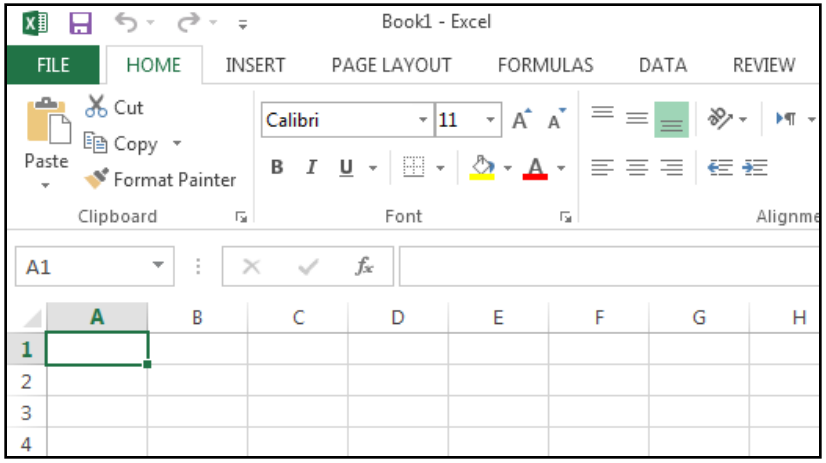
Graphical User Interfaces JavaFX GUI Basics

CSE219, Computer Science III

Stony Brook University

http://www.cs.stonybrook.edu/~cse219

GUI Examples

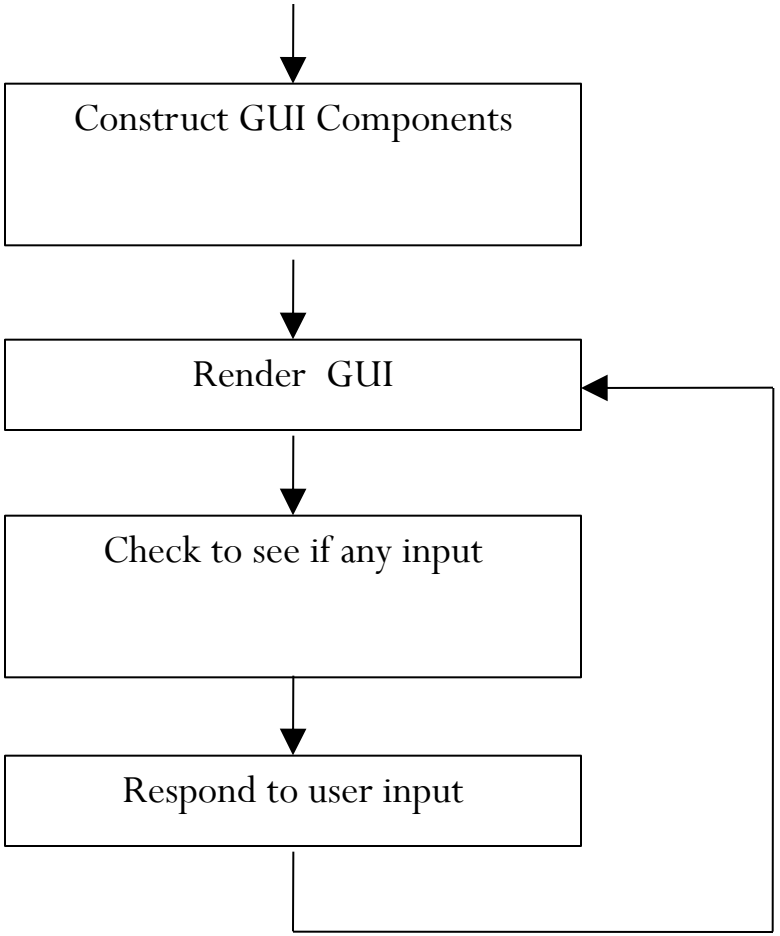


GUI

- Graphical User Interface (GUI)
  - provides user-friendly human interaction
- Building Java GUIs require use of multiple frameworks:
  - JavaFX (part of JSE 8, 2014)
  - An old framework would use:
    - Java's GUI component Libraries
      - **`javax.swing.*`**
    - Java's Event Programming Libraries
      - **`java.awt.event.*`**
      - **`Javax.swing.event.*`**
    - Java's Graphics Programming Libraries
      - **`java.awt.*`**
      - **`java.awt.geom.*`**

How do GUIs work?

- They loop and respond to events



Example: a mouse click on a button

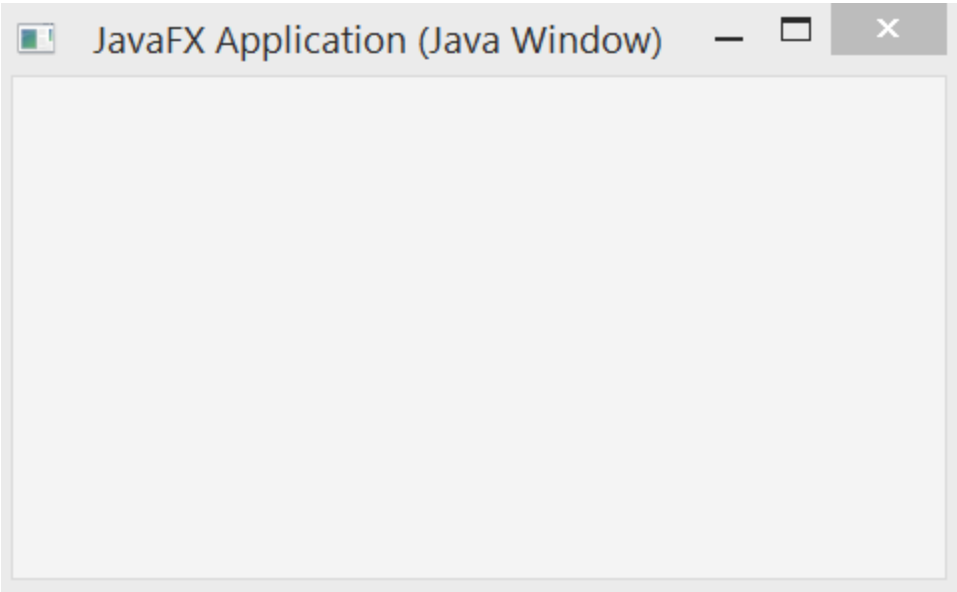
- Operating System recognizes mouse click
  - determines which window it was inside
  - notifies that program
- Program runs in loop
  - checks input buffer filled by OS
  - if it finds a mouse click:
    - determines which component in the program
    - if the click was on a relevant component
      - respond appropriately according to handler

GUI Look vs. Behavior

- Look
  - physical appearance
  - custom component design
  - containment
  - layout management
- Behavior
  - interactivity
  - event programmed response

What does a GUI framework do for you?

- Provides ready made visible, interactive, customizable components
  - you wouldn't want to have to code your own window

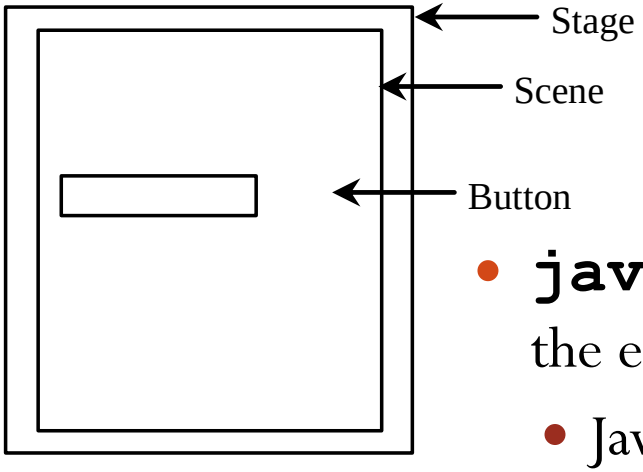



```
public class JavaFXApplication1
       extends Application {
 @Override
 public void start(Stage
       primaryStage) {
  Scene scene =
       new Scene(root, 300, 250);
  primaryStage.setTitle("JavaFX
     Application(Java Window)");
  primaryStage.setScene(scene);
  primaryStage.show();
 }
 public static void main(
         String[] args) {
  launch(args);
 }
}
```

JavaFX vs Swing and AWT

- Swing and AWT are replaced by the JavaFX platform for developing rich Internet applications in JDK8.
  - When Java was introduced, the GUI classes were bundled in a library known as the Abstract Windows Toolkit (AWT).
    - AWT is fine for developing simple graphical user interfaces, but not for developing comprehensive GUI projects.
    - In addition, AWT is prone to platform-specific bugs.
  - The AWT user-interface components were replaced by a more robust, versatile, and flexible library known as Swing components.
    - Swing components are painted directly on canvases using Java code.
    - Swing components depend less on the target platform and use less of the native GUI resource.
  - **With the release of Java 8, Swing is replaced by a completely new GUI platform: JavaFX.**

