

JavaFX

Introduction to GUI Concepts

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Introduction to GUI Concepts

Introduction to GUI Concepts

- ▶ GUI stands for “Graphical User Interface”.
- ▶ GUI programs are graphical components, such as buttons, textfields, menus, and scrollbars.
- ▶ Users employ a mouse and keyboard to interact with the program.

Event Driven Programming

Events occur when a user interacts with the program through a GUI component. There are usually two varieties.

- ▶ Mouse clicks.
- ▶ Key presses.

Event Handling

When an event occurs on a component, the program needs to handle it by calling an appropriate method in an event-handler object that has previously been attached to that component.

General Format for GUI programs.

- ▶ Create the user interface and arrange components.
- ▶ For each component, identify the events of that component that your program needs to handle.
- ▶ Write the handlers to those events.
- ▶ Display the user interface.

JavaFX

- ▶ JavaFX is a the latest class libraries for creating GUI programs in Java.
- ▶ JavaFX can be used to develop GUI applications that run on the desktop, inside of a web browser, and on mobile devices such as tablets and smart phone
- ▶ JavaFX is intended to replace the older and better known Swing library.
 - ▶ You've used Swing before. JOptionPane is part of Swing.

Stages and Scenes

GUI Programming with JavaFX

To create a JavaFX program, we create a subclass of Application.

```
public class JavaFXApplication1
    extends Application {

    @Override
    public void start(Stage stage) {
        // Build User Interface
        // and attach event handlers
    }

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

An aside: What's subclass?

- ▶ A subclass way of creating new classes with new features based on existing classes without having to rewrite an existing class.
- ▶ The term for this feature is **inheritance**.
- ▶ Inheritance promotes code reuse.
- ▶ The Java keyword to create a subclass is **extends**.
 - ▶ Look for this keyword in the previous slide. What are we extending?

The launch method.

- ▶ The `launch()` method is a static method inherited from `Application`. It should be called by the `main()` method.
- ▶ The `launch()` method sets up the JavaFX `Application` object, creates a `Stage` object, and calls the `start()` method of the `Application` object with the stage object as parameter.

The start() Method

- ▶ Receives a Stage object as parameter
- ▶ Creates a Scene object that consists of a hierarchy of UI components and sets the scene onto the stage object
- ▶ Sets event handlers on some of the components
- ▶ Shows the stage to the user

Scene Graphs and Scene Graph Nodes

Scene Graphs and Scene Graph Nodes

- ▶ The totality of UI components appearing on the screen of a JavaFX application form a scene
- ▶ The UI components are nested, forming a hierarchical tree structure called a scene graph
- ▶ Each component that is part of a scene graph is called a scene graph node

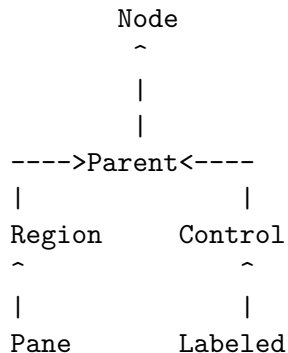
The Node Class

- ▶ The Node class is the superclass of all classes of that describe a component that can appear on the screen as part of a scene
- ▶ Examples of subclasses of Node are Button, TextField, Label, and various types of panes
- ▶ A pane is a UI component that can contains other UI components and arranges them according to some layout discipline

Branch Nodes and Leaves

- ▶ In a scene graph, a node that contains other nodes is called a **branch node**
- ▶ A scene graph node that does not contain other nodes is called a **leaf**
- ▶ A branch node is the **parent** of the nodes it contains; the contained nodes are called **children** of the branch node

Node and its Subclasses



Node and its Subclasses

- ▶ Node: A UI component with a visual representation on the screen
- ▶ Parent: A UI component that can contain other UI components (can have children)
- ▶ Region: A container that can layout its children and have its appearance styled using CSS
- ▶ Pane: A container that allows programmers to add and remove child nodes
- ▶ Control: A UI component that can be used to interact with and exchange information with the user (e.g. TextField, Button, Label, etc)

Creating a Scene

- ▶ All the UI components that will appear on the screen are nested in such a way that they form a hierarchical tree structure called the scene graph
- ▶ The top-most container is called the root of the scene graph; it must be an instance of the Parent class
- ▶ The root of the scene graph is used to create a scene via one of the constructors for the Scene class:
 - ▶ `Scene(Parent root, double width, double height)`
 - ▶ `Scene(Parent root)`
- ▶ The created scene object is set onto the stage and the stage is shown:
 - ▶ `Parent root = new Label("Hello World");`
 - ▶ `Scene scene = new Scene(root);`
 - ▶ `stage.setScene(scene);`
 - ▶ `stage.show();`

Example JavaFX Program

