Programming of Interactive Systems

Anastasia.Bezerianos@lri.fr

All Homework and deadlines

individual ones due on Mon night, group ones on Tue night
be ready to show them the following day

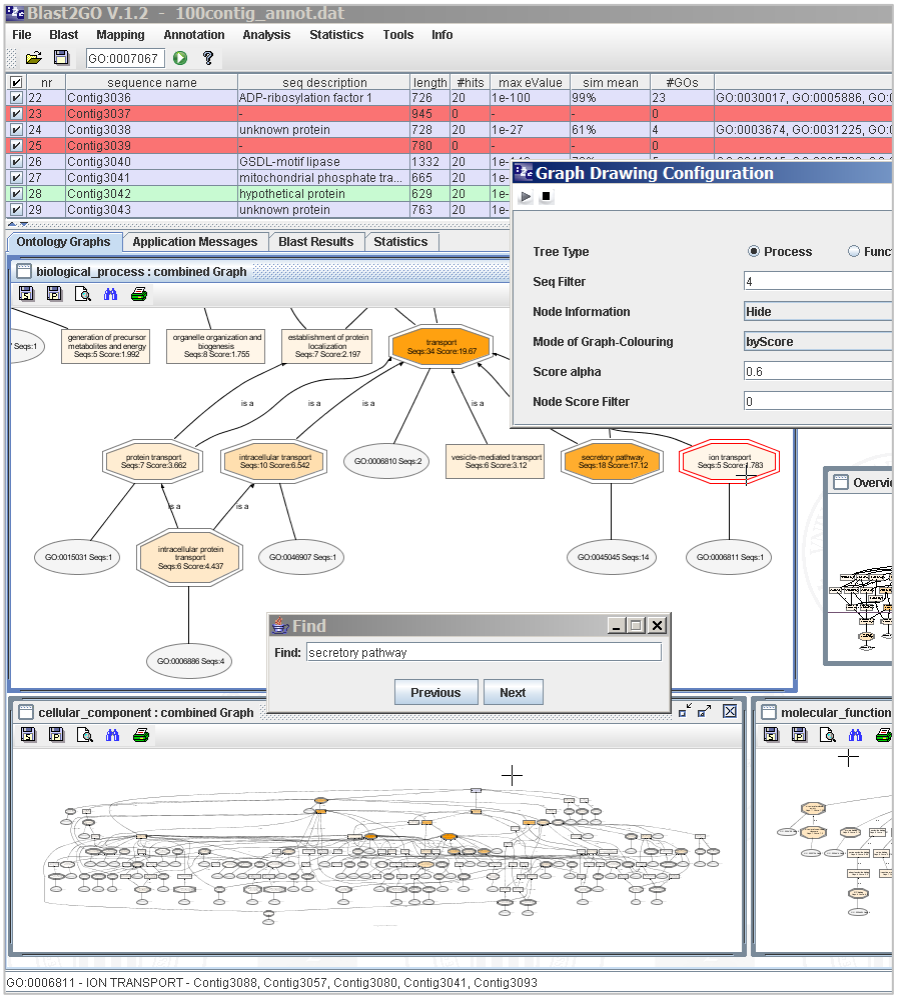
	individual Work	group Work
week1 - 06 Sep		
week2 - 13 Sep	MineSweeper Storyboard	
week3 - 20 Sep		Project Storyboard
week4 - 27 Sep	MineSweeper v1	
week5 - 04 Oct		Project update
week6 - 11 Oct	MineSweeper v2	
week7 - 18 Oct		Project final

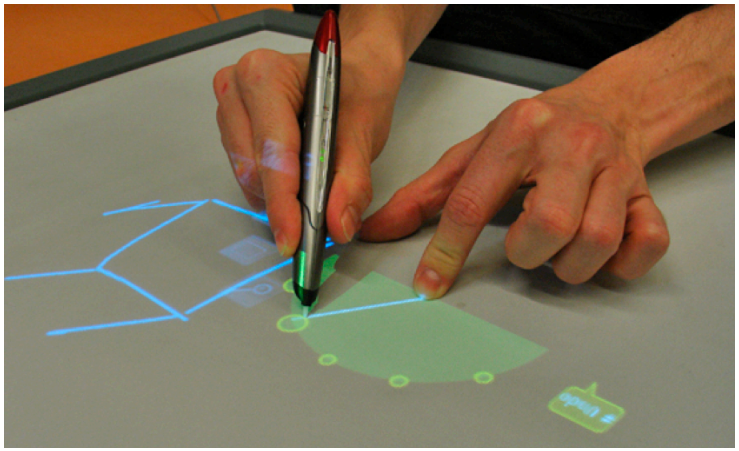
Week 2 :
a. Intro JavaFX

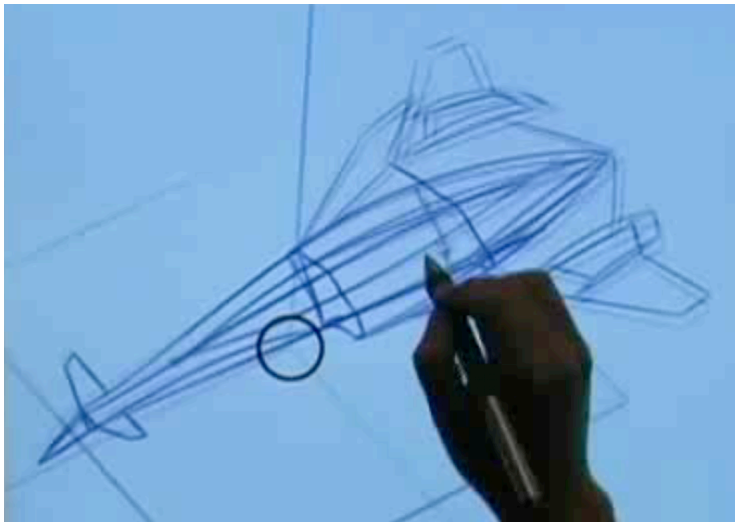
Anastasia.Bezerianos@lri.fr

(part of this class is based on previous classes from Anastasia,
and of T. Tsandilas, S. Huot, M. Beaudouin-Lafon, N.Roussel, O.Chapuis)

interactive systems



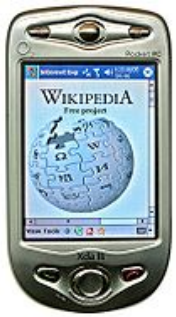




graphical interfaces

A **graphical** **user interface** or **GUI**, is an interface that allows users to interact with electronic devices through graphical icons and visual components (widgets)

GUIs: input events (and their result) are specified w.r.t. output (on what widget they act on)



events

Event: An object that represents a user's interaction with a GUI component. Can be "handled" to make components interactive.

Types of UI events:

- Mouse: move/drag/click button press/release, …
- Keyboard: key press/release, sometimes with modifiers like shift/control/alt, …
- Touchscreen: finger tap/drag, …
- Window: resize, minimize, restore, close …

interface toolkits

libraries of interactive objects (« widgets », e.g. buttons) that we use to construct interfaces

functions to help the programming of GUIs

usually also handle input events

This week we focus on a specific toolkit, JavaFX.
Later in the class we will discuss toolkits more …

JavaFX

JavaFX toolkit (and ancestors)

- Original Java GUI was the Abstract Window Toolkit (AWT), that was platform dependent.
- Swing was introduced in 1997 to fix the problems with AWT, with higher level components, with pluggable look and feel.
- Swing is built on AWT, default until Java 7 (likely will never die, many Apps running it)
- In Java 8, **JavaFX** is included in SDK but still not the standard (built on Swing/AWT)
- Since then Java not free for commercial use and the SDK has been stripped down a bit

JavaFX

Java + Flash + Flex

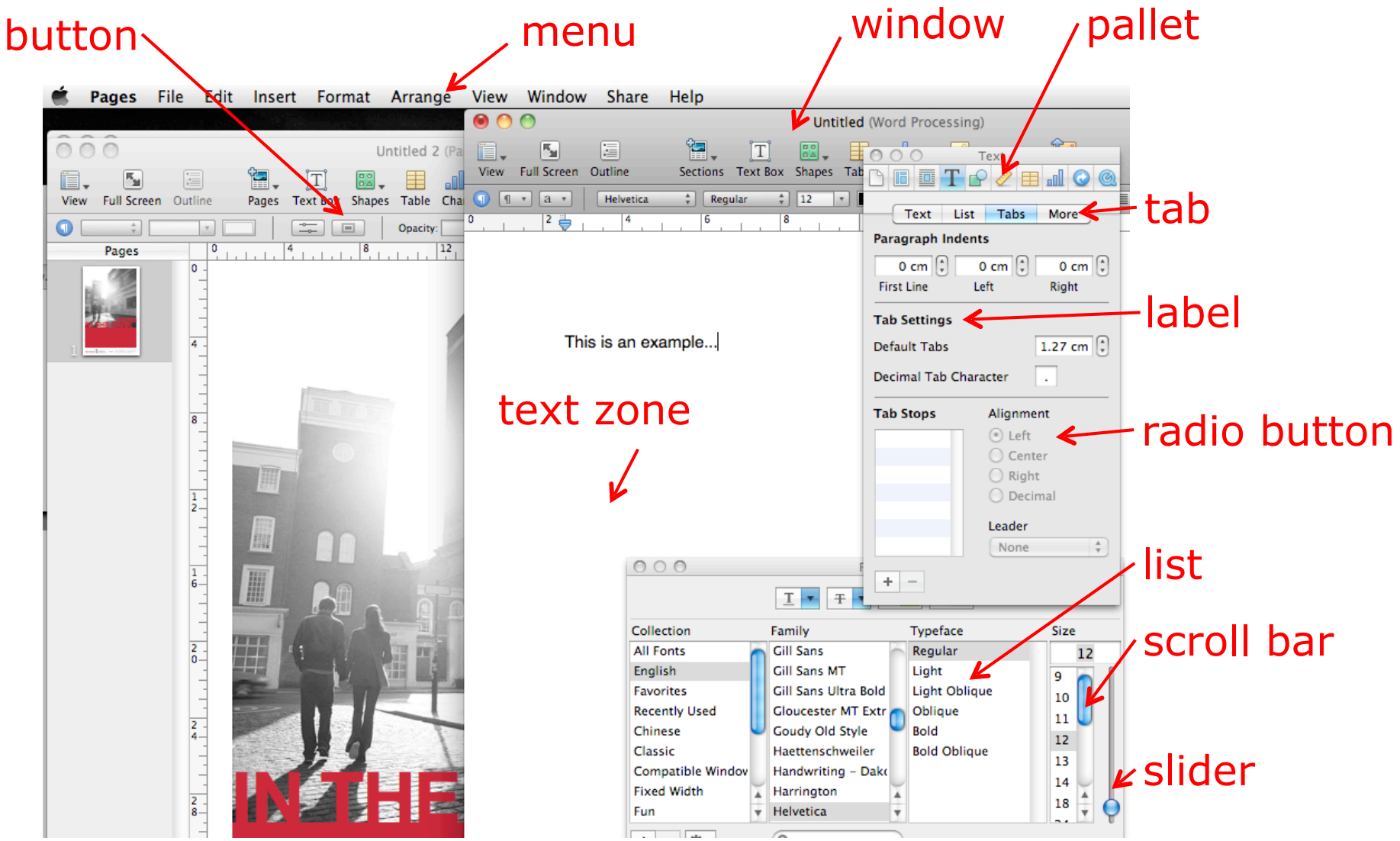
As with Java, it is cross-platform

Can use tools for interface building WYSIWYG (SceneBuilder, more later)