Basic Structure of JavaFX

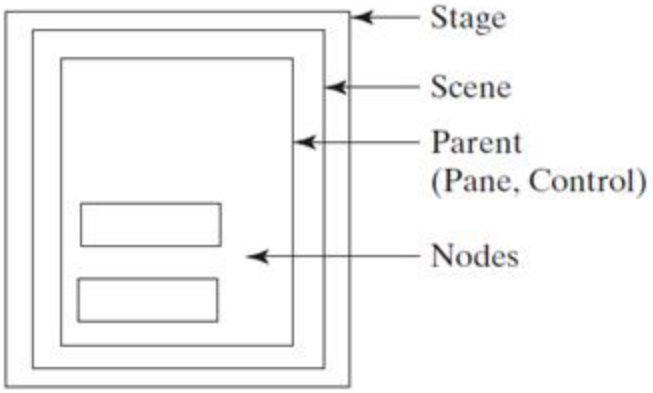


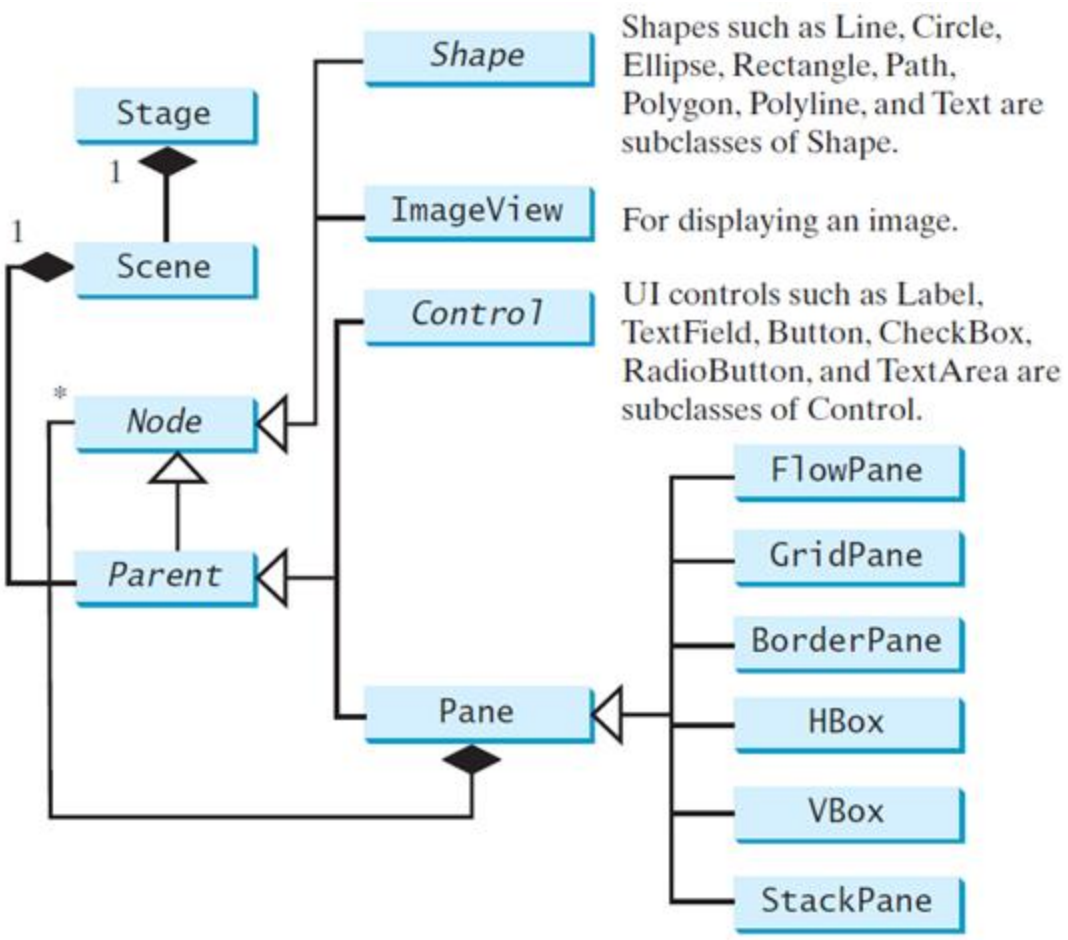
- **`javafx.application.Application`** is the entry point for JavaFX applications
  - JavaFX creates an application thread for running the application start method, processing input events, and running animation timelines.
  - Override the start(Stage) method!
- **`javafx.stage.Stage`** is the top level JavaFX container.
  - The primary Stage is constructed by the platform.
- **`javafx.scene.Scene`** class is the container for all content in a scene graph.
- **`javafx.scene.Node`** is the base class for scene graph nodes.

```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;

public class MyFirstJavaFX extends Application {
  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    // Create a button and place it in the scene
    Button btOK = new Button("OK");
    Scene scene = new Scene(btOK, 200, 250);
    primaryStage.setTitle("MyJavaFX"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }

  /**
   * The main method is only needed for the IDE with limited
   * JavaFX support. Not needed for running from the command line.
   */
  public static void main(String[] args) {
    launch(args);
  }
}
```

```
// Multiple stages can be added beside the primaryStage
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;
public class MultipleStageDemo extends Application {
  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    // Create a scene and place a button in the scene
    Scene scene = new Scene(new Button("OK"), 200, 250);
    primaryStage.setTitle("MyJavaFX"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
    Stage stage = new Stage(); // Create a new stage
    stage.setTitle("Second Stage"); // Set the stage title
    // Set a scene with a button in the stage
    stage.setScene(new Scene(new Button("New Stage"), 100, 100));
    stage.show(); // Display the stage
  }

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

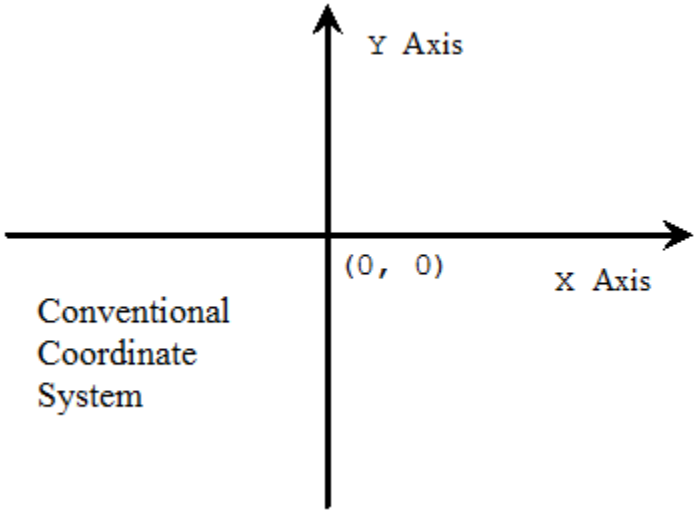
Panes, UI Controls, and Shapes



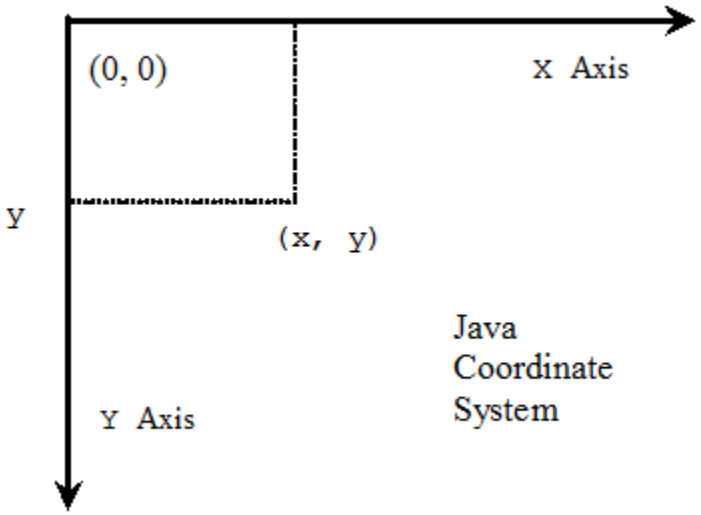


```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.layout.StackPane;
import javafx.stage.Stage;

public class ButtonInPane extends Application {

  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    // Create a scene and place a button in the scene
    StackPane pane = new StackPane();
    pane.getChildren().add(new Button("OK"));
    Scene scene = new Scene(pane, 200, 50);
    primaryStage.setTitle("Button in a pane"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }

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

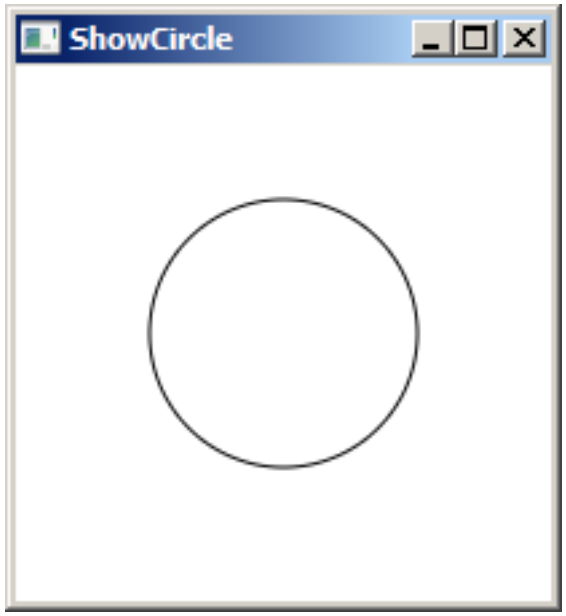
Display a Shape



- Programming Coordinate Systems start from the left-upper corner



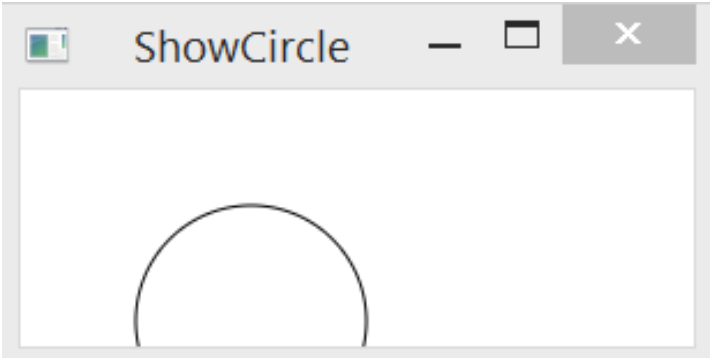
Circle in a Pane



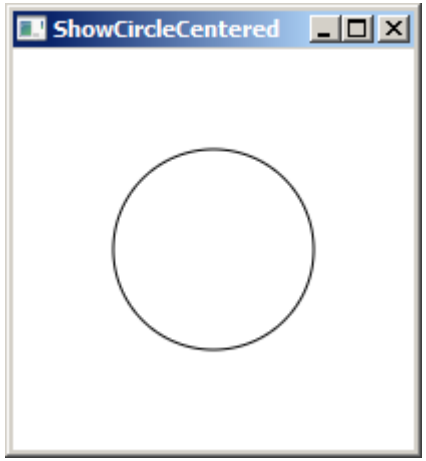

```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.scene.shape.Circle;
import javafx.stage.Stage;
public class ShowCircle extends Application {
  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    // Create a circle and set its properties
    Circle circle = new Circle();
    circle.setCenterX(100);
    circle.setCenterY(100);
    circle.setRadius(50);
    circle.setStroke(Color.BLACK);
    circle.setFill(null);
    // Create a pane to hold the circle
    Pane pane = new Pane();
    pane.getChildren().add(circle);
    // Create a scene and place it in the stage
    Scene scene = new Scene(pane, 200, 200);
    primaryStage.setTitle("ShowCircle"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }

  /**
   * The main method is only needed for the IDE with limited
   * JavaFX support. Not needed for running from the command line.
   */
  public static void main(String[] args) {
    launch(args);
  }
}
```

