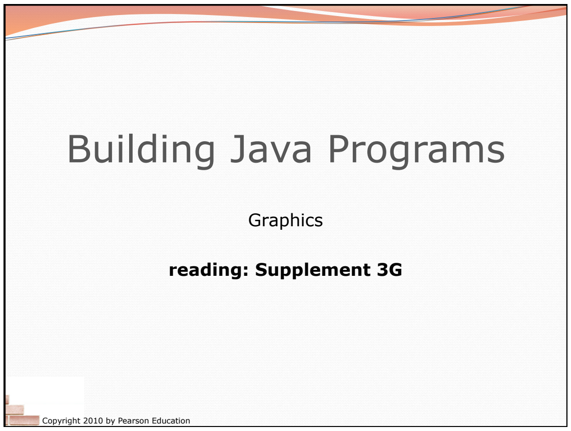
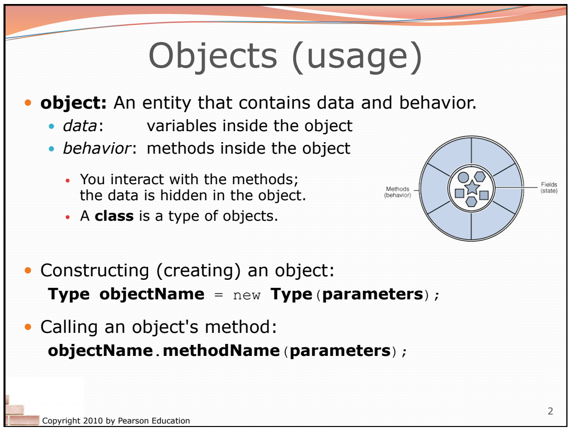
hi



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.

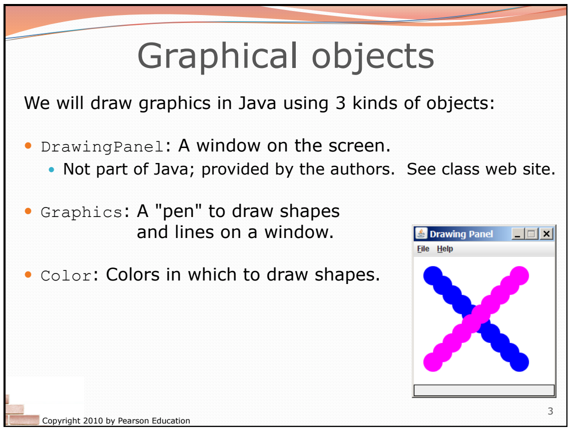
Methods (behavior)
Fields (state)

- Constructing (creating) an object:

  Type objectName = new **Type**(**parameters**);

- Calling an object's method:

  objectName.**methodName**(**parameters**);

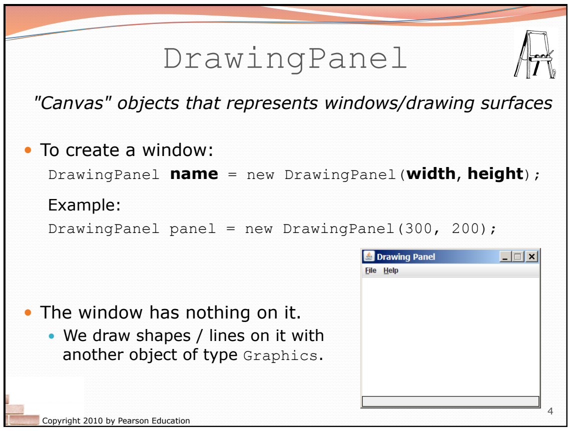


Graphical objects

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.

