P3. USER INTERACTION

Interfaces Persona Computador

Depto. Sistemas Informáticos y Computación

UPV

Outline

- Introduction to JavaFX Events (*Event Handlers*)
- Convenience Methods
- Events and Event Handlers in FXML
- Observer Design Pattern
- Properties
- Binding

Introduction

- Buttons and menus
- Selectors, switches, sliders, etc.
- Item selection in lists, tables, etc.
- Gestures in touch devices
- …

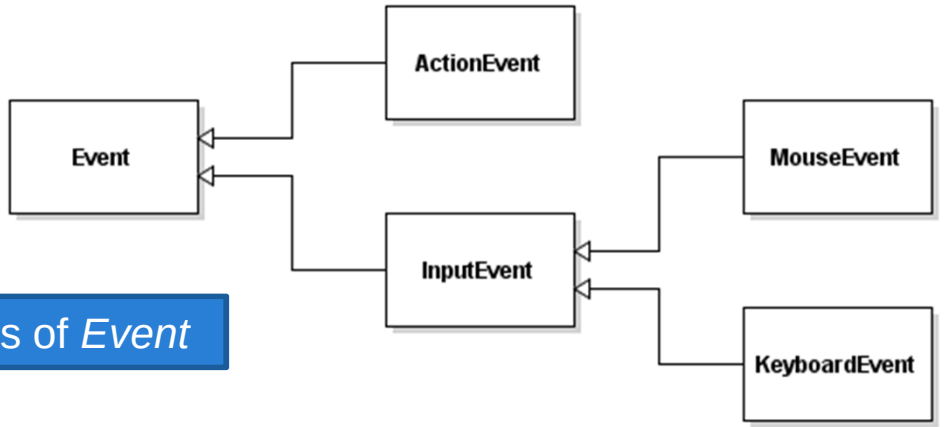
What do they all have in common?

Event-driven Interaction

- Event = notification that something happened.
  - Events are generated when the user clicks a button, presses a key, moves the mouse or performs other actions
- Event Handler: method that specify what to do when a given event is received

Events

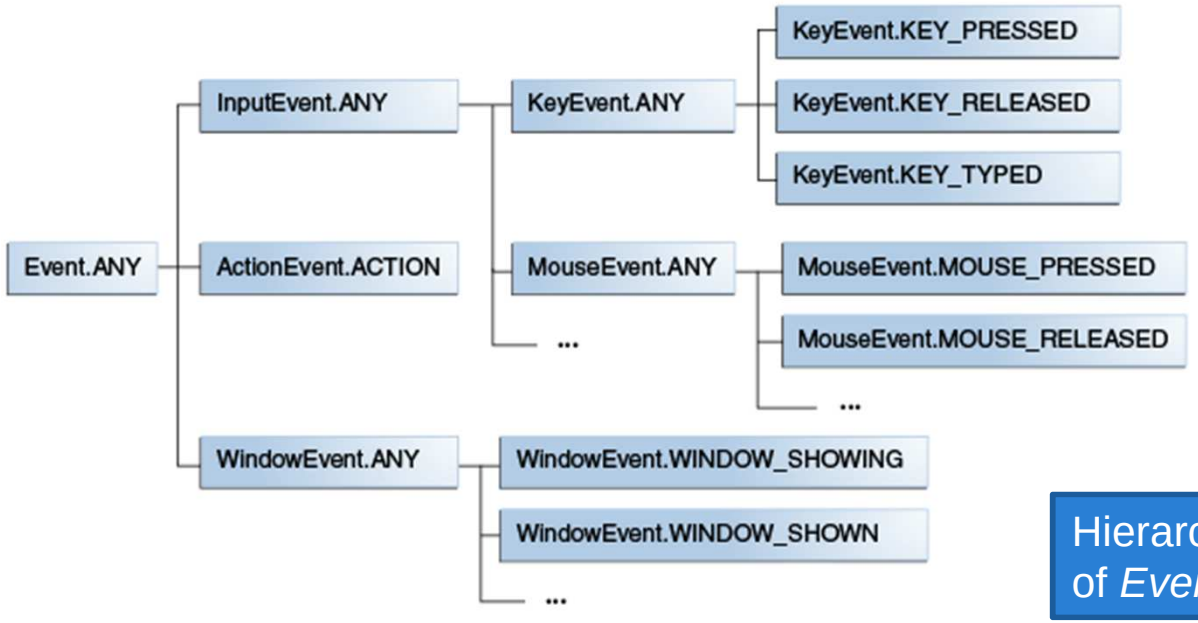
- All events inherit from the class *Event*
- The most important attributes of class Event are:
  - ***eventType***: an object of type *EventType*.
  - ***source***: the object who fired the event (for example, a button can be the source of an *ActionEvent*, that fires whenever the button is clicked)
- The Event class has several subclasses. Each subclass has specific attributes. For example, a *MouseEvent* contains the window coordinates (x, y) of the position of the mouse cursor when the event was fired



