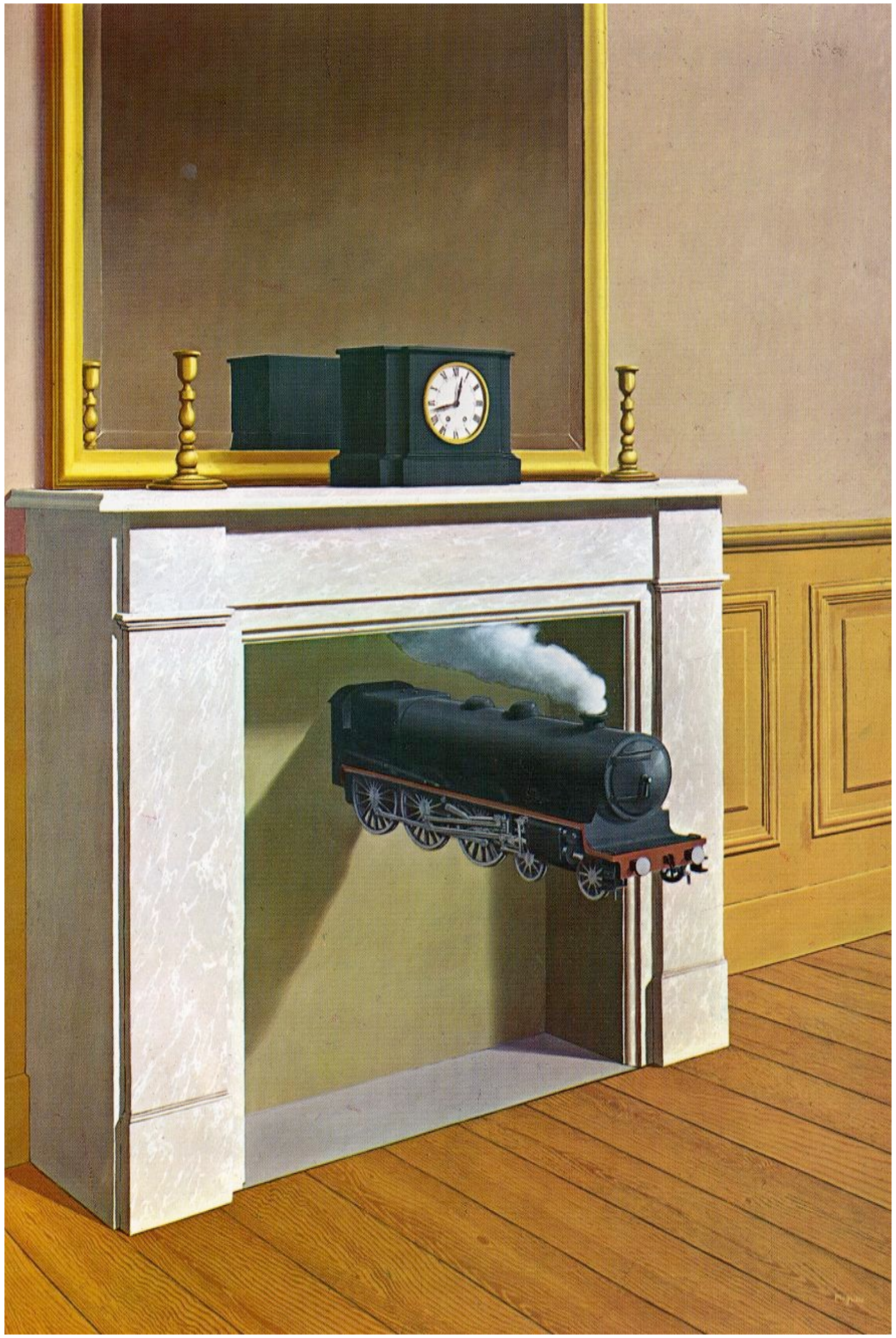


Event-driven programming and GUI input

Lecture 19

CS 2112 – Fall 2021

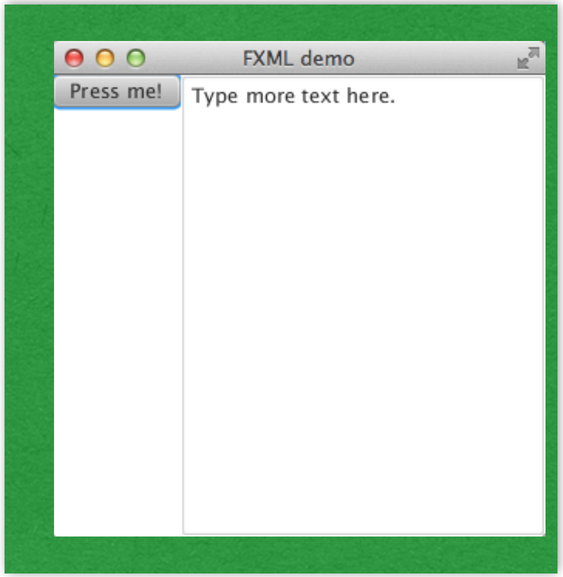
JavaFX GUI

http://docs.oracle.com/javase/8/javase-clienttechnologies.htm

- Output: what's drawn on the screen
  - Nodes
    - E.g., Button, buttons, labels, lists, sliders, canvas
  - Parent nodes: contain other nodes, control layout
    - Pane, HBox, VBox, GridPane, StackPane, Group…
- Helper classes
    - E.g., Graphics, Color, Font, FontMetrics, Dimension
- Input: handling user interaction
  - Events
    - E.g., button-press, mouse-click, key-press
    - EventHandlers: an object that responds to an event
  - Properties
    - Listeners
    - Animation

UI Builder tool

https://gluonhq.com/products/scene-builder/



- The JavaFX Scene Builder makes XML representations of UI node layouts.
  - Example: simple.fxml

```
<?xml version="1.0" encoding="UTF-8"?>
…
<AnchorPane id=“AnchorPane" prefHeight="299.0" prefWidth="319.0"
xmlns:fx="http://javafx.com/fxml/1" xmlns="http://javafx.com/javafx/2.2">
  <children>
    <HBox layoutX="0.0" layoutY="0.0" prefHeight="299.0" prefWidth="333.0">
      <children>
        <Button id="pressme" mnemonicParsing="false" text="Press me!" />
        <TextArea id="typeme" prefHeight="299.0" prefWidth="236.0" text="Type
more text here." wrapText="true" />
      </children>
    </HBox>
  </children>
</AnchorPane>
```

- Can read XML into UI nodes with FXMLLoader.load(url)

Events

http://docs.oracle.com/javase/8/javafx/events-tutorial/events.htm#JFXED117

- GUI code responds to (and creates) events
    - E.g., mouse button, keyboard pressed, mouse motion, window exposed, …
    - All subclasses of javafx.ui.Event
- Some nodes already handle events on their own, generate new events, e.g.:
    - Buttons: mouse press, release → ‘button clicked’
    - Scrollbar: mouse clicks, motion → scrollbar value
    - Multiple press/release events → ‘double-click’
- Application defines how to handle both ‘raw’ and synthesized events, can generate its own events.

Event handlers

- An `EventHandler<T>` is an object that handles events of type `T`:

```
interface EventHandler<T> {
      void handle(T event);
}
```

- Event handlers can be registered with nodes that generate events:

```
Button b = new Button(“press me”);
b.setOnAction(myButtonHandler);
Scrollbar s = new Scrollbar();
s.setOnScroll(myScrollEventHandler);
```

