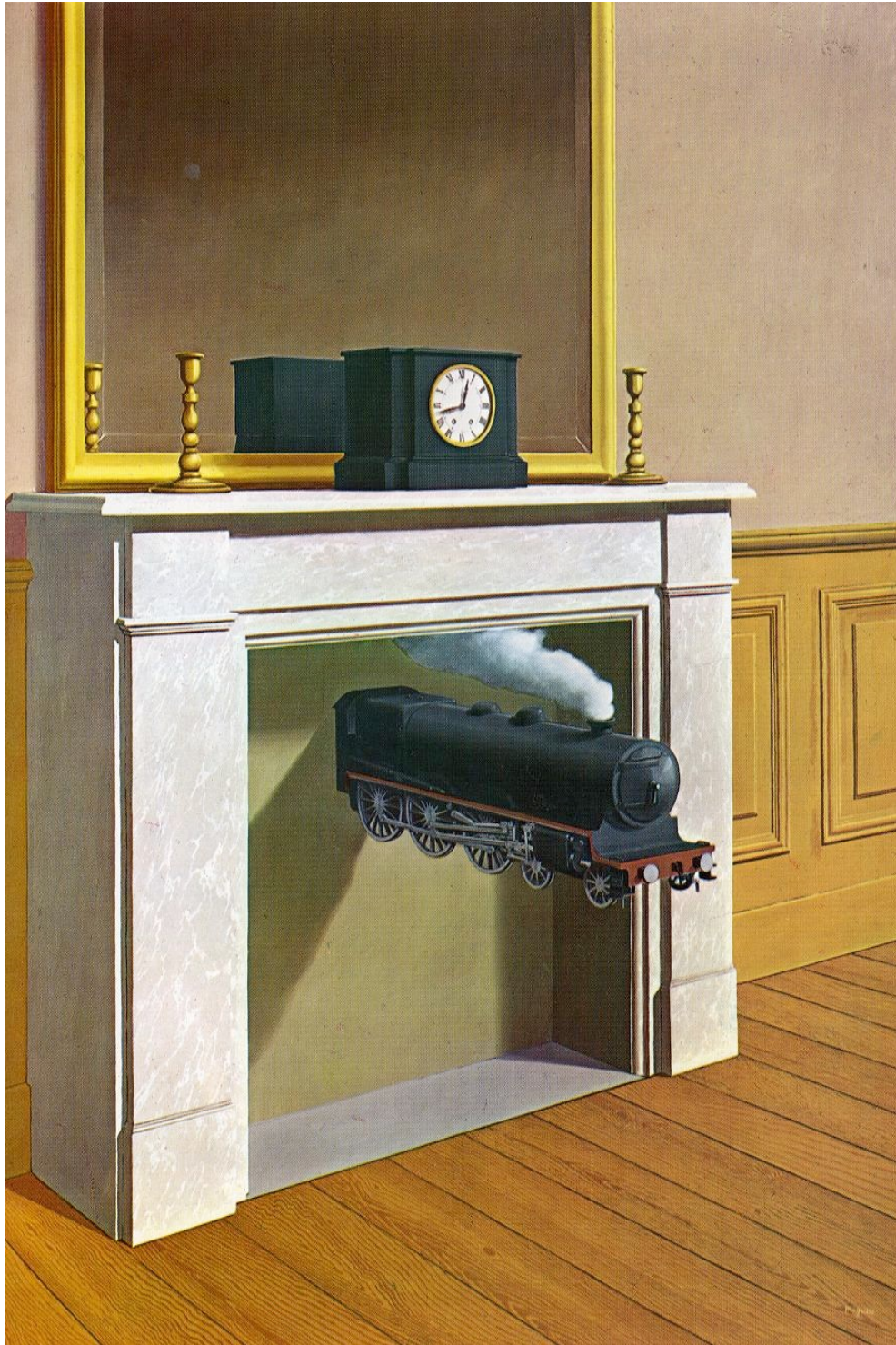




Event-Driven Programming

Lecture 21

CS2112 – Fall 2024

JavaFX GUI

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

- Output (statics): what's drawn on the screen
 - Nodes
 - Buttons, labels, lists, sliders, canvas, ...
 - Parent nodes: contain other nodes, control layout
 - Pane, HBox, VBox, GridPane, StackPane, Group, ...
 - Helper classes
 - Graphics, Color, Font, FontMetrics, Dimension
- Input (dynamics): handling events
 - User-generated events
 - Button-press, mouse-click, key-press, ...
 - EventHandlers: methods that respond to events
 - Properties
 - Listeners
 - Animation