Binding Properties

- JavaFX introduces a new concept called ***binding property*** that enables a target object to be bound to a source object.
  - If the value in the source object changes, the target property is also changed automatically.
  - The target object is simply called a binding object or a binding property.
- Resizing the window in the previous example would cover the object:



```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.scene.shape.Circle;
import javafx.stage.Stage;
public class ShowCircleCentered extends Application {
  @Override // Override the start method in the Application class
  public void start(Stage primaryStage) {
    // Create a pane to hold the circle
    Pane pane = new Pane();
    // Create a circle and set its properties
    Circle circle = new Circle();
    circle.centerXProperty().bind(pane.widthProperty().divide(2));
    circle.centerYProperty().bind(pane.heightProperty().divide(2));
    circle.setRadius(50);
    circle.setStroke(Color.BLACK);
    circle.setFill(Color.WHITE);
    pane.getChildren().add(circle); // Add circle to the pane
    // Create a scene and place it in the stage
    Scene scene = new Scene(pane, 200, 200);
    primaryStage.setTitle("ShowCircleCentered"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }

  /**
   * The main method is only needed for the IDE with limited
   * JavaFX support. Not needed for running from the command line.
   */
  public static void main(String[] args) {
    launch(args);
  }
}
```



JavaFX Beans and Binding

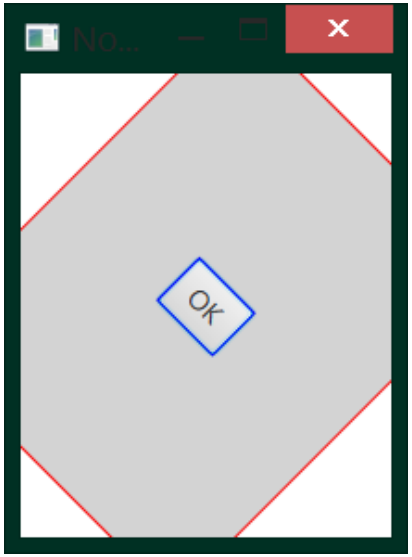
- Changes made to one object will automatically be reflected in another object
  - A graphical user interface automatically keeps its display synchronized with the application's underlying data: a binding observes its list of dependencies for changes, and then updates itself automatically after a change has been detected.

```
import javafx.beans.property.DoubleProperty;
import javafx.beans.property.SimpleDoubleProperty;

public class BindingDemo {
  public static void main(String[] args) {
    DoubleProperty d1 = new SimpleDoubleProperty(1);
    DoubleProperty d2 = new SimpleDoubleProperty(2);
    d1.bind(d2);
    System.out.println("d1 is " + d1.getValue()
      + " and d2 is " + d2.getValue());

    d2.setValue(70.2);
    System.out.println("d1 is " + d1.getValue()
      + " and d2 is " + d2.getValue());
  }
}
```

Output:
d1 is 2.0 and d2 is 2.0

d1 is 70.2 and d2 is 70.2

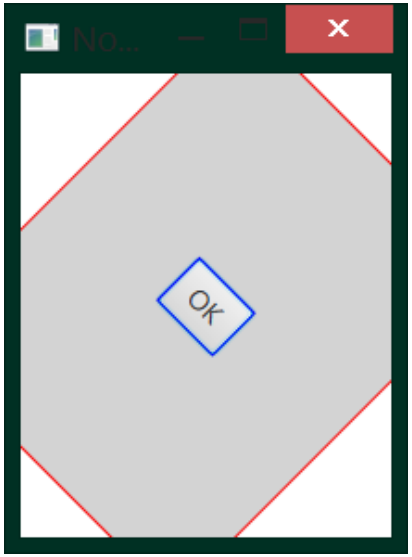
JavaFX CSS style and Node rotation




```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;
import javafx.scene.layout.StackPane;
public class NodeStyleRotateDemo extends Application {
  @Override
  public void start(Stage primaryStage) {
    StackPane pane = new StackPane();
    Button btOK = new Button("OK");
    btOK.setStyle("-fx-border-color: blue;");
    pane.getChildren().add(btOK);
    pane.setRotate(45);
    pane.setStyle("-fx-border-color: red; -fx-background-color: lightgray;");
    Scene scene = new Scene(pane, 200, 250);
    primaryStage.setTitle("NodeStyleRotateDemo"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }

  /**
   * The main method is only needed for the IDE with limited
   * JavaFX support. Not needed for running from the command line.
   */
  public static void main(String[] args) {
    launch(args);
  }
}
```

JavaFX CSS style and Node rotation

```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;
import javafx.scene.layout.StackPane;
public class NodeStyleRotateDemo extends Application {
  @Override
  public void start(Stage primaryStage) {
    StackPane pane = new StackPane();
```

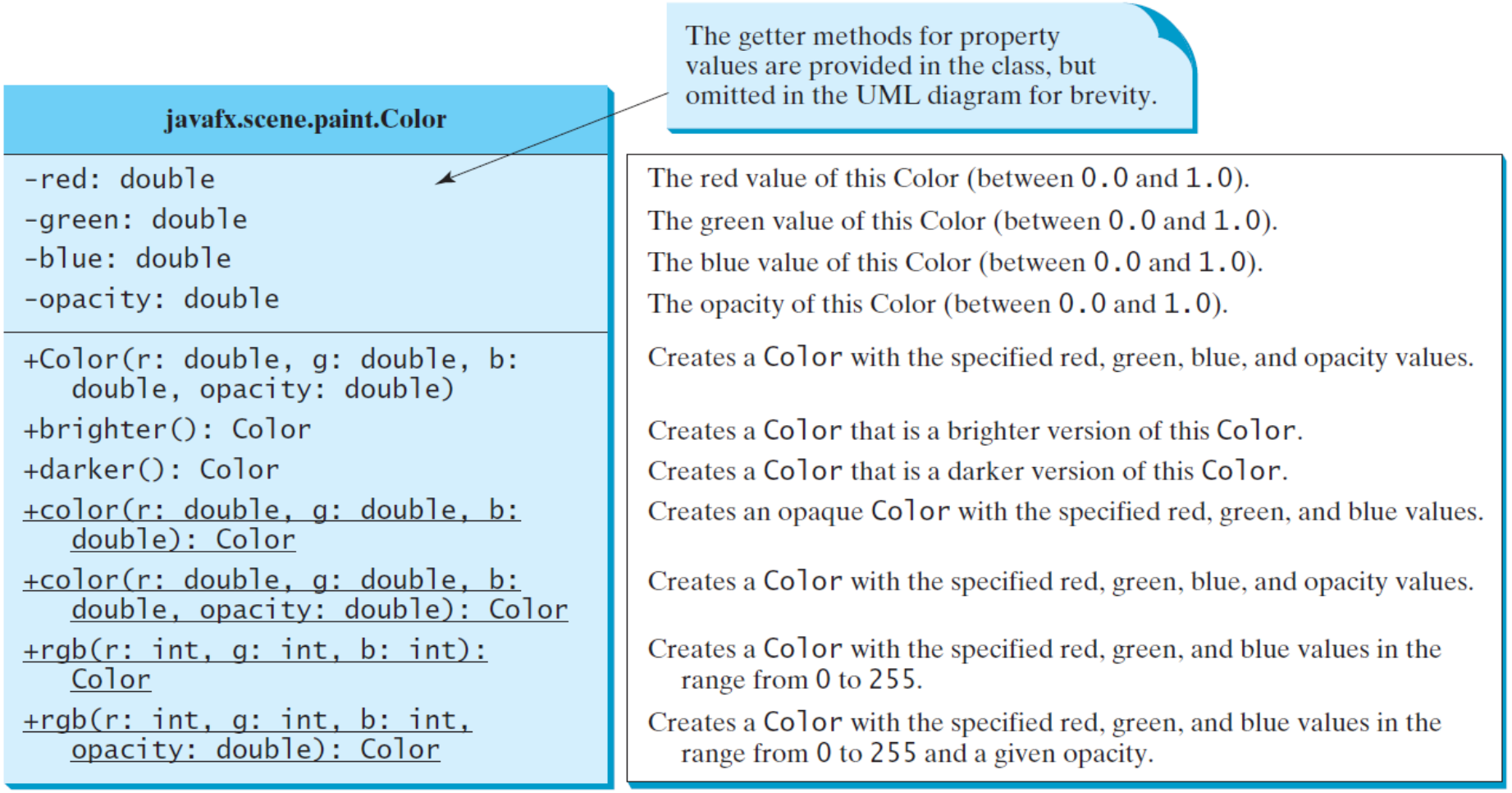



```
/* The StackPane layout pane places all of the nodes within
a single stack with each new node added on top of the
previous node. This layout model provides an easy way to
overlay text on a shape or image and to overlap common
shapes to create a complex shape. */
```

