BIRZEIT UNIVERSITY

JavaFX Basics

Motivations

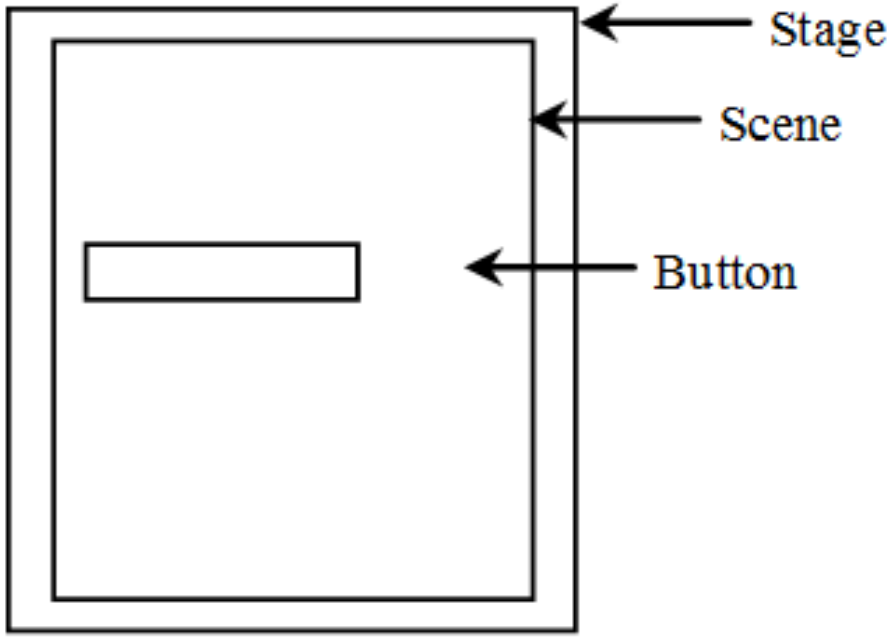
- **JavaFX** is a new framework for developing Java graphical user interface (**GUI)** programs.
- The **JavaFX API** is an **excellent** example of how the **OO** principle is applied.
- This chapter serves two purposes:
  - First, it presents the basics of **JavaFX** programming.
  - Second, it uses **JavaFX** to demonstrate **OOP**.
- Specifically, this chapter introduces the framework of **JavaFX** and discusses **JavaFX GUI** components and their relationships.

JavaFX vs Swing and AWT

- 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**.
  - In addition, **AWT** is prone to platform-specific bugs.
- The **AWT** components were replaced by a more robust, versatile, and flexible library known as ***Swing***.
  - **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 known as ***JavaFX***.

Basic Structure of JavaFX

- Application
- Override the start (**Stage**) method
- **Stage**, **Scene**, and **Nodes**



