Chapter 34

Advanced JavaFX

Objectives

- To specify styles for UI nodes using JavaFX CSS (§34.2).
- To simplify creating JavaFX nodes using the builder classes (§34.3).
- To create quadratic curve, cubic curve, and path using the QuadCurve, CubicCurve, and Path classes (§34.4).
- To translation, rotation, and scaling to perform coordinate transformations for nodes (§34.5).
- To define a shape's border using various types of strokes (§34.6).
- To create menus using the Menu, MenuItem, CheckMenuItem, and RadioMemuItem classes (§34.7).
- To create context menus using the ContextMenu class (§34.8).
- To use SplitPane to create adjustable horizontal and vertical panes (§34.9).
- To create tab panes using the TabPane control (§34.10).
- To create and display tables using the TableView and TableColumn classes (§34.11).

34.1 Introduction

Key Point: JavaFX can be used to develop comprehensive rich Internet applications.

Chapters 14-16 introduced basics of JavaFX, event-driven programming, animations, and simple UI controls. This chapter introduces some advanced features for developing comprehensive rich Internet applications.

34.2 JavaFX CSS

Key Point: JavaFX cascading style sheets can be used to specify styles for UI nodes.

JavaFX cascading style sheets are based on CSS with some extensions. CSS defines the style for Web pages. It separates the contents of Web pages from its style. JavaFX CSS can be used to define the style for the UI and separates the contents of the UI from the style. You can define the look and feel of the UI in a JavaFX CSS file and use the style sheet to set the color, font, margin, border of the UI components. A JavaFX CSS file makes it easy to modify the style without modifying the Java source code.

A JavaFX style property is defined with a prefix `-fx-` to distinquish it from a property in CSS. All the available JavaFX properties are defined in http://docs.oracle.com/javafx/2/api/javafx/scene/doc-files/cssref.html. Listing 34.1 gives an example of a style sheet .

Listing 34.1 mystyle.css

```
.plaincircle {
  -fx-fill: white;
  -fx-stroke: black;
}
.circleborder {
  -fx-stroke-width: 5;
  -fx-stroke-dash-array: 12 2 4 2;
}
.border {
  -fx-border-color: black;
  -fx-border-width: 5;
}
#redcircle {
  -fx-fill: red;
```

```
  -fx-stroke: red;
}
#greencircle {
  -fx-fill: green;
  -fx-stroke: green;
}
```

A style sheet uses the style class or style id to define styles. Multiple style classes can be applied to a single node and a style id to a unique node. The syntax `.styleclass` defines a style class. Here the the style classes are named `plaincircle`, `circleborder`, and `circleborder`. The syntax `#styleid` defines a style id. Here the the style ids are named `redcircle` and `greencircle`.

Each node in JavaFX has a `styleClass` variable of the `List<String>` type, which can be obtained from invoking `getStyleClass()`.You can add multiple style classes to a node and only one id to a node. Each node in JavaFX has an `id` variable of the `String` type, which can be set using the `setID(String id)` method. You can set only one id to a node.

The `Scene` and `Parent` class have the `stylesheets` property, which can be obtained from invoking the `getStylesheets()` method. This property is of the `ObservableList<String>` type. You can add multiple style sheets into this property. You can load a style sheet into a `Scene` or a `Parent`. Note that `Parent` is the superclass for containers and UI control.

Listing 34.2 gives an example that uses the style sheet defined in Listing 34.1.

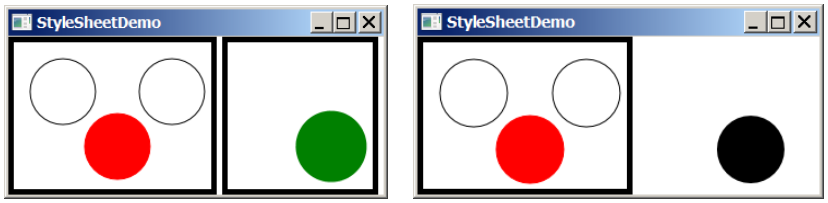
Listing 34.2 StyleSheetDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.HBox;
 4  import javafx.scene.layout.Pane;
 5  import javafx.scene.shape.Circle;
 6  import javafx.stage.Stage;
 7
 8  public class StyleSheetDemo extends Application {
 9    @Override // Override the start method in the Application class
10    public void start(Stage primaryStage) {
11      HBox hBox = new HBox(5);
12      Scene scene = new Scene(hBox, 300, 250);
13      scene.getStylesheets().add("mystyle.css"); // Load the stylesheet
14
15      Pane pane1 = new Pane();
16      Circle circle1 = new Circle(50, 50, 30);
17      Circle circle2 = new Circle(150, 50, 30);
```

```
18      Circle circle3 = new Circle(100, 100, 30);
19      pane1.getChildren().addAll(circle1, circle2, circle3);
20      pane1.getStyleClass().add("border");
21
22      circle1.getStyleClass().add("plaincircle"); // Add a style class
23      circle2.getStyleClass().add("plaincircle"); // Add a style class
24      circle3.setId("redcircle"); // Add a style id
25
26      Pane pane2 = new Pane();
27      Circle circle4 = new Circle(100, 100, 30);
28      circle4.getStyleClass().addAll("circleborder", "plainCircle");
29      circle4.setId("greencircle"); // Add a style class
30      pane2.getChildren().add(circle4);
31      pane2.getStyleClass().add("border");
32
33      hBox.getChildren().addAll(pane1, pane2);
34
35      primaryStage.setTitle("StyleSheetDemo"); // Set the window title
36      primaryStage.setScene(scene); // Place the scene in the window
37      primaryStage.show(); // Display the window
38    }
39  }
```

Figure 34.1

The style sheet is used to style the nodes in the scene.



(a) (b)

The program loads the style sheet from the file mystyle.css by adding it to the **stylesheets** property (line 13). The file should be placed in the same directory with the source code for it to run correctly. After the style sheet is loaded, the program sets the style class **plaincircle** for **circle1** and **circle2** (lines 22-23), and sets the style id **redcircle** for **circle3** (line 24). The program sets style classes **circleborder** and **plaincircle** and an id **greencircle** for **circle4** (lines 28-29). The style class **border** is set for both **pane1** and **pane2** (lines 20, 31).

The style sheet is set in the scene (line 13). All the nodes inside the scene can use this style sheet. What would happen if line 13 is deleted and the following line is inserted after line 15?

```
pane1.getStylesheets().add("mystyle.css");
```

In this case, only **pane1** and the nodes inside **pane1** can access the style sheet, but **pane2** and **circle4** cannot use this style sheet. So everything in **pane1** is displayed same as before the change and **pane2** and

`circle4` are displayed without applying the style class and id, as shown in Figure 34.1b.

Note that the style class `plaincircle` and id `greencircle` both are applied to `circle4` (lines 28-29). `plaincircle` sets `fill` to white and `greencircle` sets `fill` to green. The property settings in id take precedence over the ones in classes. So, `circle4` is displayed in green in this program.

Check point

34.1 How do you load a style sheet to a `Scene` or a `Parent`? Can you load multiple style sheets?

34.2 If a style sheet is loaded from a node, can the pane and all its containing nodes access the style sheet?

34.3 Can a node add multiple style classes? Can a node set multiple style ids?

34.4 If the same property is defined in both a style class and a style id and applied to a node, which one has the precedence?

34.3 Builder Classes

Key Point: The builder classes can be used to simplify creating JavaFX nodes.

So far you have used the constructors to create nodes. For example, the following code constructs a `Circle` using the `Circle` constructor and sets its properties:

```
Circle circle = new Circle(40, 30, 25);
circle.setFill(Color.WHITE);
circle.setStroke(Color.BLACK);
```

The preceding code can be replaced using a builder class as follows:

```
Circle circle = CircleBuilder.create().centerX(40).centerY(30)
  .radius(25).fill(Color.WHITE).stroke(Color.BLACK).build();
```

The `CircleBuilder` class is called a builder class for the `Circle` class. The `CircleBuilder`'s static method `create()` returns an instance of `CircleBuilder`. The class contains the methods for setting property values for a `Circle` object. These methods are conveniently named using the property names such as `centerX`, `centerY`, and `radius`. All these methods return an instance of the builder class. Finally, invoking the `build()` method returns an instance of `Circle`.

JavaFX provides a builder class for every node. Using the builder class can sometimes simplify coding. It is particularly useful when creating multiple objects of the same type with common properties. Listing 34.3 gives an

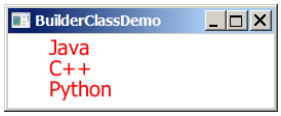
example that uses builder classes. A sample run of the program is shown in Figure 34.3.

Listing 34.3 BuilderClassDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.layout.PaneBuilder;
 5  import javafx.scene.paint.Color;
 6  import javafx.scene.text.Font;
 7  import javafx.scene.text.Text;
 8  import javafx.scene.text.TextBuilder;
 9  import javafx.stage.Stage;
10
11  public class BuilderClassDemo extends Application {
12    @Override // Override the start method in the Application class
13    public void start(Stage primaryStage) {
14      Pane pane = PaneBuilder.create().build();
15
16      TextBuilder textBuilder = TextBuilder.create().fill(Color.RED)
17        .font(Font.font("Times", 20)).x(40);
18      Text text1 = textBuilder.y(20).text("Java").build();
19      Text text2 = textBuilder.y(40).text("C++").build();
20      Text text3 = textBuilder.y(60).text("Python").build();
21
22      pane.getChildren().addAll(text1, text2, text3);
23
24      Scene scene = new Scene(pane, 300, 250);
25      primaryStage.setTitle("BuilderClassDemo"); // Set the window title
26      primaryStage.setScene(scene); // Place the scene in the window
27      primaryStage.show(); // Display the window
28    }
29  }
```

Figure 14.3

Three texts are placed in a pane.



The program creates a pane using the `PaneBuilder` class (line 14). The `PaneBuilder`'s static method `create()` returns an instance of `PaneBuilder` and invoking `build()` on a `PaneBuilder` instance returns a `Pane` object.

The program creates an instance of `TextBuilder` (lines 16-17). This builder object is reused to create three `Text` objects (line 18-20). Using `TextBuilder` simplifies coding in this case. Without using `TextBuilder`, the code would be much longer.

Check point

34.5 Use `Rectangle`'s builder class to create a `Rectangle` with its upper left corner at (100, 75.5), width 50

and height 60. Set its fill property to white and stroke to green.

34.6 What is the method to create an instance of a builder class? What is the method to create a node from its builder object?

34.4 `QuadCurve`, `CubicCurve`, and `Path`

Key Point: JavaFX provides the **`QuadCurve`**, **`CubicCurve`**, and **`Path`** classes for creating advanced shapes. Section 14.11 introduces drawing simple shapes using the **`Line`**, **`Rectangle`**, **`Circle`**, **`Ellipse`**, **`Arc`**, **`Polygon`**, and **`Polyline`** classes. This section introduces drawing advanced shapes using the **`CubicCurve`**, **`QuadCurve`**, and **`Path`** classes.

34.4.1 `QuadCurve` and `CubicCurve`

JavaFX provides the **`QuadCurve`** and **`CubicCurve`** classes for modeling quadratic curves and cubic curves. A quadratic curve is mathematically defined as a quadratic polynomial. To create a **`QuadCurve`**, use its no-arg constructor or the following constructor:

```
QuadCurve(double startX, double startY,
  double controlX, double controlY, double endX, double endY)
```

where (**`startX`**, **`startY`**) and (**`endX`**, **`endY`**) specify two endpoints and (**`controlX`**, **`controlY`**) is a control point. The control point is usually not on the curve instead of defining the trend of the curve, as shown in Figure 34.3a. Figure 34.4 shows the UML diagram for the **`QuadCurve`** class.

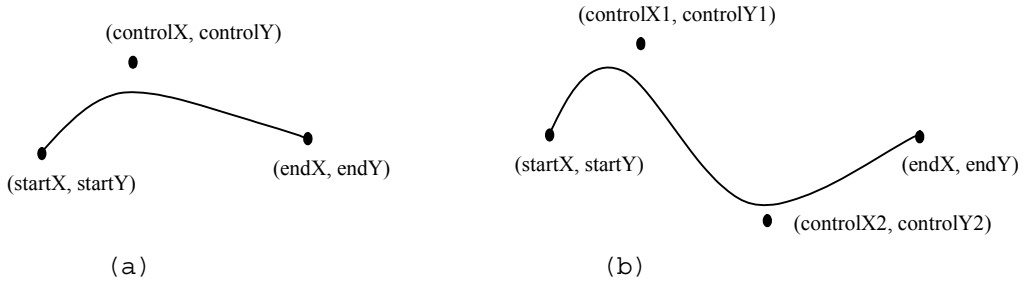
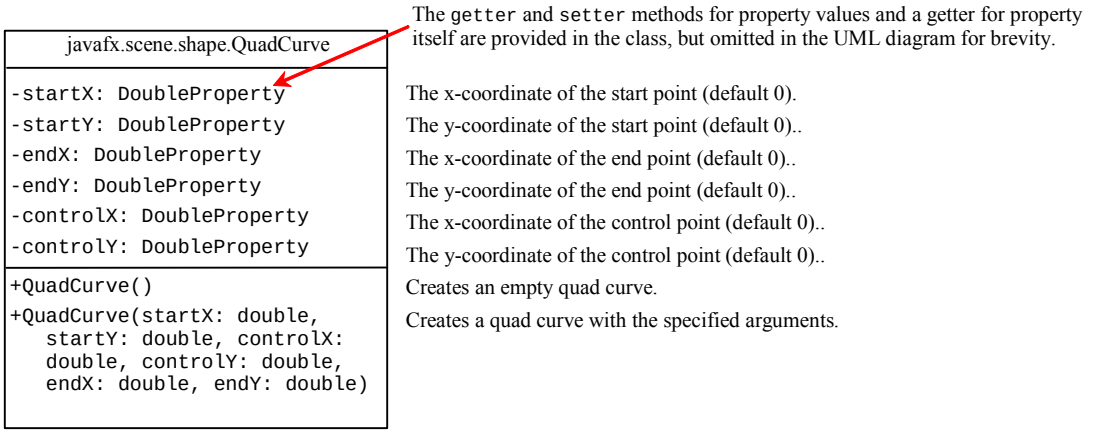


Figure 34.3

(a) A quadratic curve is specified using three points. (b) A cubic curve is specified using four points.