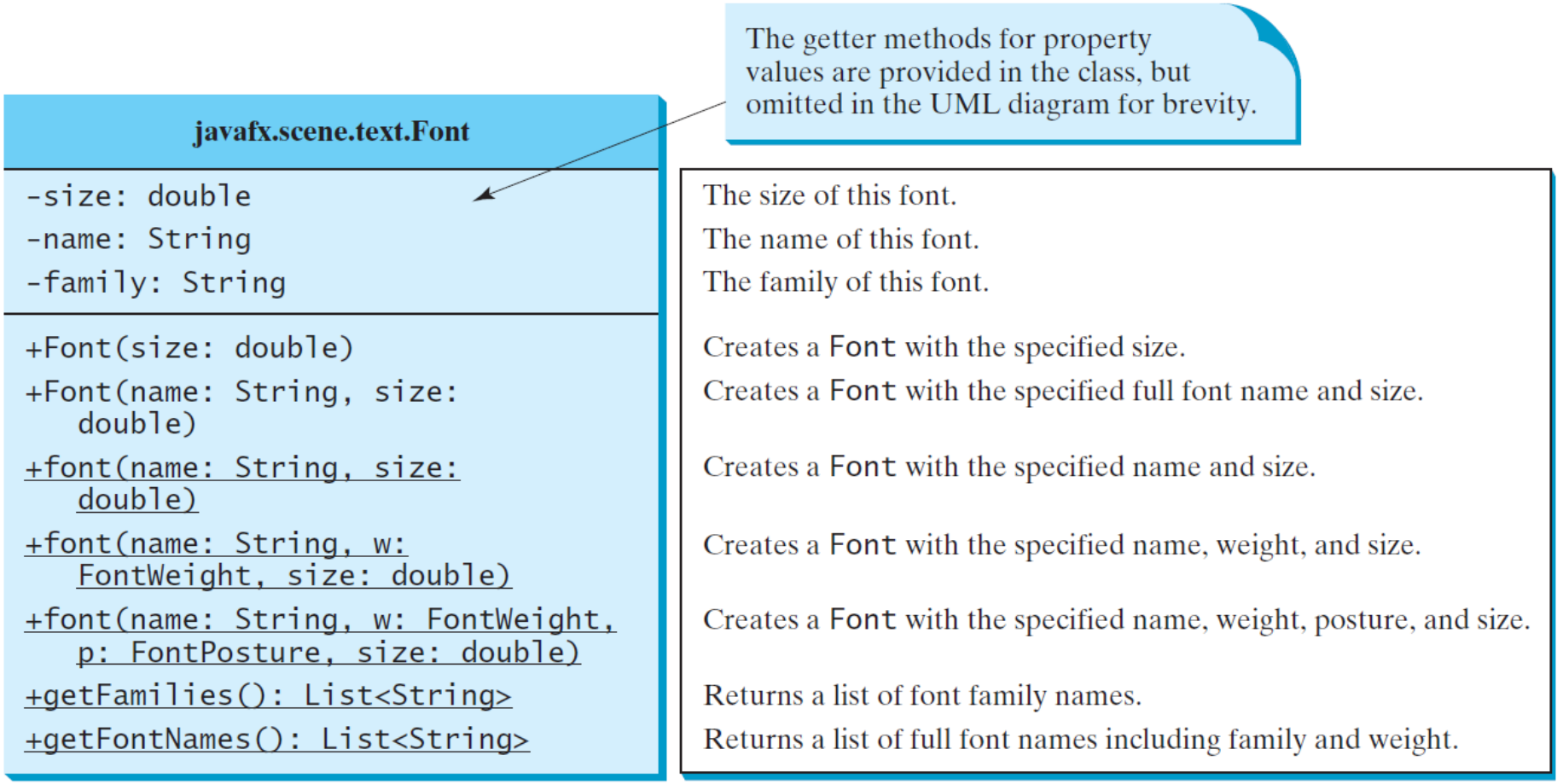
JavaFX External CSS style file

```
// Example to load and use a CSS style file in a scene
import javafx.application.Application;
import javafx.stage.Stage;
import javafx.scene.Scene;
import javafx.scene.layout.BorderPane;

public class ExternalCSSFile extends Application {
  @Override
  public void start(Stage primaryStage) {
    try {
      BorderPane root = new BorderPane();
      Scene scene = new Scene(root,400,400);
      scene.getStylesheets().add(getClass().getResource("application.css")
         .toExternalForm());
      primaryStage.setScene(scene);
      primaryStage.show();
    } catch(Exception e) {
      e.printStackTrace();
    }
  }

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

Helper classes: The Color Class



Helper classes: The Font Class



The Image and ImageView Classes

The getter methods for property values are provided in the class, but omitted in the UML diagram for brevity.

javafx.scene.image.Image

```
-error: ReadOnlyBooleanProperty
-height: ReadOnlyBooleanProperty
-width: ReadOnlyBooleanProperty
-progress: ReadOnlyBooleanProperty
+Image(filenameOrURL: String)
```

Indicates whether the image is loaded correctly?
The height of the image.
The width of the image.
The approximate percentage of image's loading that is completed.

Creates an `Image` with contents loaded from a file or a URL.

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

javafx.scene.image.ImageView

```
-fitHeight: DoubleProperty
-fitWidth: DoubleProperty
-x: DoubleProperty
-y: DoubleProperty
-image: ObjectProperty<Image>
+ImageView()
+ImageView(image: Image)
+ImageView(filenameOrURL: String)
```

The height of the bounding box within which the image is resized to fit.
The width of the bounding box within which the image is resized to fit.
The x-coordinate of the ImageView origin.
The y-coordinate of the ImageView origin.
The image to be displayed in the image view.

Creates an `ImageView`.
Creates an `ImageView` with the specified image.
Creates an `ImageView` with image loaded from the specified file or URL.

```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.HBox;
import javafx.scene.layout.Pane;
import javafx.geometry.Insets;
import javafx.stage.Stage;
import javafx.scene.image.Image;
import javafx.scene.image.ImageView;

public class ShowImage extends Application {
  @Override
  public void start(Stage primaryStage) {
    // Create a pane to hold the image views
    Pane pane = new HBox(10);
    pane.setPadding(new Insets(5, 5, 5, 5));
    Image image = new Image("paul.jpg");
    pane.getChildren().add(new ImageView(image));
    ImageView imageView2 = new ImageView(image);
    imageView2.setFitHeight(100);
    imageView2.setFitWidth(100);
    imageView2.setRotate(90);
    pane.getChildren().add(imageView2);
    Scene scene = new Scene(pane);
    primaryStage.setTitle("ShowImage");
    primaryStage.setScene(scene);
    primaryStage.show();
  }
  public static void main(String[] args) {
    launch(args);
  }
}
```

Layout Panes

- JavaFX provides many **types of panes for organizing nodes in a container.**

Class	*Description*
`Pane`	Base class for layout panes. It contains the `getChildren()` method for returning a list of nodes in the pane.
`StackPane`	Places the nodes on top of each other in the center of the pane.
`FlowPane`	Places the nodes row-by-row horizontally or column-by-column vertically.
`GridPane`	Places the nodes in the cells in a two-dimensional grid.
`BorderPane`	Places the nodes in the top, right, bottom, left, and center regions.
`HBox`	Places the nodes in a single row.
`VBox`	Places the nodes in a single column.

FlowPane

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

javafx.scene.layout.FlowPane

```
-alignment: ObjectProperty<Pos>
-orientation:
   ObjectProperty<Orientation>
-hgap: DoubleProperty
-vgap: DoubleProperty
```

```
+FlowPane()
+FlowPane(hgap: double, vgap:
   double)
+FlowPane(orientation:
   ObjectProperty<Orientation>)
+FlowPane(orientation:
   ObjectProperty<Orientation>,
   hgap: double, vgap: double
```

The overall alignment of the content in this pane (default: `Pos.LEFT`).
The orientation in this pane (default: `Orientation.HORIZONTAL`).

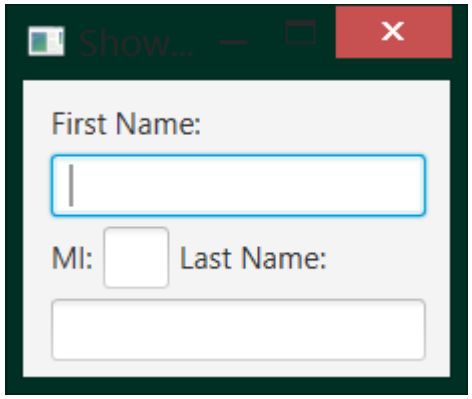
The horizontal gap between the nodes (default: `0`).
The vertical gap between the nodes (default: `0`).

Creates a default `FlowPane`.
Creates a `FlowPane` with a specified horizontal and vertical gap.

Creates a `FlowPane` with a specified orientation.

Creates a `FlowPane` with a specified orientation, horizontal gap and vertical gap.

```
import javafx.application.Application;
import javafx.geometry.Insets;
import javafx.scene.Scene;
import javafx.scene.control.Label;
import javafx.scene.control.TextField;
import javafx.scene.layout.FlowPane;
import javafx.stage.Stage;
public class ShowFlowPane extends Application {
  @Override
  public void start(Stage primaryStage) {
    FlowPane pane = new FlowPane();
    pane.setPadding(new Insets(11, 12, 13, 14));
    pane.setHgap(5);
    pane.setVgap(5);
    // Place nodes in the pane
    pane.getChildren().addAll(new Label("First Name:"),
      new TextField(), new Label("MI:"));
    TextField tfMi = new TextField();
    tfMi.setPrefColumnCount(1);
    pane.getChildren().addAll(tfMi, new Label("Last Name:"),
      new TextField());
    // Create a scene and place it in the stage
    Scene scene = new Scene(pane, 210, 150);
    primaryStage.setTitle("ShowFlowPane");
    primaryStage.setScene(scene); // Place the scene in the stage
    primaryStage.show(); // Display the stage
  }
    public static void main(String[] args) {
    launch(args);
  }
}
```



GridPane

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

javafx.scene.layout.GridPane

```
-alignment: ObjectProperty<Pos>
-gridLinesVisible:
   BooleanProperty
-hgap: DoubleProperty
-vgap: DoubleProperty
```

