Event-Driven Programming with GUIs

- Slides derived (or copied) from slides created by Rick Mercer for CSc 335

Event Driven GUIs

- A Graphical User Interface (GUI) presents a graphical view of an application to users
- To build an event-driven GUI application, you must:
  - Have a well-tested model that is independent of the view
  - Make graphical components visible to the user
  - Ensure the correct things happen for each event
    - user clicks a button, or moves the mouse, or presses the enter key, ...
- Let's first consider some of Java's GUI components:
  - Pane, Button, Label, TextField

Graphical Components in JavaFX:

- JavaFX has many graphical components

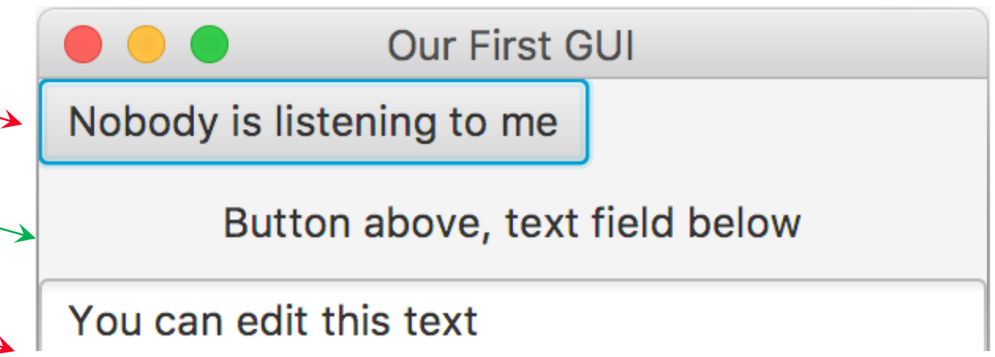
Stage: window with title, border, menu, buttons

BorderPane: where we can add Buttons, Labels, … (inside the Scene)

Button: A component that can "clicked"

Label: A display area for a small amount of text

TextField: Allows editing of a single line of text



Get the app to show itself

```
// Show an empty stage with no components in it
public class FirstApp extends Application {

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

  @Override
  public void start(Stage stage) throws Exception {
    stage.setTitle("Our First GUI");
    BorderPane window = new BorderPane();
    Scene scene = new Scene(window, 300, 90); // 300 pixels wide, 90 tall
    stage.setScene(scene);
    //  Don't forget to show the running app:
    stage.show();
  }
```

The main entry point for all JavaFX apps

The top level JavaFX container.

One of many Pane Types

The container for all content

Add some components:

- So far we have an empty stage
- Let us add a Button, a Label, and a one line Editor (TextField)
- First construct three graphical components

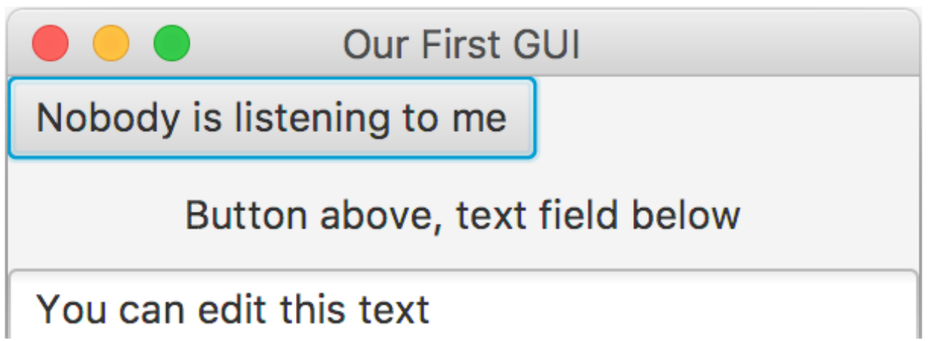
```
// Three different UI controls as instance variables
private Button button = new Button("Nobody is listening to me");
private Label label = new Label("Button above, text field below");
private TextField textField = new TextField("You can edit this text");
```