Figure 34.4

`QuadCurve` *defines a quadratic curve.*



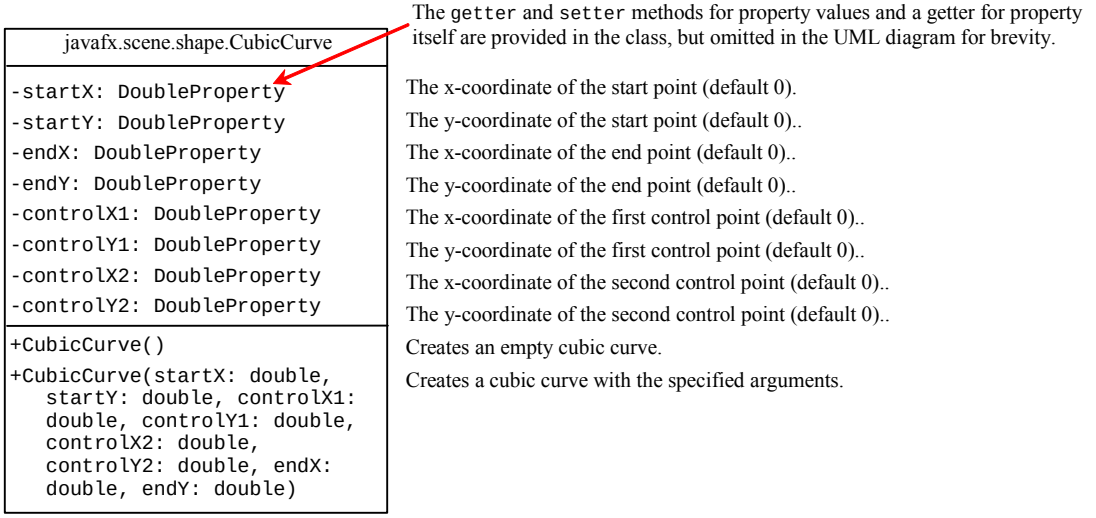
A cubic curve is mathematically defined as a cubic polynomial. To create a **`CubicCurve`**, use its no-arg constructor or the following constructor:

```
CubicCurve(double startX, double startY, double controlX1,
  double controlY1, double controlX2, double controlY2,
  double endX, double endY)
```

where (**`startX`**, **`startY`**) and (**`endX`**, **`endY`**) specify two endpoints and (**`controlX1`**, **`controlY1`**) and (**`controlX2`**, **`controlY2`**) are two control points. The control points are usually not on the curve instead of defining the trend of the curve, as shown in Figure 34.3b. Figure 34.5 shows the UML diagram for the **`CubicCurve`** class.

Figure 34.5

`CubicCurve` *defines a quadratic curve.*



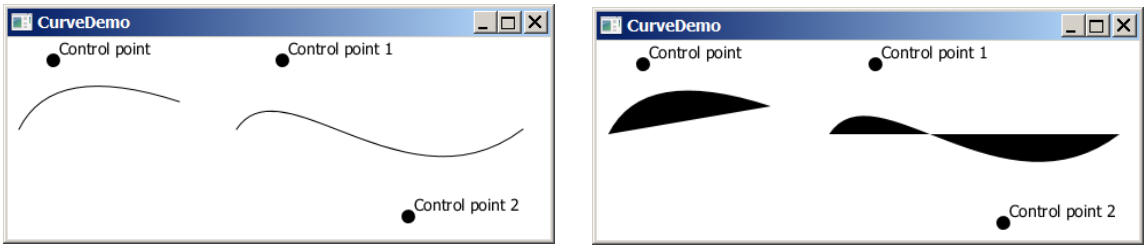
Listing 34.4 gives a program that demonstrates how to draw quadratic curves and cubic curves. Figure 34.6a shows a sample run of the program.

Listing 34.4 CurveDemo.java

```
1  import javafx.application.Application;
2  import javafx.scene.Scene;
3  import javafx.scene.layout.Pane;
4  import javafx.scene.text.Text;
5  import javafx.scene.layout.PaneBuilder;
6  import javafx.scene.paint.Color;
7  import javafx.scene.shape.*;
8  import javafx.stage.Stage;
9
10 public class CurveDemo extends Application {
11   @Override // Override the start method in the Application class
12   public void start(Stage primaryStage) {
13     Pane pane = PaneBuilder.create().build();
14
15     // Create a QuadCurve
16     QuadCurve quadCurve = new QuadCurve(10, 80, 40, 20, 150, 56);
17     quadCurve.setFill(Color.WHITE);
18     quadCurve.setStroke(Color.BLACK);
19
20     pane.getChildren().addAll(quadCurve, new Circle(40, 20, 6),
21       new Text(40 + 5, 20 - 5, "Control point"));
22
23     // Create a CubicCurve
24     CubicCurve cubicCurve = new CubicCurve
25       (200, 80, 240, 20, 350, 156, 450, 80);
26     cubicCurve.setFill(Color.WHITE);
27     cubicCurve.setStroke(Color.BLACK);
28
29     pane.getChildren().addAll(cubicCurve, new Circle(240, 20, 6),
30       new Text(240 + 5, 20 - 5, "Control point 1"),
31       new Circle(350, 156, 6),
32       new Text(350 + 5, 156 - 5, "Control point 2"));
33
34     Scene scene = new Scene(pane, 300, 250);
35     primaryStage.setTitle("CurveDemo"); // Set the window title
36     primaryStage.setScene(scene); // Place the scene in the window
37     primaryStage.show(); // Display the window
38   }
39 }
```

Figure 34.6

You can draw quadratic and cubic curves using QuadCurve and CubicCurve.



(a) (b)

The program creates a `QuadCurve` with the specified start, control, and end points (line 16) and places the `QuadCurve` to the pane (line 20). To illustrate the control point, the program also displays the control point as a solid circle (line 21).

The program creates a `CubicCurve` with the specified start, first control, second control, and end points (lines 24-25) and places the `CubicCurve` to the pane (line 29). To illustrate the control points, the program also displays the control points in the pane (lines 29-32).

Note that the curves are filled with color. The program sets the color to white and stroke to black in order to display the curves (lines 17-18, 26-27). If these code lines are removed from the program, the sample run would look like the one in Figure 34.6b.

34.4.2 `Path`

The `Path` class models an arbitrary geometric path. A path is constructed by adding path elements into the path. The `PathElement` is the root class for the path elements `MoveTo`, `HLineTo`, `VLineTo`, `LineTo`, `ArcTo`, `QuadCurveTo`, `CubicCurveTo`, and `ClosePath`.

You can create a `Path` using its no-arg constructor. The process of the path construction can be viewed as drawing with a pen. The path does not have a default initial position. You need to set an initial position by adding a `MoveTo(startX, startY)` path element to the path. Adding a `HLineTo(newX)` element draws a horizontal line from the current position to the new x-coordinate. Adding a `VLineTo(newY)` element draws a vertical line from the current position to the new y-coordinate. Adding a `LineTo(newX, newY)` element draws a line from the current position to the new position. Adding an `ArcTo(radiusX, radiusY, xAxisRotation, newX, newY, largeArcFlag, sweepArcFlag)` element draws an arc from the previous position to the new position with the specified radius. Adding a `QuadCurveTo(controlX, controlY, newX, newY)` element draws a quadratic curve from the previous position to the new position with the specified control point.

Adding a `CubicCurveTo(controlX1, controlY1, controlX2, controlY2, newX, newY)` element draws a cubic curve from the previous position to the new position with the specified control points.

Adding a `ClosePath()` element closes the path by drawing a line that connects the starting point with the end point of the path.

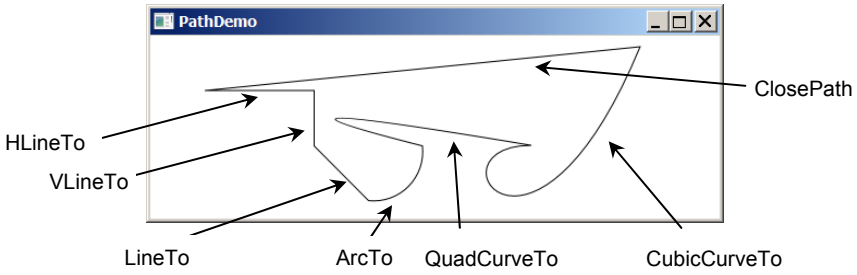
Listing 34.5 gives an example that creates a path. A sample run of the program is shown in Figure 34.7.

Listing 34.5 PathDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.paint.Color;
 5  import javafx.scene.shape.*;
 6  import javafx.stage.Stage;
 7
 8  public class PathDemo extends Application {
 9    @Override // Override the start method in the Application class
10    public void start(Stage primaryStage) {
11      Pane pane = new Pane();
12
13      // Create a Path
14      Path path = new Path();
15      path.getElements().add(new MoveTo(50.0, 50.0));
16      path.getElements().add(new HLineTo(150.5));
17      path.getElements().add(new VLineTo(100.5));
18      path.getElements().add(new LineTo(200.5, 150.5));
19
20      ArcTo arcTo = ArcToBuilder.create().x(250).y(100.5).radiusX(45)
21        .radiusY(45).sweepFlag(true).build();
22      path.getElements().add(arcTo);
23
24      path.getElements().add(new QuadCurveTo(50, 50, 350, 100));
25      path.getElements().add(
26        new CubicCurveTo(250, 100, 350, 250, 450, 10));
27
28      path.getElements().add(new ClosePath());
29
30      pane.getChildren().add(path);
31      path.setFill(Color.BLACK);
32      Scene scene = new Scene(pane, 300, 250);
33      primaryStage.setTitle("PathDemo"); // Set the window title
34      primaryStage.setScene(scene); // Place the scene in the window
35      primaryStage.show(); // Display the window
36    }
37  }
```

Figure 34.7

You can draw a path by adding path elements.



The program creates a `Path` (line 13), moves its position (line 14), adds a horizontal line (line 15), a vertical line (line 16), and a line (line 17). The `getElements()` method returns an `ObservableList<PathElement>`.

The program creates an `ArcTo` object using its builder class (lines 19-20). The ArcTo class also contains the `largeArcFlag` and `sweepFlag` properties. By default, these property values are `false`. You may set these properties to `ture` to display a large arc in the opposite direction.

The program adds a quadratic curve (line 23) and a cubic curve (lines 24-25) and closes the path (line 27).

By default, the path is not filled. You may change the `fill` property in the path to specify a color to fill the path.

Check point

34.7 Use `QuadCurve`'s builder class to create a `QuadCurve` with starting point (100, 75.5), control point (40, 55.5), and end point (56, 80). Set its fill property to white and stroke to green.

34.8 Create `CubicCurve` object with starting point (100, 75.5), control point 1 (40, 55.5), control point 2 (78.5, 25.5), and end point (56, 80). Set its fill property to white and stroke to green.

34.9 Does a path have a default initial position? How do you set a position for a path?

34.10 How do you close a path?

34.11 How do you display a filled path?

34.5 Coordinate Transformations

Key Point: JavaFX supports coordinate transformations using translation, rotation, and scaling.

You have used the `rotate` method to rotate a node. You can also perform translations and scaling.

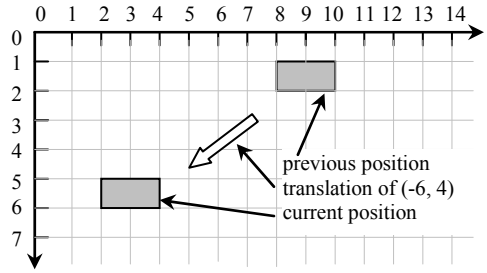
34.5.1 Translations

You can use the `setTranslateX(double x)`, `setTranslateY(double y)`, and `setTranslateZ(double z)`methods in the `Node` class to translate the coordinates for a node. For example,

`setTranslateX(5)` moves the node 5 pixels to the right and `setTranslateY(-10)` 10 pixels up from the previous position. Figure 34.8 shows a rectangle displayed before and after applying translation. After invoking `rectangle.setTranslateX(-6),` and `rectangle.setTranslateY(4)`, the rectangle is moved 6 pixels to the left and 4 pixels down from the previous position. Note that the coordinate transformation using translation, rotation, and scaling does not change the contents of the shape being transferred. For example, if a rectangle's x's is 30 and width is 100, after applying transformations to the rectangle, its x is still 30 and width is still 100.

Figure 34.8

After applying translation of (-6, 4), the rectangle is moved by the specified distance relative to the previous position.



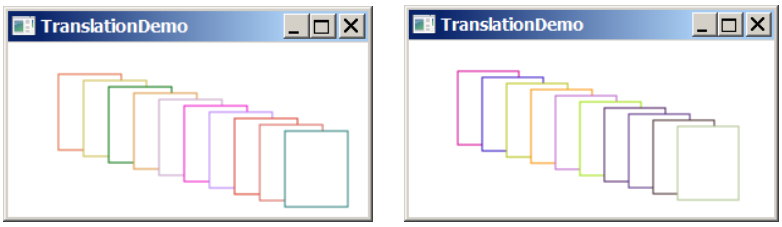
Listing 34.6 TranslationDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.paint.Color;
 5  import javafx.scene.shape.Rectangle;
 6  import javafx.stage.Stage;
 7
 8  public class TranslationDemo extends Application {
 9    @Override // Override the start method in the Application class
10    public void start(Stage primaryStage) {
11      Pane pane = new Pane();
12
13      double x = 10;
14      double y = 10;
15      java.util.Random random = new java.util.Random();
16      for (int i = 0; i < 10; i++) {
17        Rectangle rectangle = new Rectangle(10, 10, 50, 60);
18        rectangle.setFill(Color.WHITE);
19        rectangle.setStroke(Color.color(random.nextDouble(),
20          random.nextDouble(), random.nextDouble()));
21        rectangle.setTranslateX(x += 20);
22        rectangle.setTranslateY(y += 5);
23        pane.getChildren().add(rectangle);
24      }
```

```
25
26      Scene scene = new Scene(pane, 300, 250);
27      primaryStage.setTitle("TranslationDemo"); // Set the window title
28      primaryStage.setScene(scene); // Place the scene in the window
29      primaryStage.show(); // Display the window
30    }
31  }
```

Figure 34.9

The rectangles are displayed successively in new locations.



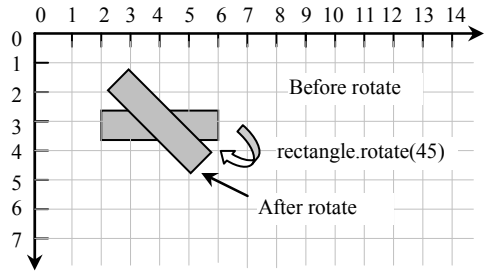
The program repeatedly creates ten rectangles (line 17). For each rectangle, it sets its `fill` property to white (line 18), its `stroke` property to a random color (lines 19-20), and translate it to a new location (lines 21-22). The variables `x` and `y` are used to set the `translateX` and `translateY` properties. These two variable values are changed every time it is applied to a rectangle.