```
public class JavaFXHelloWorld extends Application {  
    @Override  
    public void start(Stage stage) {  
        // Create label  
        Label label = new Label("Hello World!");  
        // Set label as root of scene graph.  
        Scene scene = new Scene(label , 300, 80);  
        stage.setScene(scene);  
        // Set stage title and show the stage.  
        stage.setTitle("Hello World!");  
        stage.show();  
    }  
}
```

Panes and Component Layout

Panes and Component Layout

- ▶ Pane objects keep their child nodes in a collection of type `ObservableList` which has two methods that can be used to add nodes
 - ▶ `boolean add(Node child)`
 - ▶ `boolean addAll(Node... children)`
- ▶ The `Pane` class exposes this list of child nodes through a method
 - ▶ `ObservableList getChildren()`

One vertical column

The VBox Pane arranges its children in one vertical column:

```
public void start(Stage stage) {  
    Button b1 = new Button("One");  
    Button b2 = new Button("Two");  
    Button b3 = new Button("Three");  
  
    VBox vPane = new VBox();  
    vPane.getChildren().addAll(b1, b2, b3);  
  
    stage.setScene(new Scene(vPane));  
    stage.show();  
}
```


One vertical column with spacing

A VBox(double spacing) constructor inserts vertical spacing between its children:

```
public void start(Stage stage) {  
    Button b1 = new Button("One");  
    Button b2 = new Button("Two");  
    Button b3 = new Button("Three");  
  
    VBox vPane = new VBox(10);  
    vPane.getChildren().addAll(b1, b2, b3);  
  
    stage.setScene(new Scene(vPane));  
    stage.show();  
}
```

Alignment

By default, children of VBox huddle together in the top left corner of the pane

This default alignment can be changed by calling the VBox method

```
void setAlignment(Pos value)
```

and specifying a Pos enumeration value as parameter

Pos Values

Pos is an enumeration type whose values specify vertical and horizontal alignment of content:

TOP_LEFT	TOP_CENTER	TOP_RIGHT
CENTER_LEFT	CENTER	CENTER_RIGHT
BOTTOM_LEFT	BOTTOM_CENTER	BOTTOM_RIGHT

- ▶ You can set alignment on a pane to CENTER:
 - ▶ `vPane.setAlignment(Pos.CENTER);`
- ▶ The Label class has a similar method for setting alignment of content:
 - ▶ `myLabel.setAlignment(Pos.CENTER);`

Hbox Pane

The Hbox Pane is similar to VBox, except it lays out its children in a single horizontal row:

```
Button b1 = new Button("One");  
Button b2 = new Button("Two");  
Button b3 = new Button("Three");  
  
HBox hPane = new HBox(10);  
hPane.getChildren().addAll(b1, b2, b3);
```

Margin and Padding

- ▶ Margin and Padding are used to achieve spacing and give the UI a pleasing look
- ▶ Margin is the spacing around the outside border of a node
- ▶ Padding is the spacing inside the border of a node: padding surrounds the node's content and sets it off from the node's border

Margin and Padding

- ▶ Margin and Padding are specified by objects of type Insets:
 - ▶ Insets(double top, double right, double bottom, double left)
 - ▶ Insets(double width)

Setting Margin and Padding

- ▶ Pane has method for setting the padding around its content:
 - ▶ `void setPadding(Insets value)`
- ▶ Pane has a static method that sets the margin around a specific child node.
 - ▶ `static void setMargin(Node child, Insets value)`

Effect of Margin, Padding and Alignment

```
HBox hPane = new HBox();  
hPane.getChildren().addAll(b1, b2, b3);  
  
hPane.setPadding(new Insets(10));  
  
HBox.setMargin(b2, new Insets(0, 20, 0, 10));  
  
hPane.setAlignment(Pos.CENTER);
```


Nested Layouts

- ▶ You can achieve the look you want by nesting different types of panes
- ▶ The above UI uses a VBox with center alignment containing a label and a Hbox, also with center alignment

Events and Event Handling

Events and Event Handling

- ▶ An event is an occurrence within a program that requires a response
- ▶ An event handler is an object containing a method that is called to respond to an event
- ▶ Events occur on UI components
- ▶ Event handlers are set on UI components to respond to events that occur on those components

ActionEvent

- ▶ The ActionEvent class describes certain types of events where the user is expecting the program to respond by performing some sort of action
- ▶ An ActionEvent is generated by Button when the user clicks a button
- ▶ An ActionEvent is generated by TextField when the user types ENTER in the text field
- ▶ Handling ActionEvent
- ▶ An event handler for ActionEvent is an object of a class that implements the interface EventHandler
- ▶ This interface has a single abstract method void handle(ActionEvent evt)

Code.