Drawing Panel
File Help



DrawingPanel

"Canvas" objects that represents windows/drawing surfaces

- To create a window:

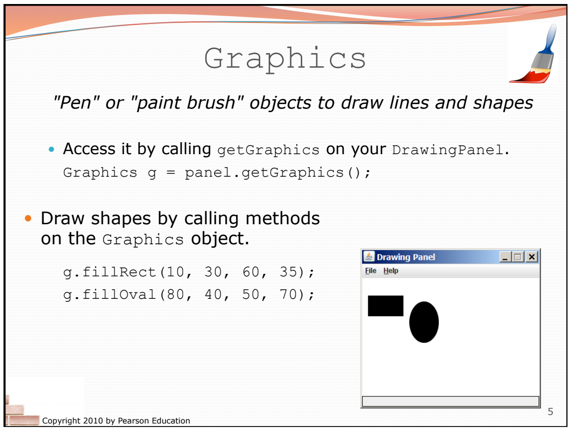
  `DrawingPanel` **name** `= new DrawingPanel(`**width**, **height**`);`

  Example:

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

- The window has nothing on it.
  - We draw shapes / lines on it with another object of type `Graphics`.

Drawing Panel
File Help



Graphics

"Pen" or "paint brush" objects to draw lines and shapes

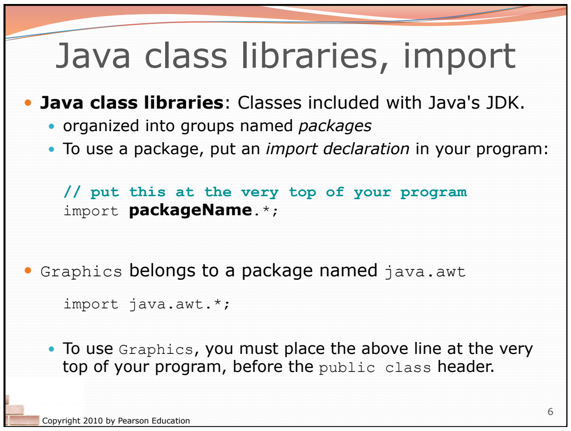
- Access it by calling `getGraphics` on your `DrawingPanel`.

```
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);
```

Drawing Panel
File Help



Java class libraries, import

- **Java class libraries**: Classes included with Java's JDK.
  - organized into groups named *packages*
  - To use a package, put an *import declaration* in your program:

```
// put this at the very top of your program
import packageName.*;
```

- `Graphics` belongs to a package named `java.awt`

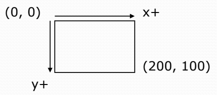
```
import java.awt.*;
```

  - To use `Graphics`, you must place the above line at the very top of your program, before the `public class` header.

bye

Coordinate system

- Each (x, y) position is a *pixel* ("picture element").
- Position (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:



Graphics methods

Method name	Description
`g.drawLine(`**x1, y1, x2, y2**`);`	line between points (*x1*, *y1*), (*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 of 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

Color

- Specified as predefined `Color` class constants:

  `Color.`**CONSTANT_NAME**

  where **CONSTANT_NAME** is one of:

```
BLACK,   BLUE,        CYAN,      DARK_GRAY,   GRAY,
GREEN,   LIGHT_GRAY,  MAGENTA,   ORANGE,
PINK,    RED,         WHITE,     YELLOW
```

- Or create one using Red-Green-Blue (RGB) values of 0-255

```
Color name = new Color(red, green, blue);
```

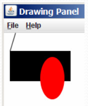
  - Example:

```
Color brown = new Color(192, 128, 64);
```

Using colors

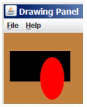
- Pass a `Color` to `Graphics` object's `setColor` method
  - Subsequent shapes will be drawn in the new color.

```
g.setColor(Color.BLACK);
g.fillRect(10, 30, 100, 50);
g.drawLine(20, 0, 10, 30);
g.setColor(Color.RED);
g.fillOval(60, 40, 40, 70);
```



- Pass a color to `DrawingPanel`'s `setBackground` method
  - The overall window background color will change.

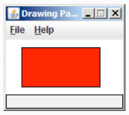
```
Color brown = new Color(192, 128, 64);
panel.setBackground(brown);
```



Outlined shapes

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

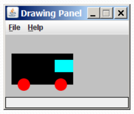
```
import java.awt.*;  // so I can use Graphics
public class OutlineExample {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(150, 70);
        Graphics g = panel.getGraphics();
        // inner red fill
        g.setColor(Color.RED);
        g.fillRect(20, 10, 100, 50);
        // black outline
        g.setColor(Color.BLACK);
        g.drawRect(20, 10, 100, 50);
    }
}
```



Superimposing shapes

- When ≥ 2 shapes occupy the same pixels, the last drawn "wins."