34.5.2 Rotations

Rotation was introduced in Chapter 14. This section discusses it in more depth. You can use the `rotate(double theta)` method in the `Node` class to rotate a node by theta degrees from its pivot point clockwise, where theta is a double value in degrees. The pivot point is automatically computed based on the bounds of the node. For a circle, ellipse, a rectangle, the pivot point is the center point of these nodes. For example, `rectangle.rotate(45)` rotates the rectangle 45 degrees clockwise along the eastern direction from the center, as shown in Figure 34.10.

Figure 34.10

After performing rectangle.rotate(45), the rectangle is rotated in 45 degrees from the center.



Listing 49.7 gives a program that demonstrates the effect of rotation of coordinates. Figure 34.11 shows a sample run of the program.

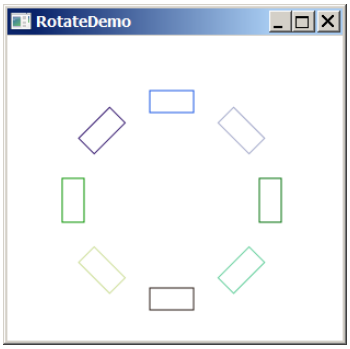
Listing 34.7 RotateDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.paint.Color;
 5  import javafx.scene.shape.Rectangle;
 6  import javafx.stage.Stage;
 7
 8  public class RotateDemo extends Application {
 9    @Override // Override the start method in the Application class
10    public void start(Stage primaryStage) {
11      Pane pane = new Pane();
12      java.util.Random random = new java.util.Random();
13      // The radius of the circle for anchoring rectangles
14      double radius = 90;
15      double width = 20; // Width of the rectangle
16      double height = 40; // Height of the rectangle
17      for (int i = 0; i < 8; i++) {
18        // Center of a rectangle
19        double x = 150 + radius * Math.cos(i * 2 * Math.PI / 8);
20        double y = 150 + radius * Math.sin(i * 2 * Math.PI / 8);
21        Rectangle rectangle = new Rectangle(
22          x - width / 2, y - height / 2, width, height);
23        rectangle.setFill(Color.WHITE);
24        rectangle.setStroke(Color.color(random.nextDouble(),
25          random.nextDouble(), random.nextDouble()));
26        rectangle.setRotate(i * 360 / 8); // Rotate the rectangle
27        pane.getChildren().add(rectangle);
28      }
29
30      Scene scene = new Scene(pane, 300, 300);
31      primaryStage.setTitle("RotateDemo"); // Set the window title
32      primaryStage.setScene(scene); // Place the scene in the window
33      primaryStage.show(); // Display the window
34    }
35  }
```

<end listing 34.7>

Figure 34.11

The rotate method rotates a node.



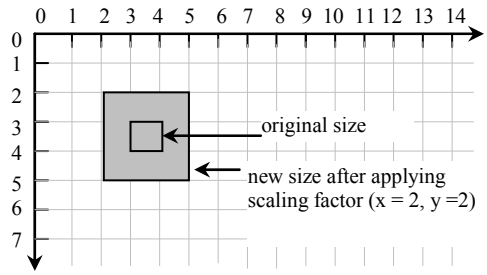
The program creates eight rectangles in a loop (lines 17-28). The center of each rectangle is located on the circle centered as (150, 150) (lines 19-20). A rectangle is created by specifying its upper left corner position with width and height (lines 21-22). The rectangle is rotated in line 26 and added to the pane in line 27.

34.5.3 Scaling

You can use the `setScaleX(double sx)`, `setScaleY(double sy)` , and `setScaleY(double sy)` methods in the `Node` class to specify a scaling factor. The node will appear larger or smaller depending on the scaling factor. Scaling alters the coordinate space of the node such that each unit of distance along the axis is multiplied by the scale factor. As with rotation transformations, scaling transformations are applied to enlarge or shrink the node around the pivot point. For a node of the rectangle shape, the pivot point is the center of the rectangle. For example, if you apply a scaling factor (x = 2, y = 2), the entire rectangle including the stroke will double in size, growing to the left, right, up, and down from the center, as shown in Figure 34.12.

Figure 34.12

After applying scaling (x = 2, y = 2), the node is doubled in size.



Listing 34.8 gives a program that demonstrates the effect of using scaling. Figure 34.13 shows a sample run of the program.

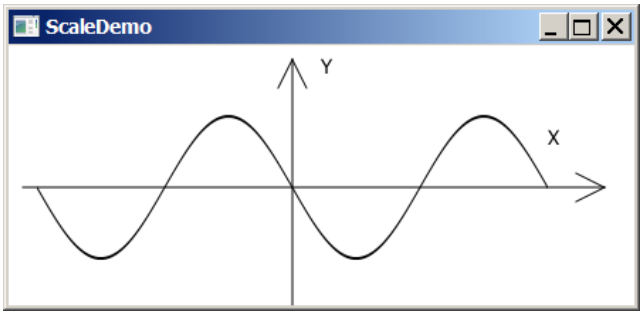
Listing 34.8 ScaleDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.shape.Line;
 5  import javafx.scene.text.Text;
 6  import javafx.scene.shape.Polyline;
 7  import javafx.stage.Stage;
 8
 9  public class ScaleDemo extends Application {
10    @Override // Override the start method in the Application class
11    public void start(Stage primaryStage) {
12      // Create a polyline to draw a sine curve
13      Polyline polyline = new Polyline();
14      for (double angle = -360; angle <= 360; angle++) {
15        polyline.getPoints().addAll(
16          angle, Math.sin(Math.toRadians(angle)));
17      }
18      polyline.setTranslateY(100);
19      polyline.setTranslateX(200);
20      polyline.setScaleX(0.5);
21      polyline.setScaleY(50);
22      polyline.setStrokeWidth(1.0 / 25);
23
24      // Draw x-axis
25      Line line1 = new Line(10, 100, 420, 100);
26      Line line2 = new Line(420, 100, 400, 90);
27      Line line3 = new Line(420, 100, 400, 110);
28
29      // Draw y-axis
30      Line line4 = new Line(200, 10, 200, 200);
31      Line line5 = new Line(200, 10, 190, 30);
32      Line line6 = new Line(200, 10, 210, 30);
33
34      // Draw x, y axis labels
35      Text text1 = new Text(380, 70, "X");
36      Text text2 = new Text(220, 20, "Y");
37
38      // Add nodes to a pane
39      Pane pane = new Pane();
40      pane.getChildren().addAll(polyline, line1, line2, line3, line4,
41        line5, line6, text1, text2);
42
43      Scene scene = new Scene(pane, 450, 200);
44      primaryStage.setTitle("ScaleDemo"); // Set the window title
45      primaryStage.setScene(scene); // Place the scene in the window
46      primaryStage.show(); // Display the window
47    }
48  }
```

<end listing 34.8>

Figure 34.13

The scale method scales the coordinates in the node.



The program creates a polyline (line 13) and adds the points for a sine curve into the polyline (lines 14-17). Since |sin(x)| <= 1, the y-coordinates are too small. To see the sine curve, the program scales the y-coordinates up by 50 times (line 21) and shrinks the x-coordinates by half (line 20).

Note that scaling also causes the stroke width to change. To compensate it, the stroke width is purposely set to 1.0 / 25 (line 22).

Check point

34.12 Can you perform a coordinate transformation on any node? Does a coordinate transformation change the contents of a Shape object?

34.13 Does the method `setTranslateX(6)` move the node's x-coordinate to 6? Does the method `setTranslateX(6)` move the node's x-coordinate 6 pixel right from its current location?

34.14 Does the method `rotate(Math.PI / 2)` rotate a node 90 degrees? Does the method `rotate(90)` rotate a node 90 degrees?

34.15 How is the pivot point determined for performing a rotation?

34.16 What method do you use to scale a node two times on its x-axis?

34.6 Strokes

Key Point: Stroke defines a shape's border line style.

JavaFX allows you to specify the attributes of a shape's boundary using the methods in Figure 34.14.

Figure 34.14

The `Shape` class contains the methods for setting stroke properties.

javafx.scene.shape.Shape	
+setStroke(paint: Paint): void	Sets a paint for the stroke.
+setStrokeWidth(width: double): void	Sets a width for the stroke (default 1).
+setStrokeType(type: StrokeType): void	Sets a type for the stroke to indicate whether the stroke is placed inside, centered, or outside of the border (default: CENTERED).
+setStrokeLineCap(type: StrokeLineCap): void	Specifies the end cap style for the stroke (default: BUTT).
+setStrokeLineJoin(type: StrokeLineJoin): void	Specifies how two line segments are joined (default: MITER).
+getStrokeDashArray(): ObservableList<Double>	Returns a list that specifies a dashed pattern for line segments.
+setStrokeDashOffset(distance: double): void	Specifies the offset to the first segment in the dashed pattern.

The **`setStroke(paint)`** method sets a paint for the stroke. The width of the stroke can be specified using the **`setStrokeWidth(width)`** method.

The **`setStrokeType(type)`** method sets a type for the stroke. The type defines whether the stroke is inside, outside, or in the center of the border using the constants **`StrokeType.INSIDE`**, **`StrokeType.CENTERED`** (default), or **`StrokeType.OUTSIDE`**, as shown in Figure 34.15.

Figure 34.15

(a) No stroke is used. (b) A stroke is placed inside the border. (c) A stroke is placed in the center of the border. (d) A stroke is placed outside of the border.

(a) (b) (c) (d)

Note that for the centered style, the stroke is applied by extending the boundary of the node by a distance of half of the **`strokeWidth`** on either side (inside and outside) of the boundary.

The **`setStrokeLineCap(capType)`** method sets an end cap style for the stroke. The styles are defined as **`StrokeLineCap.BUTT`** (default), **`StrokeLineCap.ROUND`**, and **`StrokeLineCap.SQUARE`**, as illustrated in Figure 34.16. The **`BUTT`** stroke ends an unclosed path with no added decoration. The **`ROUND`** stroke ends an unclosed side of a path with an added half circle whose radius is half of the stroke width. The **`SQUARE`** stroke ends an unclosed side of a path with an added square that extends half of the stroke width.

Figure 34.16

(a) No decoration for a BUTT line cap. (b) A half circle is added to an unclosed path. (c) A square with half of the stroke width is extended to an unclosed path.

(a) BUTT (b) ROUND (c) SQUARE

The `setStrokeLineJoin` method defines the decoration applied where path segments meet. You can specify three types of line join using the constants `StrokeLineJoin.MITER` (default), `StrokeLineJoin.BEVEL`, and `StrokeLineJoin.ROUND`, as shown in Figure 34.17.

Figure 34.17

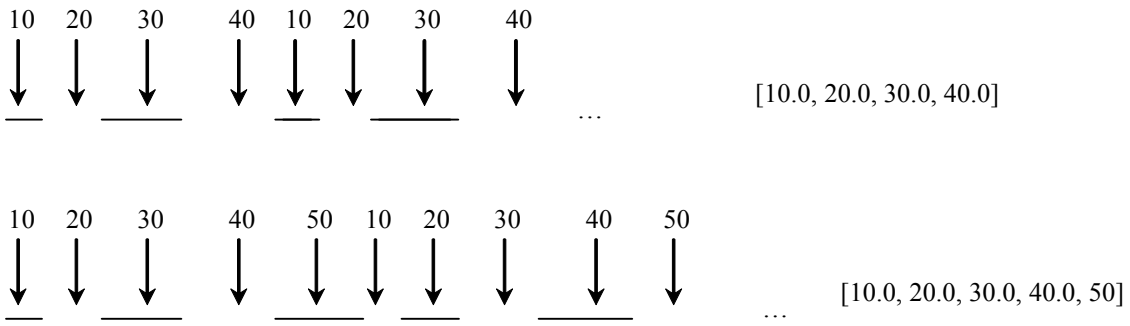
Path segments can be joined in three ways: (a) MITER, (b) BEVEL, and (c) ROUND.

(a) MITER (b) BEVEL (c) ROUND

The `Shape` class has a property named `strokeDashArray` of the `ObservableList<Double>` type. This property is used to define a dashed pattern for the stroke. Alternate numbers in the list specify the lengths of the opaque and transparent segments of the dashes. For example, the list `[10.0, 20.0, 30.0, 40.0]` specifies a pattern as shown in Figure 34.18.

Figure 34.18

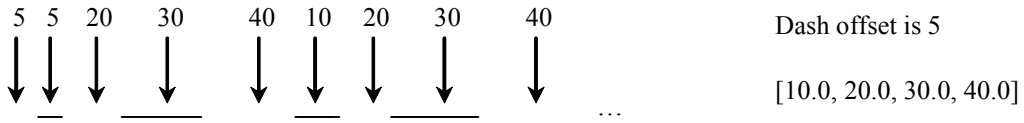
The numbers in the list specify the opaque and transparent segments of the stroke alternately.



The `setStrokeDashOffset(distance)` method defines the offset to the first segment in the dash pattern. Figure 34.19 illustrates the offset 5 for the dash list `[10.0, 20.0, 30.0, 40.0]`.

Figure 34.19

The dash offset specifies on offset for the first segment.



Listing 34.9 gives a program that demonstrates the methods to set attributes for a stroke. Figure 34.20 shows a sample run of the program.