Some subclasses of *Event*

Event Types

- Each subclass of Event defines one or more instances of the class *EventType*
- The class *EventType* has an attribute called *superType*, of the same class, that defines a hierarchy of objects, as shown in the following figure



Hierarchy of instances of *EventType*

Event Handlers

- JavaFX components generate events when the user interact with them. We can register handlers that will be notified whenever an event of a particular type is fired
  - Using the method *addEventHandler* from the *Node* class

    ```
    void addEventHandler(EventType<T> eventType,
        EventHandler<? super T> eventHandler)
    ```

  - Or using a *convenience method* defined in the control class

    `setOn`*`EventType`*`(EventHandler<? super T> eventHandler)`
- A handler must implement the *EventHandler<T extends Event>* interface, that declares a single method:

  `void handle(T event);` method executed when a event that matches the desired event type is fired

Convenience Methods

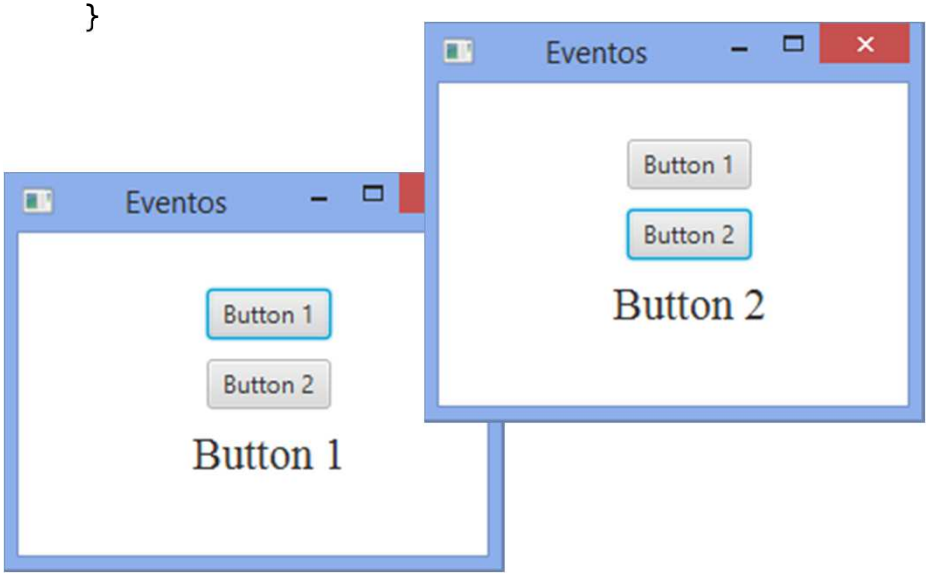
- ActionEvent
  - `setOnAction(EventHandler<ActionEvent> value)`
- KeyEvent
  - `setOnKeyTyped(EventHandler<KeyEvent> value)`
  - `setOnKeyPressed(…)`
  - `setOnKeyReleased(…)`
- MouseEvent
  - `setOnMouseClicked(EventHandler<MouseEvent> value)`
  - `setOnMouseEntered(…)`
  - `setOnMouseExited(…)`
  - `setOnMousePressed(…)`

Learn more at: http://docs.oracle.com/javafx/2/events/convenience_methods.htm

Example

```
public class EventHandlerSample1
                    extends Application {
 Label label;
  @Override
 public void start(Stage stage) {
    // Create the controls
    label = new Label();
    label.setFont(Font.font("Times New Roman", 22));
    Button button1 = new Button("Button 1");
    Button button2 = new Button("Button 2");
 // Create a container and insert the controls
     VBox vbox = new VBox();
     vbox.setAlignment(Pos.CENTER);
     vbox.setSpacing(10);
     vbox.getChildren().add(button1);
     vbox.getChildren().add(button2);
     vbox.getChildren().add(label);
 // Create the scene
     Scene scene = new Scene(vbox, 250, 200);
```

```
// Setting stage properties
    stage.setTitle("Eventos");
// Setting the scene and showing the stage
    stage.setScene(scene);
    stage.show();
 }
 public static void main(String[] args) {
        launch(args);
    }
}
```