```
class SimpleHandler implements EventHandler<ActionEvent> {  
    public void handle(ActionEvent event) {  
        JOptionPane.showMessageDialog(null, "Hello World!")  
    }  
}
```

Setting an Event Handler on a Component

Here is how to create and set an event handler on a button:

```
public void start(Stage stage) {  
    // Button in HBox  
    Button b1 = new Button("Click Me");  
    HBox hPane = new HBox();  
    hPane.setAlignment(Pos.CENTER);  
    hPane.getChildren().add(b1);  
  
    // Create scene and show on stage  
    stage.setScene(new Scene(hPane));  
    stage.show();  
  
    // Set handler on button  
    b1.setOnAction(new SimpleHandler());  
}
```

Passing Information to Event Handlers

- ▶ Imagine a program that displays a label with a number that starts at 0, together with a button
- ▶ Every time the button is clicked, the number on the label is incremented by 1

Passing Information to an Event Handler

Create the Label and Button.

```
Label label = new Label("0");  
Button button = new Button("Click");
```

- ▶ and add them to a VBox pane
- ▶ Create an event handler class called ClickHandler
- ▶ The click handler object will need access to the label so it can increment. The label will be passed to handler when it is being created: `new ClickHandler(label);`

Passing Information to an Event Handler

```
public void start(Stage stage) {  
    // Create label, button, attach handler to button.  
    Label label = new Label("0");  
    Button button = new Button("Click");  
    button.setOnAction(new ClickHandler(label));  
  
    // Add the label and button to a pane.  
    VBox pane = new VBox(10);  
    pane.setAlignment(Pos.CENTER);  
    pane.getChildren().addAll(label, button);  
  
    // Set up the stage.  
    stage.setScene(new Scene(pane, 200, 80));  
    stage.setTitle("Click Count");  
    stage.show();  
}
```


The ClickHandler Class

The ClickHandler class has a Label field to hold the information passed to its constructor:

```
// Reference to label that will be updated
private Label rLabel;
public ClickHandler(Label cParamLabel) {
    rLabel = cParamLabel;
}
```

The ClickHandler handle() Method

The handle() method has access to the label so it can retrieve the number from the label, increment it, and set it back onto the label:

```
class ClickHandler implements EventHandler<ActionEvent> {  
    private Label rLabel;  
    public ClickHandler(Label cParamLabel) {  
        rLabel = cParamLabel;  
    }  
    @Override  
    public void handle(ActionEvent event) {  
        int count = Integer.parseInt(rLabel.getText());  
        count ++;  
        rLabel.setText(String.valueOf(count));  
    }  
}
```

Inner classes as Event Handlers

- ▶ If you define the handler as a local inner class, it will automatically have access to all local variables that are effectively final
- ▶ Local inner classes are convenient to use as handlers because you do not need to use constructor parameters to pass information
- ▶ Using a separate class for the handler often makes for cleaner and more reusable code

Using an Inner Class as Handler

```
public void start(Stage stage) {  
    // Create label, button, and attach event handler to the button  
    Label label = new Label("0");  
    Button button = new Button("Click");  
  
    // Define an inner class to use as event handler.  
    class ClickHandler implements EventHandler<ActionEvent> {  
        public void handle(ActionEvent event) {  
            int count = Integer.parseInt(label.getText());  
            count++;  
            label.setText(String.valueOf(count));  
        }  
    }  
    // Create a handler based on the inner class and set on the button  
    button.setOnAction(new ClickHandler());  
    // More code ....  
}
```

Anonymous Local Inner Classes

- ▶ In Java, you can create an object of a class that implements an interface without defining the class and giving it a name.
- ▶ Such a class (with no name) is called an anonymous class.
- ▶ You instantiate an object of such a class by specifying the interface, providing definitions for the methods in the interface, and using the new operator to instantiate the object

Code.