Listing 34.9 StrokeDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.layout.Pane;
 4  import javafx.scene.paint.Color;
 5  import javafx.stage.Stage;
 6  import javafx.scene.shape.*;
 7
 8  public class StrokeDemo extends Application {
 9    @Override // Override the start method in the Application class
10    public void start(Stage primaryStage) {
11      RectangleBuilder rectangleBuilder = RectangleBuilder.create()
12        .x(20).y(20).width(70).height(120).fill(Color.WHITE)
13        .strokeWidth(15).stroke(Color.ORANGE);
14
15      Rectangle rectangle1 = rectangleBuilder.build();
16
17      Rectangle rectangle2 = rectangleBuilder.build();
18      rectangle2.setTranslateX(100);
19      rectangle2.setStrokeLineJoin(StrokeLineJoin.BEVEL);
20
21      Rectangle rectangle3 = rectangleBuilder.build();
22      rectangle3.setTranslateX(200);
23      rectangle3.setStrokeLineJoin(StrokeLineJoin.ROUND);
24
25      Line line1 = new Line(320, 20, 420, 20);
26      line1.setStrokeLineCap(StrokeLineCap.BUTT);
27      line1.setStrokeWidth(20);
28
29      Line line2 = new Line(320, 70, 420, 70);
30      line2.setStrokeLineCap(StrokeLineCap.ROUND);
31      line2.setStrokeWidth(20);
32
33      Line line3 = new Line(320, 120, 420, 120);
34      line3.setStrokeLineCap(StrokeLineCap.SQUARE);
35      line3.setStrokeWidth(20);
36
37      Line line4 = new Line(460, 20, 560, 120);
38      line4.getStrokeDashArray().addAll(10.0, 20.0, 30.0, 40.0);
39
40      Pane pane = new Pane();
41      pane.getChildren().addAll(rectangle1, rectangle2, rectangle3,
42        line1, line2, line3, line4);
```

```
43
44      Scene scene = new Scene(pane, 610, 180);
45      primaryStage.setTitle("StrokeDemo"); // Set the window title
46      primaryStage.setScene(scene); // Place the scene in the window
47      primaryStage.show(); // Display the window
48    }
49  }
```

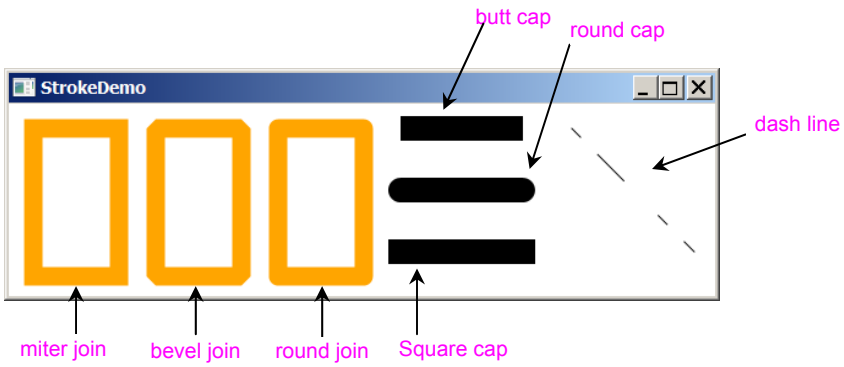


Figure 34.20

You can specify the attributes for strokes.

The program creates a **`RectangleBuilder`** (lines 11-13) and uses it to create three rectangles (lines 15, 17, 21). Rectangle 1 uses default miter join, rectangle 2 uses bevel join (line 19), and rectangle 3 uses round join (line 23). The program creates three lines with butt, round, and square end cap (lines 25-35).

The program creates a line and sets dash pattern for this line (line 38). Note that the **`strokeDashArray`** property is of the **`ObservableList<Double>`** type. You have to add **`Double`** values to the list. Adding a number such as 10 would cause an error.

Check point

34.17 Are the methods for setting a stroke and its attributes defined in the **`Node`** or **`Shape`** class?

34.18 How do you set a stroke width to **`3`** pixels?

34.19 What are the stroke types? What is the default stroke type? How do you set a stroke type?

34.20 What are the stroke line join types? What is the default stroke line join type? How do you set a stroke line join type?

34.21 What are the stroke cap types? What is the default stroke cap type? How do you set a stroke cap type?

34.22 How do you specify a dashed pattern for strokes?

34.7 Menus

Key Point: You can create menus in JavaFX.

Menus make selection easier and are widely used in window applications. JavaFX provides five classes that implement menus: MenuBar, Menu, MenuItem, CheckMenuItem, and RadioButtonMenuItem.

MenuBar is a top-level menu component used to hold the menus. A menu consists of menu items that the user can select (or toggle on or off). A menu item can be an instance of MenuItem, CheckMenuItem, or RadioButtonMenuItem. Menu items can be associated with nodes and keyboard accelerators.

34.7.1 Creating Menus

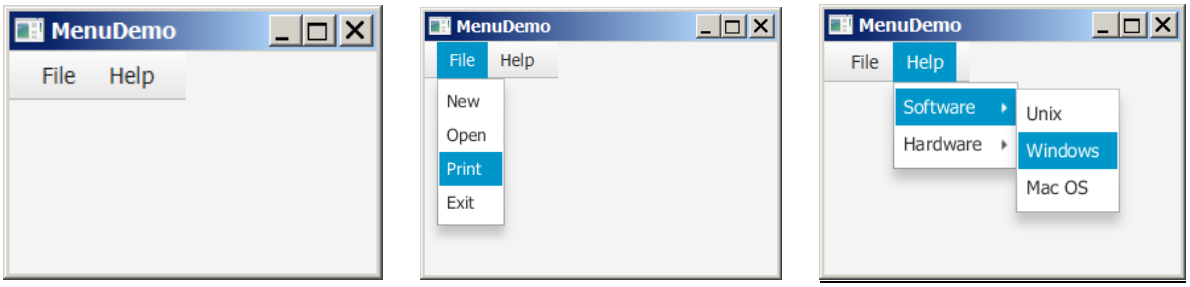
The sequence of implementing menus in JavaFX is as follows:

1. Create a menu bar and add it to a pane. For example, the following code creates a pane and a menu bar, and adds the menu bar to the pane:

```
MenuBar menuBar = new MenuBar();
Pane pane = new Pane();
pane.getChildren().add(menuBar);
```

2. Create menus and add them under the menu bar. For example, the following creates two menus and add them to a menu bar, as shown in Figure 34.21a:

```
Menu menuFile = new Menu("File");
Menu menuHelp = new Menu("Help");
menuBar.getMenus().addAll(menuFile, menuHelp);
```



(a) **(b)** **(c)**

Figure 34.21
(a) The menus are placed under a menu bar. (b) Clicking a menu on the menu bar reveals the items under the menu. (c) Clicking a menu item reveals the submenu items under the menu item.

3. Create menu items and add them to the menus.

```
menuFile.getItems().addAll(new MenuItem("New"),
```

```
        new MenuItem("Open"), new MenuItem("Print"),
        new MenuItem("Exit"));
```

This code adds the menu items New, Open, Print, and Exit, in this order, to the File menu, as shown in Figure 34.21b.

3.1. Creating submenu items.

You can also embed menus inside menus so that the embedded menus become submenus. Here is an example:

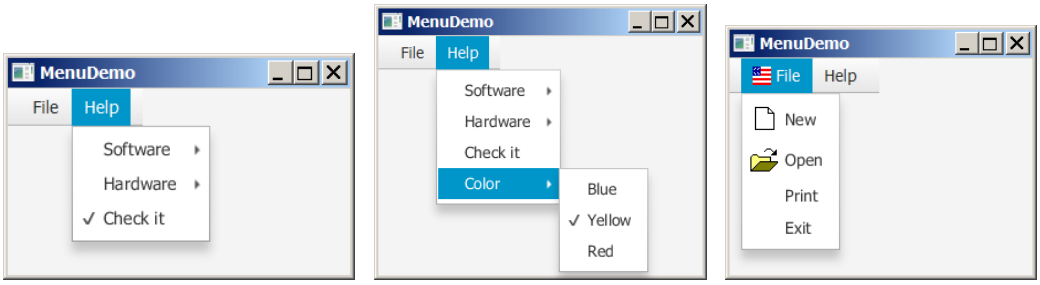
```
Menu softwareHelpSubMenu = new Menu("Software");
Menu hardwareHelpSubMenu = new Menu("Hardware");
menuHelp.getItems().add(softwareHelpSubMenu);
menuHelp.getItems().add(hardwareHelpSubMenu);
softwareHelpSubMenu.getItems().add(new MenuItem("Unix"));
softwareHelpSubMenu.getItems().add(new MenuItem("Windows"));
softwareHelpSubMenu.getItems().add(new MenuItem("Mac OS"));
```

This code adds two submenus, softwareHelpSubMenu and hardwareHelpSubMenu, in MenuHelp. The menu items Unix, NT, and Win95 are added to softwareHelpSubMenu (see Figure 34.21c).

3.2. Creating check-box menu items.

You can also add a CheckMenuItem to a Menu. CheckMenuItem is a subclass of MenuItem that adds a Boolean state to the MenuItem, and displays a check when its state is true. You can click a menu item to turn it on or off. For example, the following statement adds the check-box menu item Check it (see Figure 34.22a).

```
menuHelp.getItems().add(new CheckMenuItem("Check it"));
```



(a) **(b)** **(c)**

Figure 34.22
(a) A check box menu item lets you check or uncheck a menu item just like a check box. (b) You can use RadioMenuItem to choose among mutually exclusive menu choices. (c) You can set image icons and keyboard accelerators in menus.

3.3. Creating radio menu items.

You can also add radio menu items to a menu, using the RadioMenuItem class. This is often useful when you have a group of mutually exclusive choices in the menu. For example, the following statements add a submenu named Color and a set of radio buttons for choosing a color (see Figure 34.22b):

```
RadioMenuItem rmiBlue, rmiYellow, rmiRed;
colorHelpSubMenu.getItems().add(rmiBlue =
  new RadioMenuItem("Blue"));
colorHelpSubMenu.getItems().add(rmiYellow =
  new RadioMenuItem("Yellow"));
colorHelpSubMenu.getItems().add(rmiRed =
  new RadioMenuItem("Red"));

ToggleGroup group = new ToggleGroup();
rmiBlue.setToggleGroup(group);
rmiYellow.setToggleGroup(group);
rmiRed.setToggleGroup(group);
```

4. The menu items generate ActionEvent. To handle ActionEvent, implement the setOnAction method.

5. Image Icons and Keyboard Accelerators

The Menu, CheckMenuItem, and RadioMenuItem are the subclasses of MenuItem. The MenuItem has a graphic property for specifying a node to be displayed in the menu item. Usually, the graphic is an image view. The classes Menu, MenuItem, CheckMenuItem, and RadioMenuItem have another constructor that you can use to specify a graphic. For example, the following code add an image to the menu, menu item, check menu item, and radio menu item (see Figure 34.22c).

```
Menu menuFile = new Menu("File",
    new ImageView("image/usIcon.gif"));
MenuItem menuItemOpen = new MenuItem("New",
   new ImageView("image/new.gif"));
CheckMenuItem checkMenuItem = new CheckMenuItem("Check it",
   new ImageView("image/us.gif"));
RadioMenuItem rmiBlue = new RadioMenuItem("Blue",
   new ImageView("image/us.gif"));
```

A key accelerator lets you select a menu item directly by pressing the CTRL and the accelerator key. For example, by using the following code, you can attach the accelerator key CTRL+N to the Open menu item:

```
menuItemOpen.setAccelerator(
  KeyCombination.keyCombination("Ctrl+O"));
```

34.7.2 Example: Using Menus

This section gives an example that creates a user interface to perform arithmetic. The interface contains labels and text fields for Number 1, Number 2, and Result. The Result text field displays the result of the arithmetic operation between Number 1 and Number 2. Figure 34.23 contains a sample run of the program.

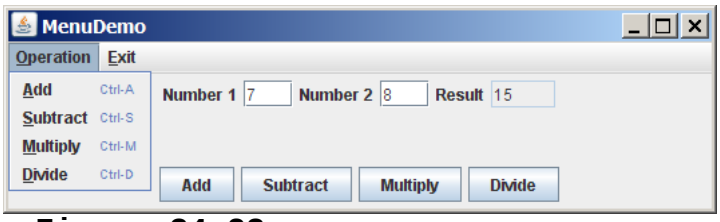


Figure 34.23
Arithmetic operations can be performed by clicking buttons or by choosing menu items from the Operation menu.

Here are the major steps in the program (Listing 34.10):

1. Create a menu bar and add it into a VBox. Create the menus Operation and Exit, and add them to the menu bar. Add the menu items Add, Subtract, Multiply, and Divide under the Operation menu, and add the menu item Close under the Exit menu.

2. Create an HBox to hold labels and text fields, and place it into the VBox.

3. Create an HBox to hold the four buttons labeled Add, Subtract, Multiply, and Divide. Place it into the VBox.

4. Implement the handlers to process the events from the menu items and the buttons.

Listing 34.10 MenuDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.geometry.Pos;
 3  import javafx.scene.Scene;
 4  import javafx.scene.control.Button;
 5  import javafx.scene.control.Label;
 6  import javafx.scene.control.Menu;
 7  import javafx.scene.control.MenuBar;
 8  import javafx.scene.control.MenuItem;
 9  import javafx.scene.control.TextField;
10  import javafx.scene.input.KeyCombination;
11  import javafx.scene.layout.HBox;
12  import javafx.scene.layout.VBox;
13  import javafx.stage.Stage;
14
```

```
15  public class MenuDemo extends Application {
16    private TextField tfNumber1 = new TextField();
17    private TextField tfNumber2 = new TextField();
18    private TextField tfResult = new TextField();
19
20    @Override // Override the start method in the Application class
21    public void start(Stage primaryStage) {
22      MenuBar menuBar = new MenuBar();
23
24      Menu menuOperation = new Menu("Operation");
25      Menu menuExit = new Menu("Exit");
26      menuBar.getMenus().addAll(menuOperation, menuExit);
27
28      MenuItem menuItemAdd = new MenuItem("Add");
29      MenuItem menuItemSubtract = new MenuItem("Subtract");
30      MenuItem menuItemMultiply = new MenuItem("Multiply");
31      MenuItem menuItemDivide = new MenuItem("Divide");
32      menuOperation.getItems().addAll(menuItemAdd, menuItemSubtract,
33        menuItemMultiply, menuItemDivide);
34
35      MenuItem menuItemClose = new MenuItem("Close");
36      menuExit.getItems().add(menuItemClose);
37
38      menuItemAdd.setAccelerator(
39        KeyCombination.keyCombination("Ctrl+A"));
40      menuItemSubtract.setAccelerator(
41        KeyCombination.keyCombination("Ctrl+S"));
42      menuItemMultiply.setAccelerator(
43        KeyCombination.keyCombination("Ctrl+M"));
44      menuItemDivide.setAccelerator(
45        KeyCombination.keyCombination("Ctrl+D"));
46
47      HBox hBox1 = new HBox(5);
48      tfNumber1.setPrefColumnCount(2);
49      tfNumber2.setPrefColumnCount(2);
50      tfResult.setPrefColumnCount(2);
51      hBox1.getChildren().addAll(new Label("Number 1:"), tfNumber1,
52        new Label("Number 2:"), tfNumber2, new Label("Result:"),
53        tfResult);
54      hBox1.setAlignment(Pos.CENTER);
55
56      HBox hBox2 = new HBox(5);
57      Button btAdd = new Button("Add");
58      Button btSubtract = new Button("Subtract");
59      Button btMultiply = new Button("Multiply");
60      Button btDivide = new Button("Divide");
61      hBox2.getChildren().addAll(btAdd, btSubtract, btMultiply, btDivide);
62      hBox2.setAlignment(Pos.CENTER);
63
64      VBox vBox = new VBox(10);
65      vBox.getChildren().addAll(menuBar, hBox1, hBox2);
66      Scene scene = new Scene(vBox, 300, 250);
67      primaryStage.setTitle("MenuDemo"); // Set the window title
68      primaryStage.setScene(scene); // Place the scene in the window
69      primaryStage.show(); // Display the window
70
71      // Handle menu actions
72      menuItemAdd.setOnAction(e -> perform('+'));
73      menuItemSubtract.setOnAction(e -> perform('-'));
```

```
74      menuItemMultiply.setOnAction(e -> perform('*'));
75      menuItemDivide.setOnAction(e -> perform('/'));
76      menuItemClose.setOnAction(e -> System.exit(0));
77
78      // Handle button actions
79      btAdd.setOnAction(e -> perform('+'));
80      btSubtract.setOnAction(e -> perform('-'));
81      btMultiply.setOnAction(e -> perform('*'));
82      btDivide.setOnAction(e -> perform('/'));
83    }
84
85    private void perform(char operator) {
86      double number1 = Double.parseDouble(tfNumber1.getText());
87      double number2 = Double.parseDouble(tfNumber2.getText());
88
89      double result = 0;
90      switch (operator) {
91        case '+': result = number1 + number2; break;
92        case '-': result = number1 - number2; break;
93        case '*': result = number1 * number2; break;
94        case '/': result = number1 / number2; break;
95      }
96
97      tfResult.setText(result + "");
98    };
100 }
```

The program creates a menu bar (line 22), which holds two menus: menuOperation and menuExit (lines 24-36). The menuOperation contains four menu items for doing arithmetic: Add, Subtract, Multiply, and Divide. The menuExit contains the menu item Close for exiting the program. The menu items in the Operation menu are created with keyboard accelerators (lines 38-45).