- Need to add these objects to the BorderPane referenced by window

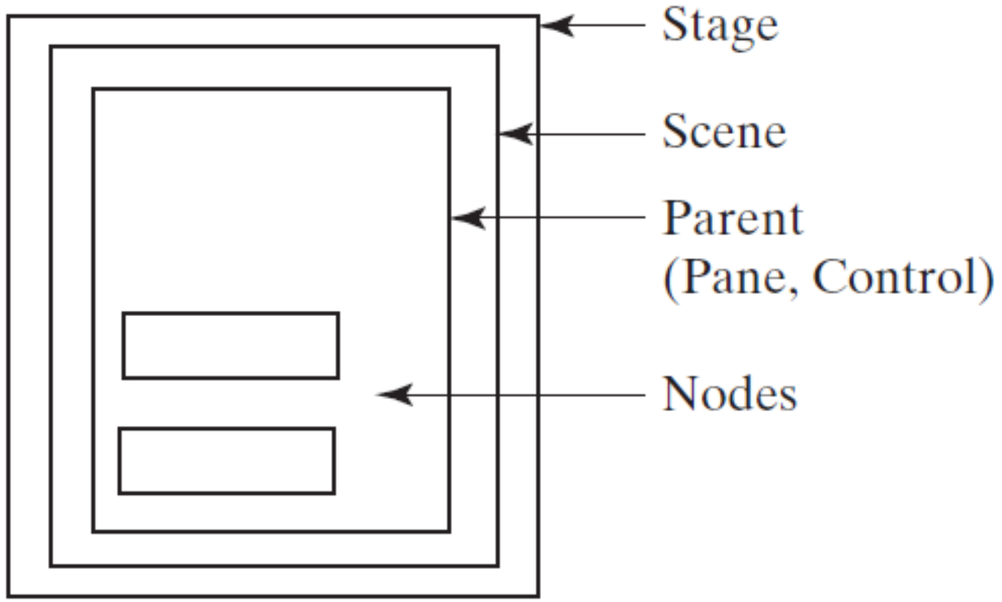
Components are nodes in a graph:

- Add three components to the BorderPane as Node objects

```
window.setTop(button);
window.setCenter(label);
window.setBottom(textField);
```



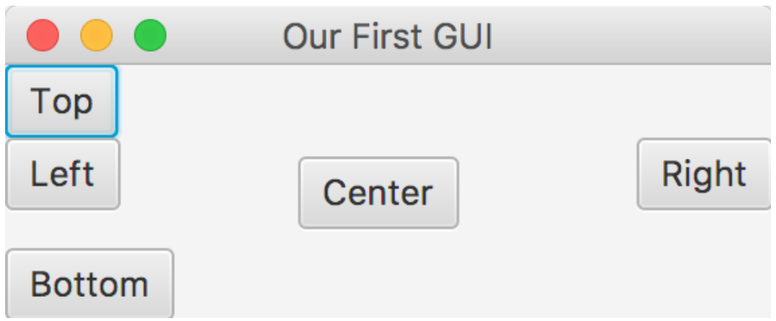
- In addition to the 3 message above, we can
  - setLeft(Node)
  - setRight(Node)
- The Node objects are in a Pane object
  - These nodes are children of the Pane
- The Pane is in a Scene object
- The Scene is in the Stage object



The 5 areas of BorderPane:

- By default, **`BorderPane`** objects have only five places where you can add components
  - a 2nd add wipes out the 1st

```
window.setTop(new Button("Top"));
window.setLeft(new Button("Left"));
window.setCenter(new Button("Center"));
window.setRight(new Button("Right"));
window.setBottom(new Button("Bottom"));
```



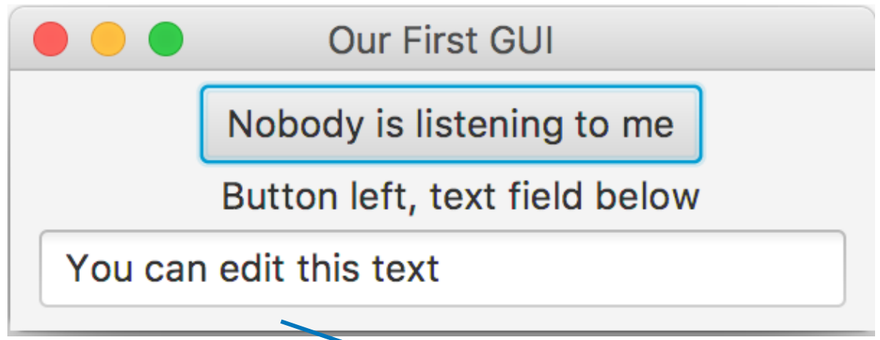
- BTW: There is no padding or locating Nodes here
  - The layout looks odd