```
+GridPane()
+add(child: Node, columnIndex:
   int, rowIndex: int): void
+addColumn(columnIndex: int,
   children: Node...): void
+addRow(rowIndex: int,
   children: Node...): void
+getColumnIndex(child: Node):
   int
+setColumnIndex(child: Node,
   columnIndex: int): void
+getRowIndex(child:Node): int
+setRowIndex(child: Node,
   rowIndex: int): void
+setHalighnment(child: Node,
   value: HPos): void
+setValighnment(child: Node,
   value: VPos): void
```

The overall alignment of the content in this pane (default: `Pos.LEFT`).
Is the grid line visible? (default: `false`)

The horizontal gap between the nodes (default: 0).
The vertical gap between the nodes (default: 0).

Creates a `GridPane`.
Adds a node to the specified column and row.

Adds multiple nodes to the specified column.

Adds multiple nodes to the specified row.

Returns the column index for the specified node.

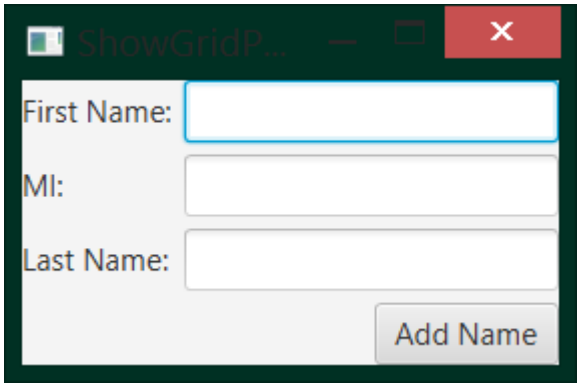
Sets a node to a new column. This method repositions the node.

Returns the row index for the specified node.
Sets a node to a new row. This method repositions the node.

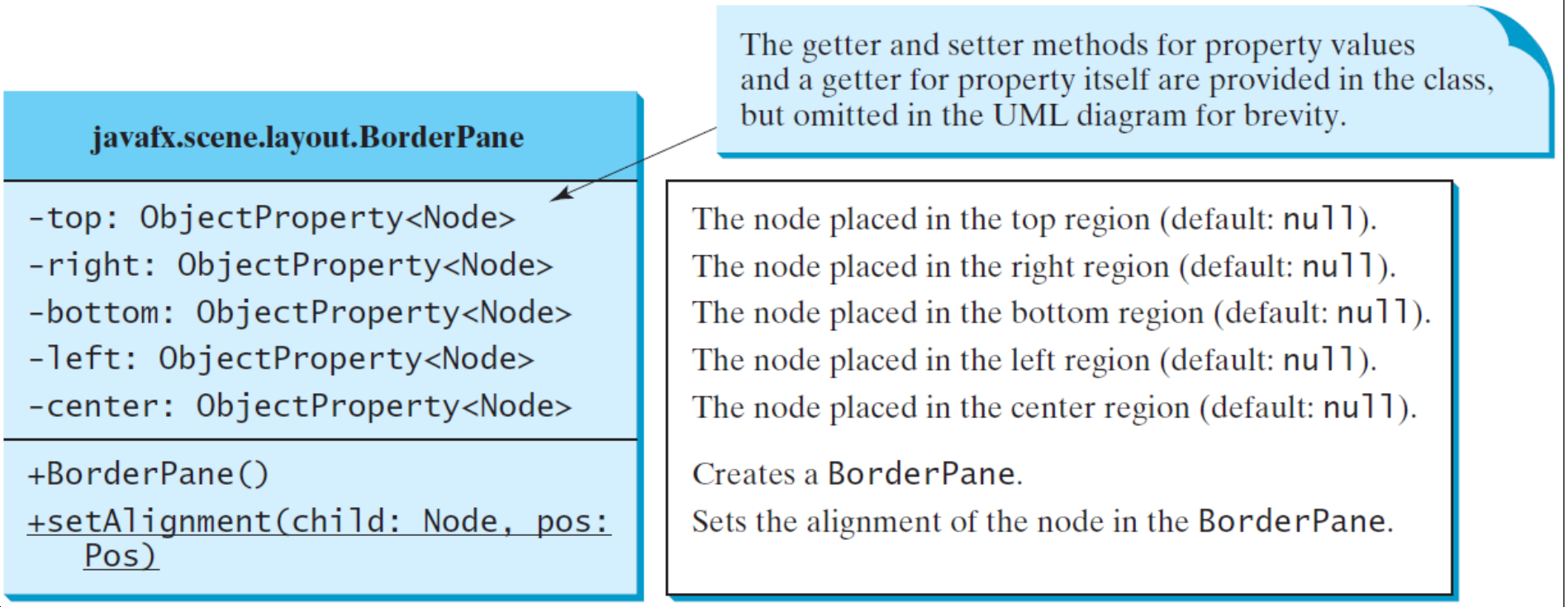
Sets the horizontal alignment for the child in the cell.

Sets the vertical alignment for the child in the cell.

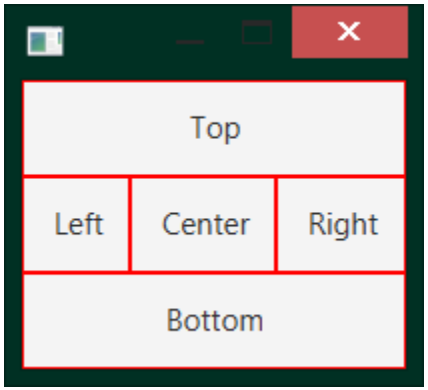
```
import javafx.application.Application;
import javafx.scene.layout.GridPane;
import javafx.geometry.*;
import javafx.scene.*;
import javafx.scene.control.*;
import javafx.stage.*;
public class ShowGridPane extends Application {
  @Override
  public void start(Stage primaryStage) {
    // Create a pane and set its properties
    GridPane pane = new GridPane();
    pane.setAlignment(Pos.CENTER);
    pane.setHgap(5.5);
    pane.setVgap(5.5);
    // Place nodes in the pane at positions   column,row
    pane.add(new Label("First Name:"), 0, 0);
    pane.add(new TextField(), 1, 0);
    pane.add(new Label("MI:"), 0, 1);
    pane.add(new TextField(), 1, 1);
    pane.add(new Label("Last Name:"), 0, 2);
    pane.add(new TextField(), 1, 2);
    Button btAdd = new Button("Add Name");
    pane.add(btAdd, 1, 3);
    GridPane.setHalignment(btAdd, HPos.RIGHT);
    // Create a scene and place it in the stage
    Scene scene = new Scene(pane);
    primaryStage.setTitle("ShowGridPane");
    primaryStage.setScene(scene); primaryStage.show(); }
  public static void main(String[] args) {
    launch(args);
  }}
```



BorderPane



```
import javafx.application.Application;
import javafx.geometry.Insets;
import javafx.scene.Scene;
import javafx.scene.control.Label;
import javafx.scene.layout.BorderPane;
import javafx.scene.layout.StackPane;
import javafx.stage.Stage;
public class ShowBorderPane extends Application {
  @Override
  public void start(Stage primaryStage) {
    BorderPane pane = new BorderPane();
    pane.setTop(new CustomPane("Top"));
    pane.setRight(new CustomPane("Right"));
    pane.setBottom(new CustomPane("Bottom"));
    pane.setLeft(new CustomPane("Left"));
    pane.setCenter(new CustomPane("Center"));
    Scene scene = new Scene(pane);
    primaryStage.setScene(scene); primaryStage.show();
  }
  public static void main(String[] args) {
    launch(args);
  }
}
class CustomPane extends StackPane {
  public CustomPane(String title) {
    getChildren().add(new Label(title));
    setStyle("-fx-border-color: red");
    setPadding(new Insets(11.5, 12.5, 13.5, 14.5));
  }
}
```



Hbox and VBox

javafx.scene.layout.HBox

-alignment: ObjectProperty<Pos>
-fillHeight: BooleanProperty
-spacing: DoubleProperty

+HBox()
+HBox(spacing: double)
+setMargin(node: Node, value: Insets): void

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

The overall alignment of the children in the box (default: `Pos.TOP_LEFT`).
Is resizable children fill the full height of the box (default: `true`).
The horizontal gap between two nodes (default: 0).

Creates a default `HBox`.
Creates an `HBox` with the specified horizontal gap between nodes.
Sets the margin for the node in the pane.

javafx.scene.layout.VBox

-alignment: ObjectProperty<Pos>
-fillWidth: BooleanProperty
-spacing: DoubleProperty

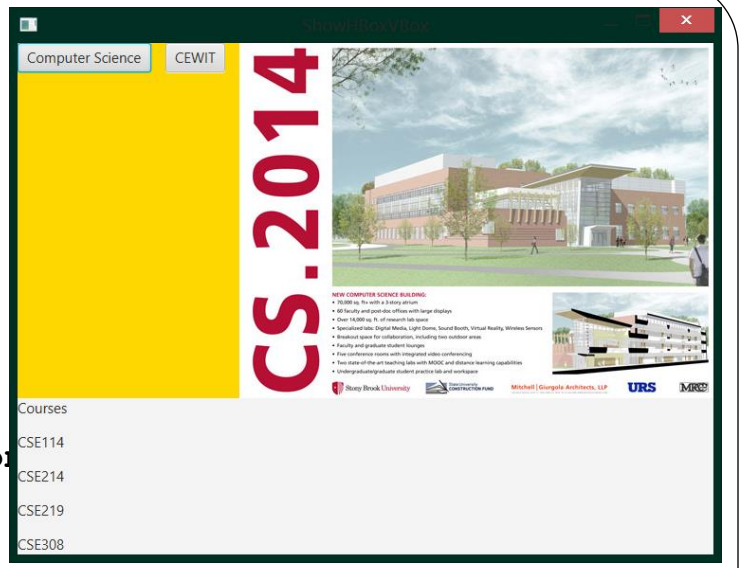
+VBox()
+VBox(spacing: double)
+setMargin(node: Node, value: Insets): void

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

The overall alignment of the children in the box (default: `Pos.TOP_LEFT`).
Is resizable children fill the full width of the box (default: `true`).
The vertical gap between two nodes (default: 0).

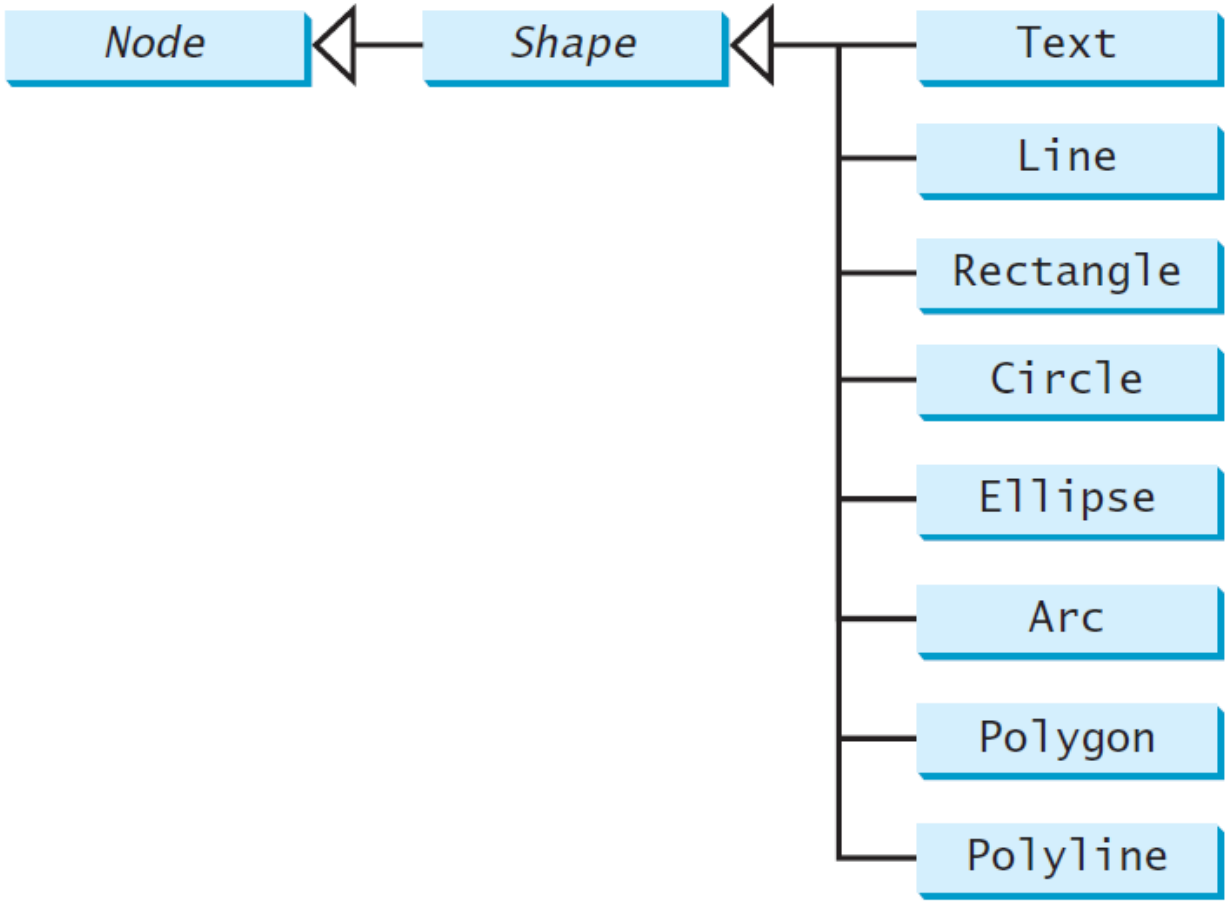
Creates a default `VBox`.
Creates a `VBox` with the specified horizontal gap between nodes.
Sets the margin for the node in the pane.