Adding Handlers

Inner Classes

```
@Override
 public void start(Stage stage) {
    …
button1.addEventHandler(ActionEvent.ACTION,
    new button1ActionHandler());
    …
 }

 class Button1ActionHandler implements
              EventHandler<ActionEvent> {
  @Override
  public void handle(ActionEvent event) {
    label.setText("Button 1");
  }
}
```

Anonymous Classes

```
button1.addEventHandler(ActionEvent.ACTION,
       new EventHandler<ActionEvent>() {
  @Override
  public void handle(ActionEvent event) {
    label.setText("Button 1");
  }
});
```

Lambda functions

```
button1.setOnAction((ActionEvent e) -> {
  label.setText("Button 1");
});
```

Extended example

Mouse events
MouseEvent.MOUSE_ENTERED
MouseEvent.MOUSE_EXITED

```
DropShadow shadow = new DropShadow();
button2.addEventHandler(MouseEvent.MOUSE_ENTERED, (MouseEvent e) -> {
  button2.setEffect(shadow);
});

button2.addEventHandler(MouseEvent.MOUSE_EXITED, (MouseEvent e) -> {
  button2.setEffect(null);
});

scene.setOnKeyPressed((KeyEvent ke) -> {
  if (ke.getCode() == KeyCode.ESCAPE) {
    stage.close();
  }
});
```

Key event handler registered using a convenience method
`KeyEvent.KEY_PRESSED`

Reference to Methods as Event Handlers

```
@Override
  public void start(Stage stage) {
...
      button1.setId("B1");
      button2.setId("B2");
      button1.setOnAction((ActionEvent e) -> buttonClicked(e));
      button2.setOnAction(this::buttonClicked);
       …
}
```

Alternative syntax (method reference)

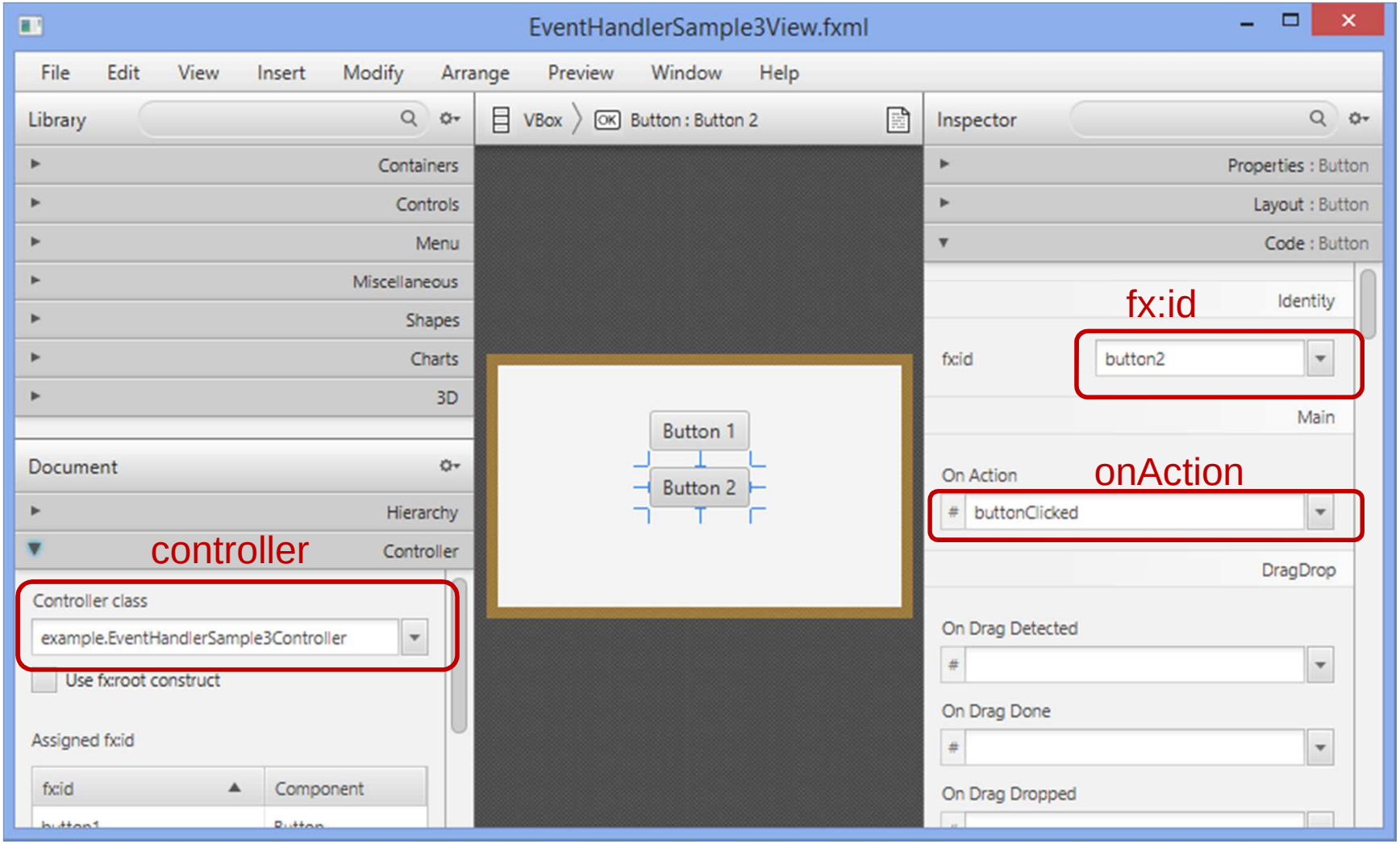
Event handler defined in a separated method

```
void buttonClicked(ActionEvent event) {
  Button button = (Button) event.getSource();
  String id = button.getId();
  label.setText(button.getText() + " (" + id +")");
}
```