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

public class MyJavaFX 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
   * JavaFX support. Not needed for running fro
   */
  public static void main(String[] args) {
    launch(args);
  }
}
```

Extend Application

Override start

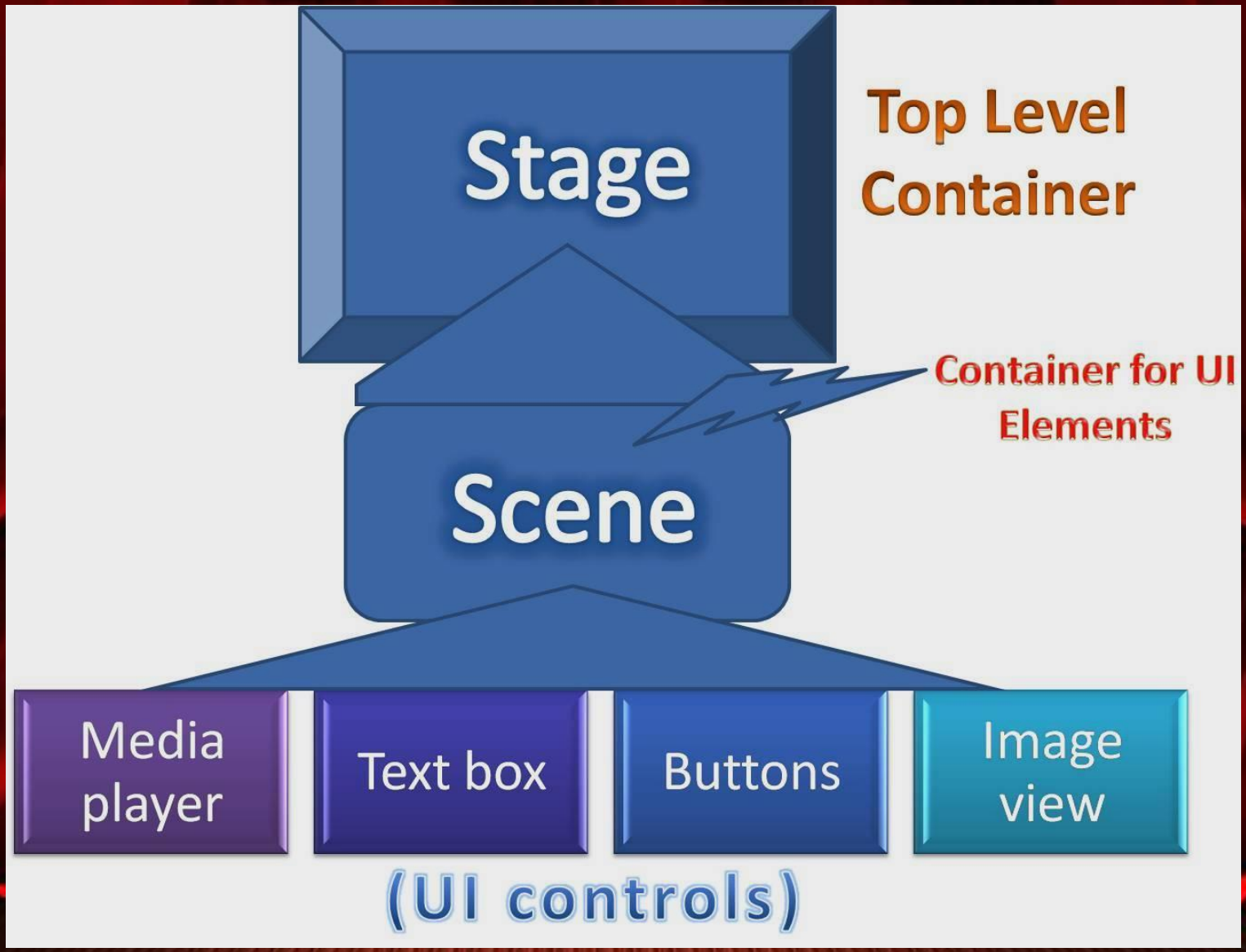
Create a button

Create a scene

Set a scene

Display stage

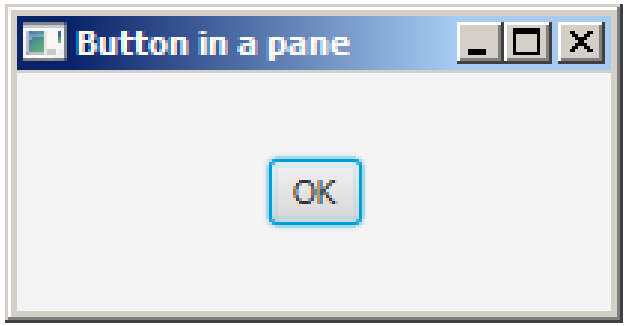
Launch application



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

public class MultipleStageDemo extends Application {
  public void start(Stage primaryStage) {
    Scene scene = new Scene(new Button("OK"), 200, 250);
    primaryStage.setTitle("MyJavaFX");
    primaryStage.setScene(scene);
    primaryStage.show();
    // Create a new stage
    Stage stage = new Stage();
    stage.setTitle("Second Stage");
    stage.setScene(new Scene(new Button("New Stage"), 100, 100));
    stage.show(); // Display the stage
  }

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

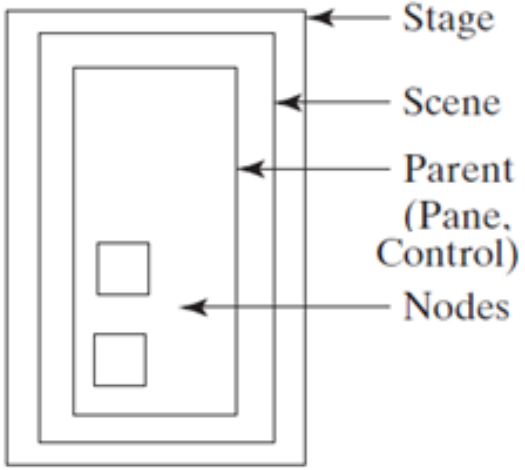
Result is Two Stages/Windows

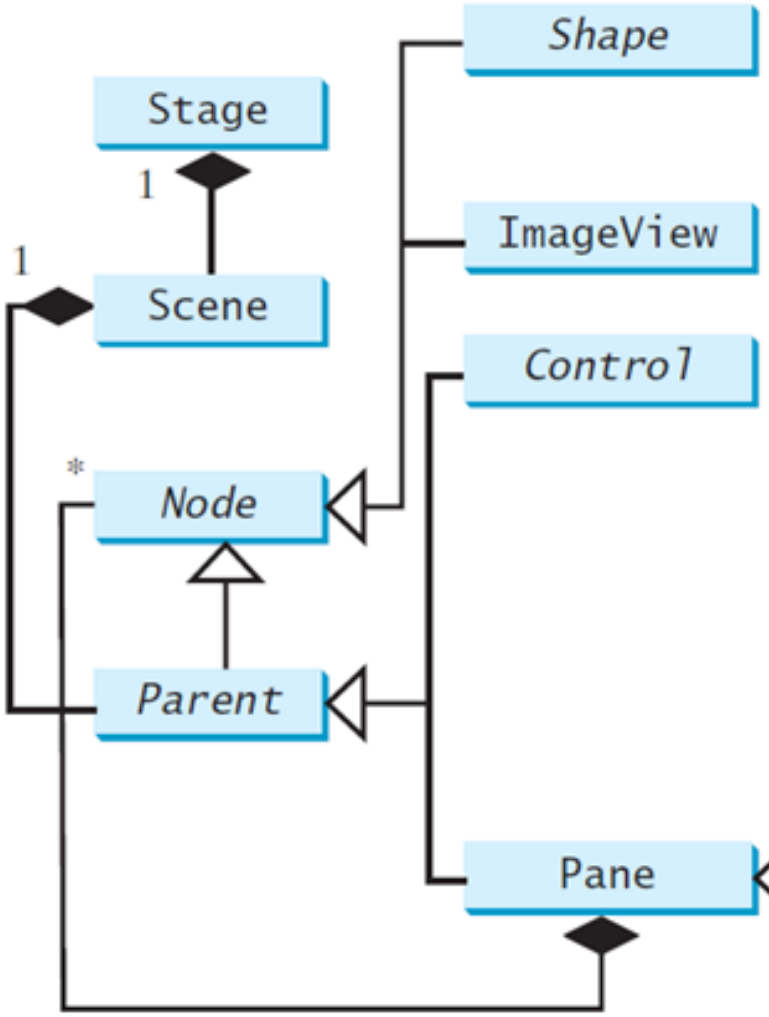
```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.layout.StackPane;
import javafx.stage.Stage;
```




```
public class ButtonInPane extends Application {
  public void start(Stage primaryStage) {
    StackPane pane = new StackPane();
    pane.getChildren().add(new Button("OK"));
    Scene scene = new Scene(pane, 200, 50);
    primaryStage.setTitle("Button in a pane");
    primaryStage.setScene(scene);
    primaryStage.show();
  }