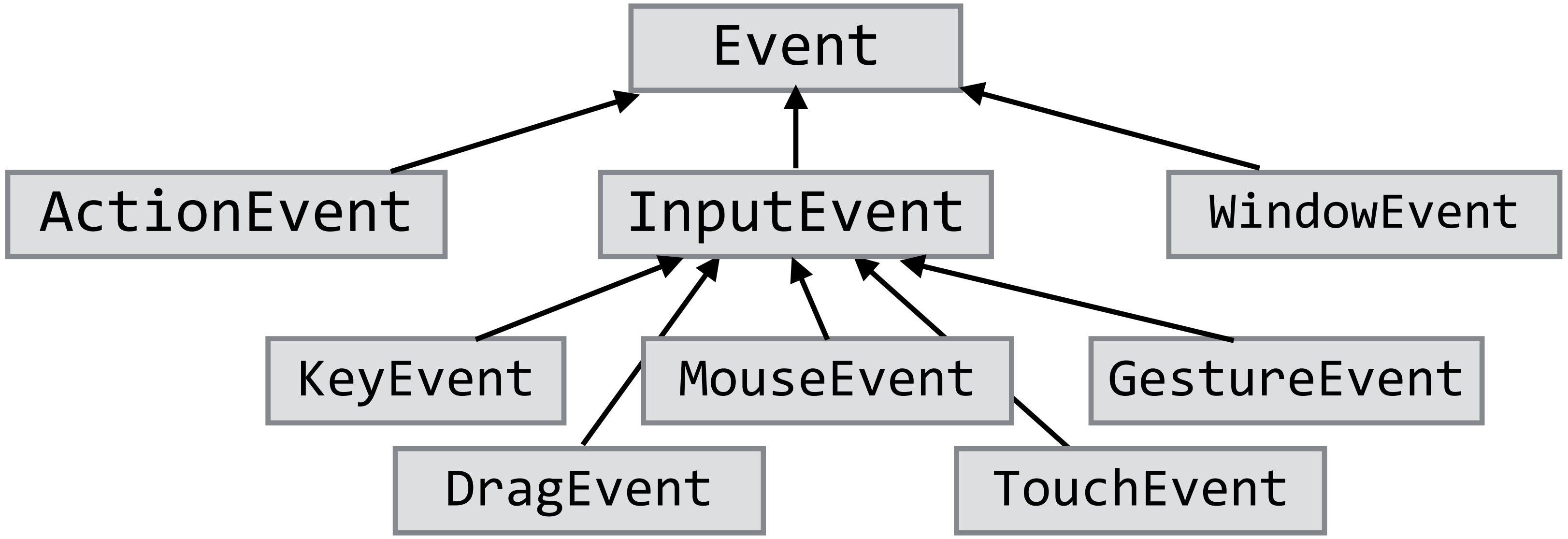
Note: there can be only one.

A brief example

```
class PrintIt implements EventHandler<ActionEvent> {
    @Override
    public void handle(ActionEvent _) {
        System.out.println("Button was clicked");
    }
}
public class Main extends Application {
    public void start(Stage stage) throws Exception {
        try {
            URL r = getClass().getResource("simple.fxml");
            if (r == null) …; // error
            Scene scene = new Scene(FXMLLoader.load(r));
            stage.setScene(scene);
            stage.sizeToScene();
            Button b = (Button) scene.lookup("#pressme");
            b.setOnAction(new PrintIt());
            stage.show();
        catch … // error
    }
}
```

creating the node hierarchy {

Event types



- Different kinds of events represented by different event classes
- E.g., MouseEvent reports mouse position

Delegation Model

- Timeline for an event
  - User (or program) does something to a component, event is generated.
  - Event is passed down **event dispatch chain** to find handlers for event
    - Event dispatch chain determined by the **event target** the event is sent to (e.g., the window = Stage).
    - Event dispatch chain usually corresponds to chain of nodes in layout tree from root to leaf—can be overridden, but usually not necessary.
  - Each event handler uses event to update application state appropriately.
    - handler can modify, consume event (so not seen by rest of chain), generate new events.

Accessing state from handler

```
class PrintIt implements EventHandler<ActionEvent> {
    Main main;
    PrintIt(Main m) { main = m; }
    @Override
    public void handle(ActionEvent e) {
        System.out.println(main.message);
    }
}
public class Main extends Application {
    String message = “Button was clicked”;
    public void start(Stage stage) throws Exception {
        …
         Button b = (Button) scene.lookup("#pressme");
         b.setOnAction(new PrintIt(this));
        …
    }
}
```

Event handler as main

```
public class Main extends Application
     implements EventHandler<ActionEvent> {
    String message = “Button was clicked”;
    public void start(Stage stage) throws Exception {
          …
               Button b = (Button)scene.lookup("#pressme");
               b.setOnAction(this);
          …
    }
    public void handle(ActionEvent e) {
        System.out.println(message);
    }
}
```

Event handler as inner class

```
public class Main extends Application {
   String message = “Button was clicked”;
   public void start(Stage stage) throws Exception {
         …
          Button b = (Button) scene.lookup("#pressme");
          b.setOnAction(new PrintIt());
         …
   }
   class PrintIt implements EventHandler<ActionEvent> {
      public void handle(ActionEvent e) {
         System.out.println(message);
      }
   }
}
```

…as anonymous inner class

```
public class Main extends Application {
   String message = “Button was clicked”;
   public void start(Stage stage) throws Exception {
      …
      Button b = (Button) scene.lookup("#pressme");
      b.setOnAction(new EventHandler<ActionEvent> () {
         public void handle(ActionEvent e) {
            System.out.println(message);
         }
      });
   }
}
```

…as lambda expression

```
public class Main extends Application {
   String message = “Button was clicked”;
   public void start(Stage stage) throws Exception {
      …
      Button b = (Button) scene.lookup("#pressme");
      b.setOnAction(e -> System.out.println(message));
   }
}
```

