GUI Output

Adapted from slides by Michelle Strout with some slides from Rick Mercer

CSc 210

GUI (Graphical User Interface)

- We all use GUI's every day
- Text interfaces great for testing and debugging
- Infants know how to use GUIs on phones
- What GUI features ...
  - Do you like most?
  - Have Opportunities For Improvement (OFI)?

AWT then Swing

- Java's first GUI support (1995) was called the Abstract Window Toolkit (`AWT`)
- `AWT` had some limitations, and some particular problems with how it was implemented on some platforms
- `AWT` was replaced by a new library called `Swing`
  - more versatile, more robust, and more flexible
- `Swing` was designed primarily for use in desktop applications
  - Could do some web-based things with it though Applets

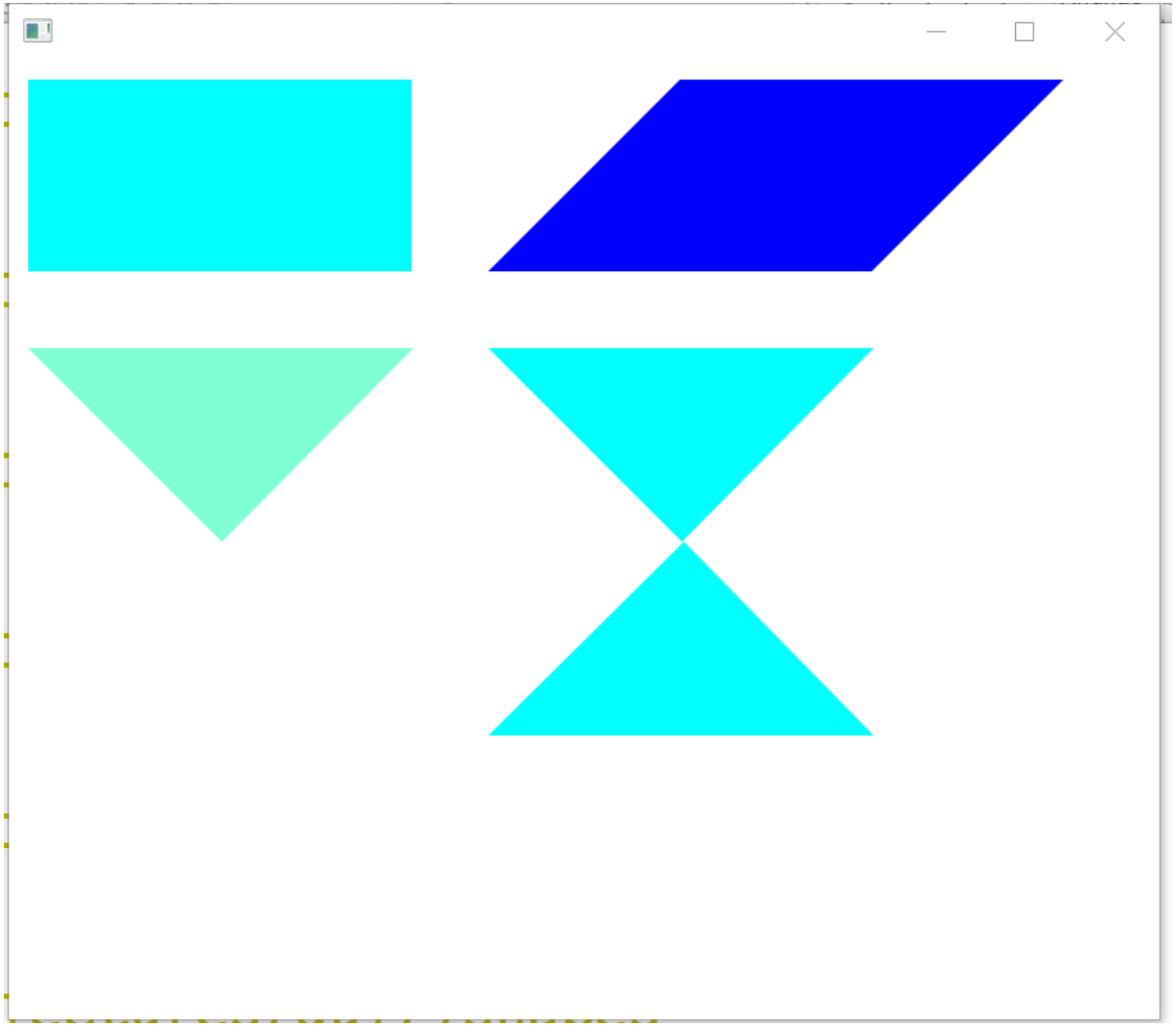
GUI I/O Implemented with Libraries

- Some popular GUI Libraries and App Frameworks
  - Python has tKinter
  - Java has Swing
  - C++ has QT
  - Unity
  - .NET on Microsoft Windows Platforms
- Java FX
  - Improving on Swing
  - Will be used in 335

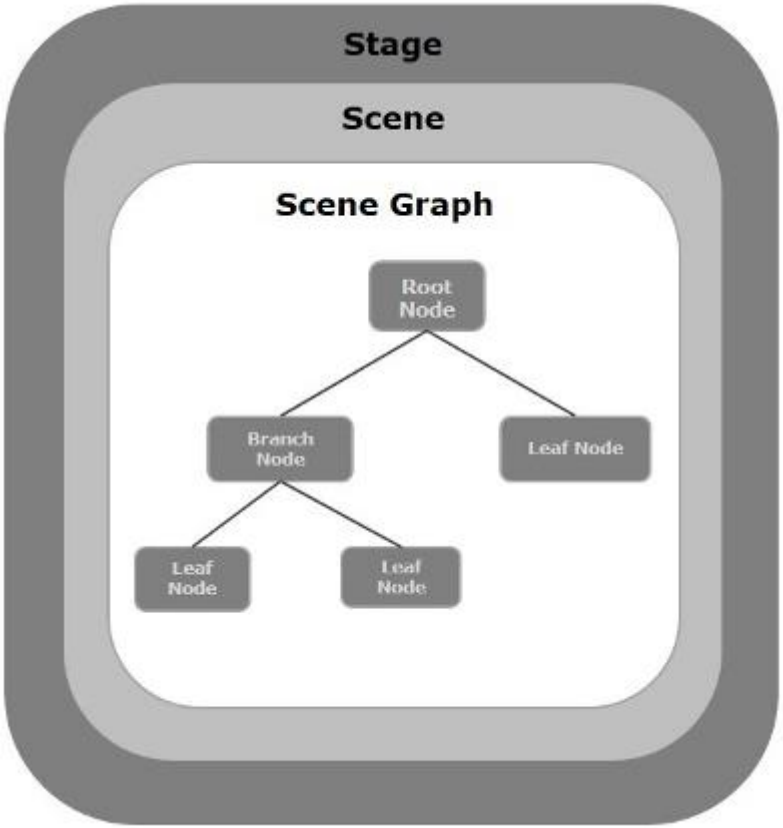
Today's Goals

- Draw some shapes with JavaFX
  - Basics for making a window
  - Coordinate system used in JavaFX
  - Interface for drawing basic shapes

Today we will learn to draw



JavaFX Layout



A JavaFX Application has 3 major components:

1. Stage
2. Scene
3. Nodes

Stage

- A stage (window) contains the JavaFX objects
- The primary stage is created by the platform
- There are five types of stages available
- You must call the show() method to display the contents of the stage.

Scene

- A scene represents the physical contents of the application.
- Like a play, you can use different scenes to show different displays
- When you create a scene you can opt for the display size and give it's root node.

Scene Graph

- A Scene Graph (tree) represents the objects in a scene. It consists of nodes (Node class)

- There are three types of nodes:
  1. Root Node - the root of the tree
  2. Parent Node
  3. Leaf Node

Parent Node

- The root node as well as all parent nodes must be a child of the abstract class Parent. It's children are:
  - **Group** - a collective node that contains a list of children nodes
  - **Region** - the base class of all JavaFX Node based UI controls
  - **WebView** - manages the web engine

Basics for making a window (slide 1)

- Classes you will need to import

```
import javafx.application.Application;
import javafx.stage.Stage;
import javafx.scene.Scene;
import javafx.scene.layout.BorderPane;
```

- Inherit from Application class and call launch()

```
public class Drawing extends Application {
    public static void main(String[] args) {
        launch(args);
     }
...
}
```

Basics for making a window (slide 2)