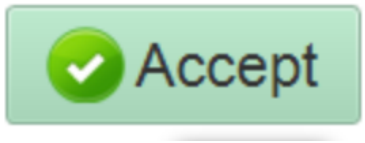
Supports advanced event handling (Swing/AWT)

CSS styling

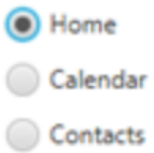
« widgets » (window gadget)



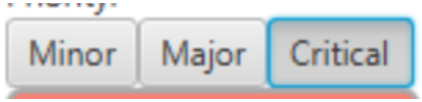
JavaFX widgets (atomic interactive)



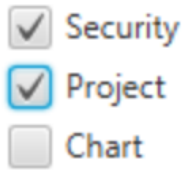
Button



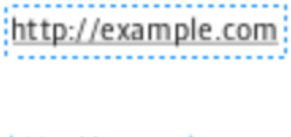
RadioButton



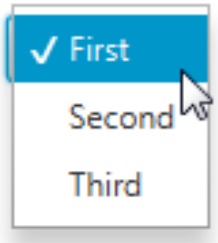
ToggleButton



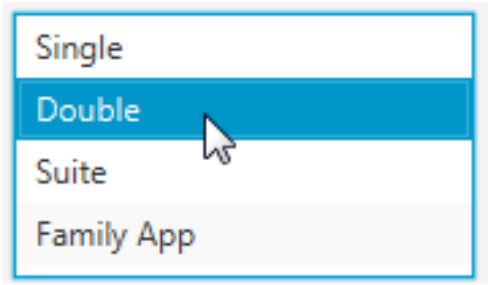
CheckBox



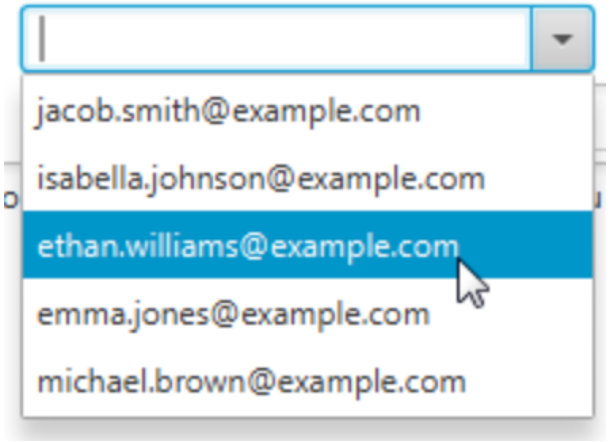
Hyperlink



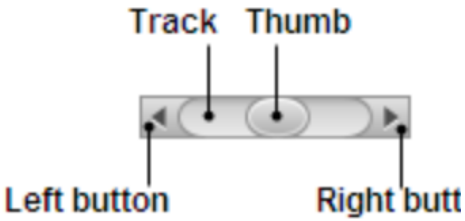
ChoiceBox



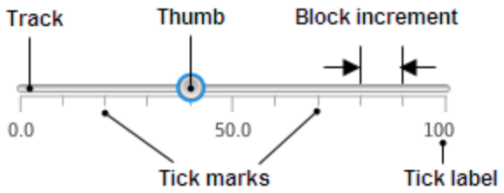
ListView



ComboBox



ScrollBar



Slider

PasswordField

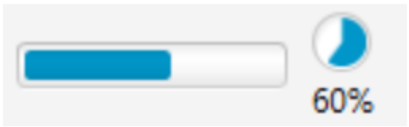
TextField

https://docs.oracle.com/javase/8/javafx/user-interface-tutorial/ui_controls.htm#JFXUI336

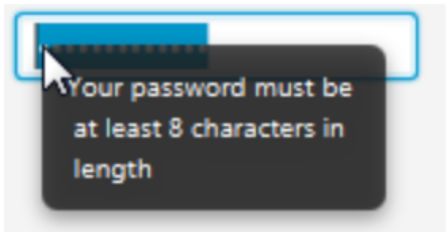
JavaFX widgets (non-editable)

Label

Separator



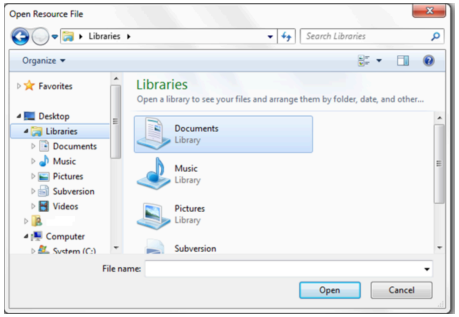
ProgressBar
ProgressIndicator



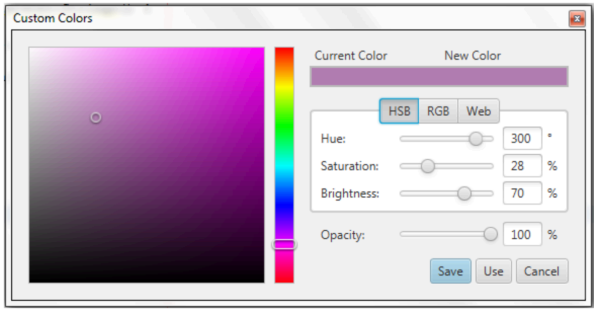
Tooltip

https://docs.oracle.com/javase/8/javafx/user-interface-tutorial/ui_controls.htm#JFXUI336

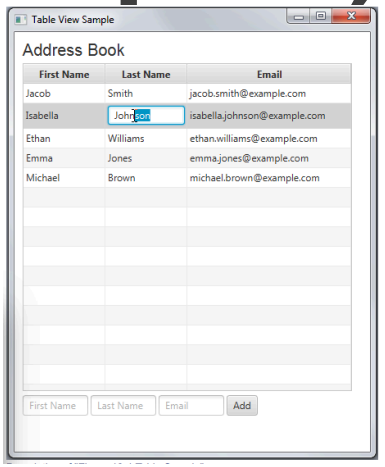
JavaFX widgets (more complex)