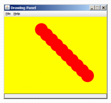
```
import java.awt.*;

public class Car {
    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

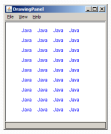
- The *x*,*y*,*w*,*h* expressions can use the loop counter variable:

```
panel.setBackground(Color.YELLOW);
g.setColor(Color.RED);
for (int i = 1; i <= 10; i++) {
    //                x          y         w   h
    g.fillOval(100 + 20 * i, 5 + 20 * i, 50, 50);
}
```



- Nested loops can be used with graphics:

```
g.setColor(Color.BLUE);

for (int x = 1; x <= 4; x++) {
    for (int y = 1; y <= 9; y++) {
        g.drawString("Java", x * 40, y * 25);
    }
}
```



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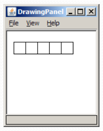
Zero-based loops

- Beginning at 0 and using < can make coordinates easier.

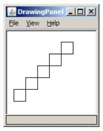
```
DrawingPanel panel = new DrawingPanel(150, 140);
Graphics g = panel.getGraphics();

// horizontal line of 5 20x20 rectangles starting
// at (11, 18); x increases by 20 each time
for (int i = 0; i < 5; i++) {
    g.drawRect(11 + 20 * i, 18, 20, 20);
}
```



- Exercise: Write a variation of the above program that draws the output at right.
  - The bottom-left rectangle is at (11, 98).

```
for (int i = 0; i < 5; i++) {
    g.drawRect(11 + 20 * i, 98 - 20 * i, 20, 20);
}
```



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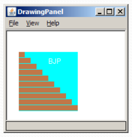
Java book figure

- Write a program that draws the following figure:
  - drawing panel is size 200x150
  - book is at (20, 35), size 100x100
  - cyan background
  - white "BJP" text at position (70, 55)
  - stairs are in color (red=191, green=118, blue=73)
  - each stair is 9px tall
    - 1st stair is 10px wide
    - 2nd stair is 20px wide ...
  - stairs are 10px apart (1 blank pixel between)



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Java book solution

```
// Draws a Building Java Programs textbook with DrawingPanel.
import java.awt.*;

public class Book {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(200, 150);
        panel.setBackground(Color.WHITE);
        Graphics g = panel.getGraphics();

        g.setColor(Color.CYAN);            // cyan background
        g.fillRect(20, 35, 100, 100);

        g.setColor(Color.WHITE);           // white "bjp" text
        g.drawString("BJP", 70, 55);

        g.setColor(new Color(191, 118, 73));
        for (int i = 0; i < 10; i++) {     // orange "bricks"
            g.fillRect(20, 35 + 10 * i, 10 + 10 * i, 9);
        }
    }
}
```

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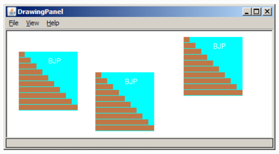
Multiple Java books

- Modify the Java book program so that it can draw books at different *positions* as shown below.
  - book top/left positions: (20, 35), (150, 70), (300, 10)
  - drawing panel's new size: 450x180



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Multiple books solution

- To draw in a method, you must pass `Graphics g` to it.

```
// Draws many BJP textbooks using parameters.
import java.awt.*;

public class Book2 {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(450, 180);
        panel.setBackground(Color.WHITE);
        Graphics g = panel.getGraphics();

        // draw three books at different locations
        drawBook(g, 20, 35);
        drawBook(g, 150, 70);
        drawBook(g, 300, 10);
    }