Using ids to identify the source of the event

```
void buttonClicked(ActionEvent event) {
      String id = ((Node) event.getSource()).getId();
      if (id.equals("B1")) {
         label.setText("Button 1");
      } else {
         label.setText("Button 2");
      } }
```

Events in SceneBuilder



Example: FXML + Controller

```
<VBox alignment="CENTER" prefHeight="150.0" prefWidth="250.0" spacing="10.0"
xmlns="http://javafx.com/javafx/8.0.65" xmlns:fx="http://javafx.com/fxml/1"
fx:controller="example.EventHandlerSample3Controller">
   <children>
      <Button fx:id="button1" mnemonicParsing="false" onAction="#buttonClicked"
text="Button 1" />
      <Button fx:id="button2" mnemonicParsing="false" onAction="#buttonClicked"
onMouseEntered="#mouseEntered" onMouseExited="#mouseExited" text="Button 2" />
      <Label fx:id="label">
         <font>
            <Font name="Times New Roman" size="22.0" />
         </font>
      </Label>
   </children>
</VBox>
```

Example: FXML + Controller

```
public class EventHandlerSample3Controller {
 @FXML
 private Button button1;
 @FXML
 private Button button2;
 @FXML
 private Label label;
 private static final DropShadow shadow =
                              new DropShadow();

 @FXML
 void buttonClicked(ActionEvent event) {
   String id = ((Node) event.getSource()).
                                     getId();
   if (id.equals("button1")) {
     label.setText("Button 1");
   } else {
     label.setText("Button 2");
   }
 }
```

```
 @FXML
 void mouseEntered(MouseEvent event) {
    button2.setEffect(shadow);
 }

 @FXML
 void mouseExited(MouseEvent event) {
   button2.setEffect(null);
 }
}
```

JavaBeans and Properties

- In OOP, a **property** is a means of encapsulating information with a standard interface for providing access:
  - Public access methods for reading and writing named *get/set* + *PropertyName*
- The Java language does not include the concept of property, but it is the foundation for the specification of ***JavaBeans***

```
public class Node {
    private String id;

    public String getId() {
        return id;
    }
    public void setId(String value) {
        id = value;
    }
}
```

Example of Java class following the JavaBeans conventions

JavaFX Properties

- A JavaFX property is a type of object that wraps or encapsulates another object (*wrapper* design patern), adding functionality
- JavaFX classes containing properties follow the JavaBeans standard, plus a third method that returns the property (and not its value)

```
public class Node {
    private StringProperty id = new SimpleStringProperty();
    public int getId() {
        return id.get();
    }
     public void setId(String value) {
        id.set(value);
    }
     public StringProperty idProperty() {
        return id;
    }
}
```

Using properties in JavaFX components

JavaFX Properties

- We can create a property wrapping any class, but JavaFX defines property classes for all primitive types, strings and collections

  `StringProperty`

  `IntegerProperty`

  `DoubleProperty`

  `BooleanProperty`

- For generic objects JavaFX provides:

  `ObjectProperty<T>`

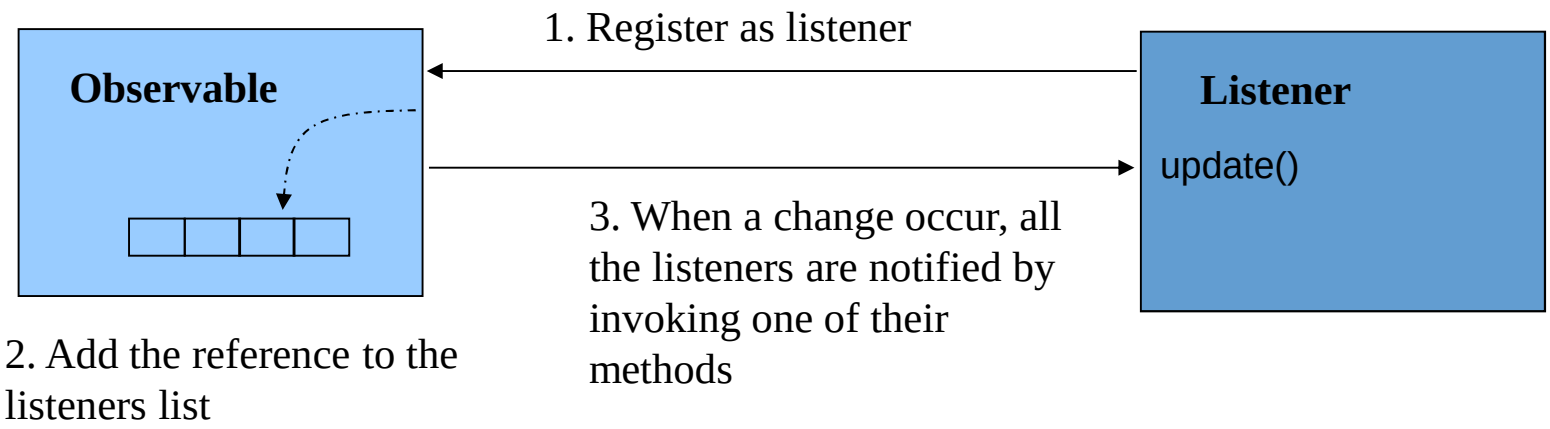
- And for collections:

  `ListProperty`

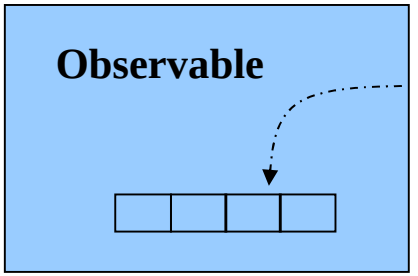
  `MapProperty`

Listening to Changes in Properties: Observer Pattern

- Dependency one-to-many between objects: when an object (source or observable object) change its state, the depending objects (listeners) are notified



Observable objects



- Implements the ObservableValue<T> interface
  - T is type of value to be “observed”
  - The interface specify 3 methods:

`void addListener(ChangeListener<? super T> listener)`

registers a new listener, who will be notified whenever the observed value changes

`void removeListener(ChangeListener<? super T> listener)`

removes from the listeners list the given listener

`T getValue()` returns the current value of the observable object

Listeners

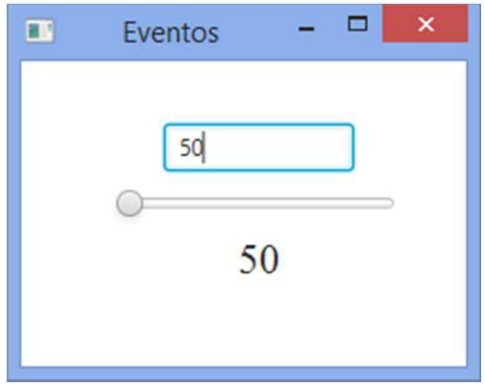
Listener

- Implements the ChangeListener<T> interface, where T is the class of the observed value
  - Defines a single method:

```
changed(ObservableValue<? extends T> observable, T oldValue, T newValue)
```

- Many JavaFX controls contain some attribute that inherits from Property<T>, that inherits from ObservableValue<T>, and therefore they accept listeners (ChangeListener<T>)
  - We can register an object as a listener with a changed method that will be executed whenever the value of the property changes