UI Builder Tool

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

- The JavaFX Scene Builder makes XML representation 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" />
```

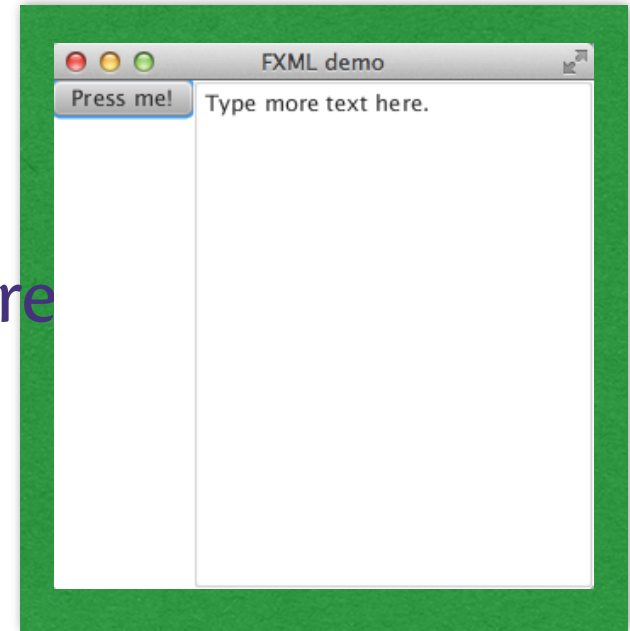
```
</children>
```

```
</HBox>
```

```
</children>
```

```
</AnchorPane>
```

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



Example

```
class PrintIt implements EventHandler<ActionEvent> {
    @Override
    public void handle(ActionEvent ae) {
        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* {

Events

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

- GUI code responds to (and creates) events
 - 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`:

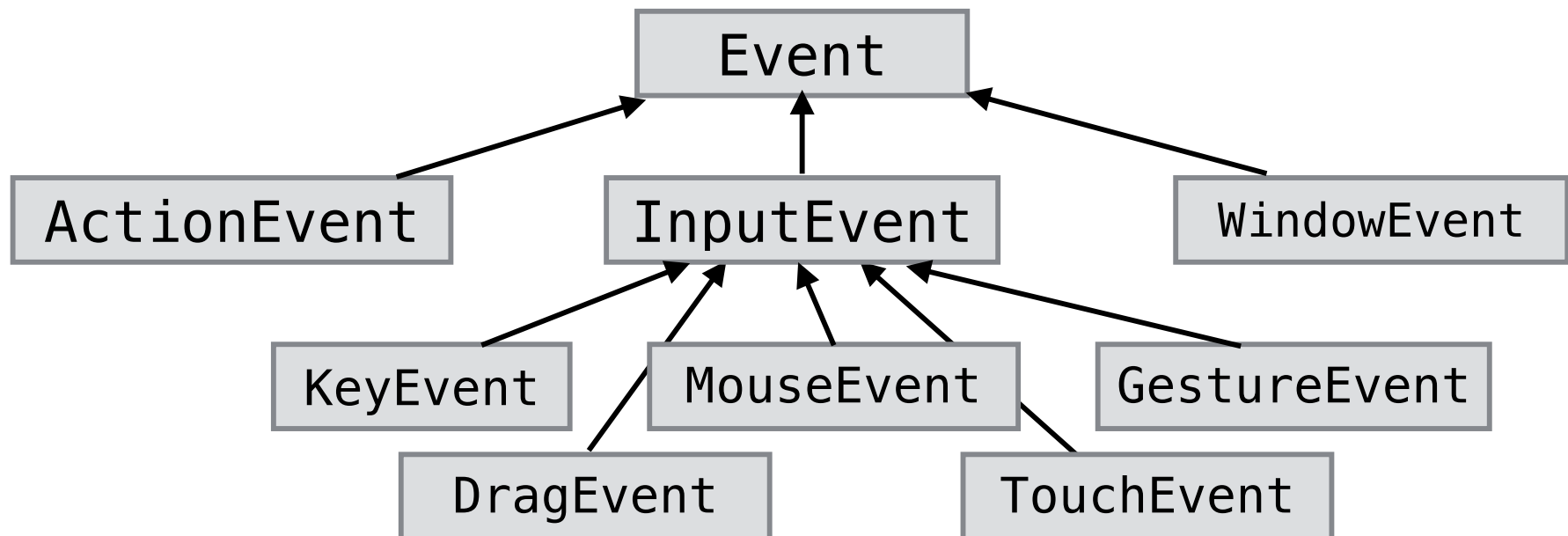
```
interface EventHandler<T> {  
    void handle(T event);  
}
```