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

Panes, UI Controls, and Shapes

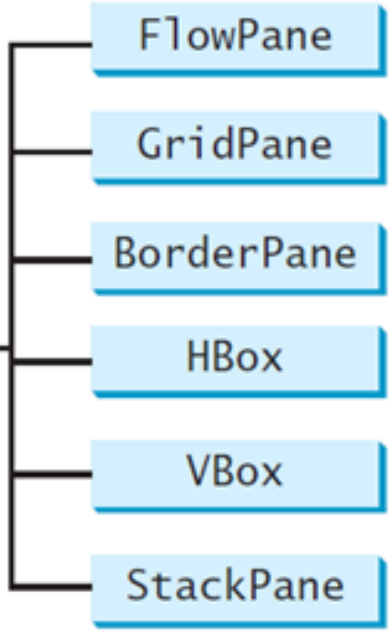




Shapes such as Line, Circle, Ellipse, Rectangle, Path, Polygon, Polyline, and Text are subclasses of Shape.

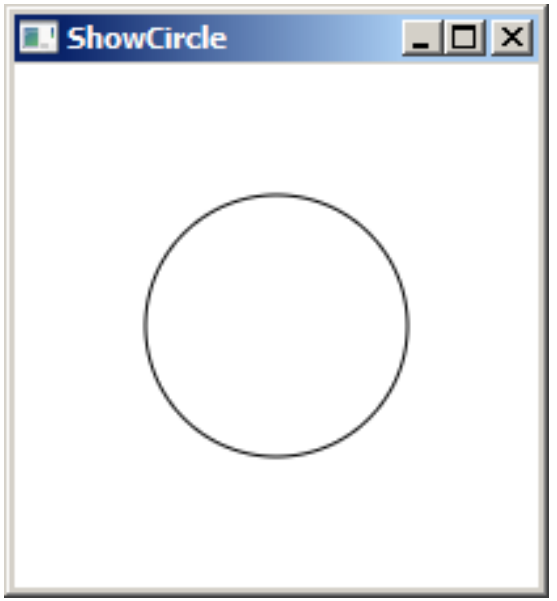
For displaying an image.

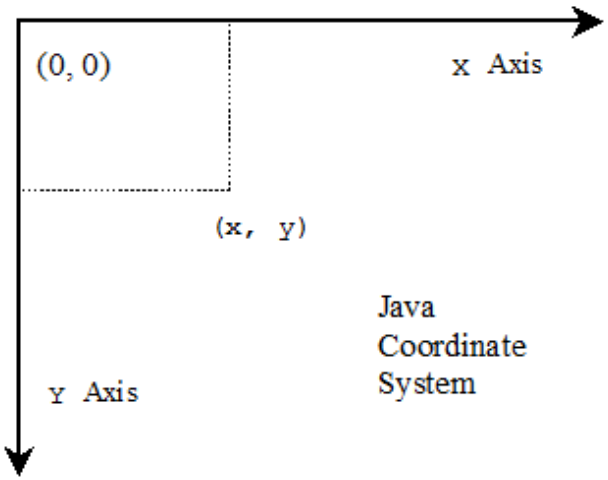
UI controls such as Label, TextField, Button, CheckBox, RadioButton, and TextArea are subclasses of Control.



Display a Shape

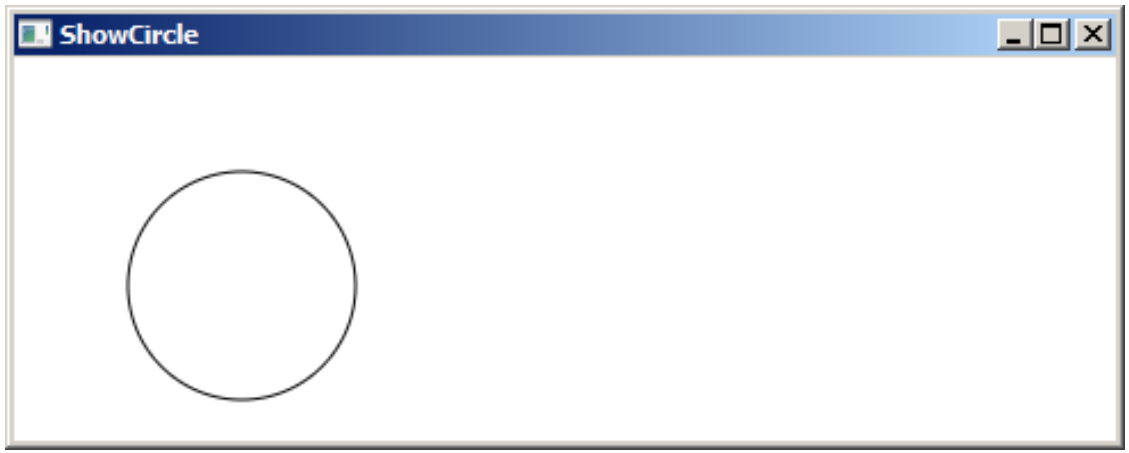
```
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.layout.Pane;
import javafx.scene.paint.Color;
import javafx.scene.shape.Circle;
import javafx.stage.Stage;

public class ShowCircle extends Application {
  public void start(Stage primaryStage) {
    Circle circle = new Circle();
    circle.setCenterX(100);
    circle.setCenterY(100);
    circle.setRadius(50);
    circle.setStroke(Color.BLACK);
    circle.setFill(null);

    Pane pane = new Pane();
    pane.getChildren().add(circle);

    Scene scene = new Scene(pane, 200, 200);
    primaryStage.setTitle("ShowCircle");
    primaryStage.setScene(scene);
    primaryStage.show();
  }
```





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***.