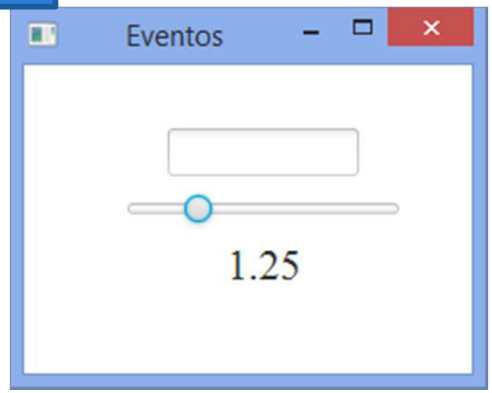
Ejemplo TextField y Slider




```
public void initialize(URL url, ResourceBundle rb) {
 textField.textProperty().addListener(
  new ChangeListener<String>() {
    @Override
    public void changed(ObservableValue<? extends String> observable,
             String oldValue, String newValue) {
        label.setText(newValue);
    }
 });
 slider.valueProperty().addListener((observable, oldVal, newVal) ->
     { label.setText(newVal + "");
 });
```

TextField listener (anonymous class)

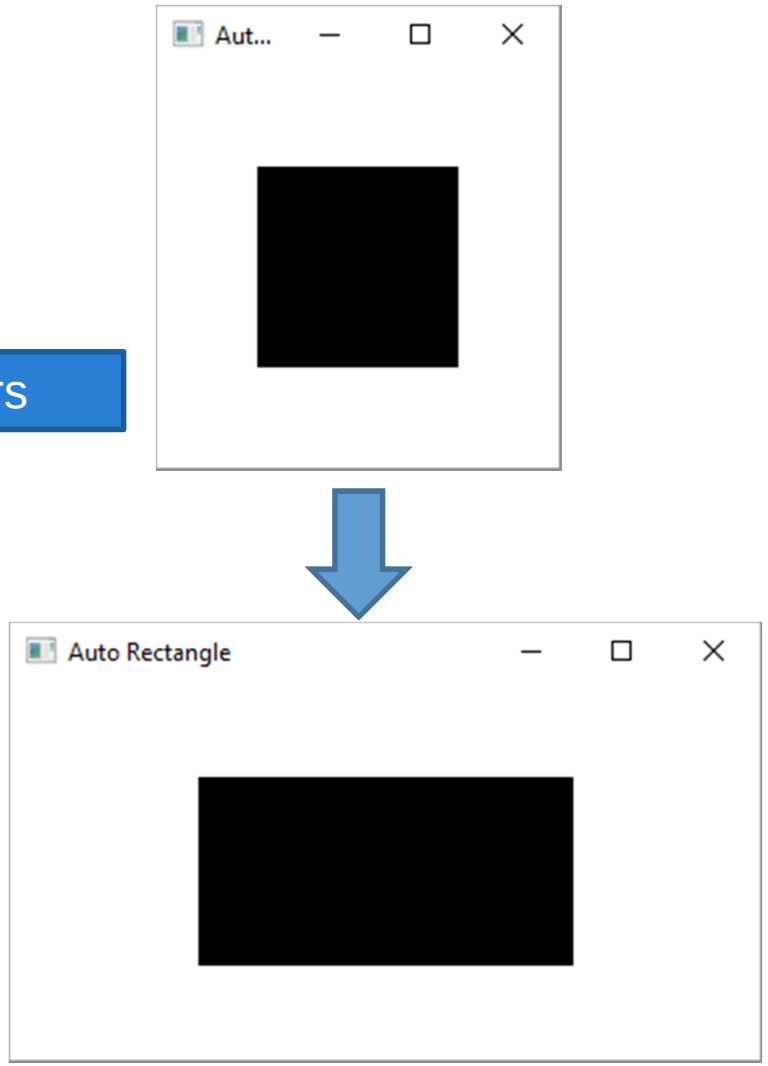
Slider listener (lambda function)



Example: Elastic Rectangle

```
public void start(Stage primaryStage) {
  Rectangle r = new Rectangle(100,100);
  StackPane p = new StackPane();
  p.setPrefWidth(200);
  p.setPrefHeight(200);
  p.getChildren().add(r);
  p.widthProperty().addListener(
    (observable, oldvalue, newvalue) ->
         r.setWidth((Double)newvalue/2)
  );
  p.heightProperty().addListener(
    (observable, oldvalue, newvalue) ->
          r.setHeight((Double)newvalue/2)
  );
  Scene scene = new Scene(p);
  primaryStage.setScene(scene);
  primaryStage.setTitle("Auto Rectangle");
  primaryStage.show();
}
```