There are many Panes with layout strategies:

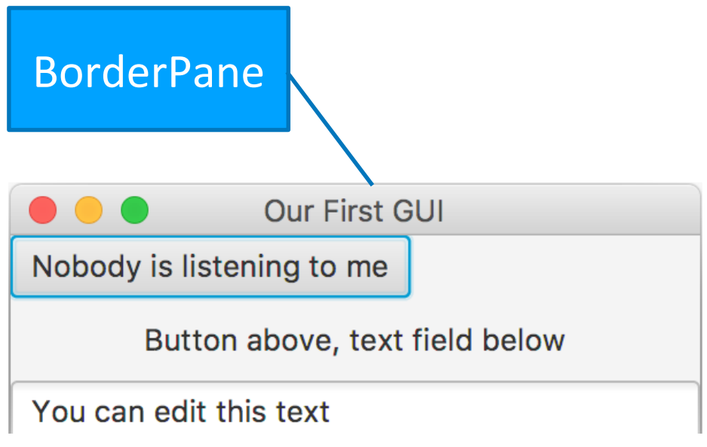
Pane Class	Strategy
BorderPane	Areas for top, bottom, left, right, center
HBox, VBox	Lines up children horizontally or vertically
GridPane	Layout children in a table like grid
TilePane	Layout children in a grid, all the same size
FlowPane	Layout children left to right, top to bottom
AnchorPane	Children are positioned in relative position to the Pane's boundary
StackPane	Wraps children inside others, used to decorate such as putting a button over a a colored rectangle

AnchorPane:

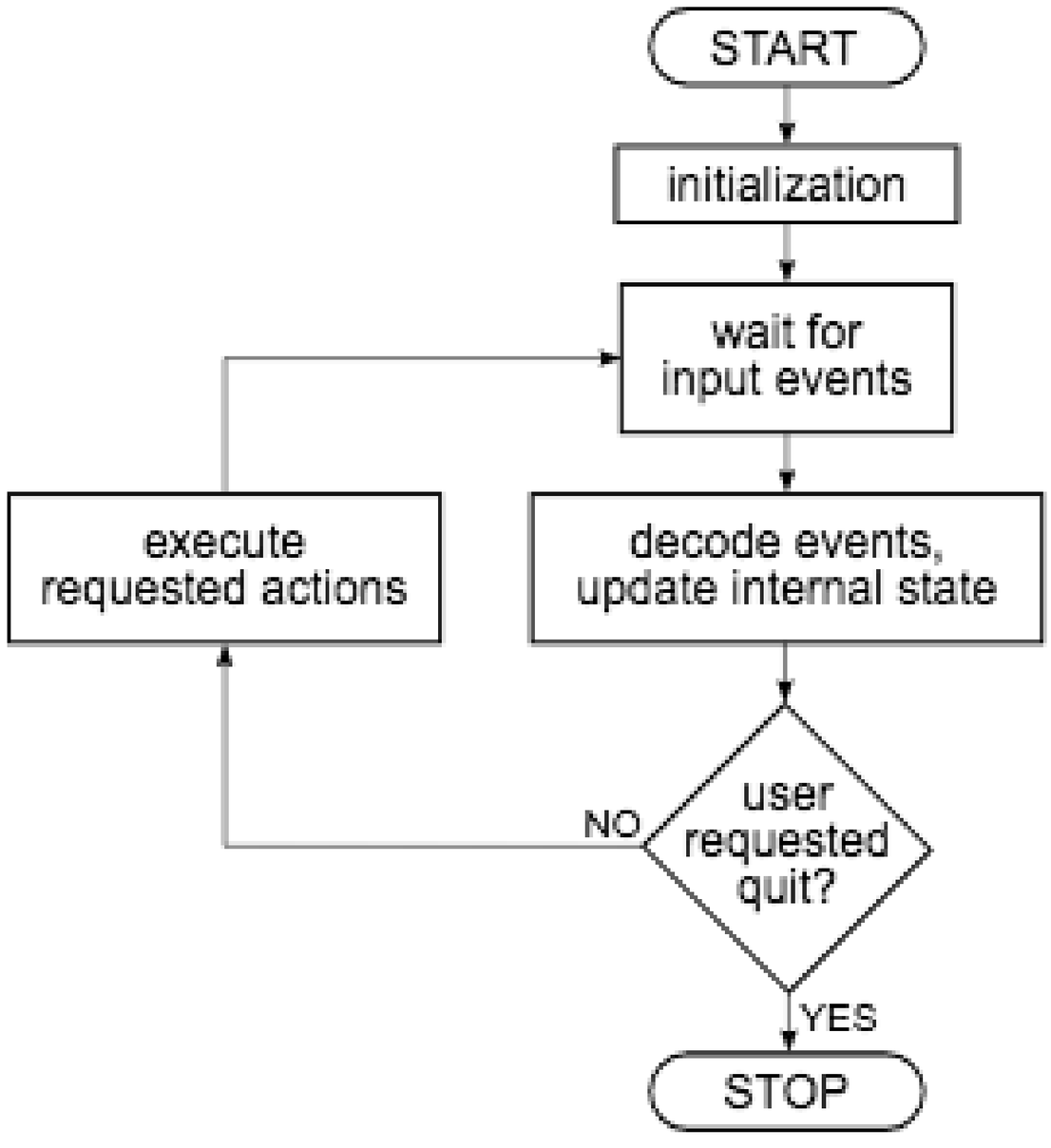
- You can change the layout strategy with a different class of Pane
- With AnchorPane, we can position children
  - specific number of pixels down from top of Pane
  - specific number of pixels from the right of the Pane