```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.control.Label;
import javafx.scene.layout.BorderPane;
import javafx.scene.layout.HBox;
import javafx.scene.layout.VBox;
import javafx.stage.Stage;
import javafx.scene.image.Image;
import javafx.scene.image.ImageView;
public class ShowHBoxVBox extends Applicatio
  @Override
  public void start(Stage primaryStage) {
    BorderPane pane = new BorderPane();
    HBox hBox = new HBox(15);
    hBox.setStyle("-fx-background-color: gold");
    hBox.getChildren().add(new Button("Computer Science"));
    hBox.getChildren().add(new Button("CEWIT"));
    ImageView imageView = new ImageView(new Image("cs14.jpg"));
    hBox.getChildren().add(imageView);
    pane.setTop(hBox);
    VBox vBox = new VBox(15);
    vBox.getChildren().add(new Label("Courses"));
    Label[] courses = {new Label("CSE114"), new Label("CSE214"),
        new Label("CSE219"), new Label("CSE308")};
    for (Label course: courses) {
      vBox.getChildren().add(course);
    }
    pane.setLeft(vBox);
    Scene scene = new Scene(pane); primaryStage.setScene(scene);
    primaryStage.show();
  }
```

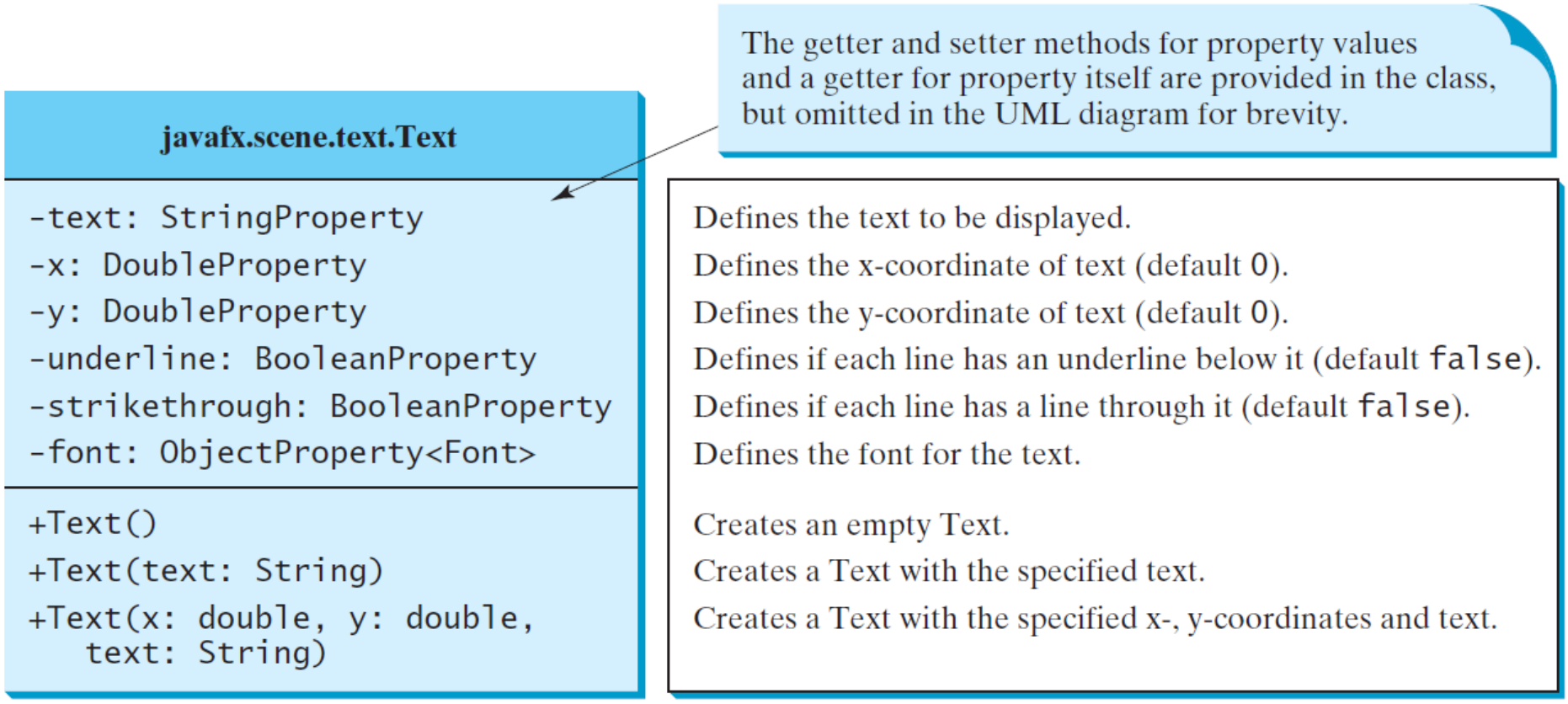


Shapes

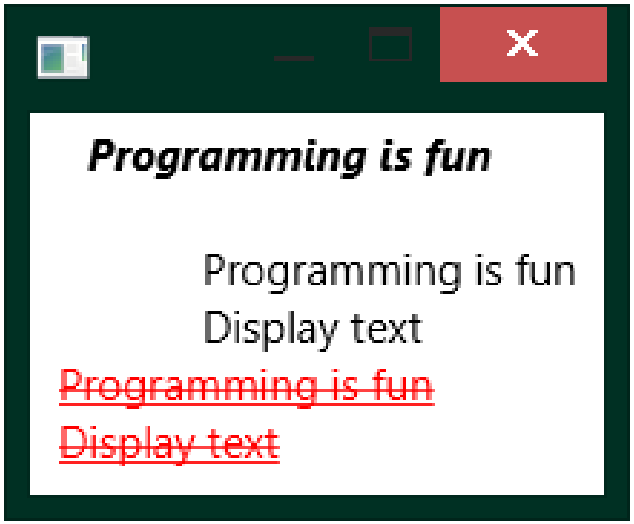
JavaFX provides many shape classes for drawing texts, lines, circles, rectangles, ellipses, arcs, polygons, and polylines.

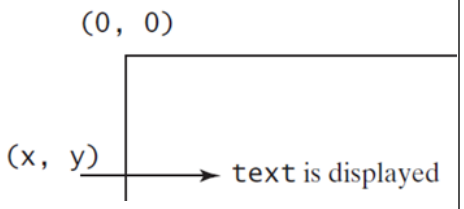


Text



