Appendix F: Java Graphics
CS 121

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Topics

- Graphics and Images
- Coordinate System
- Representing Color
- Drawing Shapes
- Scalable Drawings
- Simple Animation
A picture or drawing must be digitized for storage on a computer.

A picture is made up of pixels (picture elements), and each pixel is stored separately.

The picture resolution is the number of pixels used to represent a picture.

The number of pixels that can be displayed on a screen is called the screen resolution.
Images

- A medium resolution image.

- The same image zoomed in to show pixels.
Graphics Coordinate System

- Each pixel is identified using a two-dimensional coordinate system.
- In graphics, the origin is at the top left corner with $x$ coordinate increasing to the right and $y$ coordinate increasing going down.
Representing Color

- A black and white picture can be represented with 1 bit per pixel (0 = white, 1 = black). A grayscale picture can be represented with 8 bits per pixel (0-255).
- A colored picture can be represented as a mixture of primary colors Red, Green, and Blue. Each color is represented by three numbers between 0 and 255 that collectively are called an RGB value. How many colors can we represent with the RGB representation?
- In Java, color is represented as a Color class (from the java.awt package)
  ```java
  Color myColor = new Color(0, 255, 255);
  ```
- Some predefined colors in the Color class.

<table>
<thead>
<tr>
<th>Color</th>
<th>Object</th>
<th>RGB value</th>
</tr>
</thead>
<tbody>
<tr>
<td>black</td>
<td>Color.black</td>
<td>0, 0, 0</td>
</tr>
<tr>
<td>white</td>
<td>Color.white</td>
<td>255, 255, 255</td>
</tr>
<tr>
<td>red</td>
<td>Color.red</td>
<td>255, 0, 0</td>
</tr>
<tr>
<td>green</td>
<td>Color.green</td>
<td>0, 255, 0</td>
</tr>
<tr>
<td>blue</td>
<td>Color.blue</td>
<td>0, 0, 255</td>
</tr>
<tr>
<td>yellow</td>
<td>Color.yellow</td>
<td>255, 255, 0</td>
</tr>
<tr>
<td>cyan</td>
<td>Color.cyan</td>
<td>0, 255, 255</td>
</tr>
</tbody>
</table>
Graphics Class (1)

- We will use the Graphics class from the java.awt package for drawing shapes.
- The Graphics class provides methods for drawing lines, rectangles, ovals, arcs and strings among others.
- Shapes drawn by the Graphics class can be unfilled or filled.
- The method parameters specify coordinates and sizes.
- Shapes with curves, like an oval, are usually drawn by specifying the shape’s bounding rectangle.
- An arc is a section of an oval.
Selected methods from the Graphics class.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>drawLine(int x1, int y1, int x2, int y2)</code></td>
<td>Draws a line between the points (x1, y1) and (x2, y2)</td>
</tr>
<tr>
<td><code>drawRect(int x, int y, int width, int height)</code></td>
<td>Draws the specified rectangle.</td>
</tr>
<tr>
<td><code>fillRect(int x, int y, int width, int height)</code></td>
<td>Fills the specified rectangle.</td>
</tr>
<tr>
<td><code>drawOval(int x, int y, int width, int height)</code></td>
<td>Draws the oval bounded by the specified rectangle.</td>
</tr>
<tr>
<td><code>fillOval(int x, int y, int width, int height)</code></td>
<td>Fills the oval bounded by the specified rectangle.</td>
</tr>
<tr>
<td><code>drawArc(int x, int y, int width, int height, int startAngle, int arcAngle)</code></td>
<td>Draws the arc bounded by the specified rectangle.</td>
</tr>
<tr>
<td><code>fillArc(int x, int y, int width, int height, int startAngle, int arcAngle)</code></td>
<td>Fills the arc bounded by the specified rectangle.</td>
</tr>
<tr>
<td><code>drawString(String str, int x, int y)</code></td>
<td>Draws the text given by the specified string.</td>
</tr>
<tr>
<td><code>getColor()</code></td>
<td>Gets the current color.</td>
</tr>
<tr>
<td><code>setColor(Color c)</code></td>
<td>Sets the current color.</td>
</tr>
</tbody>
</table>

Appendix F: Java Graphics
Graphics Class (3)

- The `drawRect` method:

  ```java
text.drawRect(50, 50, 200, 100);
```

- The `drawOval` method:

  ```java
text.drawOval(50, 50, 200, 100);
```
The `drawArc` method:

```java
page.drawArc(50, 50, 200, 100, 20, 90);
```
Examples

- We will use a template that extends the `JPanel` class from the `javax.swing`. Focus only on the `paintComponent` method!

- Examples:
  - BasicShapes.java
  - Shapes.java

- Snowman.java

- **In-class Exercise:** Modify the snowman program as follows:
  - Move the sun to the upper right
  - Display your name in the upper left corner of the picture
  - Make the snowman frown instead of smile
  - Shift the entire snowman to the left by 20 pixels
Graphics Techniques

- Basic techniques for drawing:
  - Translation (Illustrated in the Snowman example using the MID variable)
  - Centering
  - Scaling
- This example illustrates how to make the graphics scale automatically if the user resizes the window.
  - DrawPieChart.java
  - DrawPieChartScalable.java
- An example that shows how to use a custom font and center a String using font metrics: CenterText.java
- Another example that shows how to draw thicker lines: Strokes.java
- Another example that shows how to load an image: ImageAvatar.java
Animation

- **Animation** involves drawing the picture multiple times (with incremental variation) per second using a timer to create the illusion of movement. The individual pictures are referred to as **frames** in movies (animated or otherwise).

- These examples show how we can animate our drawings!
  - SimpleAnimation.java
  - DigitalClock.java
Summary

- How graphics coordinate system works
- How color is represented
- How to center, scale and translate drawings
- How animation works
- Using Graphics, Color, Font and related classes
Exercises

▶ Read Appendix F (pp. 965–973).

▶ **Recommended Homework:**
  ▶ Projects: PP F.4, PP F.15.