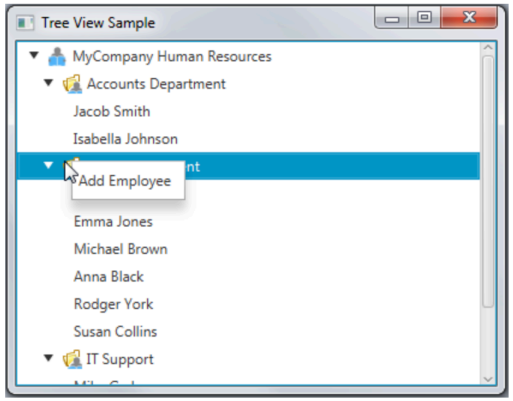
FileChooser



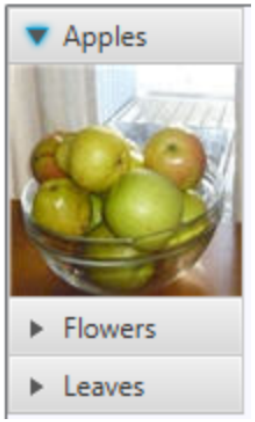
ColorPicker



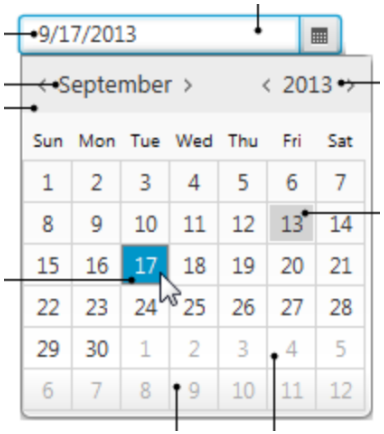
TableView,
TableColumn



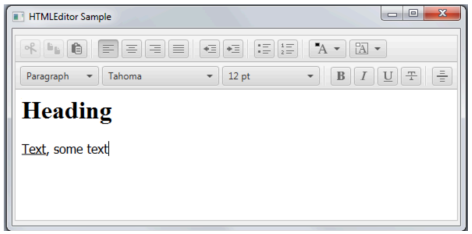
TreeView



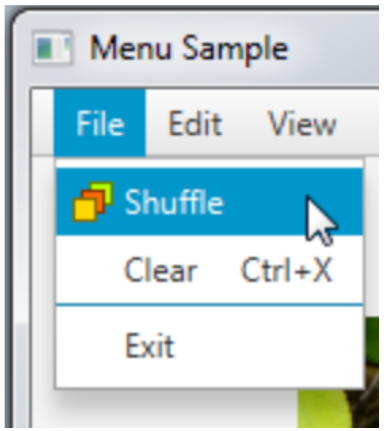
Accordion
TitlePane



DatePicker



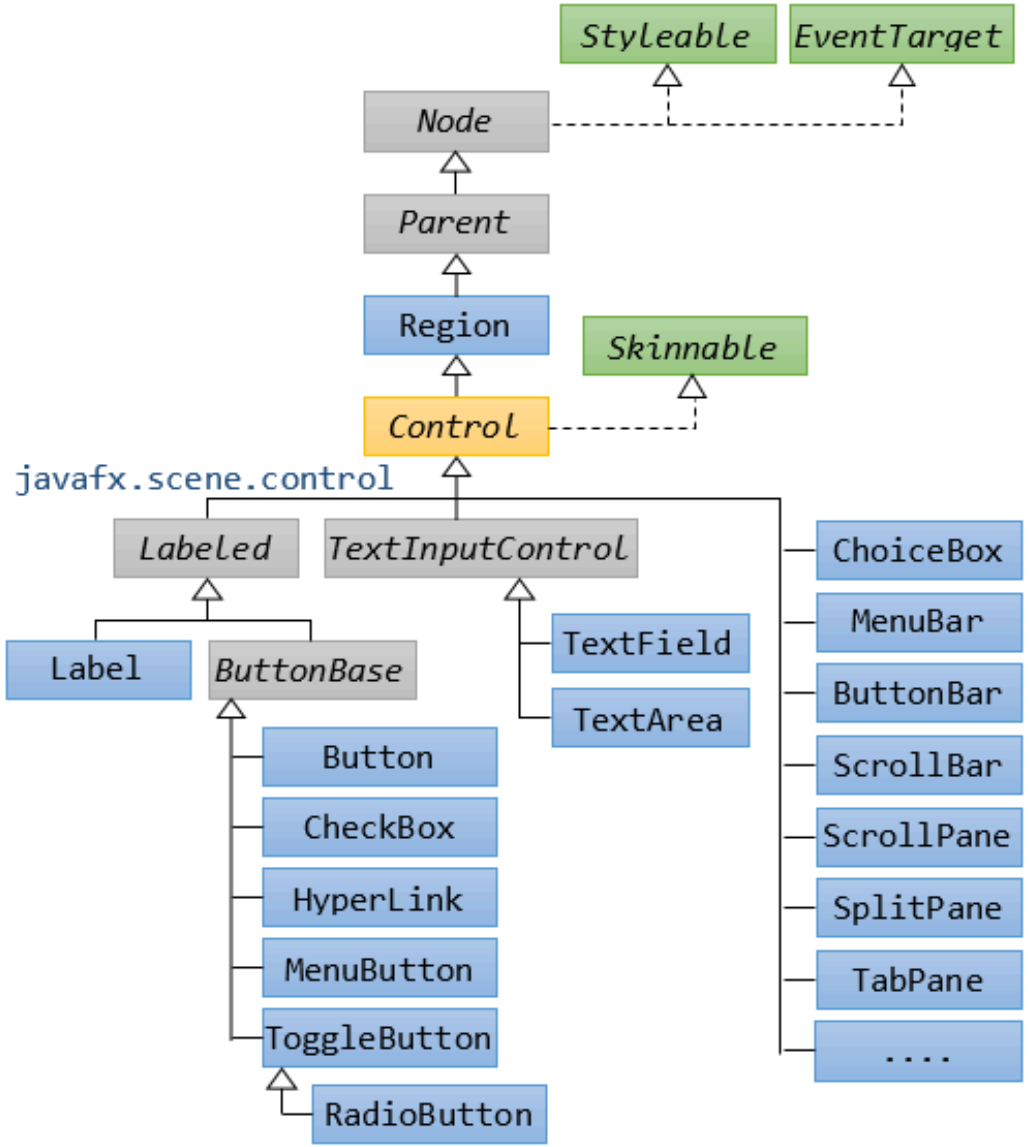
HTMLEditor



Menu, MenuItem

https://docs.oracle.com/javase/8/javafx/user-interface-tutorial/ui_controls.htm#JFXUI336

JavaFX widget (control) classes



https://docs.oracle.com/javase/8/javafx/user-interface-tutorial/ui_controls.htm#JFXUI336

JavaFX - creating a project

From now on steps we'll take in Eclipse

1. once per project

(menu) New Project > Java Project
(give it a name, we will use it for our class tutorials)

(left click) Project > Properties > Java Built Path
add your JavaFX jars (you downloaded these and used them with your TAs last week)

(make sure you have selected your project. Then in menu)
New Package
(give it a name, ex "examples")

2. for any class that has a `main()` in it

(left click) Project > New Class > Java Class
give it a name, for example HelloWorld. If it is not under your package, drag and drop it there

(left click) HelloWorld > Run configurations > (x)=...
under VM arguments put `--add-modules javafx.controls,javafx.fxml`
untick "Use the -XstartOnFirstThread ..."

(**ctrl + shift + f** corrects indentation in eclipse if you copy paste)

JavaFX - our first window

New Class with a main function (HelloWorld)

```
import javafx.application.Application;
import javafx.stage.Stage;

public class HelloWorld extends Application {

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

    @Override
    public void start(Stage primaryStage) throws Exception {
        primaryStage.setTitle("First GUI window!");
        primaryStage.show();
    }

}
```

JavaFX - our first window (2)

```
import javafx.application.Application;
import javafx.stage.Stage;

public class HelloWorld extends Application {

    public static void main(String[] args){
        System.out.println("We are starting ...");
        launch(args);
        System.out.println("Are we stopping?");
    }

    @Override
    public void start(Stage primaryStage) throws Exception {
        primaryStage.setTitle("First GUI window!");
        primaryStage.show();
    }

}
```

JavaFX - our first window (2)

```
import javafx.application.Application;
import javafx.stage.Stage;

public class HelloWorld extends Application {

    public static void main(String[] args){
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        launch(args);
        System.out.println("Are we stopping?");
    }

    @Override
    public void start(Stage primaryStage) throws Exception {
        primaryStage.setTitle("First GUI window!");
        primaryStage.show();
    }

}
```

Application class for UI windows

main uses `launch()` to launch `start()`

A Stage (here called primaryStage) is created automatically by JavaFX and passed as an argument to `start()`
A Stage is a window
`Show()` makes it appear

JavaFX - our first window (3)

```
import javafx.application.Application;
import javafx.stage.Stage;

public class HelloWorld extends Application {

    @Override
    public void start(Stage primaryStage) throws Exception {
        primaryStage.setTitle("First GUI window!");
        primaryStage.show();
    }

}
```

main() can be omitted!!!

But this only works if you have only one class that extends Application in your project (this will change soon for us!)

Application class

JavaFX programs include **one** class that extends Application (analogous to a single class with a main method for console programs).

javafx.application.Application

Application class

When running an Application class (a class that extends it), JavaFX does the following:

1. Constructs an instance of that Application class

2. Calls an `init()` method for application initialization
   … don't construct a Stage or Scene in `init()`

3. Calls the `start (javafx.stage.Stage)` method

4. Waits for the application to finish: either you call `Platform.exit()`, or the last window has been closed.

5. Calls the `stop()` method to release resources.
   init() and stop() have default do-nothing implementations.

JavaFX - our first window (cont'd)

So we have a window (Stage),
what are we going to put in it?

JavaFX - a button window

Let’s organize our code a little. If you do not already have a package, create a package (folder) for our examples:

(left click) Project > New Package

give the name “examples"

put your HelloWorld class in it

Then create a new class HelloButton

(left click) Project > New Class > Java Class

give it the name HelloButton

(left click) HelloButton > Run configurations > (x)=…

under VM arguments put `--add-modules javafx.controls,javafx.fxml`

untick “Use the -XstartOnFirstThread …“

(note) if like me you have many Java projects and have classes with similar names, make sure that Run configurations is looking for your main in the correct project and class

JavaFX - a button window


```
package examples;

import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;

public class HelloButton extends Application{
    public static void main(String[] args){
        launch(args);
    }

    @Override
    public void start(Stage primaryStage) throws Exception {

        Button okBtn = new Button("ok");

        Scene scene = new Scene (okBtn, 150, 100);
        primaryStage.setScene(scene);

        primaryStage.setTitle("First Button");
        primaryStage.show();
    }
}
```

JavaFX - a button window


```
package examples;

import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.stage.Stage;

public class HelloButton extends Application{
    public static void main(String[] args){
        launch(args);
    }

    @Override
    public void start(Stage primaryStage) {
        Button okBtn = new Button("ok");
        Scene scene = new Scene (okBtn, 150, 100);
        primaryStage.setScene(scene);

        primaryStage.setTitle("First Button");
        primaryStage.show();
    }
}
```

1. Create UI control (Button)
2. Add it to a scene (scene graph, all UI components)
3. Set the scene as the main scene of your stage (window), here called primaryStage
4. Show your stage to make the window visible

Terminology

Stage

- represents windows, top level **container**
- many setter methods, e.g., `setTitle(), setWidth()`
- one stage is created by default by Application (ex primaryStage)
- you can have multiple stages and use (**set**) one or the other as your main stage (primaryStage in our example):

  construct a Stage for each window in your application, e.g., for dialogs and pop-ups.

Scene

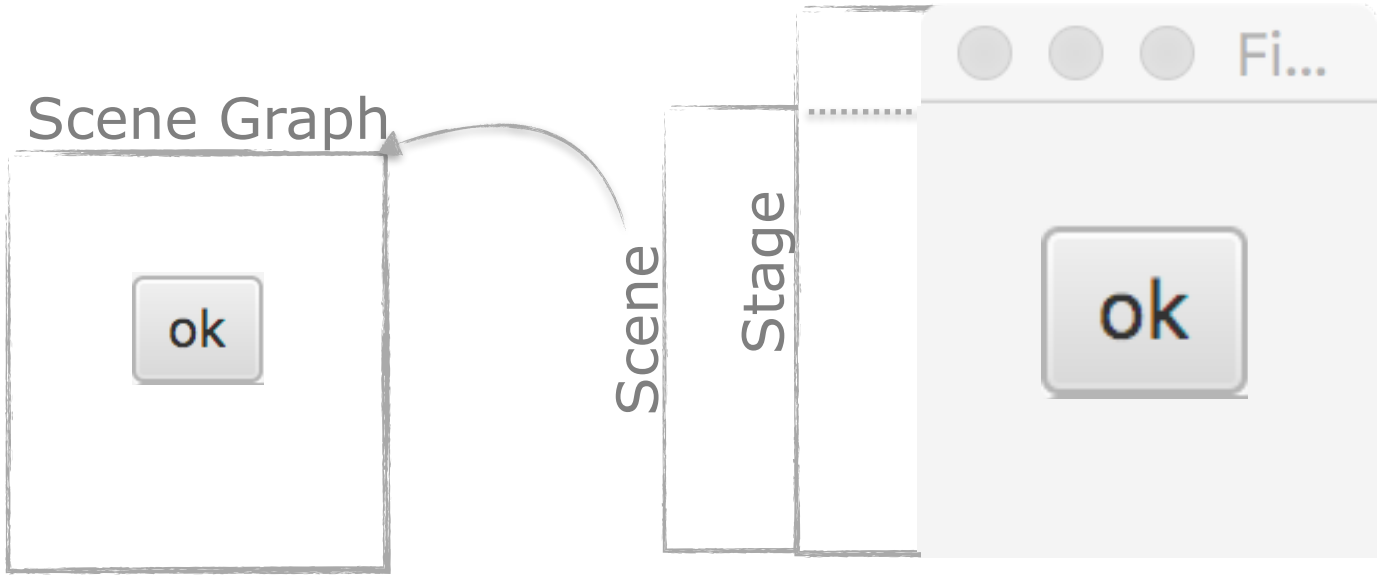
- each stage has a scene (scene graph container)
- scenes hold controls (Buttons, Labels, etc.)
- you can put controls directly in scenes, or use **Panes** for better layout hierarchies:

  construct Scene(s) for collections of widgets you want to be grouped and visible together