Binding Properties

```
public void start(Stage primaryStage) {
  Pane pane = new Pane();
  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);

  Scene scene = new Scene(pane, 200, 200);
  primaryStage.setTitle("ShowCircleCentered");
  primaryStage.setScene(scene);
  primaryStage.show();
}
```

Binding Property:

getter, setter, and property getter

```
public class SomeClassName {

  private PropertyType x;

  /** Value getter method */
  public propertyValueType getX() { ... }

  /** Value setter method */
  public void setX(propertyValueType value) { ... }

  /** Property getter method */
  public PropertyType xProperty() { ... }
}
```

(a) x is a binding property

```
public class Circle {

  private DoubleProperty centerX;

  /** Value getter method */
  public double getCenterX() { ... }

  /** Value setter method */
  public void setCenterX(double value) { ... }

  /** Property getter method */
  public DoubleProperty centerXProperty() { ... }
}
```

(b) centerX is binding property

Binding Property

❖ **JavaFX** defines binding properties for primitive types and strings:

Type	Binding Property Type
double	DoubleProperty
float	FloatProperty
long	LongProperty
int	IntegerProperty
boolean	BooleanProperty
String	StringProperty

```java
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());
  }
}
```

```
d1 is 2.0 and d2 is 2.0
d1 is 70.2 and d2 is 70.2
```

Common Properties and Methods for Nodes

- The abstract **Node** class defines many properties and methods that are common to all nodes.
  - **style**: set a **JavaFX CSS** style

```
circle.setStyle("-fx-stroke: black; -fx-fill: red;");
```

  - **rotate**: Rotate a node

```
button.setRotate(80);
```

The Color Class

javafx.scene.paint.Color	
-red: double	The red value of this Color (between 0.0 and 1.0).
-green: double	The green value of this Color (between 0.0 and 1.0).
-blue: double	The blue value of this Color (between 0.0 and 1.0).
-opacity: double	The opacity of this Color (between 0.0 and 1.0).
+Color(r: double, g: double, b: double, opacity: double)	Creates a Color with the specified red, green, blue, and opacity values.
+brighter(): Color	Creates a Color that is a brighter version of this Color.
+darker(): Color	Creates a Color that is a darker version of this Color.
+color(r: double, g: double, b: double): Color	Creates an opaque Color with the specified red, green, and blue values.
+color(r: double, g: double, b: double, opacity: double): Color	Creates a Color with the specified red, green, blue, and opacity values.
+rgb(r: int, g: int, b: int): Color	Creates a Color with the specified red, green, and blue values in the range from 0 to 255.
+rgb(r: int, g: int, b: int, opacity: double): Color	Creates a Color with the specified red, green, and blue values in the range from 0 to 255 and a given opacity.

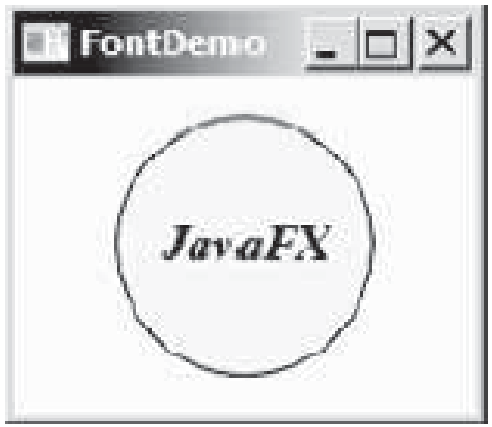
```
Color color = new Color(0.25, 0.14, 0.333, 0.51);
```

The Font Class

javafx.scene.text.Font	
-size: double	The size of this font.
-name: String	The name of this font.
-family: String	The family of this font.
+Font(size: double)	Creates a Font with the specified size.
+Font(name: String, size: double)	Creates a Font with the specified full font name and size.
+font(name: String, size: double)	Creates a Font with the specified name and size.
+font(name: String, w: FontWeight, size: double)	Creates a Font with the specified name, weight, and size.
+font(name: String, w: FontWeight, p: FontPosture, size: double)	Creates a Font with the specified name, weight, posture, and size.
+getFamilies(): List<String>	Returns a list of font family names.
+getFontNames(): List<String>	Returns a list of full font names including family and weight.

```
Font font1 = new Font("SansSerif", 16);
Font font2 = Font.font("Times New Roman", FontWeight.BOLD,
  FontPosture.ITALIC, 12);
```

```
public class FontDemo 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 StackPane();

    // Create a circle and set its properties
    Circle circle = new Circle();
    circle.setRadius(50);
    circle.setStroke(Color.BLACK);
    circle.setFill(new Color(0.5, 0.5, 0.5, 0.1));
    pane.getChildren().add(circle); // Add circle to the pane

    // Create a label and set its properties
    Label label = new Label("JavaFX");
    label.setFont(Font.font("Times New Roman",
      FontWeight.BOLD, FontPosture.ITALIC, 20));
    pane.getChildren().add(label);

    // Create a scene and place it in the stage
    Scene scene = new Scene(pane);
    primaryStage.setTitle("FontDemo"); // Set the stage title
    primaryStage.setScene(scene); // Place the scene in the stage

    primaryStage.show(); // Display the stage
  }
}
```



The Image, ImageView Class

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

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

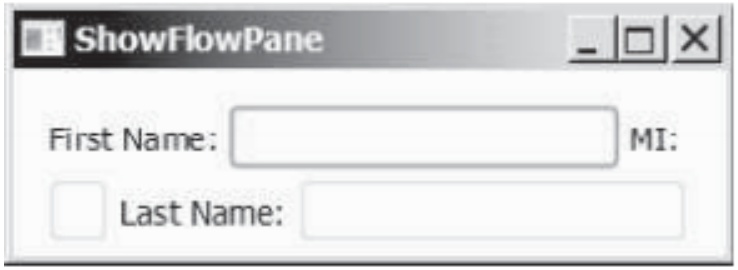
Layout Panes

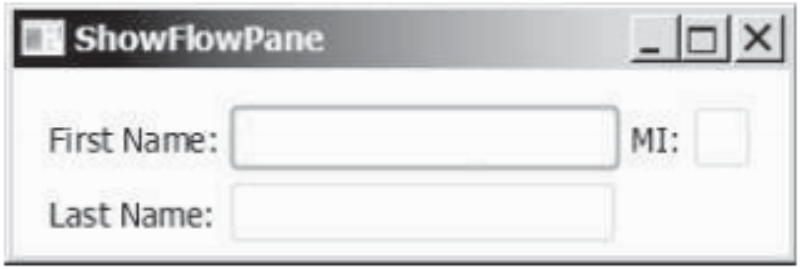
❖ **JavaFX** provides many types of panes for organizing nodes in a container.