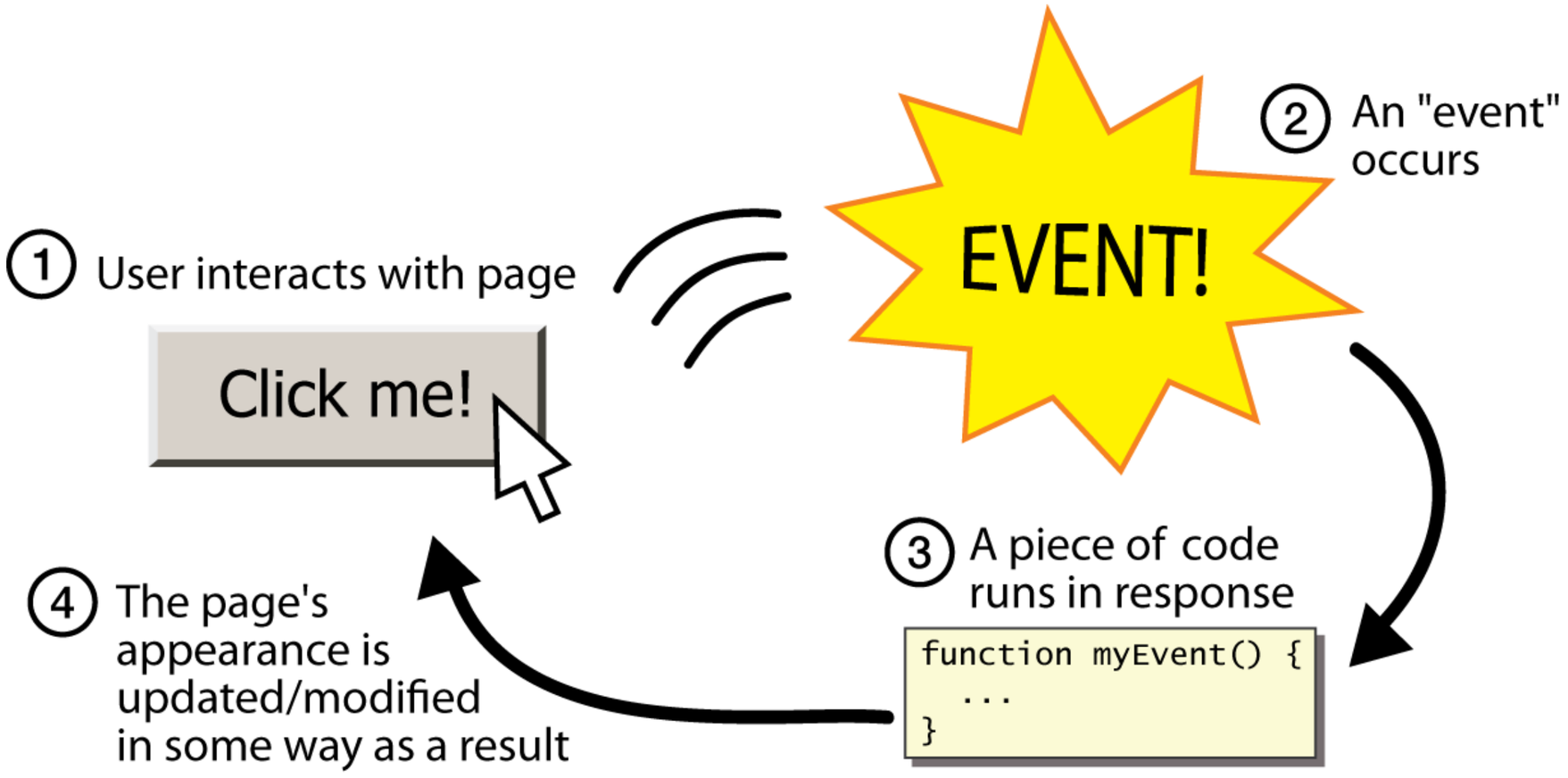

```
AnchorPane window = new AnchorPane();
AnchorPane.setTopAnchor(button, 5.0);
AnchorPane.setRightAnchor(button, 60.0);
AnchorPane.setTopAnchor(label, 35.0);
AnchorPane.setRightAnchor(label, 60.0);
textField.setPrefWidth(280);
AnchorPane.setRightAnchor(textField, 10.0);
AnchorPane.setTopAnchor(textField, 55.0);
```



Event-Driven programming:



Event-Driven programming:



Event-Driven programming?

- A style of coding where a program's overall flow of execution is dictated by events
- The program loads
- The program waits for the user to generate input
- Each event causes some particular code to respond
- Need an event handler
- The overall flow of what code is determined by the user generating a series of events

What is Event-Driven programming?

- Contrast with application- or algorithm-driven control where program expects input data in a pre-determined order and timing
- Event-driven is a different programming paradigm
  - Procedural (C)
  - Object-Oriented (Java, Python)
  - Event-driven (Java, Javascript)
  - Declarative (SQL in 337 and 460)
  - Functional (ML in 372)
  - Logic (Prolog in 372)

There are many kinds of Events

- Different events that can occur in an event-driven program with a GUI
  - Mouse move/drag/click, mouse button press/release
  - Keyboard: key press/release
  - Touchscreen finger tap/drag
  - Joystick, drawing tablet, other device inputs
  - Window resize/minimize/restore/close
  - Network activity or file I/O (start, done, error)
  - Timer interrupt
  - Move a scroll bar
  - Chose a menu selection
  - Media finishes

Java's Event Model

- Java and the operating system work together to detect user interaction
  - **Button** objects are notified when clicked
    - Send a **`handle(ActionEvent)`** message to registered ActionEvent handlers
  - **TextField** objects are notified when the user presses Enter
    - A **`handle(ActionEvent)`** message is sent to registered event handlers
- When the mouse is clicked, the node under the curser is notified
  - Send a **`handle(MouseEvent)`** message to registered Mouse event handlers
- When a key is pressed
  - Send a **`handle(KeyEvent)`** message to registered KeyEvent handlers

Example: ActionEvent

- The button and textField do not yet perform any action
- Let's make something happen when
  - The **button** is clicked
  - The user presses enters into the **textField**

