- To draw in multiple methods, you must pass Graphics g.

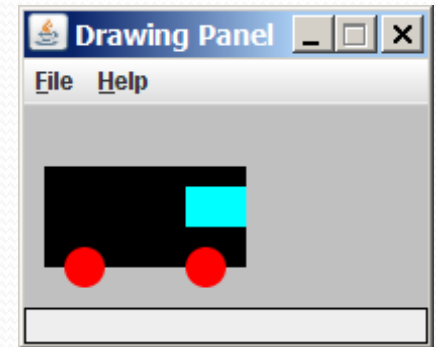
```
import java.awt.*;

public class DrawCar1 {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(200, 100);
        panel.setBackground(Color.LIGHT_GRAY);
        Graphics g = panel.getGraphics();
        drawCar(g);
    }

    public static void drawCar(Graphics g) {
        g.setColor(Color.BLACK);
        g.fillRect(10, 30, 100, 50);

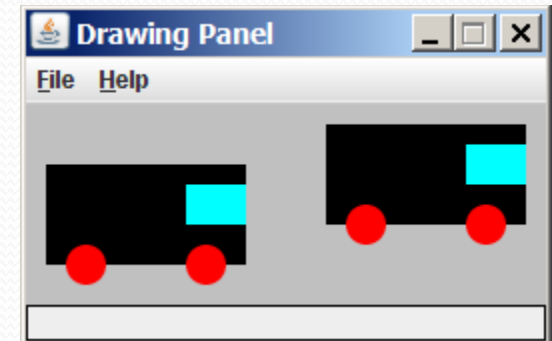
        g.setColor(Color.RED);
        g.fillOval(20, 70, 20, 20);
        g.fillOval(80, 70, 20, 20);

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



Parameterized figures

- Modify the car-drawing method so that it can draw many cars, such as in the following image.
 - Top-left corners: (10, 30), (150, 10)
 - Hint: We must modify our `drawCar` method to accept x/y coordinates as parameters.



Parameterized answer

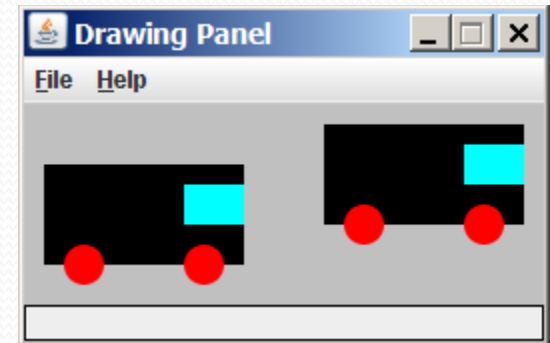
```
import java.awt.*;

public class DrawCar2 {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(260, 100);
        panel.setBackground(Color.LIGHT_GRAY);
        Graphics g = panel.getGraphics();
        drawCar(g, 10, 30);
        drawCar(g, 150, 10);
    }

    public static void drawCar(Graphics g, int x, int y) {
        g.setColor(Color.BLACK);
        g.fillRect(x, y, 100, 50);

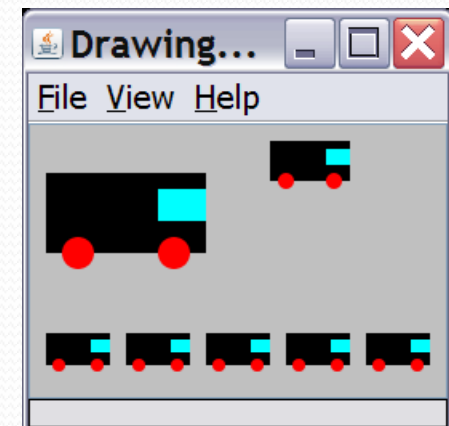
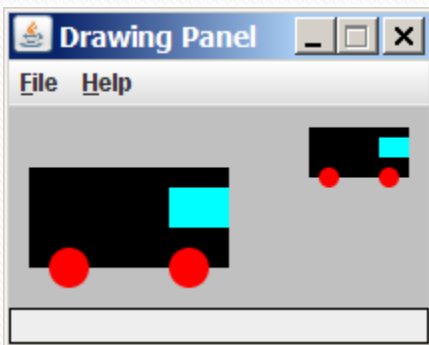
        g.setColor(Color.RED);
        g.fillOval(x + 10, y + 40, 20, 20);
        g.fillOval(x + 70, y + 40, 20, 20);

        g.setColor(Color.CYAN);
        g.fillRect(x + 70, y + 10, 30, 20);
    }
}
```



Drawing parameter question

- Modify `drawCar` to allow the car to be drawn at any size.
 - Existing car: size 100. Second car: (150, 10), size 50.
- Once you have this working, use a `for` loop with your method to draw a line of cars, like the picture at right.
 - Start at (10, 130), each size 40, separated by 50px.



Drawing parameter answer