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

javafx.scene.layout.FlowPane	
-alignment: ObjectProperty<Pos>	The overall alignment of the content in this pane (default: Pos.LEFT).
-orientation: ObjectProperty<Orientation>	The orientation in this pane (default: Orientation.HORIZONTAL).
-hgap: DoubleProperty	The horizontal gap between the nodes (default: 0).
-vgap: DoubleProperty	The vertical gap between the nodes (default: 0).
+FlowPane()	Creates a default FlowPane.
+FlowPane(hgap: double, vgap: double)	Creates a FlowPane with a specified horizontal and vertical gap.
+FlowPane(orientation: ObjectProperty<Orientation>)	Creates a FlowPane with a specified orientation.
+FlowPane(orientation: ObjectProperty<Orientation>, hgap: double, vgap: double	Creates a FlowPane with a specified orientation, horizontal gap and vertical gap.





GridPane

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.

BorderPane

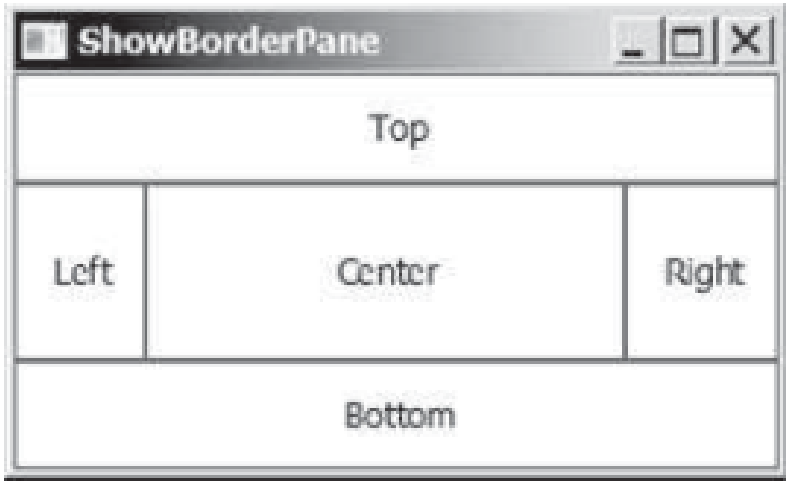
javafx.scene.layout.BorderPane

```
-top: ObjectProperty<Node>
-right: ObjectProperty<Node>
-bottom: ObjectProperty<Node>
-left: ObjectProperty<Node>
-center: ObjectProperty<Node>
```

```
+BorderPane()
+setAlignment(child: Node, pos: Pos)
```

The node placed in the top region (default: `null`).
The node placed in the right region (default: `null`).
The node placed in the bottom region (default: `null`).
The node placed in the left region (default: `null`).
The node placed in the center region (default: `null`).

Creates a `BorderPane`.
Sets the alignment of the node in the `BorderPane`.



Hbox , VBox

javafx.scene.layout.HBox

```
-alignment: ObjectProperty<Pos>
-fillHeight: BooleanProperty
-spacing: DoubleProperty
+HBox()
+HBox(spacing: double)
+setMargin(node: Node, value:
   Insets): void
```

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.

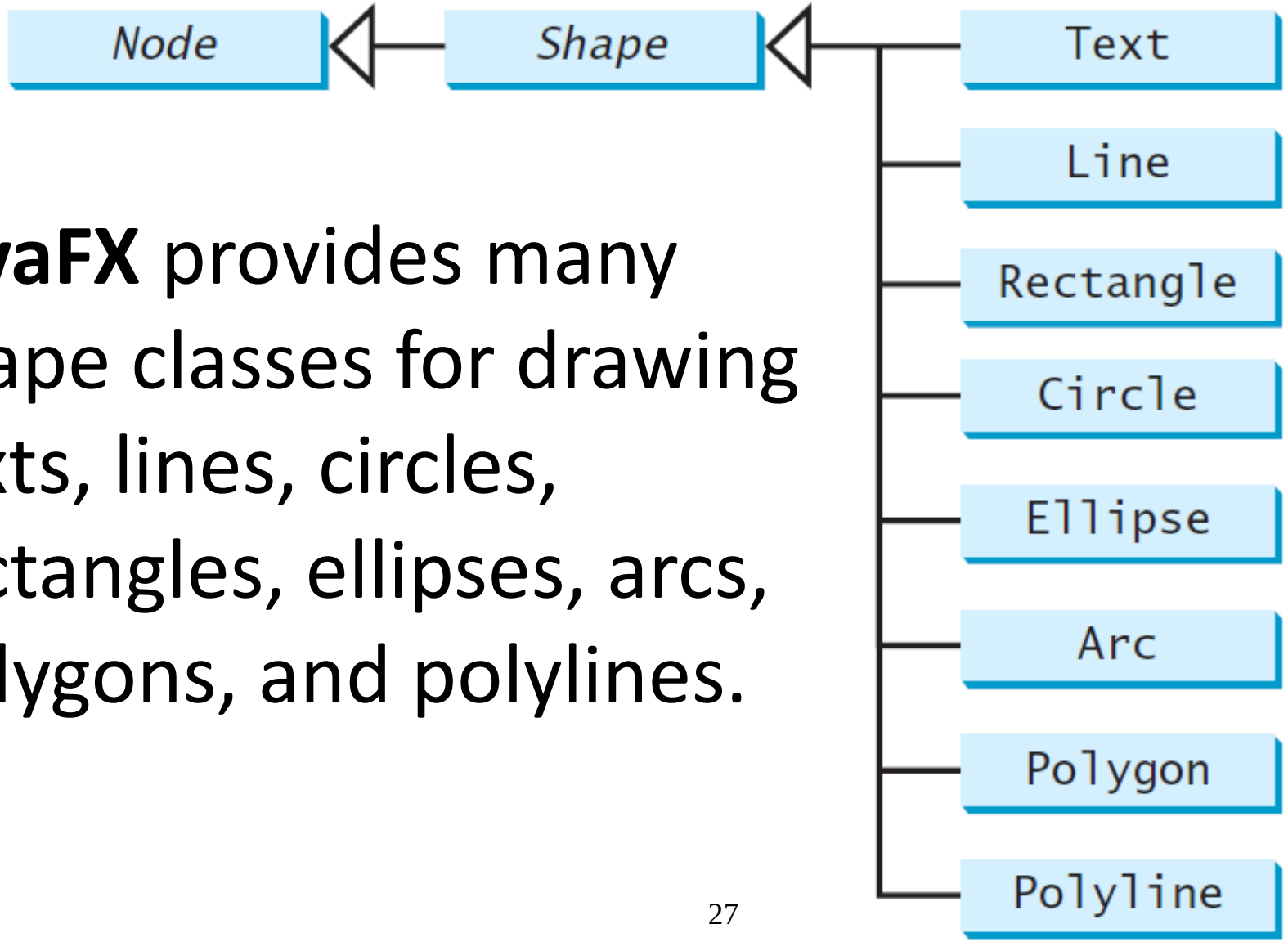
javafx.scene.layout.VBox

```
-alignment: ObjectProperty<Pos>
-fillWidth: BooleanProperty
-spacing: DoubleProperty
+VBox()
+VBox(spacing: double)
+setMargin(node: Node, value:
   Insets): void
```