    ...
```

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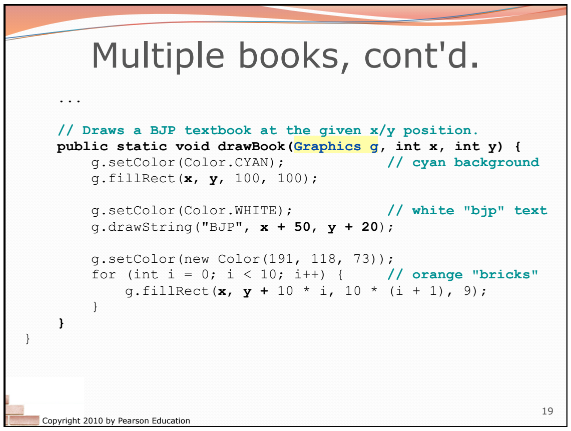
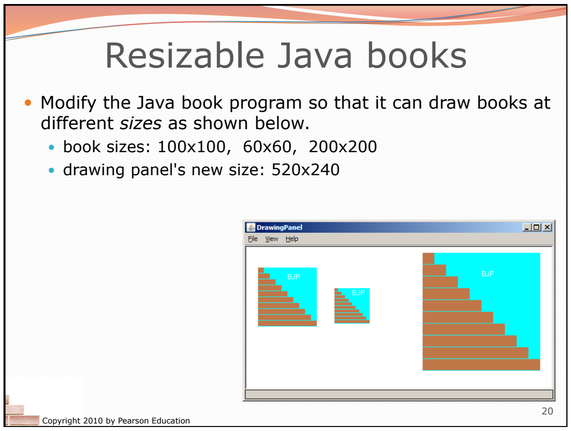


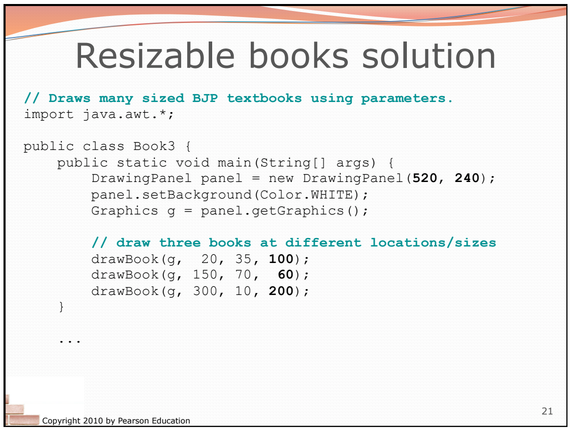
Multiple books, cont'd.

```
    ...

    // Draws a BJP textbook at the given x/y position.
    public static void drawBook(Graphics g, int x, int y) {
        g.setColor(Color.CYAN);             // cyan background
        g.fillRect(x, y, 100, 100);

        g.setColor(Color.WHITE);            // white "bjp" text
        g.drawString("BJP", x + 50, y + 20);

        g.setColor(new Color(191, 118, 73));
        for (int i = 0; i < 10; i++) {      // orange "bricks"
            g.fillRect(x, y + 10 * i, 10 * (i + 1), 9);
        }
    }
}
```



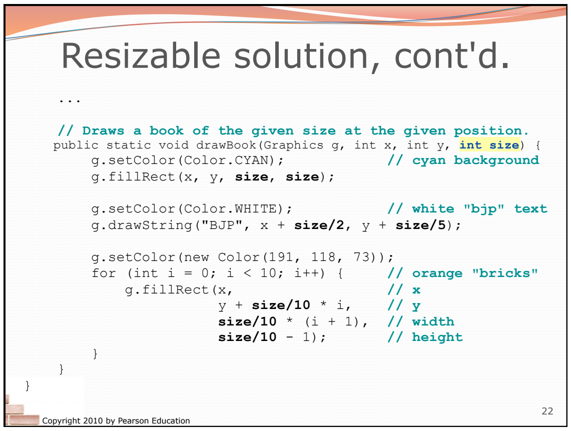
Resizable Java books

- Modify the Java book program so that it can draw books at different *sizes* as shown below.
  - book sizes: 100x100, 60x60, 200x200
  - drawing panel's new size: 520x240



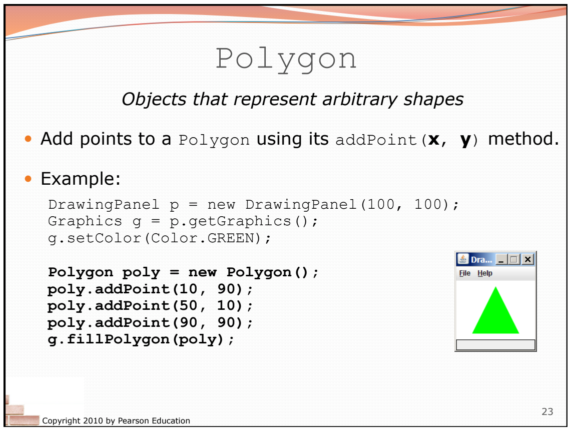
Resizable books solution