How to Handle Events

- Add a private inner class that will handle the event that the component generates
  - This class must implement an interface to guarantee that it has the expected method such as

```
public void handle(ActionEvent ae)
```

- Register the event handler so the component can later send the correct message to that event handler
- Events occur anytime in the future--the event handler is waiting for user generated events such as clicking button
- Send this message to the GUI component:

```
button.setOnAction(handler)
```

Inner Classes:

- An ***inner class*** is a class defined within another class.
- Inner class methods can access the data from the scope in which they are defined.
- Inner classes can be hidden from other classes in the same package.

Event 1: Add Event to Handle a button press

- Must add a class that implements **`EventHandler<ActionEvent>`.**

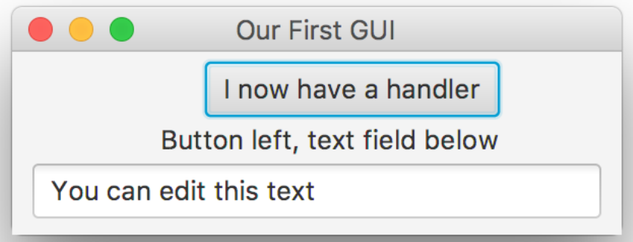
```
 EventHandler<ActionEvent> handler = new ButtonHandler();
  button.setOnAction(handler);
  stage.show();
}

private class ButtonHandler implements EventHandler<ActionEvent> {
  private int timesClicked;
  public ButtonHandler() {
    timesClicked = 0;
  }

  @Override
  public void handle(ActionEvent arg0) {
    button.setText("I now have a handler");
    timesClicked++;
    System.out.println("The button was clicked " + timesClicked +
                       " times");
    button.setText("I now have a handler");
  }
}
```

Run this program

```
43      EventHandler<ActionEvent> handler = new ButtonHandler();
44      button.setOnAction(handler);
45      stage.show();
46    }
47
48    private class ButtonHandler implements EventHandler<ActionEvent> {
49      private int timesClicked = 0;
50
51      @Override
52      public void handle(ActionEvent arg0) {
53        System.out.println(arg0.toString());
54        timesClicked++;
55        System.out.println("The button was clicked " + timesClicked + " times");
56        button.setText("I now have a handler");
57      }
58    }
```



Problems @ Javadoc Declaration Search Console Tasks Coverage

FirstApp [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_74.jdk/Contents/Home/bin/java (Jun 15, 2017, 9:20:48 PM)

```
javafx.event.ActionEvent[source=Button@23a49aa3[styleClass=button]'Nobody is listening to me']
The button was clicked 1 times
javafx.event.ActionEvent[source=Button@23a49aa3[styleClass=button]'I now have a handler']
The button was clicked 2 times
javafx.event.ActionEvent[source=Button@23a49aa3[styleClass=button]'I now have a handler']
The button was clicked 3 times
```

Event 2: Handle TextField Event:

- Must add another class that implements **`EventHandler<ActionEvent>`.**

```
    EventHandler<ActionEvent> handler2 = new TextFieldHandler();
    textField.setOnAction(handler2);
    stage.show();
   }

 private class TextFieldHandler implements EventHandler<ActionEvent> {

    private int enterPressed = 1;

    @Override
    public void handle(ActionEvent arg0) {
      enterPressed++;
      String text = textField.getText();
         if (enterPressed % 2 == 0)
        textField.setText(text.toUpperCase());
         else
        textField.setText(text.toLowerCase());
    }
 }
```

Run this Program:

```
44      EventHandler<ActionEvent> handler2 = new TextFieldHandler();
45      textField.setOnAction(handler2);
46      stage.show();
47    }
48
49    private class TextFieldHandler implements EventHandler<ActionEvent> {
50      private int enterPressed = 1;
51      @Override
52      public void handle(ActionEvent arg0) {
53        enterPressed++;
54        String text = textField.getText();
55        if (enterPressed % 2 == 0)
56          textField.setText(text.toUpperCase());
57        else
58          textField.setText(text.toLowerCase());
59      }
60    }
```