Basic structure

Basic structure of a JavaFX program

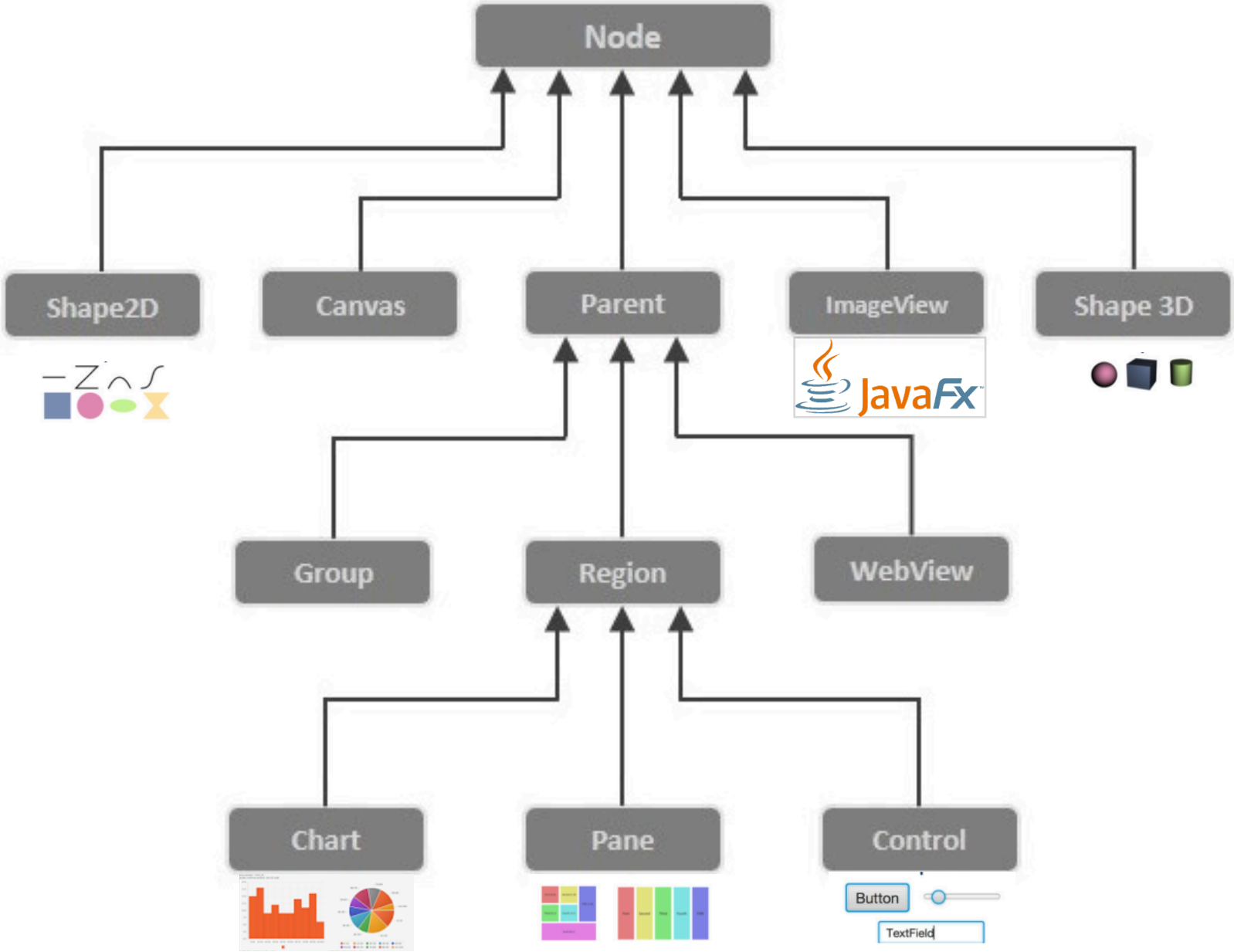
- Application
- Override the `start(Stage)` method
- Stage ← Scene ← Nodes (Panes or Controls)



widget complexity

- All UI elements are **Node**s in JavaFX
- Simple widgets (class Control)
  - buttons, scroll bars, labels, …
- Composite/complex widgets
  - containers that group other widgets (class Pane)
  - dialog boxes, menus, color pickers, …

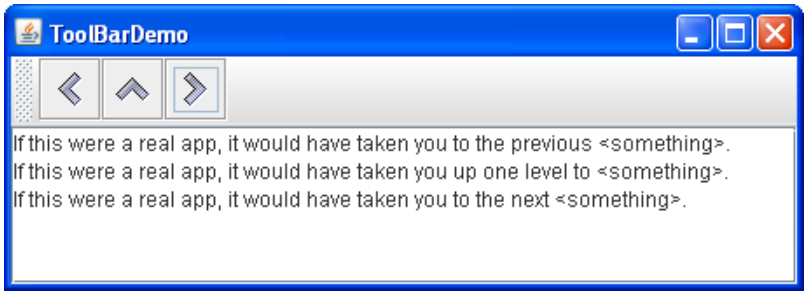
UI hierarchy



widget tree

Hierarchical representation of the widget structure

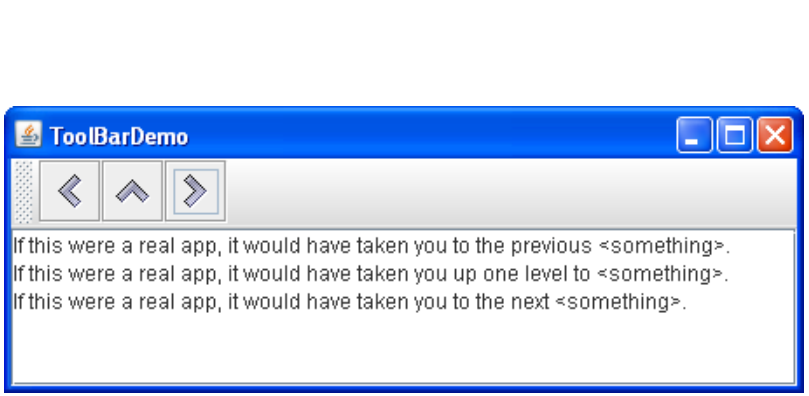
- a widget can belong to only one « container » (Pane)



widget tree

Hierarchical representation of the widget structure

- a widget can belong to only one « container » (Pane)



interface toolkits

All toolkits have:
- a collection of UI controls / components
- a way to layout these controls (next)
- a way to handle input events from users

Syntax and command parameters differ depending on language / toolkit

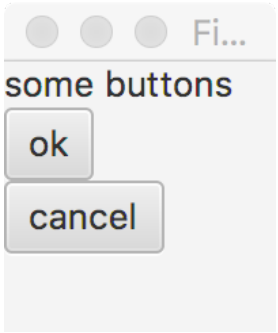
JavaFX layouts

JavaFX - complex structures

So we have a window (Stage), with a Button.
How can we add more controls on to it?

JavaFX - a button window

```
package examples;

import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.control.Label;
import javafx.scene.layout.VBox;
import javafx.stage.Stage;

public class SomeButtons extends Application {

    // add your main() here !!!!

    @Override
    public void start(Stage primaryStage) throws Exception {

        Label descriptionLabel = new Label("some buttons");
        Button okBtn = new Button("ok");
        Button cancelBtn = new Button("cancel");

        VBox root = new VBox();
        root.getChildren().addAll(descriptionLabel, okBtn, cancelBtn);

        Scene scene = new Scene(root, 100, 100);

        primaryStage.setTitle("First GUI window!");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}
```