The labels and text fields are placed in an HBox (lines 47-54) and four buttons are placed in another HBox (lines 56-62). The menu bar and these two HBoxes are added to a VBox (line 65), which is placed in the scene (line 66).

The user enters two numbers in the number fields. When an operation is chosen from the menu, its result, involving two numbers, is displayed in the Result field. The user can also click the buttons to perform the same operation.

The program sets actions for the menu items and buttons in lines 72-82. The private method perform(char operator) (lines 85–98) retrieves operands from the text fields in Number 1 and Number 2, applies the binary operator on the operands, and sets the result in the Result text field.

Check point

34.23 How do you create a menu bar, menu, menu item, check menu item, and radio menu item?

34.24 How do you place a menu into a menu bar? How do you place a menu item, check menu item, and radio menu item into a menu?

34.25 Can you place a menu item into another menu item or a check menu or a radio menu item into a menu item?

34.26 How do you associate an image with a menu, menu item, check menu item, and radio menu item?

34.27 How do you associate an accelerator CTRL+O with a menu item, check menu item, and radio menu item?

34.8 Context Menus

Key Point: You can create context menus in JavaFX.

A *context menu*, also known as a *popup menu*, is like a regular menu, but does not have a menu bar and can float anywhere on the screen. Creating a context menu is similar to creating a regular menu. First, you create an instance of ContextMenu, then you can add MenuItem, CheckMenuItem, and RadioMenuItem to the context menu. For example, the following code creates a ContextMenu and adds MenuItems into it:

```
ContextMenu contextMenu = new ContextMenu();
ContextMenu.getItems().add(new MenuItem("New"));
ContextMenu.getItems().add(new MenuItem("Open"));
```

A regular menu is always added to a menu bar, but a context menu is associated with a parent node and is displayed using the show method in the ContextMenu class. You specify the parent node and the location of the context menu, using the coordinate system of the parent like this:

```
contextMenu.show(node, x, y);
```

Customarily, you display a context menu by pointing to a GUI component and clicking a certain mouse button, the so-called popup trigger. Popup triggers are system dependent. In Windows, the context menu is displayed when the right mouse button is released. In Motif, the context menu is displayed when the third mouse button is pressed and held down.

Listing 34.11 gives an example that creates a pane. When the mouse points to the pane, clicking a mouse button displays a context menu, as shown in Figure 34.24.

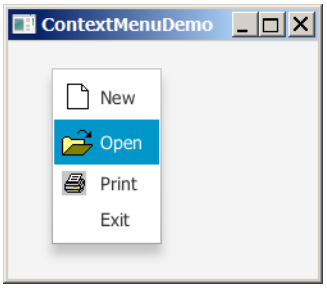


Figure 34.24
A context menu is displayed when the popup trigger is issued on the pane.

Here are the major steps in the program (Listing 34.11):

1. Create a context menu using ContextMenu. Create menu items for New, Open, Print, and Exit using MenuItem.
2. Add the menu items into the context menu.
3. Create a pane and place it in the scene.
4. Implement the handler to process the events from the menu items.
5. Implement the mouseClicked handler to display the context menu.

Listing 34.11 ContextMenuDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.scene.Scene;
 3  import javafx.scene.control.ContextMenu;
 4  import javafx.scene.control.MenuItem;
 5  import javafx.scene.image.ImageView;
 6  import javafx.scene.layout.Pane;
 7  import javafx.stage.Stage;
 8
 9  public class ContextMenuDemo extends Application {
10    @Override // Override the start method in the Application class
11    public void start(Stage primaryStage) {
12      ContextMenu contextMenu = new ContextMenu();
13      MenuItem menuItemNew = new MenuItem("New",
14        new ImageView("image/new.gif"));
15      MenuItem menuItemOpen = new MenuItem("Open",
16        new ImageView("image/open.gif"));
17      MenuItem menuItemPrint = new MenuItem("Print",
18        new ImageView("image/print.gif"));
19      MenuItem menuItemExit = new MenuItem("Exit");
20      contextMenu.getItems().addAll(menuItemNew, menuItemOpen,
21        menuItemPrint, menuItemExit);
22
23      Pane pane = new Pane();
24      Scene scene = new Scene(pane, 300, 250);
25      primaryStage.setTitle("ContextMenuDemo"); // Set the window title
26      primaryStage.setScene(scene); // Place the scene in the window
27      primaryStage.show(); // Display the window
28
```

```
29      pane.setOnMousePressed(
30        e -> contextMenu.show(pane, e.getScreenX(), e.getScreenY()));
31
32      menuItemNew.setOnAction(e -> System.out.println("New"));
33      menuItemOpen.setOnAction(e -> System.out.println("Open"));
34      menuItemPrint.setOnAction(e -> System.out.println("Print"));
35      menuItemExit.setOnAction(e -> System.exit(0));
36    }
37  }
```

The process of creating context menus is similar to the process for creating regular menus. To create a context menu, create a ContextMenu as the basis (line 12) and add MenuItems to it (lines 13-21).

To show a context menu, use the show method by specifying the parent node and the location for the context menu (lines 29-30). The show method is invoked when the context menu is triggered by a mouse click on the pane (line 30).

Check point

34.28 How do you create a context menu? How do you add menu items, check menu items, and radio menu items into a context menu?

34.29 How do you show a context menu?

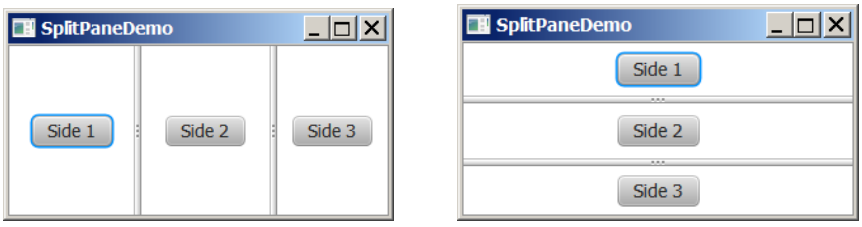
34.9 `SplitPane`

Key Point: The **`SplitPane`** class can be used to display multiple panes and allow the user to adjust the size of the panes.

The **`SplitPane`** is a control that contains two components with a separate bar known as a divider, as shown in Figure 34.25.

FIGURE 34.25

`SplitPane` *divides a container into two parts.*



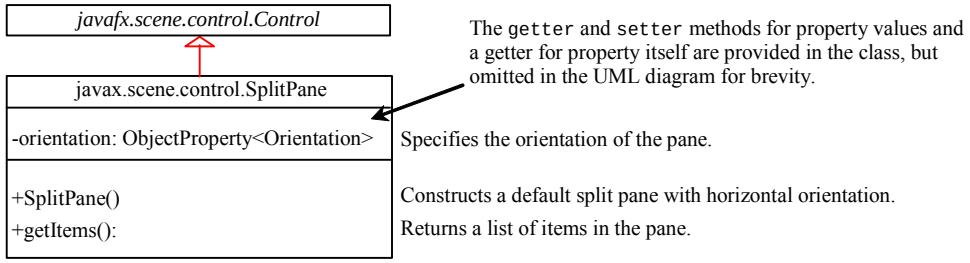
(a) Horizontal orientation (b) Vertical orientation

The two sides separated by the divider can appear in horizontal or vertical orientation. The divider separating two

sides can be dragged to change the amount of space occupied by each side. Figure 34.26 shows the frequently used properties, constructors, and methods in `SplitPane`.

FIGURE 34.26

`SplitPane` provides methods to specify the properties of a split pane and for manipulating the components in a split pane.



Listing 34.12 gives an example that uses radio buttons to let the user select a country and displays the country's flag and description in separate sides, as shown in Figure 34.27. The description of the currently selected layout manager is displayed in a text area. The radio buttons, buttons, and text area are placed in two split panes.

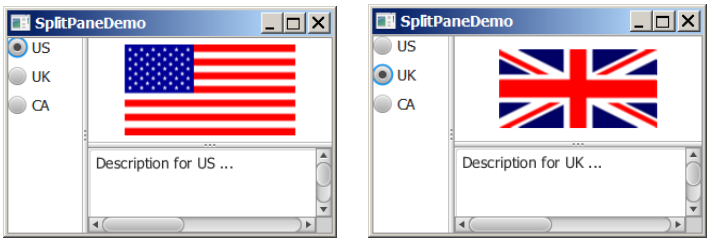
Listing 34.12 SplitPaneDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.geometry.Orientation;
 3  import javafx.scene.Scene;
 4  import javafx.scene.control.RadioButton;
 5  import javafx.scene.control.ScrollPane;
 6  import javafx.scene.control.SplitPane;
 7  import javafx.scene.control.TextArea;
 8  import javafx.scene.control.ToggleGroup;
 9  import javafx.scene.image.Image;
10  import javafx.scene.image.ImageView;
11  import javafx.scene.layout.StackPane;
12  import javafx.scene.layout.VBox;
13  import javafx.stage.Stage;
14
15  public class SplitPaneDemo extends Application {
16    private Image usImage = new Image(
17      "http://www.cs.armstrong.edu/liang/common/image/us.gif");
18    private Image ukImage = new Image(
19      "http://www.cs.armstrong.edu/liang/common/image/uk.gif");
20    private Image caImage = new Image(
21      "http://www.cs.armstrong.edu/liang/common/image/ca.gif");
22    private String usDescription = "Description for US ...";
23    private String ukDescription = "Description for UK ...";
24    private String caDescription = "Description for CA ...";
25
26    @Override // Override the start method in the Application class
27    public void start(Stage primaryStage) {
28      VBox vBox = new VBox(10);
29      RadioButton rbUS = new RadioButton("US");
```

```
30      RadioButton rbUK = new RadioButton("UK");
31      RadioButton rbCA = new RadioButton("CA");
32      vBox.getChildren().addAll(rbUS, rbUK, rbCA);
33
34      SplitPane content = new SplitPane();
35      content.setOrientation(Orientation.VERTICAL);
36      ImageView imageView = new ImageView(usImage);
37      StackPane imagePane = new StackPane();
38      imagePane.getChildren().add(imageView);
39      TextArea taDescription = new TextArea();
40      taDescription.setText(usDescription);
41      content.getItems().addAll(
42        imagePane, new ScrollPane(taDescription));
43
44      SplitPane sp = new SplitPane();
45      sp.getItems().addAll(vBox, content);
46
47      Scene scene = new Scene(sp, 300, 250);
48      primaryStage.setTitle("SplitPaneDemo"); // Set the window title
49      primaryStage.setScene(scene); // Place the scene in the window
50      primaryStage.show(); // Display the window
51
52      // Group radio buttons
53      ToggleGroup group = new ToggleGroup();
54      rbUS.setToggleGroup(group);
55      rbUK.setToggleGroup(group);
56      rbCA.setToggleGroup(group);
57
58      rbUS.setSelected(true);
59      rbUS.setOnAction(e -> {
60        imageView.setImage(usImage);
61        taDescription.setText(usDescription);
62      });
63
64      rbUK.setOnAction(e -> {
65        imageView.setImage(ukImage);
66        taDescription.setText(ukDescription);
67      });
68
69      rbCA.setOnAction(e -> {
70        imageView.setImage(caImage);
71        taDescription.setText(caDescription);
72      });
73    }
74  }
```

Figure 34.27

You can adjust the component size in the split panes.



The program places three radio buttons in a **VBox** (lines 28-32) and creates a vertical split pane for holding an image view and a text area (lines 34-42). Split panes can be embedded. The program creates a horizontal split pane and places the **VBox** and the vertical split pane into it (lines 44-45).

Adding a split pane to an existing split pane results in three split panes. The program creates two split panes (lines 54-58) to hold a panel for radio buttons, a panel for buttons, and a scroll pane.

The program groups radio buttons (lines 53-56) and processes the action for radio buttons (lines 59-72).

Check point

34.30 How do you create a horizontal **SplitPane**? How do you create a vertical **SplitPane**?

34.31 How do you add items into a **SplitPane**? Can an item added to a **SplitPane** to another **SplitPane**?

34.10 TabPane

Key Point: The **TabPane** class can be used to display multiple panes with tabs.

TabPane is a useful control that provides a set of mutually exclusive tabs, as shown in Figure 34.28. You can switch between a group of tabs. Only one tab is visible at a time. A Tab can be added to a TabPane. Tabs in a TabPane can be placed in the position top, left, bottom, or right.

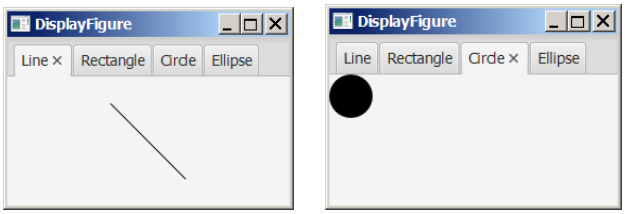


Figure 34.28

TabPane holds a group of tabs.

Each tab represents a single page. Tabs are defined in the Tab class. Tabs can contain any Node such as a pane, a shape, or a control. A tab can contain another pane. So you can create a multi-layered tab pane. Figures 34.29 and 34.30 show the frequently used properties, constructors, and methods in TabPane and Tab.