The 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.

Shapes



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

Text

javafx.scene.text.Text	
-text: StringProperty	Defines the text to be displayed.
-x: DoubleProperty	Defines the x-coordinate of text (default 0).
-y: DoubleProperty	Defines the y-coordinate of text (default 0).
-underline: BooleanProperty	Defines if each line has an underline below it (default `false`).
-strikethrough: BooleanProperty	Defines if each line has a line through it (default `false`).
-font: ObjectProperty<Font>	Defines the font for the text.
+Text()	Creates an empty Text.
+Text(text: String)	Creates a Text with the specified text.
+Text(x: double, y: double, text: String)	Creates a Text with the specified x-, y-coordinates and text.

Line

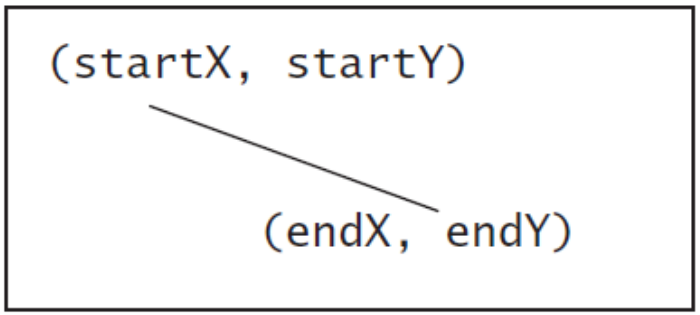
javafx.scene.shape.Line

-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.

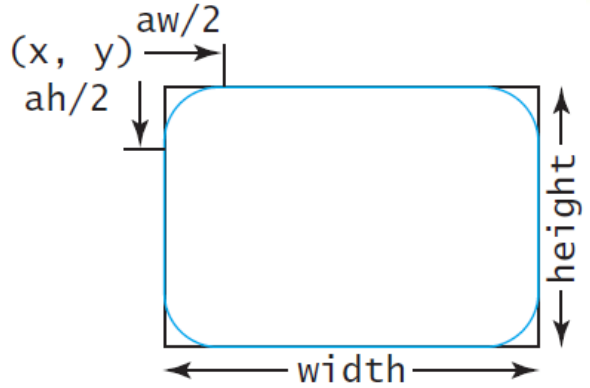
Creates an empty `Line`.
Creates a `Line` with the specified starting and ending points.



Rectangle

javafx.scene.shape.Rectangle
-x: DoubleProperty
-y:DoubleProperty
-width: DoubleProperty
-height: DoubleProperty
-arcWidth: DoubleProperty
-arcHeight: DoubleProperty
+Rectangle()
+Rectanlge(x: double, y: double, width: double, height: double)

-x: DoubleProperty	The x-coordinate of the upper-left corner of the rectangle (default 0).
-y:DoubleProperty	The y-coordinate of the upper-left corner of the rectangle (default 0).
-width: DoubleProperty	The width of the rectangle (default: 0).
-height: DoubleProperty	The height of the rectangle (default: 0).
-arcWidth: DoubleProperty	The `arcWidth` of the rectangle (default: 0). `arcWidth` is the horizontal diameter of the arcs at the corner (see Figure 14.31a).
-arcHeight: DoubleProperty	The `arcHeight` of the rectangle (default: 0). `arcHeight` is the vertical diameter of the arcs at the corner (see Figure 14.31a).
+Rectangle()	Creates an empty `Rectangle`.
+Rectanlge(x: double, y: double, width: double, height: double)	Creates a `Rectangle` with the specified upper-left corner point, width, and height.



(a) `Rectangle(x, y, w, h)`

Circle, Ellipse

javafx.scene.shape.Circle

```
-centerX: DoubleProperty
-centerY: DoubleProperty
-radius: DoubleProperty
```

```
+Circle()
+Circle(x: double, y: double)
+Circle(x: double, y: double,
   radius: double)
```

The x-coordinate of the center of the circle (default 0).
The y-coordinate of the center of the circle (default 0).
The radius of the circle (default: 0).