```
EventHandler <ActionEvent> handler = null;
handler = new EventHandler<ActionEvent> () {
    public void handle(ActionEvent evt) {
        // handler logic goes here
    }
};
button.setOnAction(handler);
```

Lambda Expressions for Event Handling

You can also use a lambda expression for an event handler

```
EventHandler <ActionEvent> handler = null;  
handler = evt-> {  
    // handler logic goes here  
};  
button.setOnAction(handler);
```

Lambda expressions are short hand for objects of local anonymous inner classes, so any variable accessed by a lambda expression must be effectively final

Lambda Expressions for Event Handling

```
public void start(Stage stage) {  
    // Create label, button  
    Label label = new Label("0");  
    Button button = new Button("Click");  
  
    // Use a lambda expression for the event handler.  
    button.setOnAction(  
        event -> {  
            int count = Integer.parseInt(label.getText());  
            count++;  
            label.setText(String.valueOf(count));  
        });  
    // additional code ....  
}
```

Determining the Target of an Event

The Target of an Event

- ▶ When an event occurs and the event handling method is called, the component on which the event occurred is called the target of the event
- ▶ The `ActionEvent` parameter `evt` passed to the `handle()` method can be used to identify the event target by calling the instance method `evt.getTarget()`

Using a Single Handler on Multiple Components

We often want to use the same handler to respond to the same event on several components of the same type:

```
EventHandler<ActionEvent> handler1= evt -> {  
    // handler logic here  
};  
button1.setAction(handler1);  
button2.setAction(handler1);
```

When button1 is clicked and handler1's handle() with parameter evt, then evt.getTarget() will return a reference to button1. Similarly for button2. Thus the handle() method can distinguish which button is "calling".

The EventTarget Interface

- ▶ Any component that can generate an event implements the EventTarget interface
- ▶ The evt.getTarget() method returns a reference to EventTarget:

Code.

```
EventTarget getTarget()
```

Typical use of getTarget() casts the returned object to a known class type, for example

```
public void handle(ActionEvent evt) {  
    Button b = (Button) evt.getTarget();  
    // Use b  
}
```

Determining the Event Target

- ▶ Consider a JavaFX program that displays two buttons on a stage
- ▶ The title of the stage is the text of whichever button was last clicked

The Event Target Program

```
public void start(Stage stage) {  
    Button button1 = new Button("One");  
    Button button2 = new Button("Two");  
  
    // Create the event handler using a lambda expression.  
    EventHandler<ActionEvent> handler = event -> {  
        Button clickedButton = (Button) event.getTarget();  
        String newTitle = clickedButton.getText();  
        // set the new stage title.  
        stage.setTitle(newTitle);  
    };  
  
    // Set the same event handler to BOTH buttons.  
    button1.setOnAction(handler);  
    button2.setOnAction(handler);  
    // More code ...  
}
```

Radio Buttons

Radio Buttons

- ▶ Radio buttons are used to select a single option from a group of choices
- ▶ A radio button becomes selected when it is clicked on
- ▶ Radio buttons are typically used in groups, with each radio button corresponding to a single choice in an associated group of choices
- ▶ An object called a toggle group is used to manage the radio buttons in a single group, ensuring that at most one of them is selected at any time

RadioButton Constructors and Methods

- ▶ `RadioButton()`
- ▶ `RadioButton(String text)`
- ▶ `boolean isSelected()`
- ▶ `void setSelected(boolean value)`
- ▶ `void setToggleGroup(ToggleGroup value)`

Programming with Radio Buttons

- ▶ Consider a program that allows the user to select one of a group of choices and click a button to display the currently selected choice in a label Radio Button Demo Program
- ▶ First, create a VBox with a gray border. This will be used to hold the radio buttons. The gray border is a visual cue that the radio buttons form a group:

Code.

```
// Vertical Box to hold the radio buttons.  
VBox radiosBox = new VBox(10);  
radiosBox.setPadding(new Insets(10, 10, 10, 10));  
// Set a gray border around the radio button box.  
radiosBox.setStyle("-fx-border-color: gray;");
```

Radio Button Demo Program

Create an array of strings to use as text for the radio buttons, create a toggle group object, and then create an array of radio buttons:

```
String [] optionLabels =  
    {"Walk", "Drive", "Take Public Transportation"};  
  
// Create a toggle group, and the array of radioButtons  
ToggleGroup radiosGroup = new ToggleGroup();  
RadioButton [] radioButtons =  
    new RadioButton[optionLabels.length];  
  
for (int k = 0; k < radioButtons.length; k++) {  
    radioButtons[k] = new RadioButton(optionLabels[k]);  
    radioButtons[k].setToggleGroup(radiosGroup);  
}
```

Radio Button Demo Program

Add the radio buttons to the VBox and select the first radio button