- 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.*

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 ae) {
        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 ae) {
        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 ae) {  
            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 ae) {  
                System.out.println(message);  
            }  
        });  
    }  
}
```

...with 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: **properties** of nodes
- Node accessors correspond to property objects:

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

Listening to Properties

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

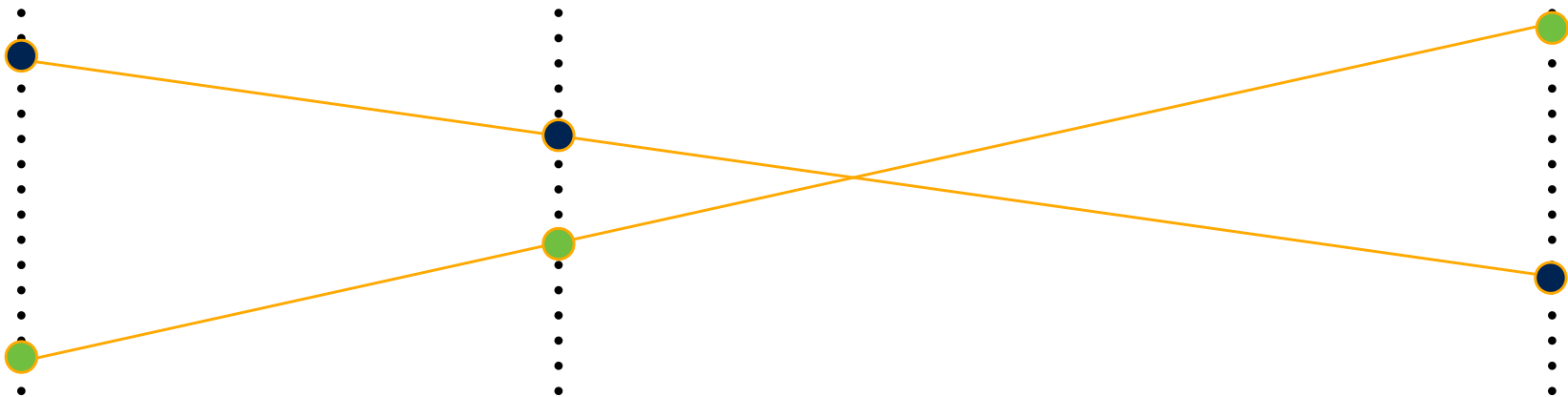
```
TextArea t = ...;
t.textProperty().addListener(new ChangeListener<String>() {
    void changed(ObservableValue<? extends String> obs,
                 String before, String after) {
        System.out.format(
            "Changed from \"%s\" to \"%s\"\\n",
            before, after);
    }
});
```

- 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 instant and defines the values of some set of properties
- JavaFX interpolates property values smoothly between key frames



Creating an Animation

- “Over the next 0.5 seconds, increase the Y position of the button by 10 pixels”

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

Property to interpolate

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: b2's Y position is recomputed and updated automatically as b1's Y position changes