```
import java.awt.*;

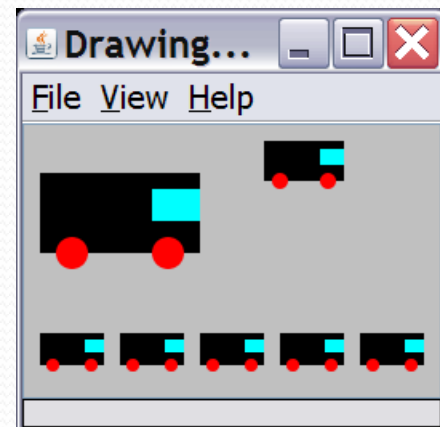
public class DrawCar3 {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(210, 100);
        panel.setBackground(Color.LIGHT_GRAY);

        Graphics g = panel.getGraphics();
        drawCar(g, 10, 30, 100);
        drawCar(g, 150, 10, 50);
        for (int i = 0; i < 5; i++) {
            drawCar(g, 10 + i * 50, 130, 40);
        }
    }

    public static void drawCar(Graphics g, int x, int y, int size) {
        g.setColor(Color.BLACK);
        g.fillRect(x, y, size, size / 2);

        g.setColor(Color.RED);
        g.fillOval(x + size / 10, y + 2 * size / 5,
                 size / 5, size / 5);
        g.fillOval(x + 7 * size / 10, y + 2 * size / 5,
                 size / 5, size / 5);

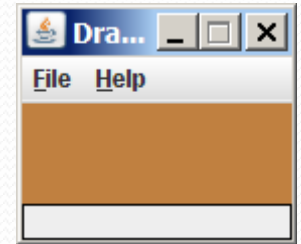
        g.setColor(Color.CYAN);
        g.fillRect(x + 7 * size / 10, y + size / 10,
                 3 * size / 10, size / 5);
    }
}
```



Custom colors

- You can construct custom `Color` objects.
 - Pass 3 numbers from 0-255 for red, green, and blue.

```
DrawingPanel panel = new DrawingPanel(80, 50);  
Color brown = new Color(192, 128, 64);  
panel.setBackground(brown);
```



- or:

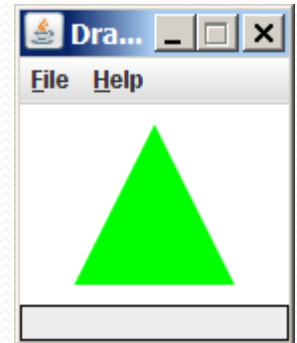
```
DrawingPanel panel = new DrawingPanel(80, 50);  
panel.setBackground(new Color(192, 128, 64));
```

Drawing polygons

- Polygon objects represent arbitrary shapes.
 - Add points to a Polygon using its `addPoint(x, y)` method.

- **Example:**

```
DrawingPanel p = new DrawingPanel(100, 100);  
Graphics g = p.getGraphics();  
g.setColor(Color.GREEN);  
Polygon poly = new Polygon();  
poly.addPoint(10, 90);  
poly.addPoint(50, 10);  
poly.addPoint(90, 90);  
g.fillPolygon(poly);
```



Animation with `sleep`

- `DrawingPanel`'s `sleep` method pauses your program for a given number of milliseconds.

- You can use `sleep` to create simple animations.

```
DrawingPanel panel = new DrawingPanel(250, 200);  
Graphics g = panel.getGraphics();
```

```
g.setColor(Color.BLUE);  
for (int i = 1; i <= NUM_CIRCLES; i++) {  
    g.fillOval(15 * i, 15 * i, 30, 30);  
    panel.sleep(500);  
}
```

- Try adding `sleep` commands to loops in past exercises in this chapter and watch the panel draw itself piece by piece.