Creates an empty `Circle`.
Creates a `Circle` with the specified center.
Creates a `Circle` with the specified center and radius.

javafx.scene.shape.Ellipse

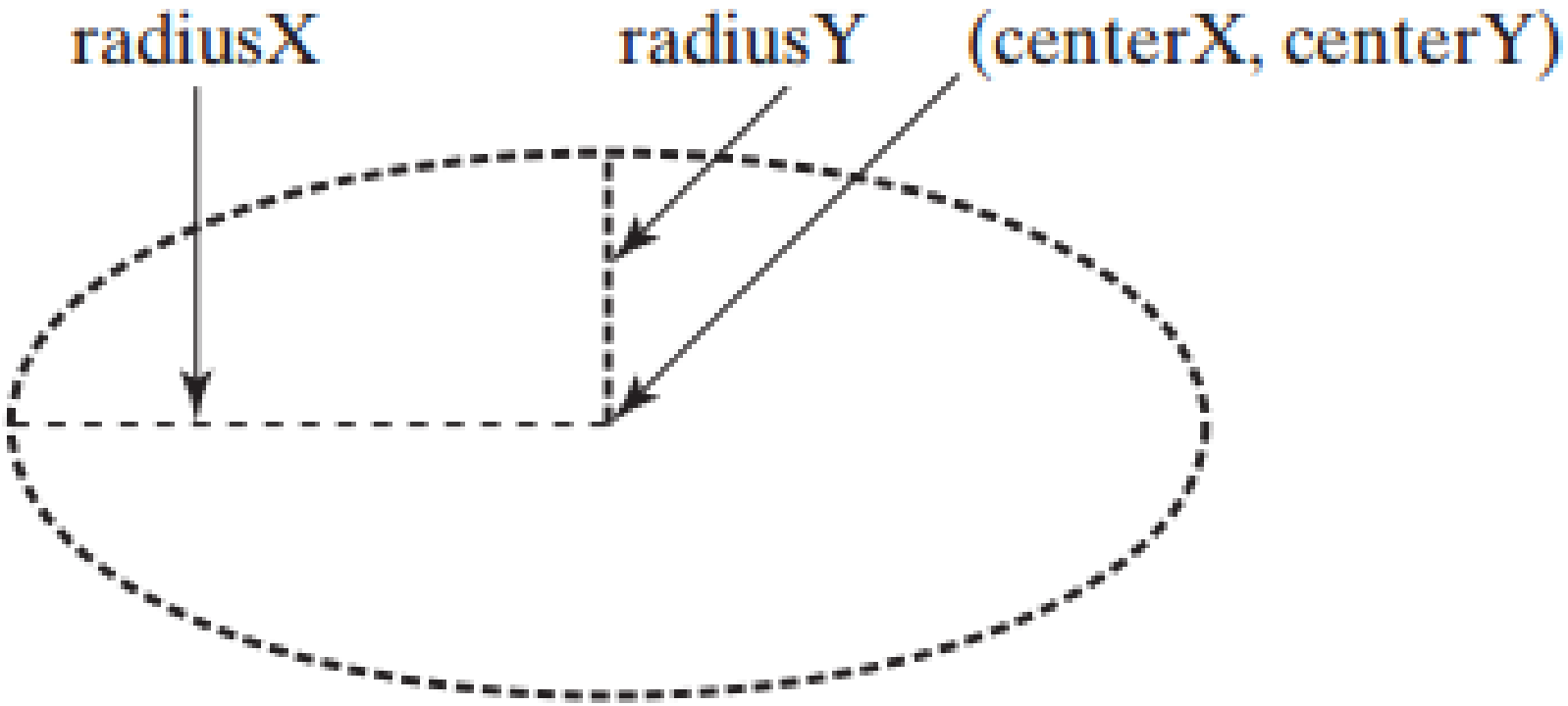
```
-centerX: DoubleProperty
-centerY: DoubleProperty
-radiusX: DoubleProperty
-radiusY: DoubleProperty
```

```
+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.

Ellipse



(a) `Ellipse(centerX, centerY, radiusX, radiusY)`

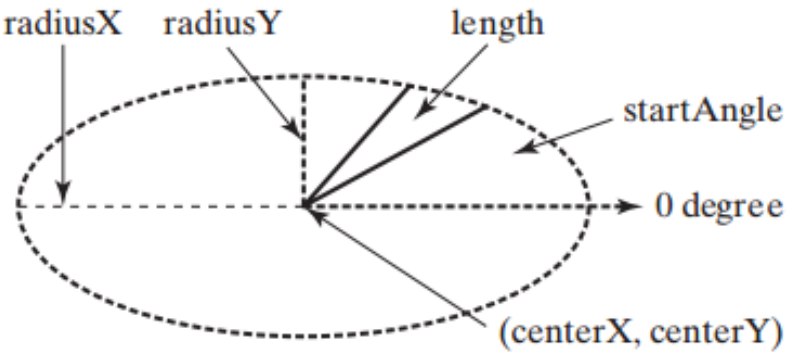
Arc

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)
```

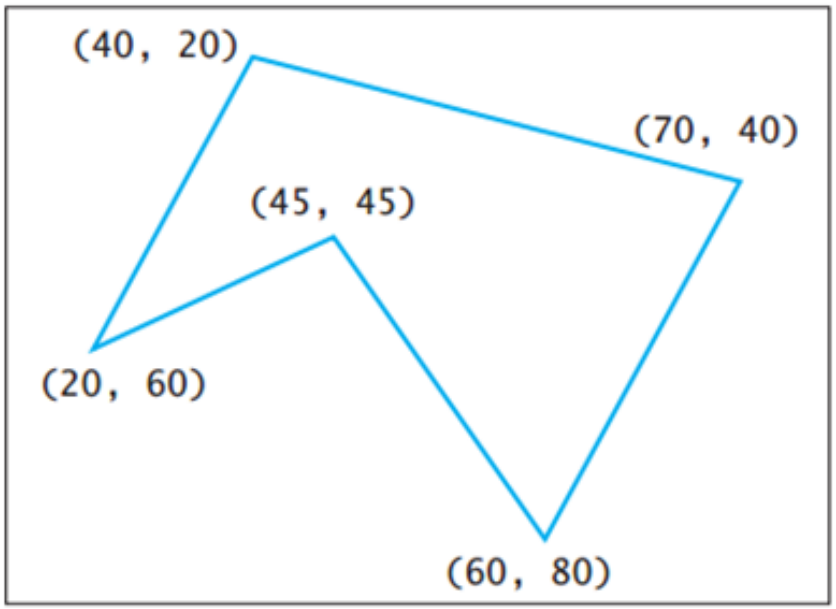
The x-coordinate of the center of the ellipse (default 0).
The y-coordinate of the center of the ellipse (default 0).
The horizontal radius of the ellipse (default: 0).
The vertical radius of the ellipse (default: 0).
The start angle of the arc in degrees.
The angular extent of the arc in degrees.
The closure type of the arc (`ArcType.OPEN`, `ArcType.CHORD`, `ArcType.ROUND`).