- launch() (or something in its call tree) calls start() and passes in a Stage
- Stage will contain Scene will contain RootPane

```
public class Drawing extends Application {
    public static void main(String[] args) {
        launch(args);
    }
    @Override public void start(Stage stage) {
        // create the root pane and then the scene
        BorderPane root_pane = new BorderPane();
        Scene scene = new Scene( root_pane, 400, 300 );

        //===== Drawing stuff goes here =====
        //===================================

        // Set the scene on the stage and show the stage.
        stage.setScene( scene );
        stage.show();
    }
}
```

Drawing on a Canvas

- Stage will contain Scene will contain RootPane
  - Will contain a Canvas

```
import javafx.scene.canvas.Canvas;
import javafx.scene.canvas.GraphicsContext;

...
        //===== Drawing stuff goes here =====
        // Construct a Canvas object and put it in
        // the root pane.
        Canvas canvas = new Canvas( 300, 200 );
        root_pane.getChildren().add(canvas);
        // Drawing on the canvas, getting a graphics context
        // and calling drawing methods on it.
        GraphicsContext gc = canvas.getGraphicsContext2D();
        gc.fillText("Text in a Canvas at 30,40", 30, 40);
        gc.fillText("Text in a Canvas at 30,50", 30, 50);
        //====================================
```