JavaFX - a button window

```
package examples;

import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.control.Label;
import javafx.scene.layout.VBox;
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        VBox root = new VBox();
        root.getChildren().addAll(descriptionLabel, okBtn, cancelBtn);

        Scene scene = new Scene(root, 100, 100);

        primaryStage.setTitle("First GUI window!");
        primaryStage.setScene(scene);
        primaryStage.show();
    }
}
```
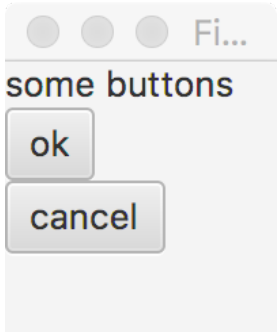
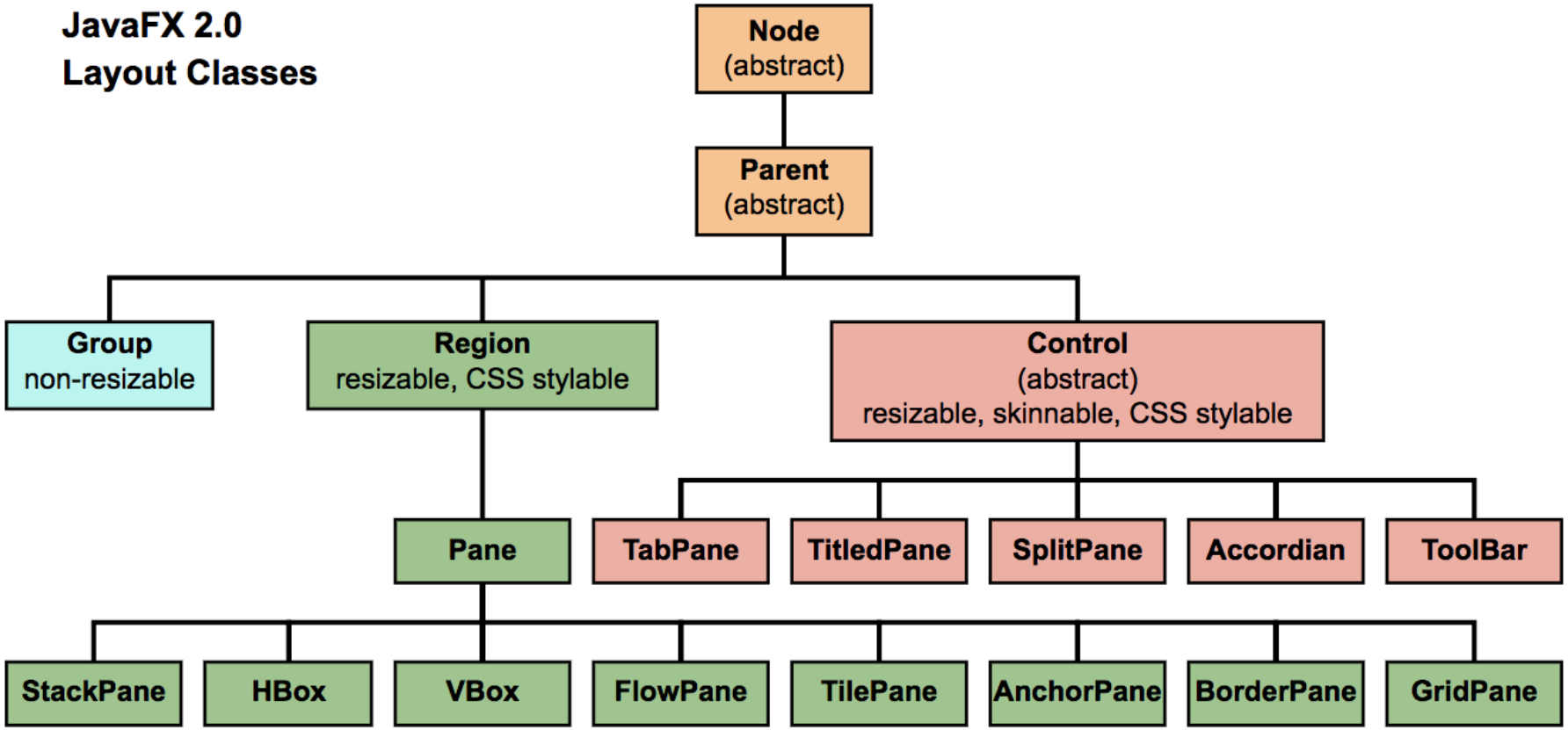



VBox will store nodes/controls and be added to a Scene

JavaFX - complex structures

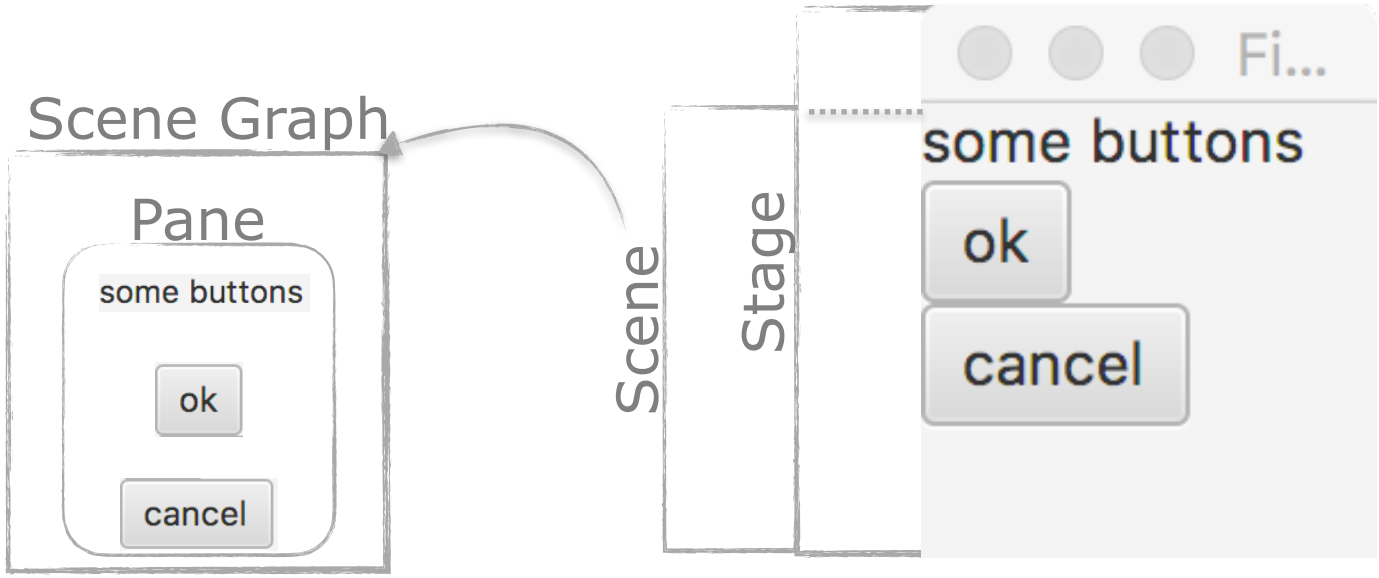
VBox is one of many *Pane* class objects
that help us organize nodes in a container



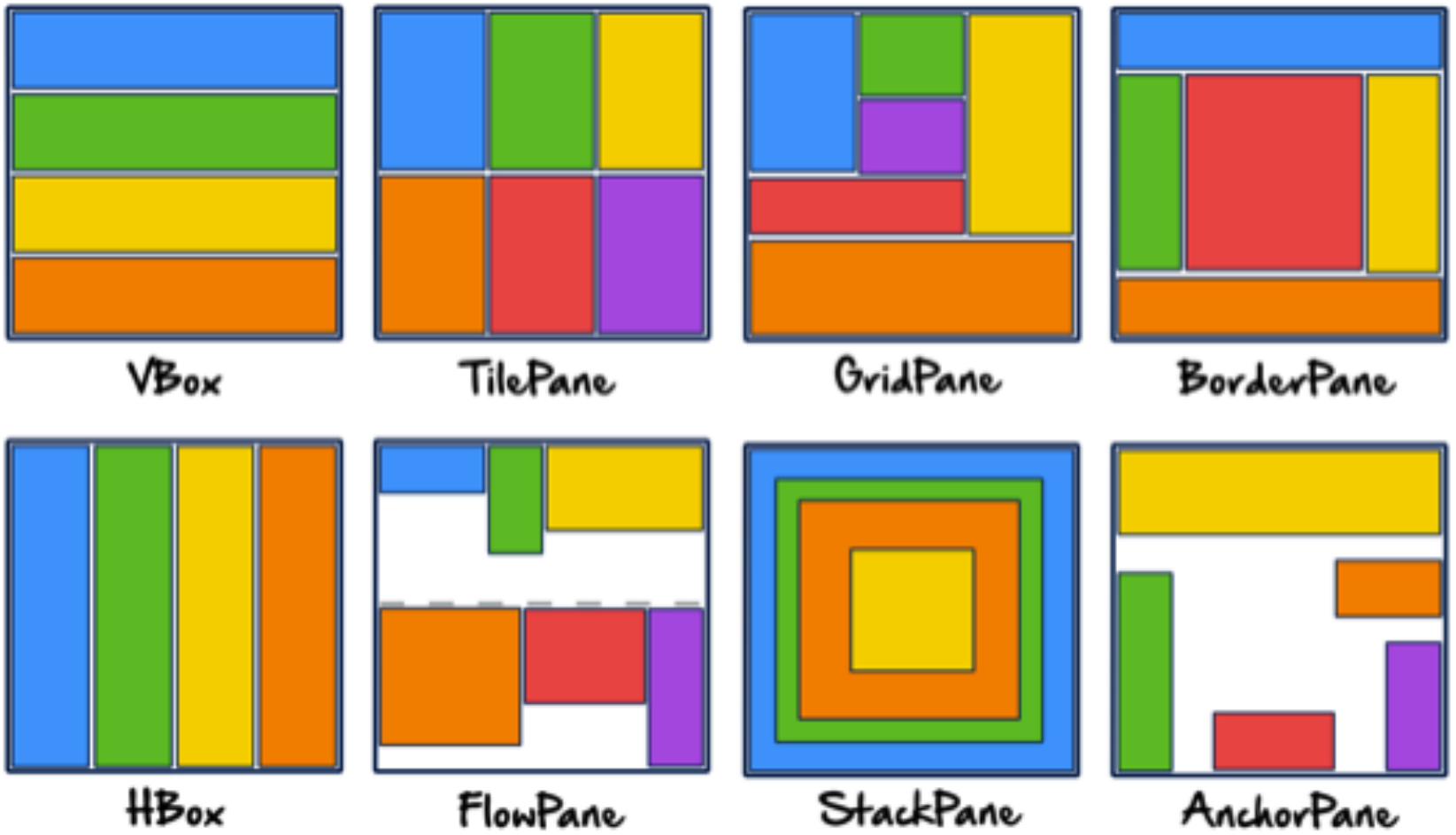
A more realistic structure

A more realistic structure of a JavaFX program

- Application
- Override the `start(Stage)` method
- Stage ← Scene ← Panes ← UI Nodes

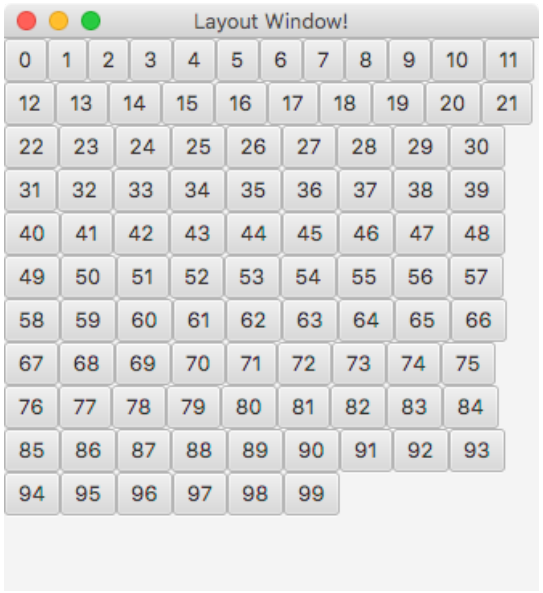


Panes for layout



more tutorials at https://docs.oracle.com/javafx/2/layout/builtin_layouts.htm
image from JavaFX 8 By Hendrik Ebbers & Michael Heinrichs