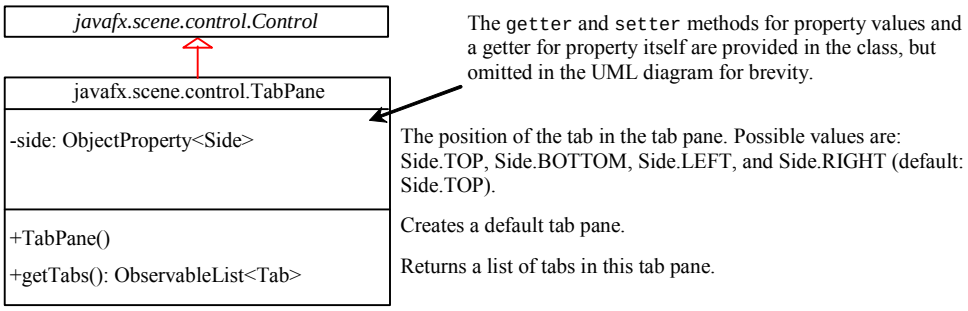


Figure 34.29

`TabPane` displays and manages the tabs.

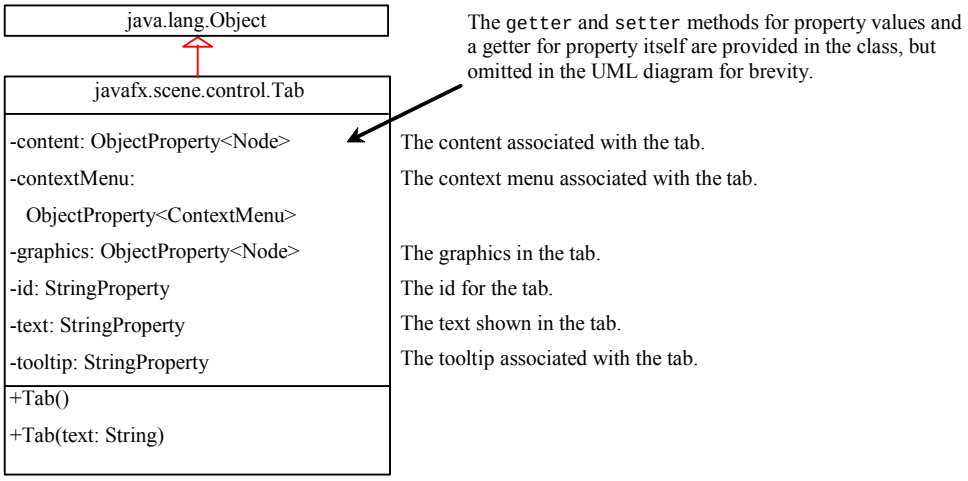


Figure 34.30

`Tab` contains a node.

Listing 34.13 gives an example that uses a tab pane with four tabs to display four types of figures: line, rectangle, rounded rectangle, and oval. You can select a figure to display by clicking the corresponding tab, as shown in Figure 34.28.

Listing 34.13 TabPaneDemo.java

```
1  import javafx.application.Application;
2  import javafx.scene.Scene;
3  import javafx.scene.control.Tab;
4  import javafx.scene.control.TabPane;
5  import javafx.scene.layout.StackPane;
6  import javafx.scene.shape.Circle;
7  import javafx.scene.shape.Ellipse;
8  import javafx.scene.shape.Line;
9  import javafx.scene.shape.Rectangle;
```

```
10  import javafx.stage.Stage;
11
12  public class TabPaneDemo extends Application {
13    @Override // Override the start method in the Application class
14    public void start(Stage primaryStage) {
15      TabPane tabPane = new TabPane();
16      Tab tab1 = new Tab("Line");
17      StackPane pane1 = new StackPane();
18      pane1.getChildren().add(new Line(10, 10, 80, 80));
19      tab1.setContent(pane1);
20      Tab tab2 = new Tab("Rectangle");
21      tab2.setContent(new Rectangle(10, 10, 200, 200));
22      Tab tab3 = new Tab("Circle");
23      tab3.setContent(new Circle(50, 50, 20));
24      Tab tab4 = new Tab("Ellipse");
25      tab4.setContent(new Ellipse(10, 10, 100, 80));
26      tabPane.getTabs().addAll(tab1, tab2, tab3, tab4);
27
28      Scene scene = new Scene(tabPane, 300, 250);
29      primaryStage.setTitle("DisplayFigure"); // Set the window title
30      primaryStage.setScene(scene); // Place the scene in the window
31      primaryStage.show(); // Display the window
32    }
33  }
```

The program creates a tab pane (line 15) and four tabs (lines 16, 20, 22, 24). A stack pane is created to hold a line (line 18) and placed into tab1 (line 19). A rectangle, circle, and oval are created and placed into tab2, tab3, and tab4. Note that the line is centered in tab1, because it is placed in a stack pane. The other shapes are directly placed into the tab. They are displayed at the upper left corner of the tab.

By default, the tabs are placed at the top of the tab pane. You can use the **`setSide`** method to change its location.

Check point

34.32 How do you create a tab pane? How do you create a tab? How do you add a tab to a tab pane?

34.33 How do you place the tabs on the left of the tab pane?

34.34 Can a tab have a text as well as an image? Write the code to set an image for tab1 in Listing 34.13.

34.11 TableView

Key Point: You can display tables using the **`TableView`** class.

TableView is a control that displays data in rows and columns in a two-dimensional grid, as shown in Figure 34.31.

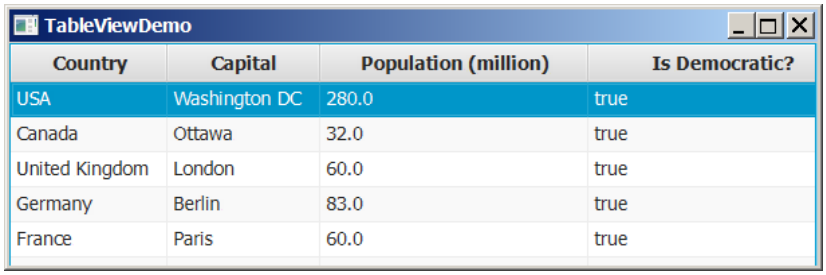


Figure 34.31

TableView displays data in a table.

TableView, TableColumn, and TableCell are used to display and manipulate a table. TableView displays a table. TableColumn defines the columns in a table. TableCell represents a cell in the table. Creating a TableView is a mult-step process. First, you need to create an instance of TableView and associate data with the TableView. Second, you need to create columns using the TableColumn class and set a column cell value factory to specify how to populate all cells within a single TableColumn.

Listing 34.14 gives a simple example to demonstrate using TableView and TableColumn. A sample run of the program is shown in Figure 34.31.

Listing 34.14 TableViewDemo.java

```
 1  import javafx.application.Application;
 2  import javafx.beans.property.SimpleBooleanProperty;
 3  import javafx.beans.property.SimpleDoubleProperty;
 4  import javafx.beans.property.SimpleStringProperty;
 5  import javafx.collections.FXCollections;
 6  import javafx.collections.ObservableList;
 7  import javafx.scene.Scene;
 8  import javafx.scene.control.TableColumn;
 9  import javafx.scene.control.TableView;
10  import javafx.scene.control.cell.PropertyValueFactory;
11  import javafx.scene.layout.Pane;
12  import javafx.stage.Stage;
13
14  public class TableViewDemo extends Application {
15    @Override // Override the start method in the Application class
16    public void start(Stage primaryStage) {
17      TableView<Country> tableView = new TableView<>();
18      ObservableList<Country> data =
19        FXCollections.observableArrayList(
20          new Country("USA", "Washington DC", 280, true),
21          new Country("Canada", "Ottawa", 32, true),
22          new Country("United Kingdom", "London", 60, true),
23          new Country("Germany", "Berlin", 83, true),
24          new Country("France", "Paris", 60, true));
25      tableView.setItems(data);
26
27      TableColumn countryColumn = new TableColumn("Country");
```

```
    countryColumn.setMinWidth(100);
    countryColumn.setCellValueFactory(
      new PropertyValueFactory<Country, String>("country"));

    TableColumn capitalColumn = new TableColumn("Capital");
    capitalColumn.setMinWidth(100);
    capitalColumn.setCellValueFactory(
      new PropertyValueFactory<Country, String>("capital"));

    TableColumn populationColumn =
      new TableColumn("Population (million)");
    populationColumn.setMinWidth(200);
    populationColumn.setCellValueFactory(
      new PropertyValueFactory<Country, Double>("population"));

    TableColumn democraticColumn =
      new TableColumn("Is Democratic?");
    democraticColumn.setMinWidth(200);
    democraticColumn.setCellValueFactory(
      new PropertyValueFactory<Country, Boolean>("democratic"));

    tableView.getColumns().addAll(countryColumn, capitalColumn,
      populationColumn, democraticColumn);

    Pane pane = new Pane();
    pane.getChildren().add(tableView);
    Scene scene = new Scene(pane, 300, 250);
    primaryStage.setTitle("TableViewDemo"); // Set the window title
    primaryStage.setScene(scene); // Place the scene in the window
    primaryStage.show(); // Display the window
  }

  public static class Country {
    private final SimpleStringProperty country;
    private final SimpleStringProperty capital;
    private final SimpleDoubleProperty population;
    private final SimpleBooleanProperty democratic;

    private Country(String country, String capital,
        double population, boolean democratic) {
      this.country = new SimpleStringProperty(country);
      this.capital = new SimpleStringProperty(capital);
      this.population = new SimpleDoubleProperty(population);
      this.democratic = new SimpleBooleanProperty(democratic);
    }

    public String getCountry() {
      return country.get();
    }

    public void setCountry(String country) {
      this.country.set(country);
    }

    public String getCapital() {
      return capital.get();
    }

    public void setCapital(String capital) {
```

```
 87       this.capital.set(capital);
 88     }
 89
 90     public double getPopulation() {
 91       return population.get();
 92     }
 93
 94     public void setPopulation(double population) {
 95       this.population.set(population);
 96     }
 97
 98     public boolean isDemocratic() {
 99       return democratic.get();
100     }
101
102     public void setDemocratic(boolean democratic) {
103       this.democratic.set(democratic);
104     }
105   }
106 }
```

The program creates a TableView (line 17). The TableView class is a generic class whose concrete type is Country. So, this TableView is for displaying Country. The table data is an ObservableList<Country>. The program creates the list (lines 18-24) and associates the list with the TableView (line 25).

The program creates a TableColumn for each column in the table (lines 27-47). A PropertyValueFactory object is created and set for each column (line 30). This object is used to populate the data in the column. The PropertyValueFactory <S, T> class is generic class. S is for the class displayed in the TableView and T is the class for the values in the column. The PropertyValueFactory object associates a property in class S with a column.

When you create a table in a JavaFX application, it is a best practice to define the data model in a class. The Country class defines the data for TableView. Each property in the class defines a column in the table. This property should be defined as binding property with the getter and setter method for the value.

The program adds the columns into the TableView (lines 49-50), adds the TableView in a pane (line 53) and places the pane in the scene (line 54). Note that line 31 can be simplified using the following code:

```
new PropertyValueFactory< >("country");
```

From this example, you see how to display data in a table using the TableView and TableColumn classes. The frequently used properties and methods for the TableView and TableColumn classes are given in Figures 34.42 and 34.33.

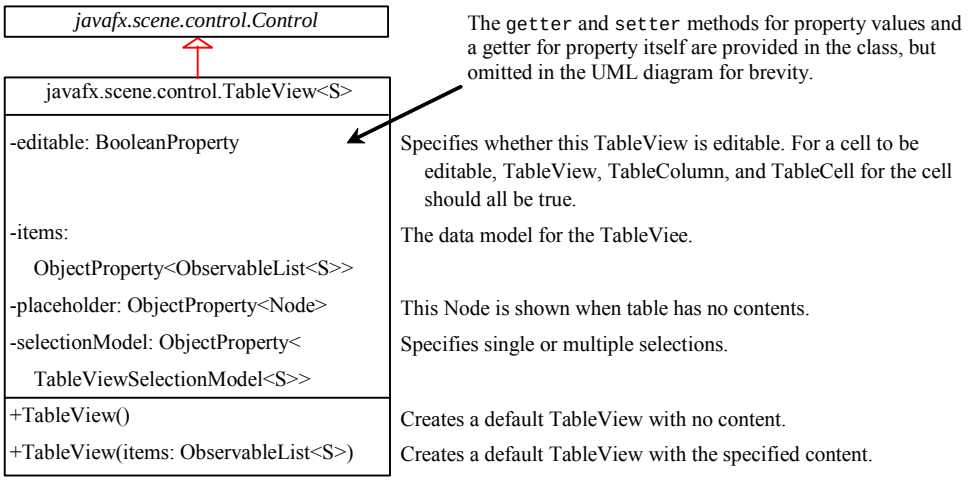


Figure 34.32

`TableView` displays a table.

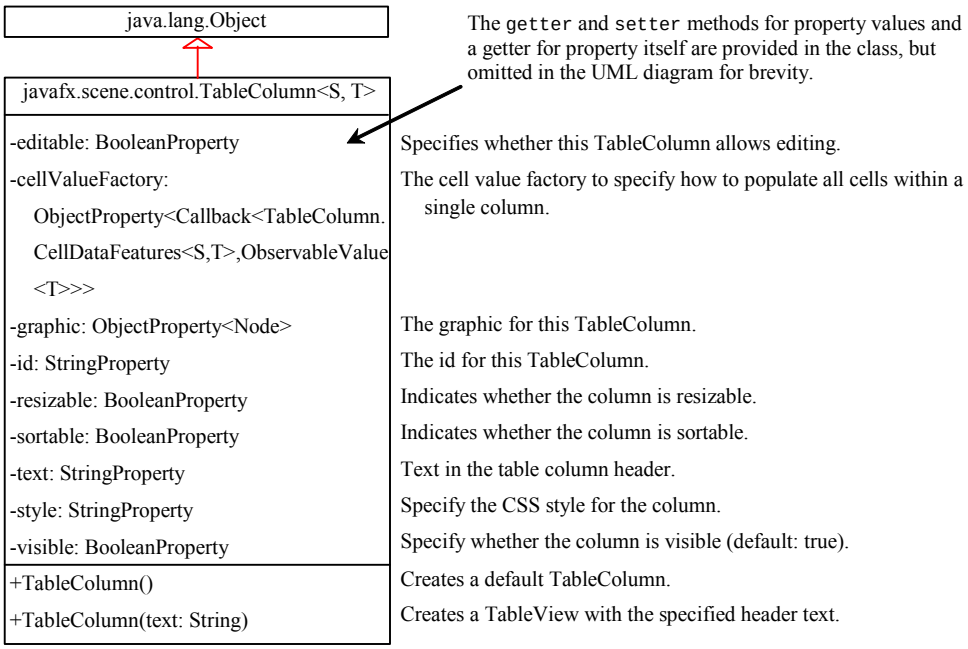


Figure 34.33

`TableColumn` defines a column in the TableView.