```
radiosBox.getChildren().addAll(radioButtons);  
radioButtons[0].setSelected(true);
```

Construct the top-level box that will be the root of the scene graph

```
VBox topLevelBox = new VBox(10);  
topLevelBox.setAlignment(Pos.CENTER);  
topLevelBox.setPadding(new Insets(10,50,10,50));
```

The Radio Demo Program

Create the show selection Button and the label to display the selected option and add them to the top-level box

```
Button showSelectionButton =  
    new Button("Show Selection");  
Label selectionLabel = new Label();  
topLevelBox.getChildren().  
    addAll(radiosBox, showSelectionButton,  
        selectionLabel);
```

Radio Button Demo Program

Finally, create an event handler for the button. The handler determines the selected radio button and sets its text as the text of the selection label

```
// Set the handler for the show selection button.  
EventHandler<ActionEvent> handler = event -> {  
    for (RadioButton rb : radioButtons) {  
        if (rb.isSelected()) {  
            selectionLabel.setText(rb.getText());  
            return;  
        }  
    }  
};  
showSelectionButton.setOnAction(handler);
```

Check Boxes

- ▶ Check boxes are used to select any number of options from a group of options
- ▶ Programming with check boxes is like programming with radio buttons, except you do not need to use a toggle group

Displaying Images and Inputting Text

Displaying Images

- ▶ Using images requires the use of the Image and ImageView classes
- ▶ Image is used to create an in-memory representation of an image.
- ▶ The image may be in an InputStream object, or may be in a location online (specified by a URL string), or on the local file system (specified by a pathname string)
- ▶ An Image object is not a JavaFX node, so cannot be displayed on the screen
- ▶ ImageView is a subclass of Node: it is used to wrap Image objects for screen display

The Image Class and ImageView Classes

- ▶ `Image(InputStream stream)`: This constructor creates an image from an input stream, for example
 - ▶ `new Image(new FileInputStream("bobross.jpg"));`
- ▶ `Image(String location)`: Creates an image by fetching content from a local file system location or from a URL, for example
 - ▶ `new Image("c:\\temp\\images\\tiger.jpg");`
- ▶ `ImageView(Image image)`: Creates an `ImageView` object by wrapping an in-memory `Image`
- ▶ `ImageView(String location)`: Fetches content from the given location, internally creates an `Image` object, and wraps it.
- ▶ `ImageView()`: creates an `ImageView` object without an `Image`. The image can be set with the `setImage(Image im)` method.

The TextField Control

- ▶ The TextField control allows the user to enter a single line of input
- ▶ You can create TextField objects using the following constructors
 - ▶ `TextField()`
 - ▶ `TextField(String text)`

TextField Methods

- ▶ `void setText(String text)`
- ▶ `String getText()`
- ▶ `void setEditable(boolean value)`
- ▶ `boolean isEditable()`
- ▶ `void clear()`
- ▶ `void setPrefColumnCount(int count)`

Working With TextField Controls

- ▶ Most of the time, we want to process the content of the TextField only after the user presses the ENTER key, and not after every character typed
- ▶ When the user types ENTER, the text field will fire an `ActionEvent`
- ▶ We can handle these events by setting an `ActionEvent` handler on the text field:

Code.

```
EventHandler<ActionEvent> handler = ...;  
myTextField.setOnAction(handler)
```

TextField Demo Program

- ▶ This program allows a user to enter an integer in one text field, and it displays the square in a second (uneditable) text field
- ▶ The user interface uses a couple of labels to identify the purpose of the text fields to the user

TextField Demo Program

Create the two labels and the two text fields

```
// Create labels for the user interface.  
Label inputLabel = new Label("Number: ");  
Label outputLabel = new Label("Square of Number: ");  
  
// Create the text fields for the user interface.  
TextField inputTextField = new TextField();  
TextField outputTextField = new TextField();  
inputTextField.setPrefColumnCount(4);  
outputTextField.setPrefColumnCount(4);  
outputTextField.setEditable(false);
```


TextField Demo Program

Create the event handler and set it on the input text field:

```
EventHandler<ActionEvent> handler = event ->
{
    // Get Number from input text field.
    String inputText = inputTextField.getText().trim();
    int number = Integer.parseInt(inputText);

    // Write the square to the output text field.
    int square = number*number;
    outputTextField.setText(String.valueOf(square));
};
// Set the handler on the input text field
inputTextField.setOnAction(handler);
```