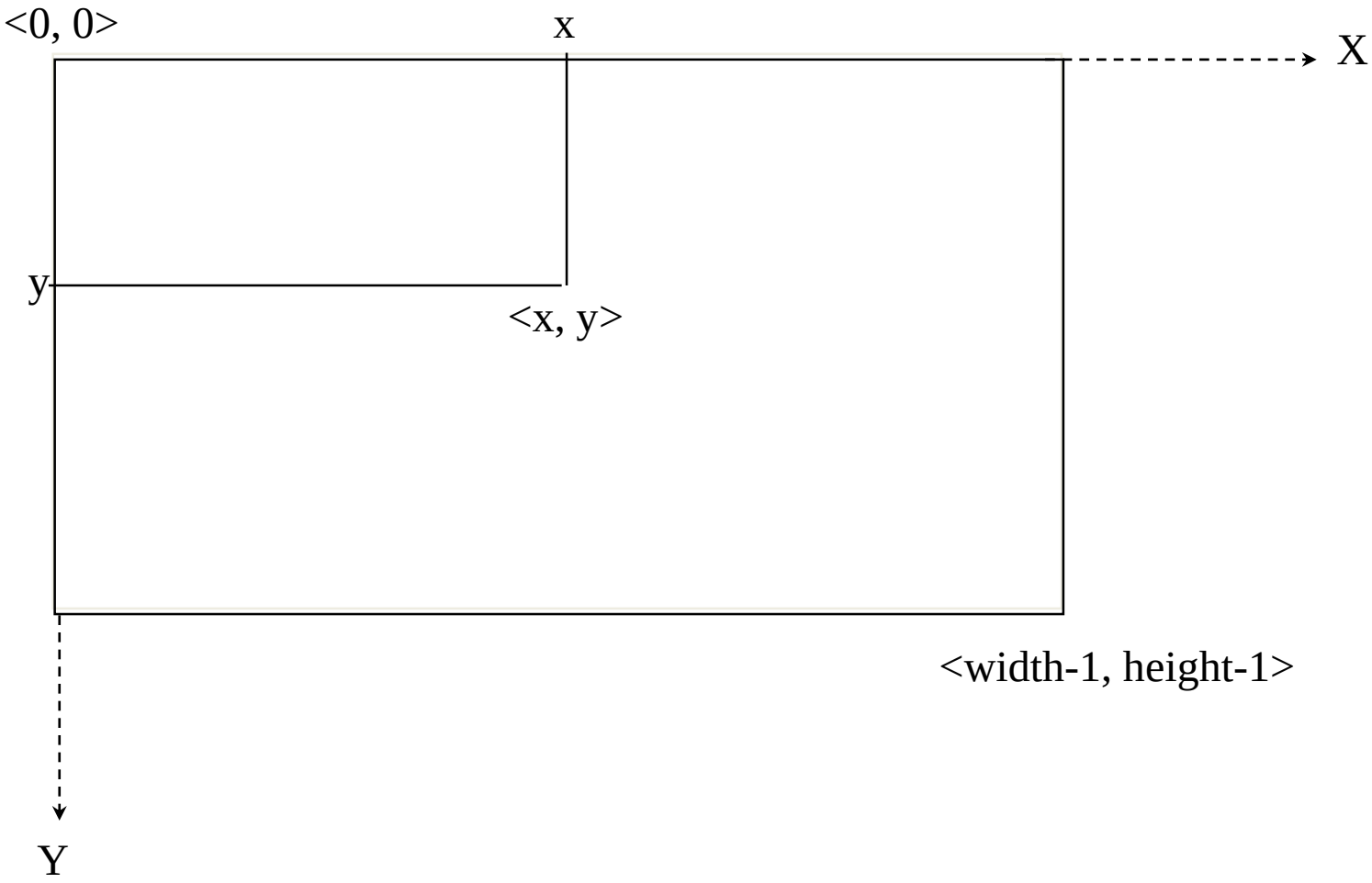
JavaFX Coordinate System

- A simple two-dimensional coordinate system exists for each graphics context, or **drawing surface**
- Each point on the coordinate system represents a pixel
- Top left corner of the area is coordinate <0, 0>

```
// This string will be drawn 20 pixels right,
// 40 pixels down as the lower left corner.
// All other shapes point is the upper left
gc.fillText("I'm in a Canvas", 20, 40);
```

- A drawing surface has a width and height
- Anything drawn outside of that area is not visible

The Coordinate System



Draw Common Shapes

- What does this do?

```
gc.strokeOval(20, 20, 40, 40);
```

A couple method headings

- Lines are drawn with stroke (lines) and fill (solid)
- Oracle has an API online for JavaFX just like for Java: https://docs.oracle.com/javase/8/javafx/api/toc.htm

public void fillOval(double x, double y, double w, double h)

Fills an oval using the current fill paint.

Parameters:

x - the X coordinate of the upper left bound of the oval.

y - the Y coordinate of the upper left bound of the oval.

w - the width at the center of the oval.

h - the height at the center of the oval.

Color

- The **Color** class is used to define and manage the color in which shapes are drawn
- Can set the color for stroke and fill with setFill(Color) and setStroke(Color)
- **javafx.scene.paint.Color;** has many, many colors from **Color.ALICEBLUE** to **Color.YELLOWGREEN**

Color

- Colors can also be defined with an *RGB value*, to set the relative contribution of the primary colors red, green, blue

```
Color color = Color.rgb(80, 210, 110);
gc.setFill(color);
gc.setStroke(color);
gc.setLineWidth(4); // width now 4 pixels
gc.strokeOval(20, 20, 40, 40);
gc.fillOval(70, 20, 40, 40);
```

Clearing GraphicsContext

public void clearRect(double x, double y, double w, double h)

Clears a portion of the canvas with a transparent color value.

Parameters:

- x - X position of the upper left corner of the rectangle.
- y - Y position of the upper left corner of the rectangle.
- w - width of the rectangle.
- h - height of the rectangle.

Clearing GraphicsContext

Example Code:

```
Canvas canvas = new Canvas(300, 300);
GraphicsContext gc = canvas.getGraphicsContext2D();
gc.clearRect(0,0,canvas.getWidth(), canvas.getHeight())
```

Interacting with Command Line

- Suppose we want to type our drawing commands through the keyboard.
- Can we just add input commands to our start method?
- No. JavaFX will not display the stage until the start method returns. ☹
- To actually take commands we need something running while JavaFX displays the stage.

Threads

- A ***program*** is a set of instructions.
- A ***process*** is a running program, it has instructions, but also data values, and control location (what in the program is currently being executed)
- ***Multi-processing*** is when more than one process is being executed at once.

Threads

- ***Multi-threading*** is when more than one control location is being executed in the same process.
- A ***thread*** is a sequential flow of control through a program

Threads

- One way to launch a thread in Java is to create a class that extends Thread.
- This class should include a public void method run(). This is the method that will run when the thread is started.

```
public class Worker extends Thread {

  @Override public void run() {
```

Threads

- You can then instantiate an object of the created class.
- Calling the **start()** method (a method of the Thread class) will create a new thread and start it executing in the classes run() method.

```
Worker w1 = new Worker(gc);
w1.start();  //starts thread
```