You can create nested columns. For example, the following code creates two subcolumns under Location, as shown in Figure 34.34.

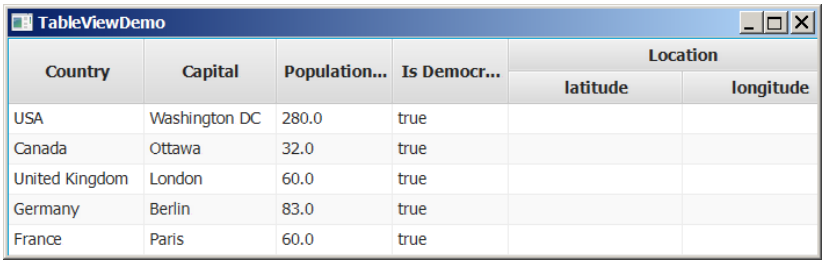


Figure 34.34

You can add subcolumns in a column.

The TableView data model is an observable list. When data is changed, the change is automatically shown in the table. Listing 34.15 gives an example that lets the user add new rows to the table.

Listing 34.15 AddNewRowDemo.java

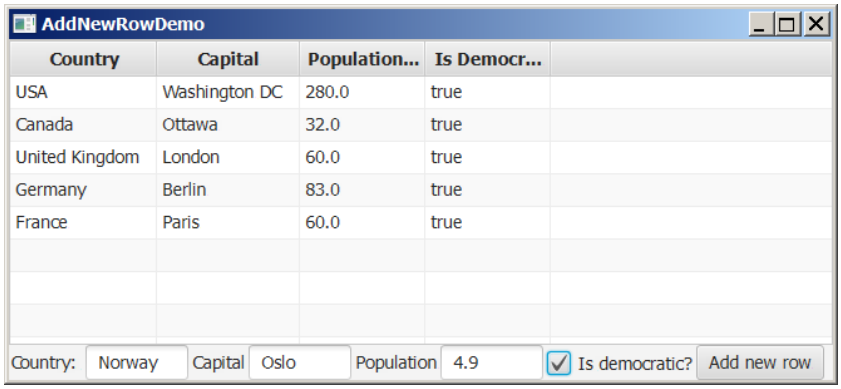
```
 1  import javafx.application.Application;
 2  import javafx.beans.property.SimpleBooleanProperty;
 3  import javafx.beans.property.SimpleDoubleProperty;
 4  import javafx.beans.property.SimpleStringProperty;
 5  import javafx.collections.FXCollections;
 6  import javafx.collections.ObservableList;
 7  import javafx.scene.Scene;
 8  import javafx.scene.control.Button;
 9  import javafx.scene.control.CheckBox;
10  import javafx.scene.control.Label;
11  import javafx.scene.control.TableColumn;
12  import javafx.scene.control.TableView;
13  import javafx.scene.control.TextField;
14  import javafx.scene.control.cell.PropertyValueFactory;
15  import javafx.scene.layout.BorderPane;
16  import javafx.scene.layout.FlowPane;
17  import javafx.stage.Stage;
18
19  public class AddNewRowDemo extends Application {
20    @Override // Override the start method in the Application class
21    public void start(Stage primaryStage) {
22      TableView<Country> tableView = new TableView<>();
23      ObservableList<Country> data =
24        FXCollections.observableArrayList(
25          new Country("USA", "Washington DC", 280, true),
26          new Country("Canada", "Ottawa", 32, true),
27          new Country("United Kingdom", "London", 60, true),
28          new Country("Germany", "Berlin", 83, true),
29          new Country("France", "Paris", 60, true));
30      tableView.setItems(data);
31
32      TableColumn countryColumn = new TableColumn("Country");
33      countryColumn.setMinWidth(100);
34      countryColumn.setCellValueFactory(
35        new PropertyValueFactory<Country, String>("country"));
36
37      TableColumn capitalColumn = new TableColumn("Capital");
38      capitalColumn.setMinWidth(100);
39      capitalColumn.setCellValueFactory(
```

```
40        new PropertyValueFactory<Country, String>("capital"));
41
42      TableColumn populationColumn =
43        new TableColumn("Population (million)");
44      populationColumn.setMinWidth(100);
45      populationColumn.setCellValueFactory(
46        new PropertyValueFactory<Country, Double>("population"));
47
48      TableColumn democraticColumn =
49        new TableColumn("Is Democratic?");
50      democraticColumn.setMinWidth(100);
51      democraticColumn.setCellValueFactory(
52        new PropertyValueFactory<Country, Boolean>("democratic"));
53
54      tableView.getColumns().addAll(countryColumn, capitalColumn,
55        populationColumn, democraticColumn);
56
57      FlowPane flowPane = new FlowPane(3, 3);
58      TextField tfCountry = new TextField();
59      TextField tfCapital = new TextField();
60      TextField tfPopulation = new TextField();
61      CheckBox chkDemocratic = new CheckBox("Is democratic?");
62      Button btAddRow = new Button("Add new row");
63      tfCountry.setPrefColumnCount(5);
64      tfCapital.setPrefColumnCount(5);
65      tfPopulation.setPrefColumnCount(5);
66      flowPane.getChildren().addAll(new Label("Country: "),
67        tfCountry, new Label("Capital"), tfCapital,
68        new Label("Population"), tfPopulation, chkDemocratic,
69        btAddRow);
70
71      btAddRow.setOnAction(e -> {
72        data.add(new Country(tfCountry.getText(), tfCapital.getText(),
73          Double.parseDouble(tfPopulation.getText()),
74          chkDemocratic.isSelected()));
75        tfCountry.clear();
76        tfCapital.clear();
77        tfPopulation.clear();
78      });
79
80      BorderPane pane = new BorderPane();
81      pane.setCenter(tableView);
82      pane.setBottom(flowPane);
83
84      Scene scene = new Scene(pane, 500, 250);
85      primaryStage.setTitle("AddNewRowDemo"); // Set the window title
86      primaryStage.setScene(scene); // Place the scene in the window
87      primaryStage.show(); // Display the window
88    }
89
90    public static class Country {
91      private final SimpleStringProperty country;
92      private final SimpleStringProperty capital;
93      private final SimpleDoubleProperty population;
94      private final SimpleBooleanProperty democratic;
95
96      private Country(String country, String capital,
97          double population, boolean democratic) {
98        this.country = new SimpleStringProperty(country);
```

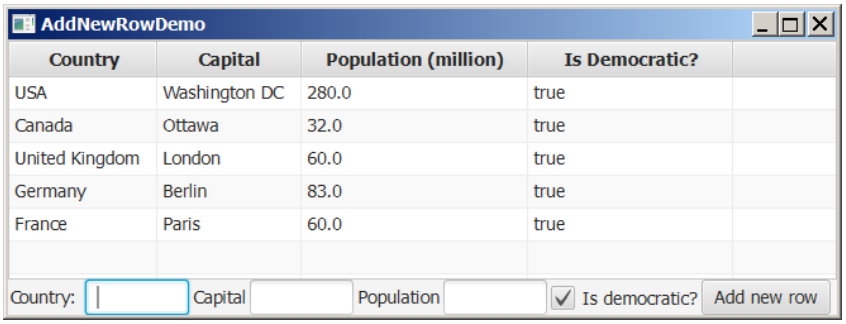
```
 99        this.capital = new SimpleStringProperty(capital);
100        this.population = new SimpleDoubleProperty(population);
101        this.democratic = new SimpleBooleanProperty(democratic);
102      }
103
104      public String getCountry() {
105        return country.get();
106      }
107
108      public void setCountry(String country) {
109        this.country.set(country);
110      }
111
112      public String getCapital() {
113        return capital.get();
114      }
115
116      public void setCapital(String capital) {
117        this.capital.set(capital);
118      }
119
120      public double getPopulation() {
121        return population.get();
122      }
123
124      public void setPopulation(double population) {
125        this.population.set(population);
126      }
127
128      public boolean isDemocratic() {
129        return democratic.get();
130      }
131
132      public void setDemocratic(boolean democratic) {
133        this.democratic.set(democratic);
134      }
135    }
136  }
```

The program is the same in Listing 34.14 except that the new code is added to let use enter a new row (lines 57-82). The user enters the new row from the text fields and a check box and presses the *Add New Row* button to add a new row to the data. Since data is an observable list, the change in data is automatically updated in the table.

As shown in Figure 34.35a, a new country information is entered in the text fields. After clicking the *Add new row button*, the new country is displayed in the table view.



(a)



(b)

Figure 34.35

Change in the table data model is automatically displayed in the table view.

TableView not only displays data, but also allows data to be edited. To enable data editing in the table, write the code as follows:

1. Set the TableView's editable to true;
2. Set the column's cell factory to a text field table cell.
3. Implement the column's setOnEditCommit method to assign the edited value to the data model.

   Here is the example of enabling editing for the countryColumn.

```
tableView.setEditable(true);
countryColumn.setCellFactory(TextFieldTableCell.forTableColumn());
countryColumn.setOnEditCommit(
  new EventHandler<CellEditEvent<Country, String>>() {
    @Override
    public void handle(CellEditEvent<Country, String> t) {
      t.getTableView().getItems().get(
        t.getTablePosition().getRow())
      .setCountry(t.getNewValue());
    }
```

```
    }
  );
```

Check point

34.35 How do you create a table view? How do you create a table column? How do you add a table column to a table view?

34.36 What is the data type for a TableView's data model? How do you associate a data model with a TableView?

34.37 How do you set a cell value factory for a TableColumn?

34.38 How do you set an image in a table column header?

Chapter Summary

1. JavaFX provides the cascading style sheets based on CSS. You can use the `getStylesheets` method to load a style sheet and use the `setStyle`, `setStyleClass`, and `setId` methods to set JavaFX CSS for nodes.
2. JavaFX provides a builder class for every node to simplify the process for constructing the node.
3. JavaFX provides the `QuadCurve`, `CubicCurve`, and `Path` classes for creating advanced shapes.
4. JavaFX supports coordinate transformations using translation, rotation, and scaling.
5. You can specify the pattern for a stroke, how the lines are joined in a stroke, the width of a stroke, the type of a stroke.
6. You can create menus using the `Menu`, `MenuItem`, `CheckMenuItem`, and `RadioMenuItem` classes.
7. You can create context menus using the `ContextMenu` class.
8. The `SplitPane` can be used to display multiple panes horizontally or vertically and allows the user to adjust the sizes of the panes.
9. The `TabPane` can be used to display multiple panes with tabs for selecting panes.
10. You can create and display tables using the `TableView` and `TableColumn` classes.

Quiz

Answer the quiz for this chapter online at www.cs.armstrong.edu/liang/intro10e/quiz.html.

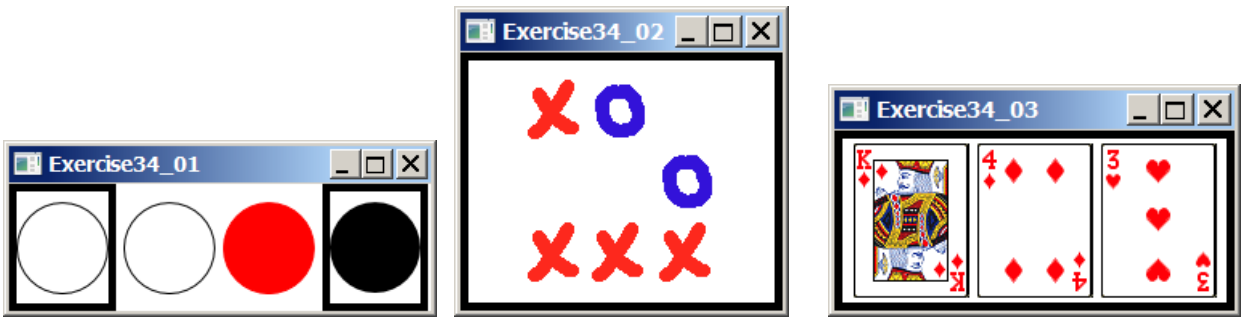
Programming Exercises

Sections 34.2

34.1 (*Use JavaFX CSS*) Create a CSS style sheet that defines a class for white fill and black stroke color and an id for red stroke and green color. Write a program that displays four circles and uses the style class and id. The sample run of the program is shown in Figure 34.36a.

Figure 34.36

(a) The border and color style for the shapes are defined in a style class. (b) Exercise 34.2 displays a tic-tac-toe board with images using style sheet for border. (c) Three cards are randomly selected.



(a) *(b)* *(c)*

***34.2** (*Tic-tac-toe board*) Write a program that displays a tic-tac-toe board, as shown in Figure 34.36b. A cell may be X, O, or empty. What to display at each cell is randomly decided. The X and O are images in the files **x.gif** and **o.gif**. Use the style sheet for border.

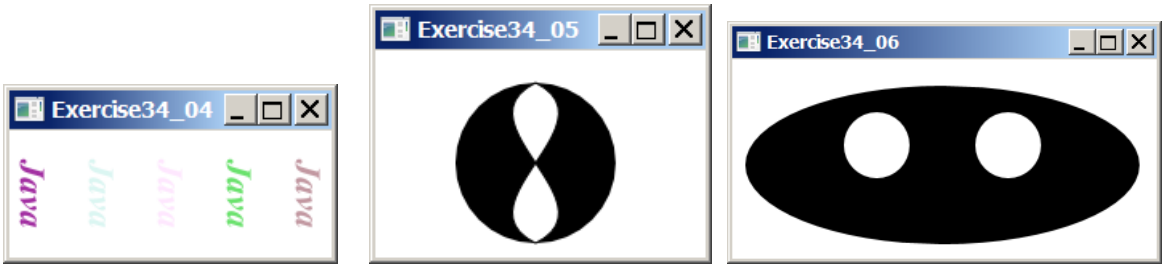
***34.3** (*Display three cards*) Write a program that displays three cards randomly selected from a deck of 52, as shown in Figure 34.36c. The card image files are named **1.png**, **2.png**, . . ., **52.png** and stored in the **image/card** directory. All three cards are distinct and selected randomly. Hint: You can select random cards by storing the numbers 1 to 52 to an array, perform a random shuffle using Section 7.2.6, and use the first three numbers in the array as the file names for the image. Use the style sheet for border.

Sections 34.3

34.4 (*Color and font*) Write a program that displays five texts vertically, as shown in Figure 14.44a. Set a random color and opacity for each text and set the font of each text to Times Roman, bold, italic, and 22 pixels. Use builder classes to create text.