Properties

http://docs.oracle.com/javafx/2/binding/jfxpub-binding.htm

- Another way to access dynamic behavior in JavaFX: node **properties**
- Node accessors correspond to property objects:

`boolean isDisabled()`	`BooleanProperty disabledProperty()`
`double getWidth(), getHeight()`	`ReadOnlyDoubleProperty widthProperty(), heightProperty()`
`double getLayoutX(), getLayoutY()`	`DoubleProperty layoutXProperty(), layoutYProperty()`
`Paint getTextFill()`	`ObjectProperty<Paint> textFillProperty()`
`String getText()`	`StringProperty getTextProperty()`

Listening to properties

- Program actions can be triggered by changes to properties, by attaching **listeners**.

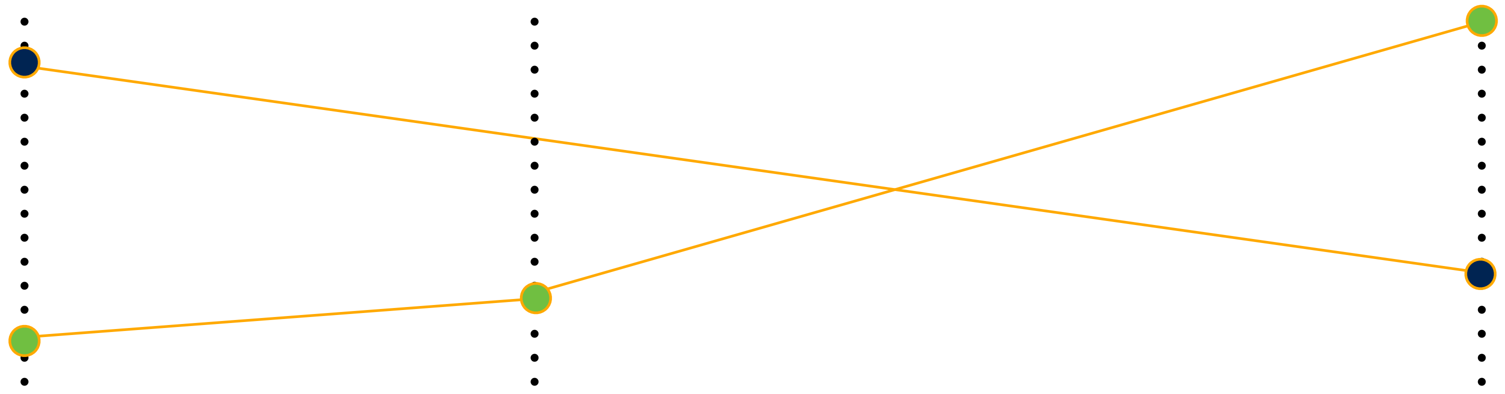
```
TextArea t = …;
t.textProperty().addListener(
    (ObservableValue<? extends String> obs,
     String before, String after) -> {
        System.out.println("Changed from ‘"
               + before + “’ to ‘”
               + after + “’”);
     }
});
```

- Any number of listeners can be attached
- Design pattern: Observer

Animations

http://docs.oracle.com/javafx/2/animations/jfxpub-animations.htm

- Properties can be controlled by animations
- Animation is defined by a sequence of **key frames**
- Each key frame has a time T and defines the values of some set of properties
- JavaFX interpolates properties smoothly between key frames.



Creating a KeyFrame

Constructor:

```
KeyFrame(Duration time,
   String name,
   EventHandler<ActionEvent> onFinished,
   KeyValue... values)
```

Length of keyframe

Action to perform when animation completes

Variable-length list of property value settings

Creating an animation

- "Over the next 0.5 seconds, increase the requested Y position of the button by 10 pixels"

Property to interpolate

```
Timeline tl = new Timeline();
tl.getKeyFrames().add(new KeyFrame(
    Duration.millis(500), "slide button down",
    new KeyValue(b.layoutYProperty(),
                     b.getLayoutY() + 10.0)));
tl.play();
```

Current Y position

Binding properties

http://docs.oracle.com/javafx/2/binding/jfxpub-binding.htm

- Properties can be bound to **computations** rather than to **values.**

```
Button b1 = new Button();
Button b2 = new Button();
DoubleProperty p = b2.getLayoutY();
p.bind(b1.layoutYProperty().add(
           new SimpleDoubleProperty(10.0));
```

- Effect: Y position of b2 is recomputed and updated *automatically* as b1's Y position changes.