Lecture 10

Graphics Part III – Building up to Cartoon

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Outline

- Shapes
  - example: `MovingShape`
  - `App`, `PaneOrganizer`, and `MoveHandler` classes
- Constants
  - Lecture Question: Slide 41
- Composite Shapes
  - example: `Alien`
  - Lecture Question: Slide 53, Slide 61
- Cartoon

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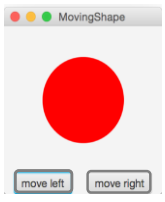
Example: `MovingShape`

- Specification: App that displays a shape and buttons that shift position of the shape left and right by a fixed increment
- Purpose: Practice working with absolute positioning of `Pane`s, various `Shape`s, and more event handling!



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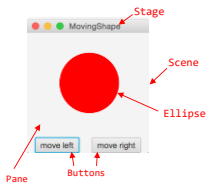
Process: MovingShapeApp

1. **Write an `App` class that extends `javafx.application.Application` and implements `start` (standard pattern)**
2. Write a `PaneOrganizer` class that instantiates root node and makes a public `getRoot()` method. In `PaneOrganizer`, create an `Ellipse` and add it as child of root `Pane`
3. Write a `ShapeMover` class which will be responsible for shape movement and other logic. It is instantiated in the `PaneOrganizer`'s constructor
4. Write `setupShape()` and `setupButtons()` helper methods to be called within `ShapeMover`'s constructor. These will factor out code for modifying our sub-`Pane`s
5. Register `Button`s with `EventHandler`s that handle `Button`s' `ActionEvent`s (clicks) by moving `Shape` correspondingly, within the `ShapeMover` class



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MovingShapeApp: App Class (1/3)

NOTE: Exactly the same process as previous examples

1a. Instantiate a `PaneOrganizer` and store it in the local variable `organizer`

```
public class App extends Application {

    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();


    }
}
```


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MovingShapeApp: App Class (2/3)

NOTE: Exactly the same process as previous examples

1a. Instantiate a `PaneOrganizer` and store it in the local variable `organizer`

1b. Instantiate a `Scene`, passing in `organizer.getRoot()` and desired width and height of `Scene` (in this case 200x200)

```
public class App extends Application {

    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();
        Scene scene = new Scene(organizer.getRoot(), 200, 200);


    }
}
```


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MovingShapeApp: App Class (3/3)

NOTE: Exactly the same process as previous examples

1a. Instantiate a `PaneOrganizer` and store it in the local variable `organizer`

1b. Instantiate a `Scene`, passing in `organizer.getRoot()` and desired width and height of `Scene` (in this case 200x200)

1c. Set `scene`, set `Stage`'s title and show it!

```
public class App extends Application {

    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();
        Scene scene = new Scene(organizer.getRoot(), 200, 200);

        stage.setScene(scene);
        stage.setTitle("MovingShape");
        stage.show();
    }

}
```


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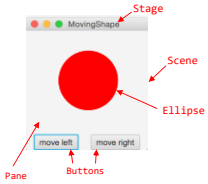
Process: MovingShapeApp

1. Write an `App` class that extends `javafx.application.Application` and implements `start` (standard pattern)
2. **Write a `PaneOrganizer` class that instantiates root node and makes a public `getRoot()` method. In `PaneOrganizer`, create all necessary `Panes` and initialize the `ShapeMover` class**
3. Write a `ShapeMover` class which will be responsible for shapes creation, movement, and other logic. It is instantiated in the `PaneOrganizer`'s constructor
4. Write `setupShape()` and `setupButtons()` helper methods to be called within `ShapeMover`'s constructor. These will factor out code for modifying our sub-`Pane`s
5. Register `Button`s with `EventHandler`s that handle `Button`s' `ActionEvent`s (clicks) by moving `Shape` correspondingly, within the `ShapeMover` class



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MovingShapeApp: PaneOrganizer Class (1/3)

2a. Instantiate the root `Pane` and store it in the instance variable `_root`

```
public class PaneOrganizer {
    private Pane _root;

    public PaneOrganizer() {
        _root = new Pane();



    }


}
```


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MovingShapeApp: PaneOrganizer Class (2/3)

2a. Instantiate the root `Pane` and store it in the instance variable `_root`

2b. Create a public `getRoot()` method that returns `_root`

```
public class PaneOrganizer {
    private Pane _root;

    public PaneOrganizer() {
        _root = new Pane();

    }

    public Pane getRoot() {
        return _root;
    }
}
```


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MovingShapeApp: PaneOrganizer Class (3/3)

2a. Instantiate the root `Pane` and store it in the instance variable `_root`

2b. Create a public `getRoot()` method that returns `_root`

2c. Create a new instance of `ShapeMover()`, defined next. Pass `_root` as argument (The constructor of `ShapeMover()` takes in a `Pane` Slide 13)

```
public class PaneOrganizer {
    private Pane _root;

    public PaneOrganizer() {
        _root = new Pane();

        new ShapeMover(_root);
    }

    public Pane getRoot() {
        return _root;
    }
}
```


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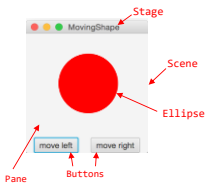
Process: MovingShapeApp