Figure 34.37

(a) Five texts are displayed with a random color and a specified font. (b) A string is displayed around the circle. (c) A checkerboard is displayed using rectangles.



Sections 34.4

34.5*
(*Cubic curve*) Write a program that creates two shapes: a circle and a path consisting of two cubic curves, as shown in Figure 34.37b.

34.6*
(*Eyes*) Write a program that displays two eyes in an oval, as shown in Figure 34.37c.

Sections 34.5

34.7*
(*Translation*) Write a program that displays a rectangle with upper-left corner point at (40, 40), width 50, and height 40. Enter the values in the text fields x and y and press the *Translate* button to translate the rectangle to a new location, as shown in Figure 34.38a.

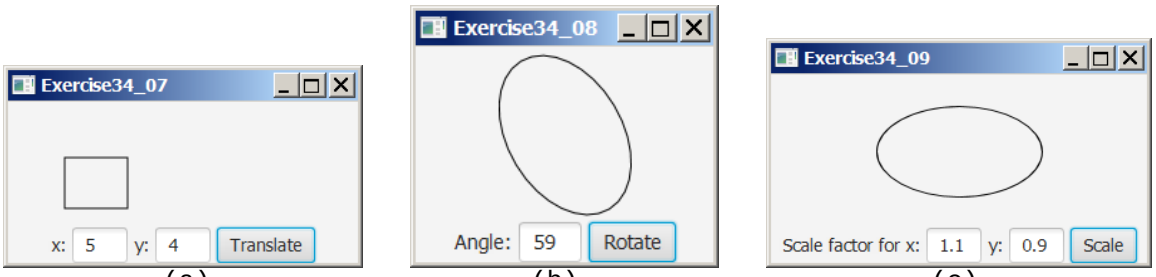


Figure 34.38

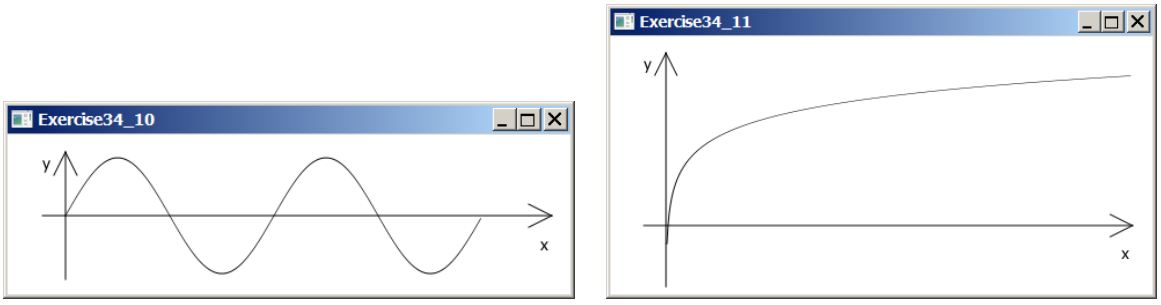
(a) Exercise 34.7 translates coordinates. (b) Exercise 34.8 rotates coordinates. (c) Exercise 34.9 scales coordinates.

34.8*
(*Rotation*) Write a program that displays an ellipse. The ellipse is centered in the pane with width 60 and height 40. Enter the value in the text field Angle and press the *Rotate* button to rotate the ellipse, as shown in Figure 34.38b.

34.9*

(*Scale graphics*) Write a program that displays an ellipse. The ellipse is centered in the pane with width 60 and height 40. Enter the scaling factors in the text fields and press the *Scale* button to scale the ellipse, as shown in Figure 34.38c.

34.10*
(*Plot the sine function*) Write a program that plots the sine function, as shown in Figure 34.39a.



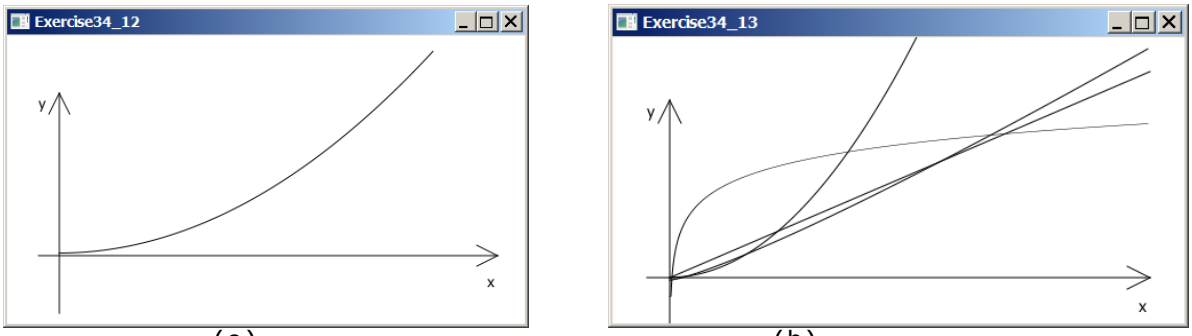
(a) (b)

Figure 34.39

(a) Exercise 34.10 displays a sine function. (b) Exercise 34.11 displays the log function. (b) Exercise 34.12 displays the n^2 function.

34.11*
(*Plot the log function*) Write a program that plots the log function, as shown in Figure 34.39a.

34.12*
(*Plot the n^2 function*) Write a program that plots the n^2 function, as shown in Figure 34.39b.



(a) (b)

Figure 34.40

(a) Exercise 34.13 displays the n^2 function. (b) Exercise 34.13 displays several functions.

34.13*
(*Plot the log, n, nlogn, and n^2 functions*) Write a program that plots the log, *n*, nlogn, and n^2 functions, as shown in Figure 34.40b.

34.14*
(***Scale and rotate graphics***) Write a program that enables the user to scale and rotate the STOP sign, as shown in Figure 34.34. The

user can press the UP/DOWN arrow key to increase/decrease the size and press the RIGHT/LEFT arrow key to rotate left or right.

Figure 34.41

The program can rotate and scale the painting.

Sections 34.6

34.15*
(*Sunshine*) Write a program that displays a circle filled with a gradient color to animate a sun and display light rays coming out from the sun using dashed lines, as shown in Figure 34.41a.

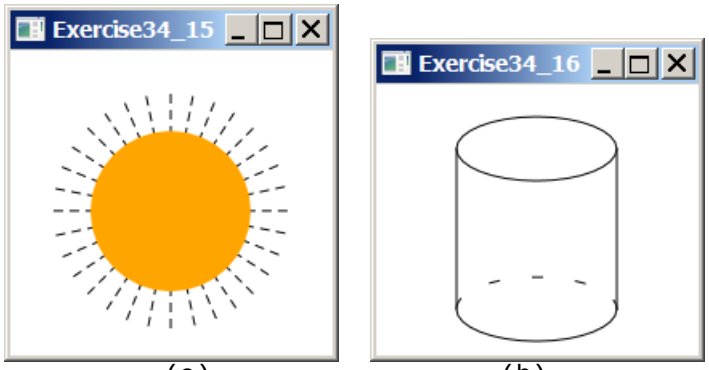


Figure 34.41

(a) Exercise 34.15 displays the sunshine. (b) Exercise 34.16 displays a cylinder.

34.16*
(*Display a cylinder*) Write a program that displays a cylinder, as shown in Figure 34.41b. Use dashed strokes to draw the dashed arc.

Sections 34.7

34.17*

(*Create an investment value calculator*) Write a program that calculates the future value of an investment at a given interest rate for a specified number of years. The formula for the calculation is as follows:

$$futureValue = investmentAmount \times (1 + monthlyInterestRate)^{years \times 12}$$

Use text fields for interest rate, investment amount, and years. Display the future amount in a text field when the user clicks the *Calculate* button or chooses Calculate from the Operation menu (see Figure 34.42). Click the Exit menu to exit the program.

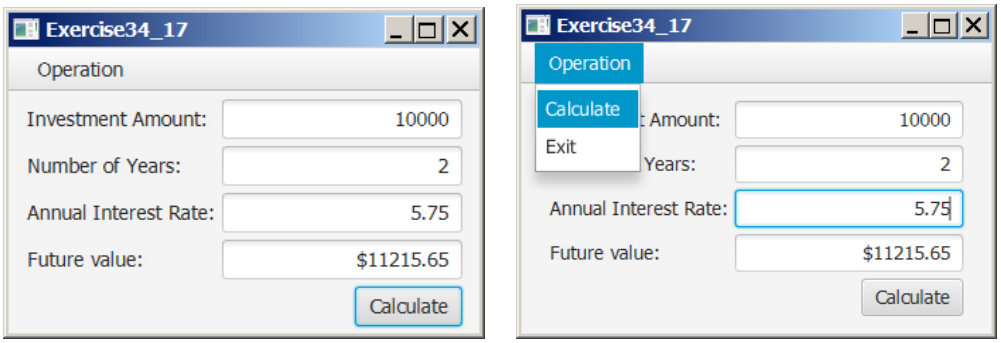


Figure 34.42
The user enters the investment amount, years, and interest rate to compute future value.

Sections 34.8

34.18* (*Use popup menus*) Modify Listing 34.10, MenuDemo.java, to create a popup menu that contains the menus Operations and Exit, as shown in Figure 34.34. The popup is displayed when you click the right mouse button on the panel that contains the labels and the text fields.

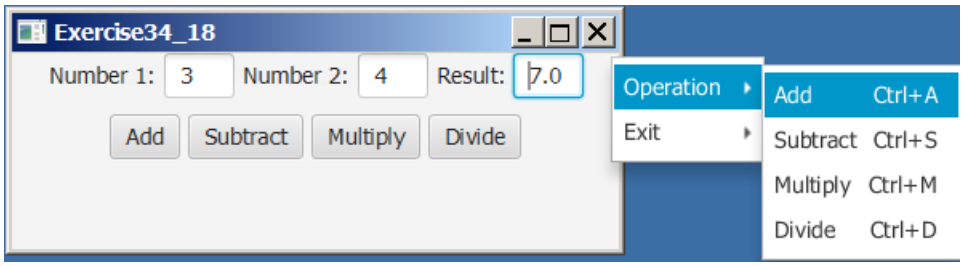
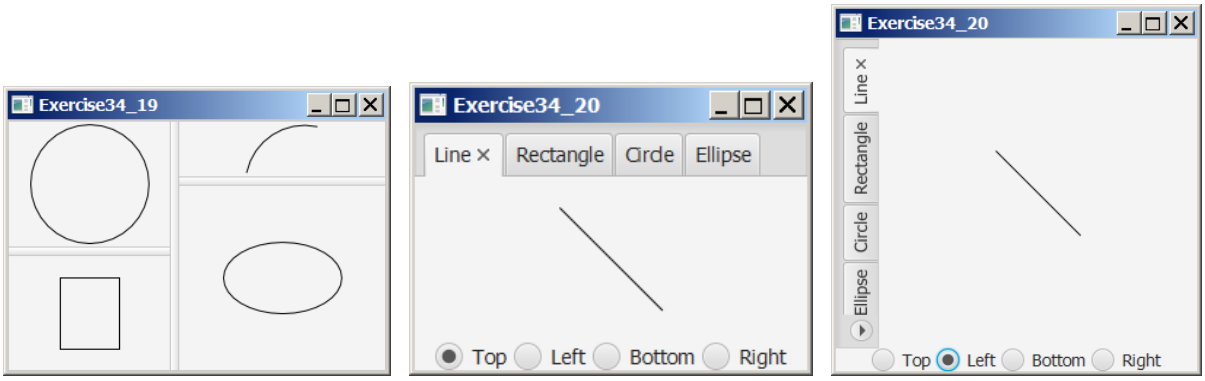


Figure 34.43
The popup menu contains the commands to perform arithmetic operations.

Sections 34.9

34.19* (*Use **SplitPane***) Create a program that displays four shapes in split panes, as shown in Figure 34.44a.



(a) **(b)** **(c)**

Figure 34.44

(a) Four shapes are displayed in split panes. (b-c) The radio buttons let you choose the tab placement of the tabbed pane.

Sections 34.10

34.20* (*Use tab panes*) Modify Listing 34.13, TabPaneDemo.java, to add a pane of radio buttons for specifying the tab placement of the tab pane, as shown in Figure 34.44b-c.

34.21* (*Use tab panes*) Write a program using tab panes for performing integer and rational number arithmetic as shown in Figure 34.45.

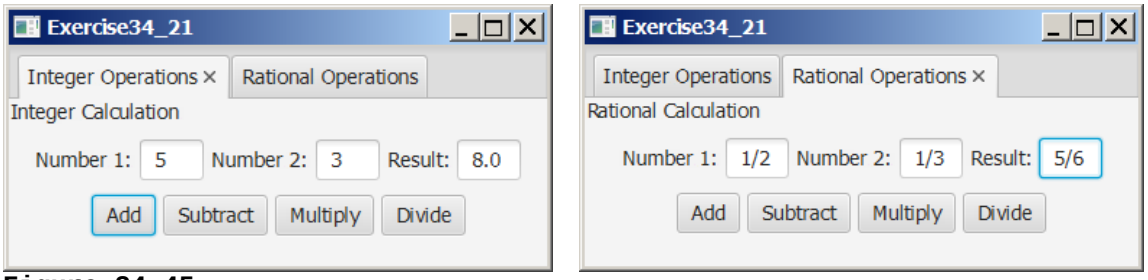


Figure 34.45

A tab pane is used to select panes that perform integer operations and rational number operations.

Sections 34.11

34.22* (*Use table view*) Revise Listing 34.15 to add a button to delete the selected row from the table, as shown in Figure 34.46.

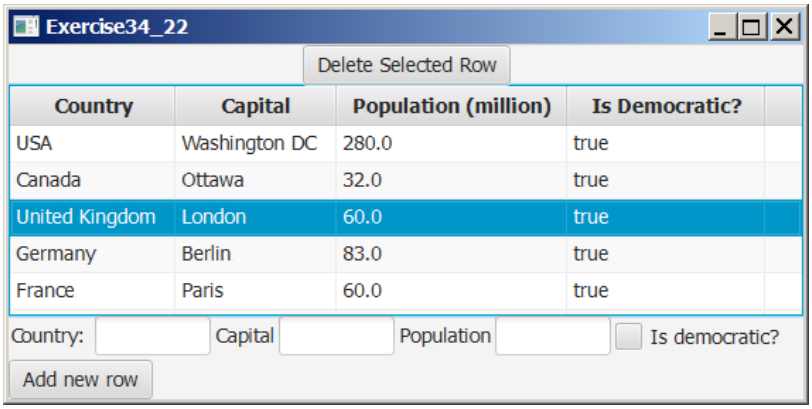


Figure 34.46

Clicking the Delete Selected Row button removes the selected row from the table.