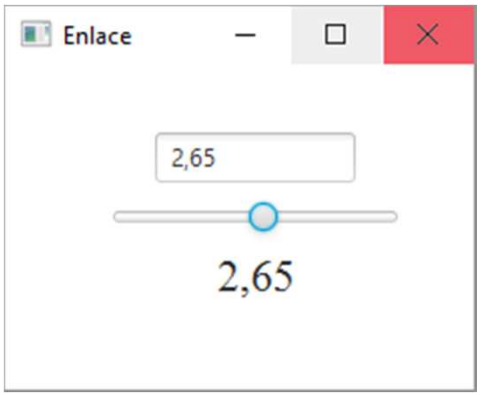
Listeners



Binding

- Unidirectional binding: if p1 is bound unidirectionally to p2, p1 will always take p2's value
  - `p1.bind(p2);`
  - Trying to manually change p1 throws an exception
- Bidirectional binding: changes in a property are propagated to the other
  - `p1.bindBidirectional(p2);`
- Bindings are created with the methods *bind/ bindBidirectional* and deleted with *unbind/ unbindBidirectional*.

Example: *TextField* and *Slider*




```
Label label = new Label();
label.setFont(Font.font("Times New Roman", 22));
TextField textField = new TextField();
textField.setMaxWidth(100);
Slider slider = new Slider(0, 5, 0);
slider.setBlockIncrement(0.5);
slider.setMaxWidth(150);
label.textProperty().bind(textField.textProperty());
textField.textProperty().bindBidirectional(
        slider.valueProperty(), new NumberStringConverter());
```

Unidirectional binding

Bidirectional binding

Converting from Number to String

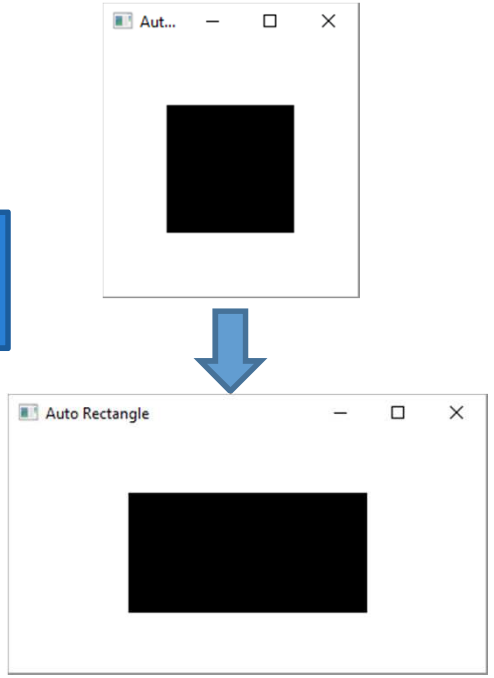
```
// label.textProperty().bind(Bindings.format("%.2f", slider.valueProperty()));
```

Bindings

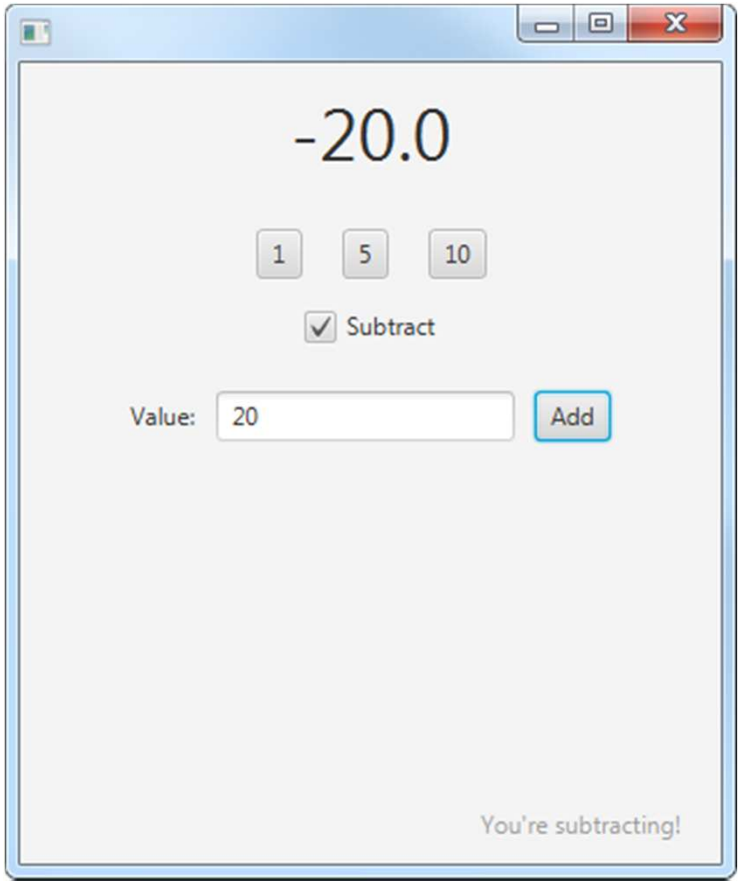
- Helper class with many utility methods: browse the documentation here

```
public void start(Stage primaryStage) {
  Rectangle r = new Rectangle(100, 100);
  StackPane p = new StackPane();
  p.setPrefWidth(200);
  p.setPrefHeight(200);
  p.getChildren().add(r);
  r.widthProperty().bind(
    Bindings.divide(p.widthProperty(), 2));
  r.heightProperty().bind(
    Bindings.divide(p.heightProperty(), 2));
  Scene scene = new Scene(p);
  primaryStage.setScene(scene);
  primaryStage.setTitle("Auto Rectangle");
  primaryStage.show();
}
```