```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.geometry.Insets;
import javafx.stage.Stage;
import javafx.scene.text.Text;
import javafx.scene.text.Font;
import javafx.scene.text.FontWeight;
import javafx.scene.text.FontPosture;
public class ShowText extends Application {
  @Override
  public void start(Stage primaryStage) {
    Pane pane = new Pane();
    pane.setPadding(new Insets(5, 5, 5, 5));
    Text text1 = new Text(20, 20, "Programming is fun");
    text1.setFont(Font.font("Courier", FontWeight.BOLD,
      FontPosture.ITALIC, 15));
    pane.getChildren().add(text1);
    Text text2 = new Text(60, 60, "Programming is fun\nDisplay text");
    pane.getChildren().add(text2);
    Text text3 = new Text(10, 100, "Programming is fun\nDisplay text");
    text3.setFill(Color.RED);
    text3.setUnderline(true);
    text3.setStrikethrough(true);
    pane.getChildren().add(text3);
    Scene scene = new Scene(pane);
    primaryStage.setScene(scene); primaryStage.show();
  }
...
}
```





Line

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

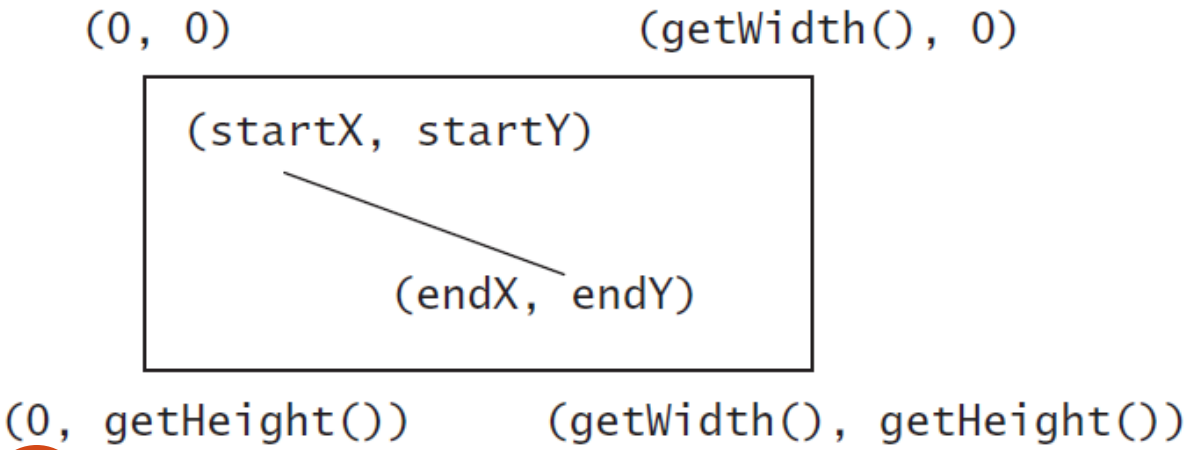
javafx.scene.shape.Line

```
-startX: DoubleProperty
-startY: DoubleProperty
-endX: DoubleProperty
-endY: DoubleProperty
```

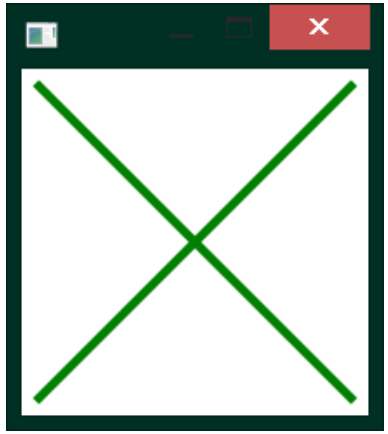
```
+Line()
+Line(startX: double, startY:
   double, endX: double, endY:
   double)
```

The x-coordinate of the start point.
The y-coordinate of the start point.
The x-coordinate of the end point.
The y-coordinate of the end point.

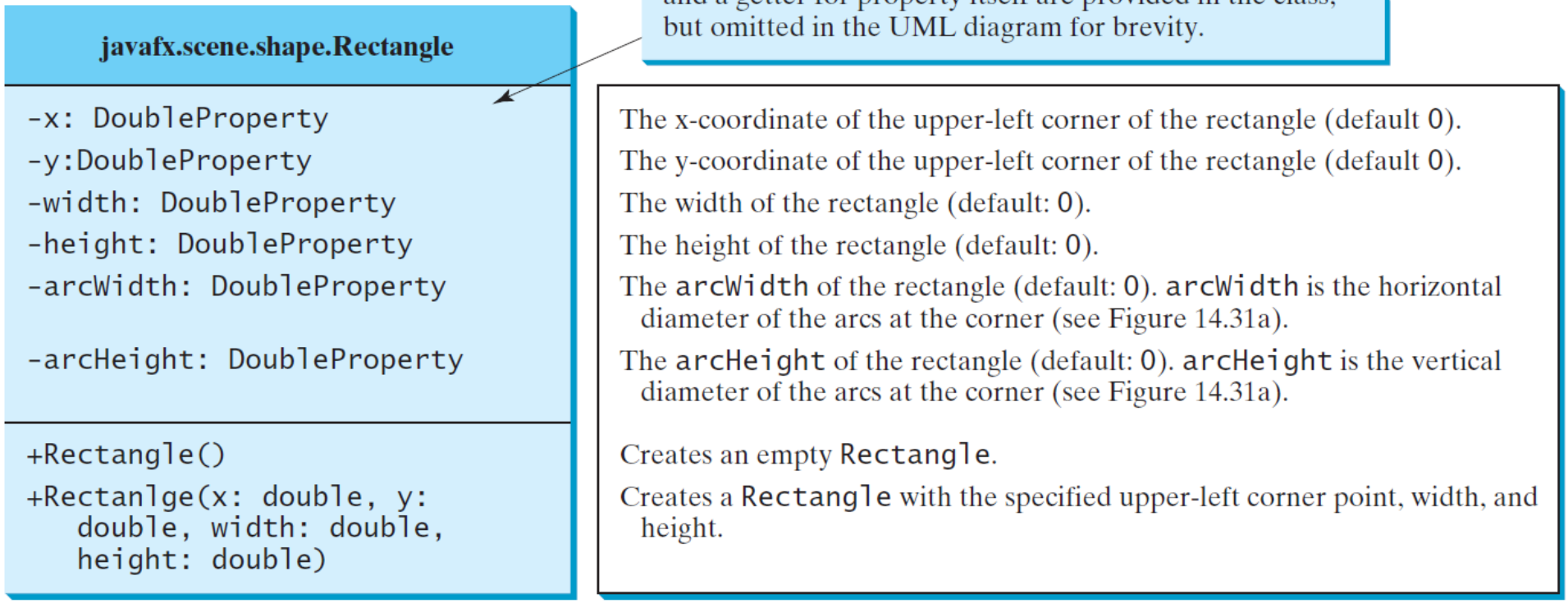
Creates an empty `Line`.
Creates a `Line` with the specified starting and ending points.



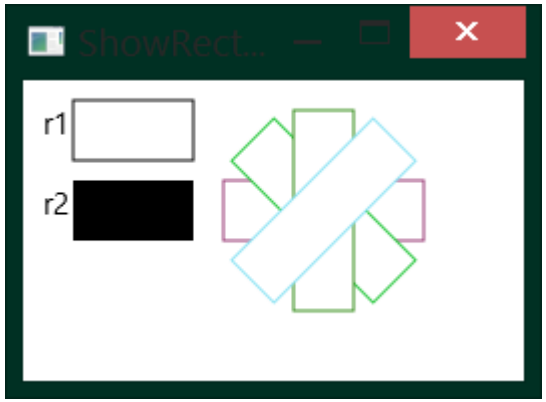
```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.stage.Stage;
import javafx.scene.shape.Line;
public class ShowLine extends Application {
    @Override
    public void start(Stage primaryStage) {
        Pane pane = new Pane();
        Line line1 = new Line(10, 10, 10, 10);
        line1.endXProperty().bind(pane.widthProperty().subtract(10));
        line1.endYProperty().bind(pane.heightProperty().subtract(10));
        line1.setStrokeWidth(5);
        line1.setStroke(Color.GREEN);
        pane.getChildren().add(line1);
        Line line2 = new Line(10, 10, 10, 10);
        line2.startXProperty().bind(pane.widthProperty().subtract(10));
        line2.endYProperty().bind(pane.heightProperty().subtract(10));
        line2.setStrokeWidth(5);
        line2.setStroke(Color.GREEN);
        pane.getChildren().add(line2);
        Scene scene = new Scene(pane, 200, 200);
        primaryStage.setScene(scene);
        primaryStage.show();
    }
    public static void main(String[] args) {
        launch(args);
    }
}
```



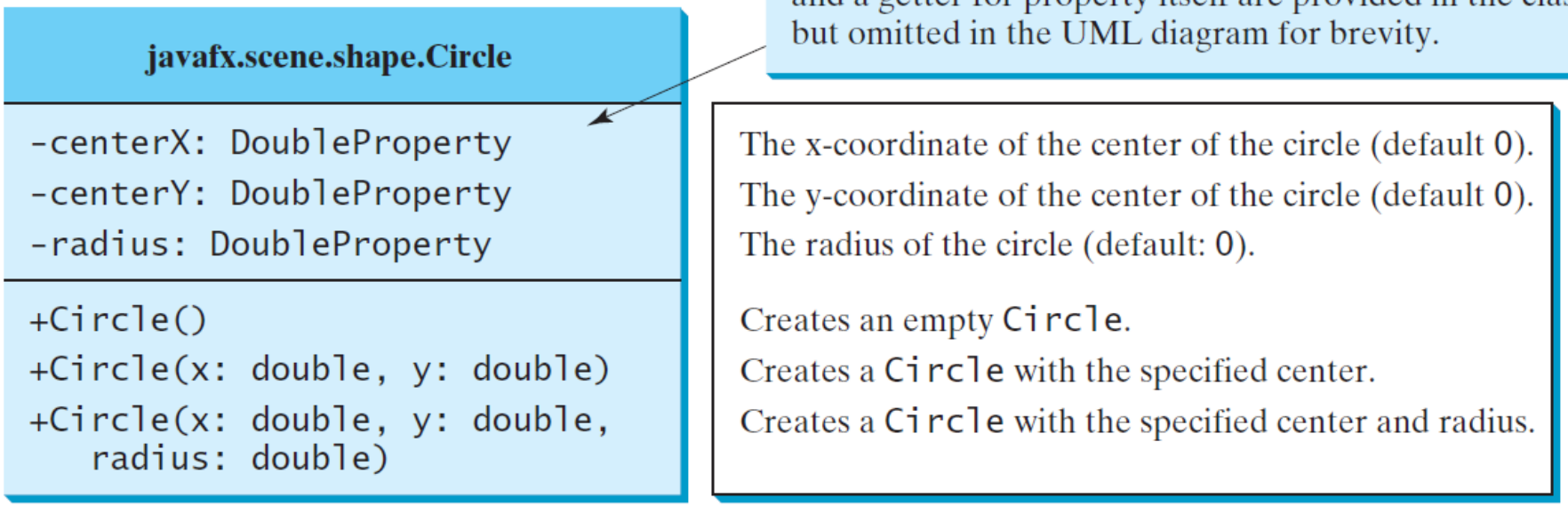
Rectangle