Panes for layout - FlowPane




```
package examples;

import javafx.application.Application;
import javafx.scene.Scene;
import javafx.scene.control.Button;
import javafx.scene.layout.FlowPane;
import javafx.stage.Stage;

public class LayoutButtons extends Application {

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

     @Override
     public void start(Stage primaryStage) throws Exception {

          FlowPane root = new FlowPane();

          for (int i = 0; i<100; ++i) {
               root.getChildren().add(new Button(Integer.toString(i)));
          }

          Scene scene = new Scene(root, 300, 300);

          primaryStage.setTitle("Layout Window!");
          primaryStage.setScene(scene);
          primaryStage.show();
     }
}
```

https://docs.oracle.com/javafx/2/layout/builtin_layouts.htm

Panes for layout - GridPane

```
public class LayoutGrid extends Application {

     // main here …

     @Override
     public void start(Stage primaryStage) throws Exception {

          GridPane root = new GridPane();
          root.setVgap(10);
          root.setHgap(10);

          int i =0;
          int j =0;

          for (i=0;i<10; ++i)
               for (j=0; j<10;++j){
                    Button btn = new Button(i + "." + j);
                    root.add( btn, i,j); // not use getChildren() as we set position
          }


          Text txt = new Text ("This is a grid");
          root.add(txt,0,j,10,1); // start column,row ; span column,row

          Scene scene = new Scene(root, 500, 500);

          primaryStage.setTitle("Layout Window!");
          primaryStage.setScene(scene);
          primaryStage.show();
     }
}
```

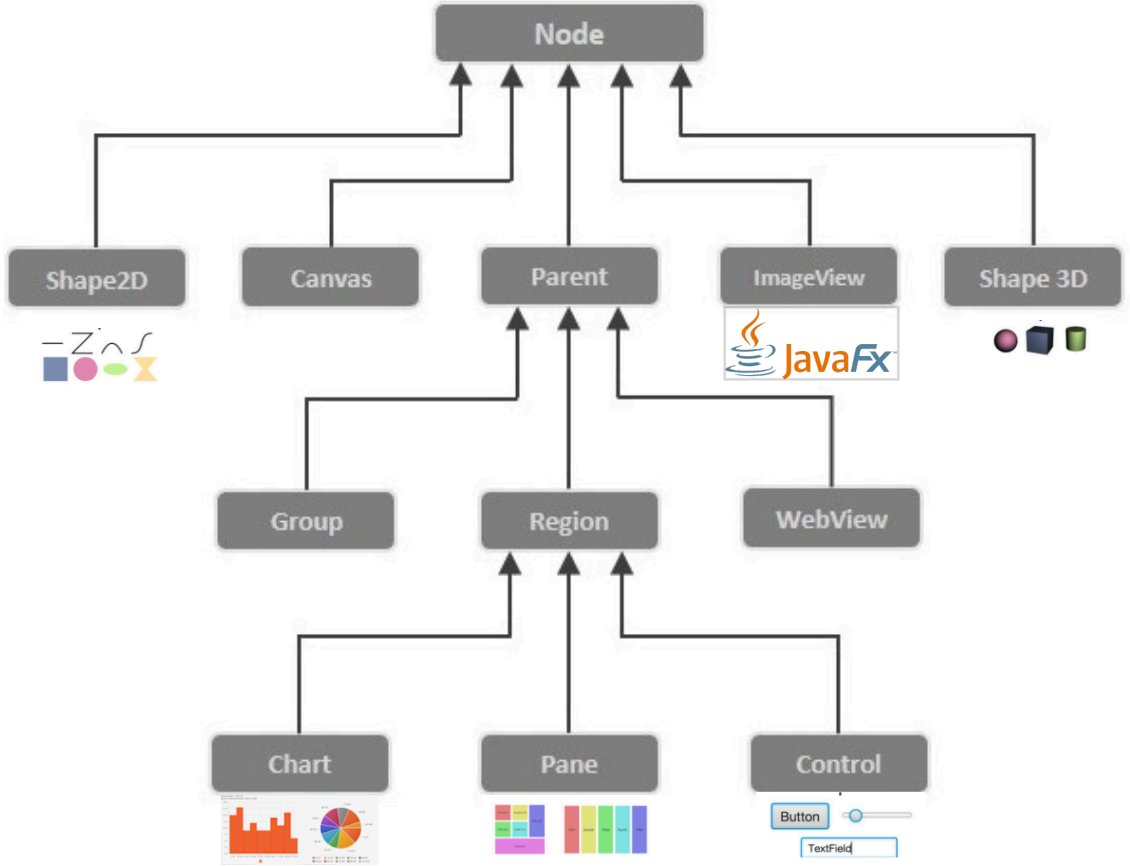
https://docs.oracle.com/javafx/2/layout/builtin_layouts.htm

Layout Pane Classes

Pane	Base class for all layout panes. It contains the `getChildren()` method that returns all **nodes** in the pane.
Stack Pane	Nodes on top of each other in centre of pane.
FlowPane	Nodes flow to fill horizontal (vertical) space.
GridPane	Nodes in cell(s) of a grid.
BorderPane	Nodes in one of five regions (T,B,C,L,R).
AnchorPane	Nodes anchored on sides or centre of pane.
HBox	Nodes horizontally.
VBox	Nodes vertically.

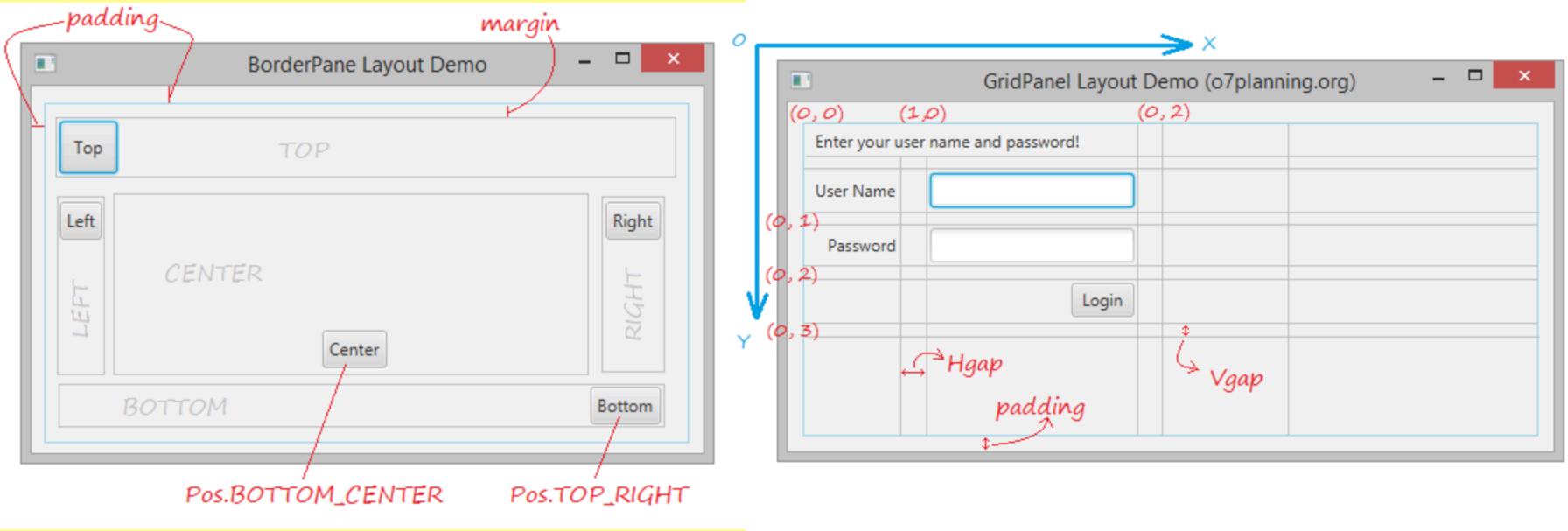
The class Node

Layout Panes are considered nodes (same as Controls)
so they can be added to other Panes



Improving layout

Layout Panes have different properties to help create layouts that persist during resizing
(margin, padding, Vgap/Hgap, alignment)



https://o7planning.org/en/10629/javafx-borderpane-layout-tutorial

Panes for layout - examples

```
import javafx.application.Application;

public class CombinedLayouts extends Application{

    // main here …

    @Override
    public void start(Stage primaryStage) throws Exception {

        HBox hbox = new HBox();
        hbox.setPadding(new Insets(15, 12, 15, 12)); // padding all around
        hbox.setSpacing(10); // space between nodes
        hbox.setStyle("-fx-background-color: #336699;"); // familiar?

        Button buttonCurrent = new Button("Current");
        buttonCurrent.setPrefSize(100, 20); // preferred size

        Button buttonProjected = new Button("Projected");
        buttonProjected.setPrefSize(100, 20);

        hbox.getChildren().addAll(buttonCurrent, buttonProjected);

        BorderPane root = new BorderPane();
        root.setTop(hbox); // a Pane added to another Pane

        Scene scene = new Scene (root, 200, 200);
        primaryStage.setTitle("Complex Window!");
        primaryStage.setScene(scene);
        primaryStage.show();

    }
}
```

https://docs.oracle.com/javafx/2/layout/builtin_layouts.htm and https://openjfx.io/javadoc/15/

building the interface

When coding (after the design phase):

- Always start by laying out nodes in the window
- Handle the functionality (discussed next) **after**

Use **Pane**s to **structure** and
sub-divide the layout.

building the interface

Example of structure and resulting code:

```
Scene
Pane
    Label "A"
    TextField
Panel
    Label "B"
    TextField
```

Structure

```
Container panel = getContentPane();

VBox panelA = new VBox();
panel.add(panelA);
panelA.add(new Label("A"));
panelA.add(new TextField(5));

VBox panelB = new VBox();
panel.add(panelB);
panelB.add(new Label("B"));
panelB.add(new TextField(5));
```

Code

JavaFX and CSS

Consistent design

Imagine we have one or more windows and decide we want to change their visual style everywhere …

CSS (cascading style sheets)

… it describes how HTML elements are to be displayed on screen, paper, or in other media …

… and saves a lot of work. It can control the layout of multiple web pages all at once

Consistent design

In the location of your main create a CSS file

New → File

give name mycss.css (do not convert your project!)