Creates an empty `Arc`.
Creates an `Arc` with the specified arguments.

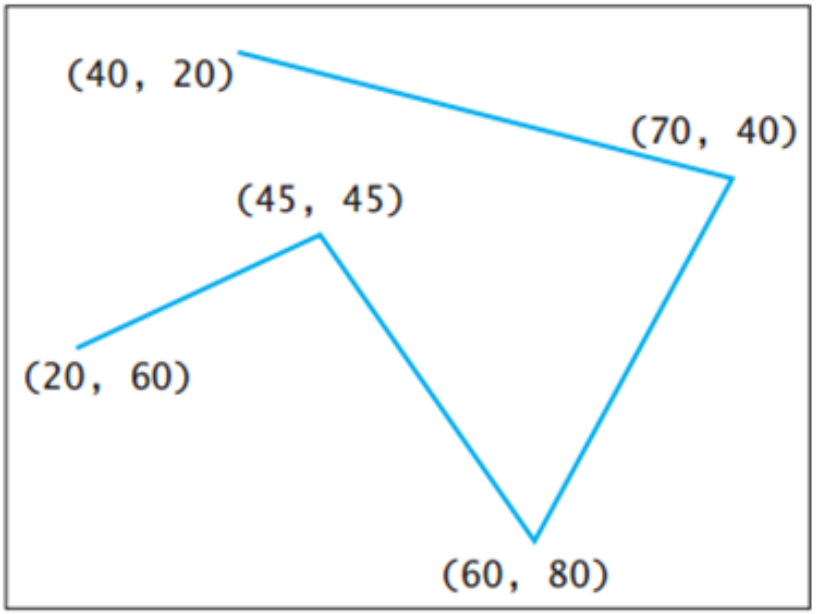


(a) `Arc(centerX, centerY, radiusX, radiusY, startAngle, length)`

Polygon and Polyline



(a) Polygon

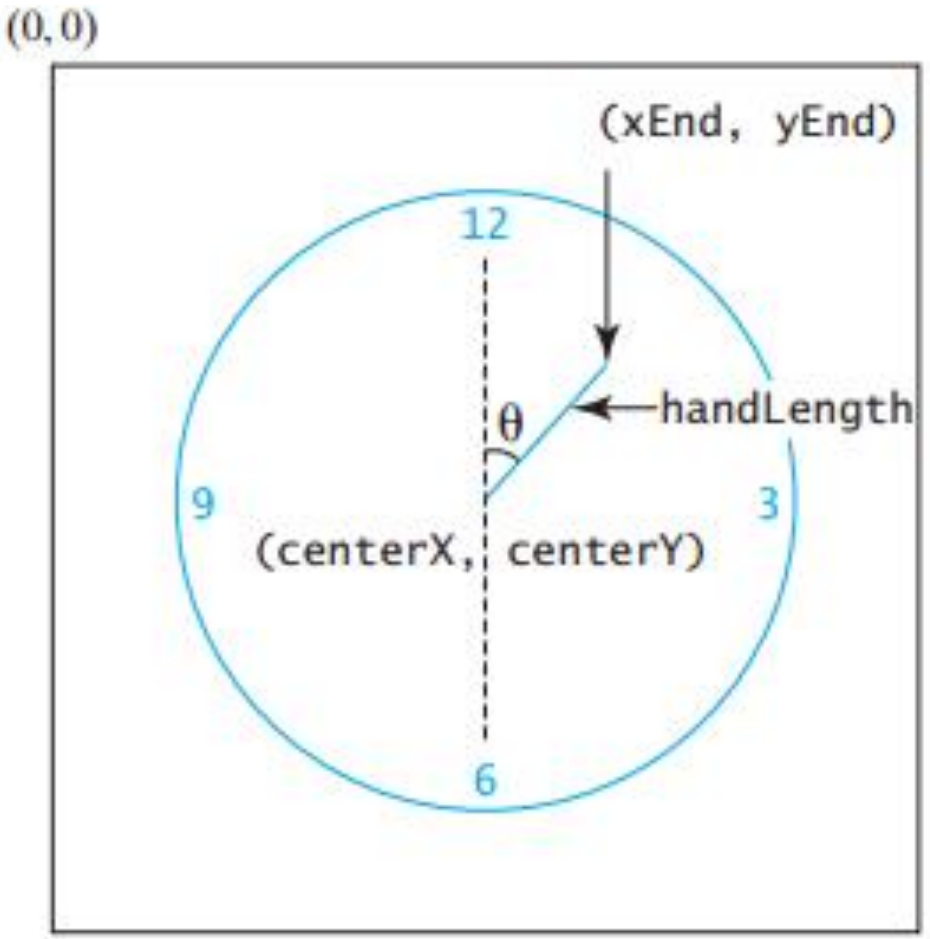


(b) Polyline

javafx.scene.shape.Polygon	
+Polygon()	Creates an empty polygon.
+Polygon(double... points)	Creates a polygon with the given points.
+getPoints(): ObservableList<Double>	Returns a list of double values as x- and y-coordinates of the points.

Case Study: The ClockPane Class

- This case study develops a class that displays a clock on a pane.



Case Study: The ClockPane Class