```
import java.util.Collections;
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.stage.Stage;
import javafx.scene.text.Text;
import javafx.scene.shape.Rectangle;
public class ShowRectangle extends Application {
  public void start(Stage primaryStage) {
    Pane pane = new Pane();
    Rectangle r1 = new Rectangle(25, 10, 60, 30);
    r1.setStroke(Color.BLACK);
    r1.setFill(Color.WHITE);
    pane.getChildren().add(new Text(10, 27, "r1"));
    pane.getChildren().add(r1);
    Rectangle r2 = new Rectangle(25, 50, 60, 30);
    pane.getChildren().add(new Text(10, 67, "r2"));
    pane.getChildren().add(r2);
    for (int i = 0; i < 4; i++) {
      Rectangle r = new Rectangle(100, 50, 100, 30);
      r.setRotate(i * 360 / 8);
      r.setStroke(Color.color(Math.random(), Math.random(),
          Math.random()));
      r.setFill(Color.WHITE);
      pane.getChildren().add(r);
    }
    Scene scene = new Scene(pane, 250, 150);
    primaryStage.setScene(scene); primaryStage.show();
  }
  ...// main
```



Circle



Ellipse

The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

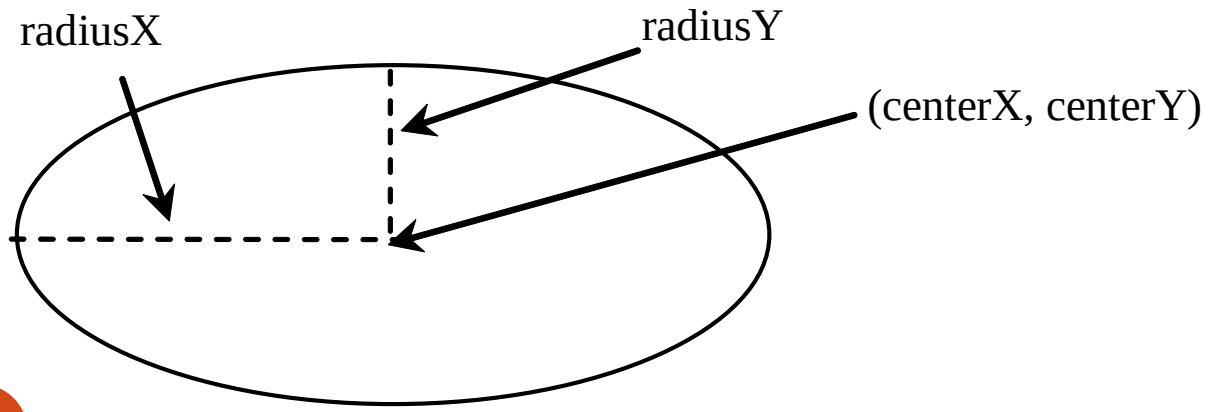
javafx.scene.shape.Ellipse

```
-centerX: DoubleProperty
-centerY: DoubleProperty
-radiusX: DoubleProperty
-radiusY: DoubleProperty
```

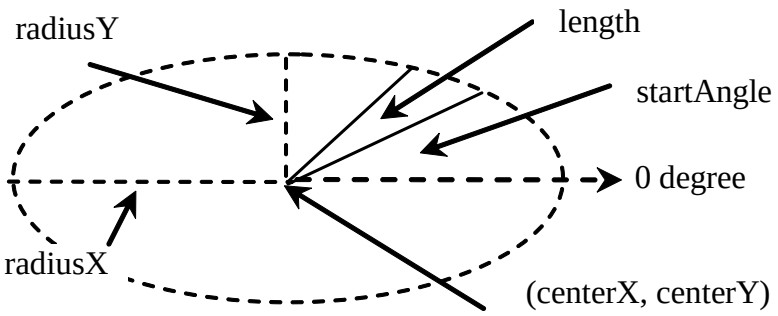
```
+Ellipse()
+Ellipse(x: double, y: double)
+Ellipse(x: double, y: double,
   radiusX: double, radiusY:
   double)
```

The x-coordinate of the center of the ellipse (default 0).
The y-coordinate of the center of the ellipse (default 0).
The horizontal radius of the ellipse (default: 0).
The vertical radius of the ellipse (default: 0).

Creates an empty `Ellipse`.
Creates an `Ellipse` with the specified center.
Creates an `Ellipse` with the specified center and radiuses.



Arc



The getter and setter methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

javafx.scene.shape.Arc

```
-centerX: DoubleProperty
-centerY: DoubleProperty
-radiusX: DoubleProperty
-radiusY: DoubleProperty
-startAngle: DoubleProperty
-length: DoubleProperty
-type: ObjectProperty<ArcType>
```

```
+Arc()
+Arc(x: double, y: double,
   radiusX: double, radiusY:
   double, startAngle: double,
   length: double)
```

The x-coordinate of the center of the ellipse (default 0).

The y-coordinate of the center of the ellipse (default 0).

The horizontal radius of the ellipse (default: 0).

The vertical radius of the ellipse (default: 0).

The start angle of the arc in degrees.

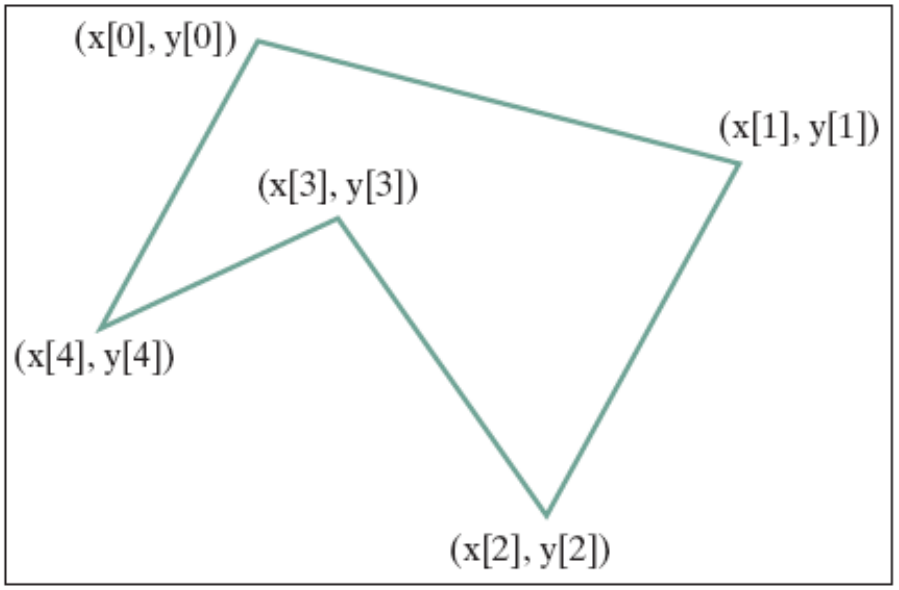
The angular extent of the arc in degrees.

The closure type of the arc (`ArcType.OPEN`, `ArcType.CHORD`, `ArcType.ROUND`).

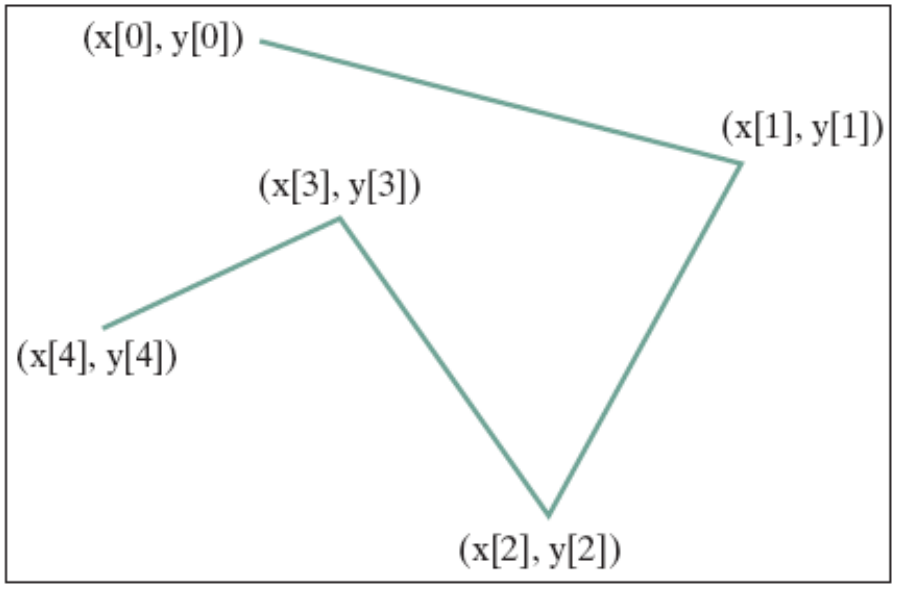
Creates an empty `Arc`.

Creates an `Arc` with the specified arguments.

Polygon and Polyline



(a) Polygon



(b) Polyline

javafx.scene.shape.Polygon
`+Polygon()`
`+Polygon(double... points)`
`+getPoints(): ObservableList<Double>`

The `getter` and `setter` methods for property values and a getter for property itself are provided in the class, but omitted in the UML diagram for brevity.

Creates an empty polygon.

Creates a polygon with the given points.

Returns a list of double values as x- and y-coordinates of the points.