Inside the css add some styling properties:

```
.root {
     -fx-background-image: url("background.jpeg");
}

.label {
    -fx-font-size: 12px;
    -fx-font-weight: bold;
    -fx-text-fill: #333333;
    -fx-effect: dropshadow( gaussian , rgba(255,255,255,0.5) , 0,0,0,1 );
}
.button {
    -fx-text-fill: white;
    -fx-font-family: "Arial Narrow";
    -fx-font-weight: bold;
    -fx-background-color: linear-gradient(#61a2b1, #2A5058);
    -fx-effect: dropshadow( three-pass-box , rgba(0,0,0,0.6) , 5, 0.0 , 0 , 1 );
}

.button:hover {
    -fx-background-color: linear-gradient(#2A5058, #61a2b1);
}
```

https://docs.oracle.com/javafx/2/get_started/css.htm

Original Class

```
public class UseNoCSS extends Application {
     // main here …
     @Override
     public void start(Stage primaryStage) throws Exception {

          GridPane grid = new GridPane();
          grid.setAlignment(Pos.CENTER);
          grid.setHgap(10);
          grid.setVgap(10);
          grid.setPadding(new Insets(25, 25, 25, 25));

          Label userName = new Label("User Name:");
          grid.add(userName, 0, 1);

          TextField userTextField = new TextField();
          grid.add(userTextField, 1, 1);

          Label pw = new Label("Password:");
          grid.add(pw, 0, 2);

          PasswordField pwBox = new PasswordField();
          grid.add(pwBox, 1, 2);

          Button okBtn = new Button("ok");
          grid.add(okBtn, 1,3);

          Scene scene = new Scene(grid, 300, 275);

          primaryStage.setScene(scene);
          primaryStage.setTitle("Trying without CSS window!");
          primaryStage.show();
     }
}
```

https://docs.oracle.com/javafx/2/get_started/css.htm

Original Class + CSS commands

```
public class UseCSS extends Application {
      // main here …
      @Override
      public void start(Stage primaryStage) throws Exception {

            GridPane grid = new GridPane();
            grid.setAlignment(Pos.CENTER);
            grid.setHgap(10);
            grid.setVgap(10);
            grid.setPadding(new Insets(25, 25, 25, 25));

            Label userName = new Label("User Name:");
            grid.add(userName, 0, 1);

            TextField userTextField = new TextField();
            grid.add(userTextField, 1, 1);

            Label pw = new Label("Password:");
            grid.add(pw, 0, 2);

            PasswordField pwBox = new PasswordField();
            grid.add(pwBox, 1, 2);

            Button okBtn = new Button("ok");
            grid.add(okBtn, 1,3);

            Scene scene = new Scene(grid, 300, 275);

            scene.getStylesheets().add
             (UseCSS.class.getResource("mycss.css").toExternalForm());

            primaryStage.setTitle("Trying with CSS");
            primaryStage.setScene(scene);
            primaryStage.show();
      }
}
```

Simple CSS use
to apply basic styling:
just load CSS file

https://docs.oracle.com/javafx/2/get_started/css.htm

Consistent design using CSS

Simple way to apply style to all windows

https://docs.oracle.com/javafx/2/get_started/css.htm

Resources

https://docs.oracle.com/javafx/2/layout/builtin_layouts.htm

https://docs.oracle.com/javase/8/javafx/layout-tutorial/size_align.htm#JFXLY133

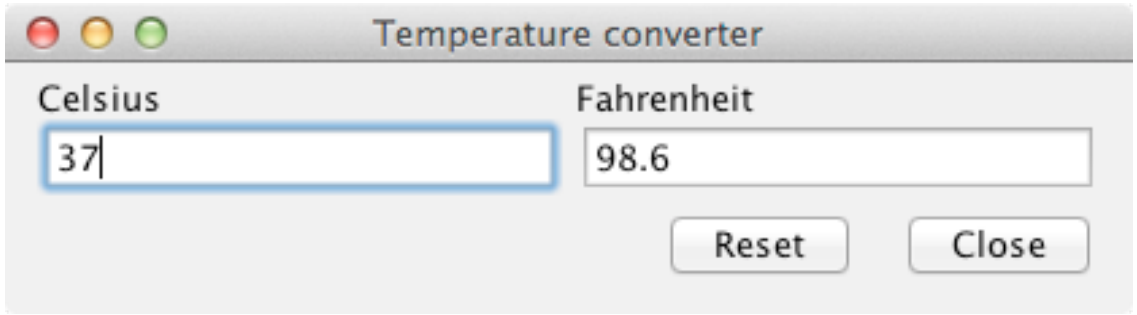
https://o7planning.org/en/11009/javafx (lots on layouts)

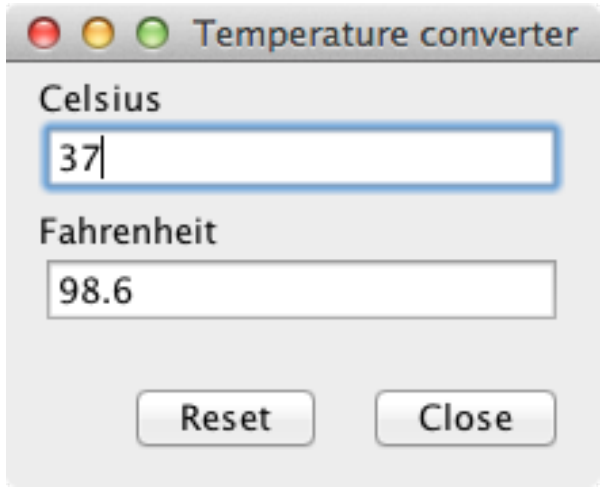
https://docs.oracle.com/javafx/2/get_started/css.htm

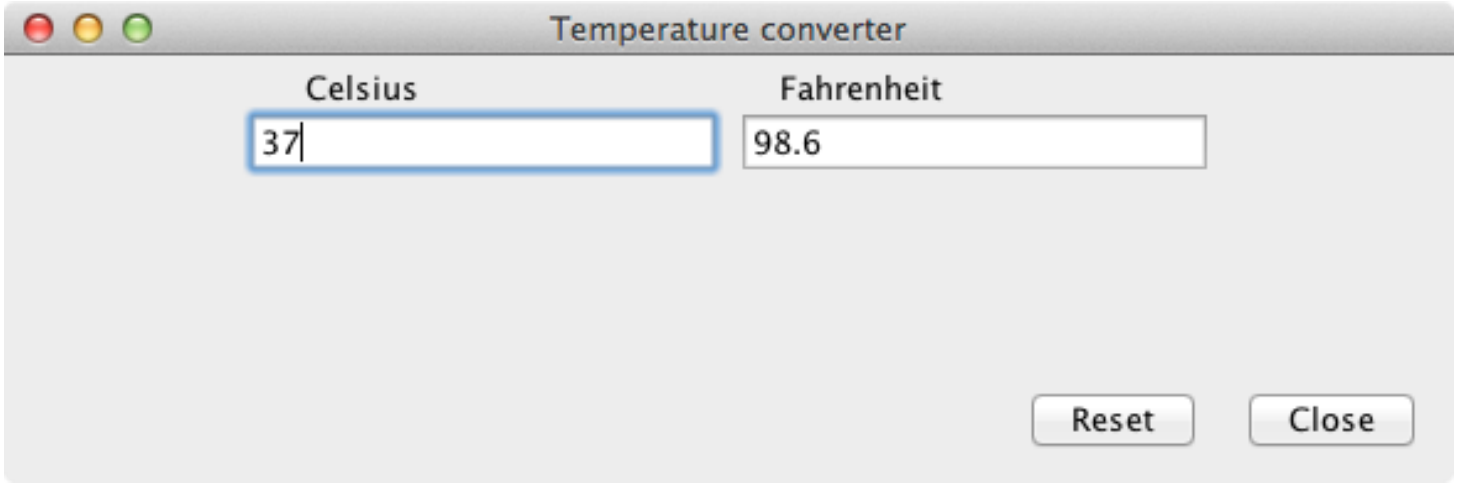
In-class exercises

In-class discussion

(this will look a bit like your TA exercise, but you'll focus there on coding on different layouts and behavior)



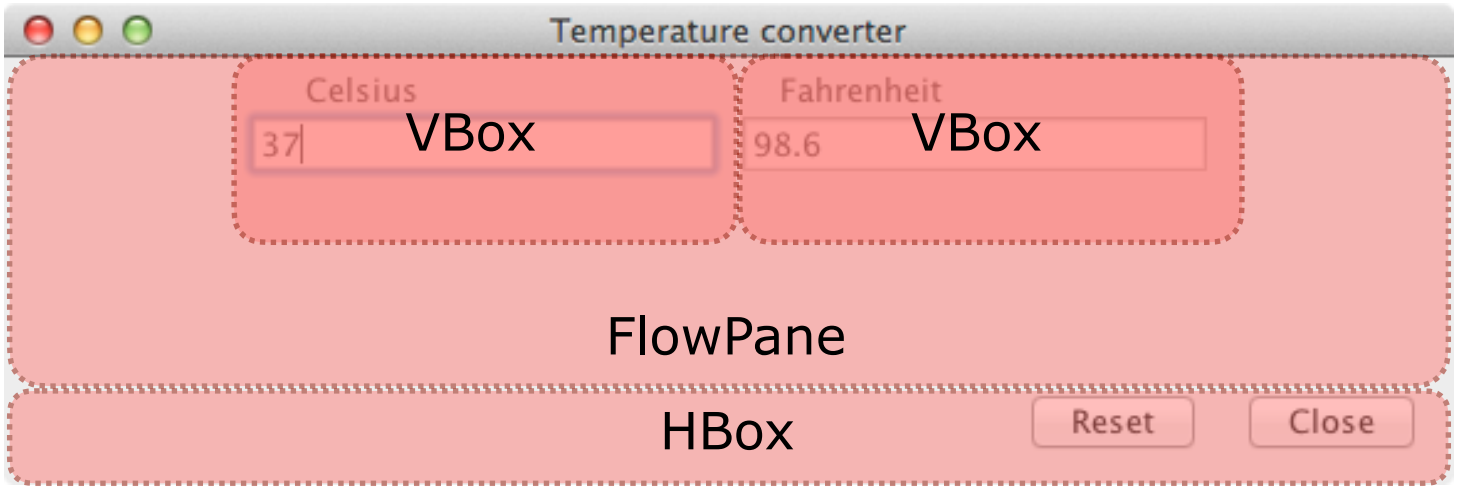




Before writing code for the layout, **identify the structure** that sub-divides nicely the UI components into rectangular areas. (*)