Example Bindings.divide(…)



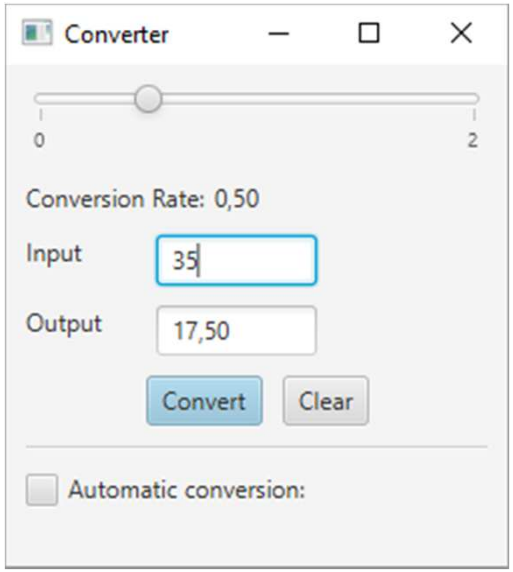
Exercise

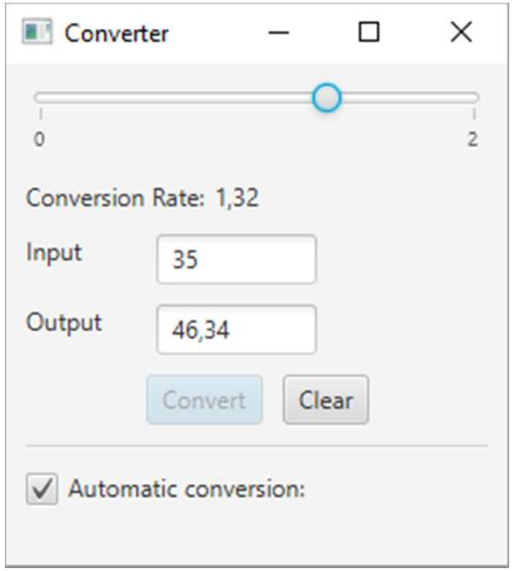


- Build the following application:
  - The label centered at the top is a counter
  - The buttons adds 1, 5 and 10 units to the counters.
  - The button Add sums to the counter the value shown in the TextField.
  - If the checkbox Subtract is selected, instead of adding, the previous actions subtract
  - Add a label to the bottom right corner that will only be shown when the option of subtracting is active

Exercise

- The application multiplies an input value by a given conversion rate to get an output value.
- The conversion ratio is defined using a slider, whose value is shown below it (use **binding**)
- In the default mode, the user has to press the button *Convert* to get the result. The button *Clear* deletes both input and output values.
- In Automatic mode, the output is recomputed whenever the input value or the conversion rate change





References

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- JavaFX 8 API: https://docs.oracle.com/javase/8/javafx/api/
- JavaFX 8 Event Handling Examples: http://code.makery.ch/blog/javafx-8-event-handling-examples/
- Lambda calculus in Java: Raoul-Gabriel Urma, Mario Fusco, and Alan Mycroft, *Java 8 in Action Lambdas, streams, and functional-style programming*