```
// Draws many sized BJP textbooks using parameters.
import java.awt.*;

public class Book3 {
    public static void main(String[] args) {
        DrawingPanel panel = new DrawingPanel(520, 240);
        panel.setBackground(Color.WHITE);
        Graphics g = panel.getGraphics();

        // draw three books at different locations/sizes
        drawBook(g,  20, 35, 100);
        drawBook(g, 150, 70,  60);
        drawBook(g, 300, 10, 200);
    }

    ...
```



Resizable solution, cont'd.

```
    ...

    // Draws a book of the given size at the given position.
   public static void drawBook(Graphics g, int x, int y, int size) {
        g.setColor(Color.CYAN);                  // cyan background
        g.fillRect(x, y, size, size);

        g.setColor(Color.WHITE);                 // white "bjp" text
        g.drawString("BJP", x + size/2, y + size/5);

        g.setColor(new Color(191, 118, 73));
        for (int i = 0; i < 10; i++) {           // orange "bricks"
            g.fillRect(x,                        // x
                       y + size/10 * i,          // y
                       size/10 * (i + 1),        // width
                       size/10 - 1);             // height
        }
    }
}
```

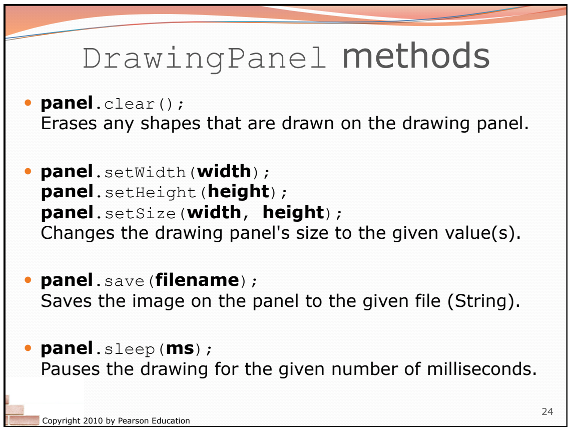


Polygon

Objects that represent arbitrary shapes

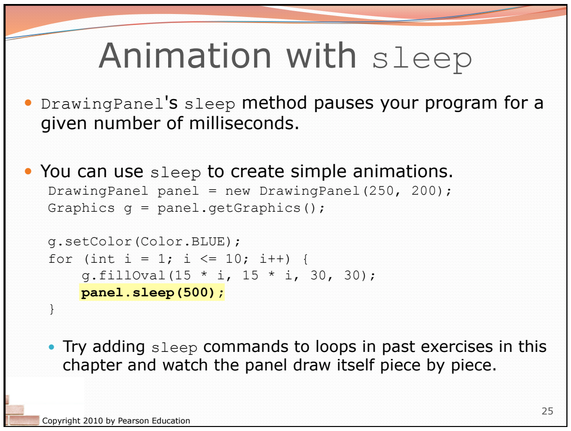
- Add points to a `Polygon` using its `addPoint(x, y)` method.
- Example:

```
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);
```



`DrawingPanel` methods

- **panel**`.clear();`
  Erases any shapes that are drawn on the drawing panel.
- **panel**`.setWidth(`**width**`);`
  panel`.setHeight(`**height**`);`
  panel`.setSize(`**width**`, `**height**`);`
  Changes the drawing panel's size to the given value(s).
- **panel**`.save(`**filename**`);`
  Saves the image on the panel to the given file (String).
- **panel**`.sleep(`**ms**`);`
  Pauses the drawing for the given number of milliseconds.



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 <= 10; 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.