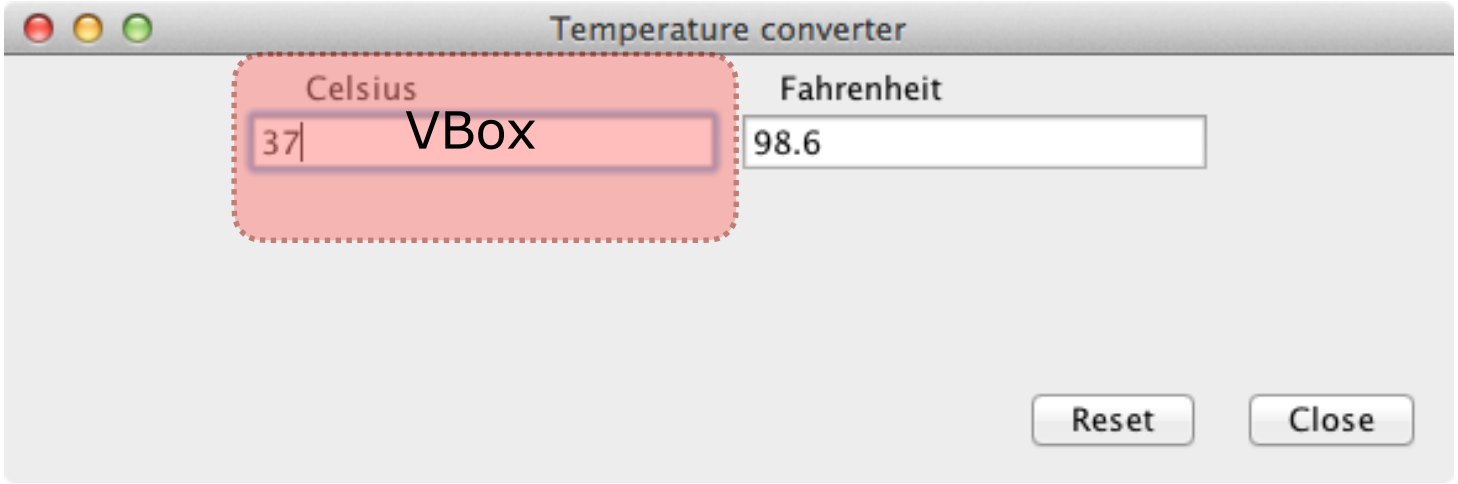
Which areas (Panes) do you see?

(*) in TA tomorrow you'll try coding this, or another solution

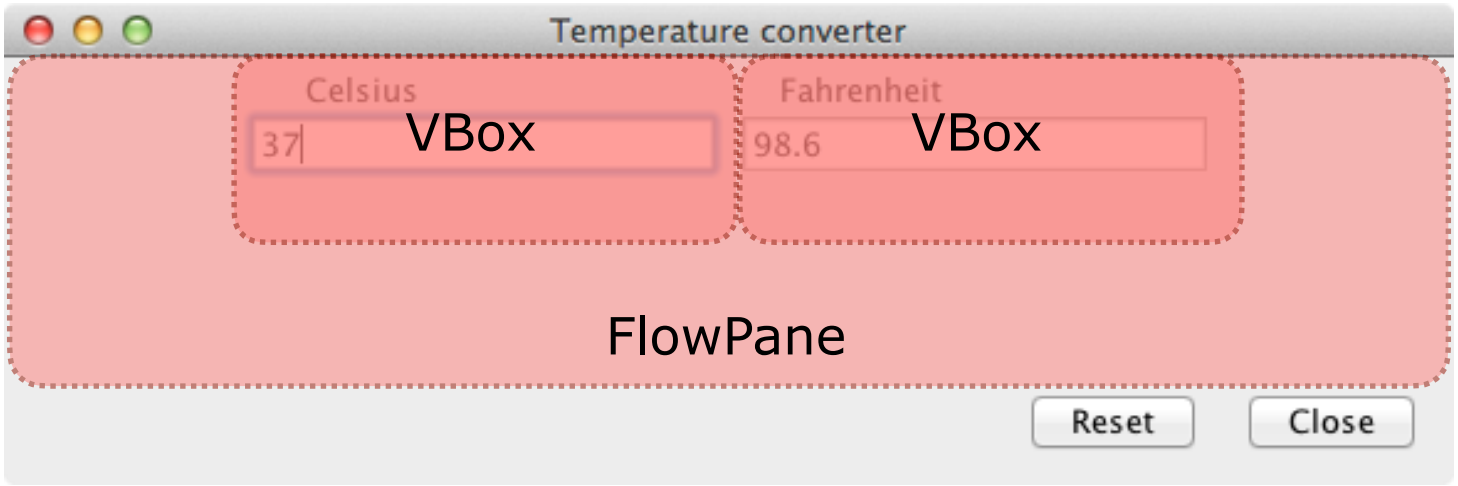


In this example, we have sub-divided the layout into different Panes and chosen a specific layout (VBox and FlowPane) for each of them.

Note that there are many possible solutions.

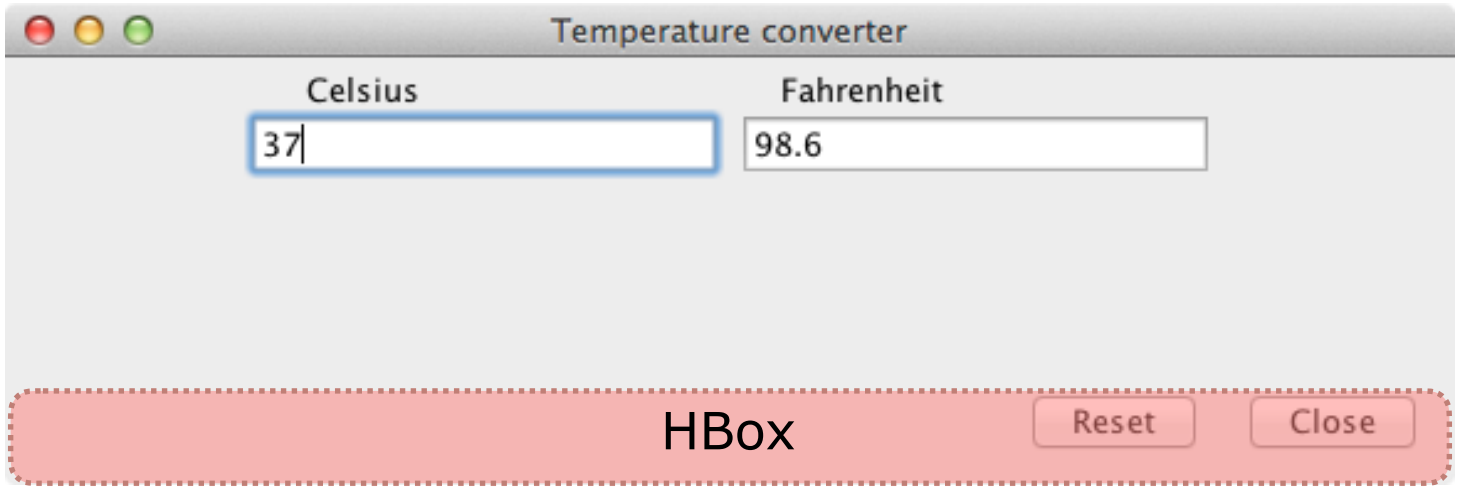



```
VBox paneC = new VBox();
paneC.setPadding(new Insets(10, 10, 10, 10));
paneC.getChildren().addAll(new Label("Celcius"), new TextField());


// similarly you can create a paneF for the Fahhrenheit data
```

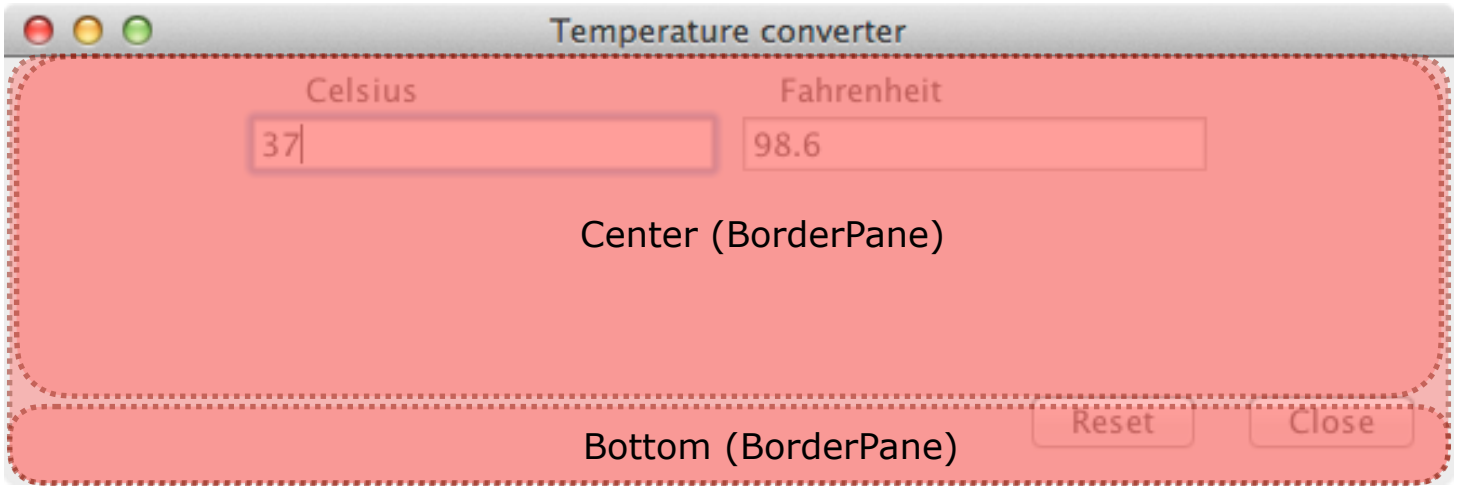



```
FlowPane paneCF = new FlowPane();
paneCF.getChildren().addAll(paneC,paneF);
```

Insertion order is important: items are added from **left to right** for horizontal layouts and **top to bottom** for vertical layouts.




```
HBox paneButtons = new HBox();
paneButtons.setPadding(new Insets(10, 10, 10, 10));
paneButtons.setSpacing(10);
paneButtons.setAlignment(Pos.CENTER_RIGHT);
paneButtons.getChildren().addAll(new Button ("Reset"),
                                 new Button("Close"));
```




```
BorderPane root = new BorderPane();
root.setCenter(paneCF);
root.setBottom(paneButtons);


// need to add root to our main Scene and
// add then scene to our Stage
```

In-class assignment

Consider your minesweeper,
how would you layout your controls?