1. Write an `App` class that extends `javafx.application.Application` and implements `start` (standard pattern)
2. Write a `PaneOrganizer` class that instantiates root node and makes a public `getRoot()` method. In `PaneOrganizer`, create an `Ellipse` and add it as child of root `Pane`
3. **Write a `ShapeMover` class which will be responsible for shape movement and other logic. It is instantiated in the `PaneOrganizer`'s constructor**
4. Write `setupShape()` and `setupButtons()` helper methods to be called within `ShapeMover`'s constructor. These will factor out code for modifying our sub-`Pane`s
5. Register `Button`s with `EventHandler`s that handle `Button`s' `ActionEvent`s (clicks) by moving `Shape` correspondingly, within the `ShapeMover` class



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MovingShapeApp: ShapeMover Class (1/4)

- PaneOrganizer was getting too complex: Factor out the program logic into ShapeMover; it will
  - set up the shape graphically and logically
  - set up the buttons graphically and logically
  - set up the EventHandler and link it to the buttons

3a. Make the constructor of ShapeMover take in the root Pane (created in PaneOrganizer, see slide 11)

```
public class ShapeMover {

    public ShapeMover(Pane root) {


    }
}
```


MovingShapeApp: ShapeMover Class (2/4)

3a. Make the constructor of ShapeMover take in the root Pane

3b. Create an instance variable _ellipse and initialize an ellipse

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane root) {
        _ellipse = new Ellipse(50, 50);


    }
}
```


MovingShapeApp: ShapeMover Class (3/4)

3a. Make the constructor of ShapeMover take in the root Pane

3b. Create an instance variable _ellipse and initialize an ellipse

3c. Add the ellipse as a child of the root Pane

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane root) {
        _ellipse = new Ellipse(50, 50);
        root.getChildren().add(_ellipse);


    }
}
```

MovingShapeApp: ShapeMover Class (4/4)

3a. Make the constructor of ShapeMover take in the root Pane

3b. Create an instance variable _ellipse and initialize an ellipse

3c. Add the ellipse as a child of the root Pane

3d. Call setupShape() and setupButtons(), defined next

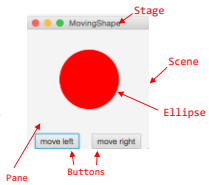
```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane root) {
        _ellipse = new Ellipse(50, 50);
        root.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(root);
    }
}
```


Process: MovingShapeApp

1. Write an App class that extends javafx.application.Application and implements start (standard pattern)
2. Write a PaneOrganizer class that instantiates root node and makes a public getRoot() method. In PaneOrganizer, create an Ellipse and add it as child of root Pane
3. Write a ShapeMover class which will be responsible for shape movement and other logic. It is instantiated in the PaneOrganizer's constructor
4. **Write setupShape() and setupButtons() helper methods to be called within ShapeMover's constructor. These will factor out code for modifying our sub-Panes**
5. Register Buttons with EventHandlers that handle Buttons' ActionEvents (clicks) by moving Shape correspondingly, within the ShapeMover class



Aside: helper methods

- As our applications start getting more complex, we will need to write a lot more code to get the UI looking the way we would like
- Such code would convolute the ShapeMover constructor—it is good practice to **factor** out code into **helper methods** that are called within the constructor—another use of the delegation pattern
  - setupShape() fills and positions Ellipse
  - setupButtons() adds and positions Buttons, and registers them with their appropriate EventHandlers
- Helper methods of the form setupX() are fancy initializing assignments. Should be used to initialize variables, but **not** for arbitrary/non-initializing code.
- Generally, helper methods should be private – more on this in a moment

`MovingShapeApp`: `setupShape()` helper method

- For this application, "helper method" `setupShape()` will only set fill color and position `Ellipse` in `Pane` using absolute positioning
- Helper method is `private`—why is this good practice?
  - only `ShapeMover()` should be allowed to initialize the color and location of the `Ellipse`
  - `private` methods are not directly inherited and are not accessible to subclasses—though inherited superclass methods may make use of them w/o the subclass knowing about them!

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane root) {
        _ellipse = new Ellipse(50, 50);
        root.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(root);
    }
    private void setupShape() {
        _ellipse.setFill(Color.RED);
        _ellipse.setCenterX(50);
        _ellipse.setCenterY(50);
    }
}
```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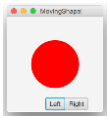
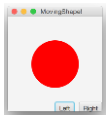
Aside: `PaneOrganizer` Class (1/3)

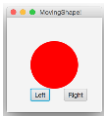
- We were able to absolutely position `_ellipse` in the root `Pane` because our root is simply a `Pane` and not one of the more specialized subclasses
- We could also use absolute positioning to position the `Button`s in the `Pane` in our `setUpButtons()` method… But look how annoying trial-and-error is!



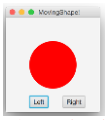

```
left.relocate(50,165);
right.relocate(120,165);
```




```
left.relocate(100,180);
right.relocate(150,180);
```




```
left.relocate(50,150);
right.relocate(120,150);
```




```
left.relocate(50,165);
right.relocate(120,165);
```

Is there a better way? ...hint: leverage Scene Graph hierarchy and delegation!

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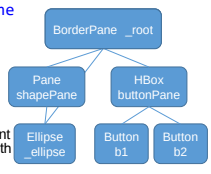
Aside: `PaneOrganizer` Class (2/3)

- Rather than absolutely positioning `Button`s directly in root `Pane`, use a specialized layout `Pane`: add a new `HBox` as a child of the root `Pane`
  - add `Button`s to `HBox`, to align horizontally
- Continuing to improve our design, use a `BorderPane` as root to use its layout manager
- Now need to add `Ellipse` to the root
  - could simply add `Ellipse` to CENTER of root `BorderPane`
  - but this won't work—if `BorderPane` dictates placement of `Ellipse` we won't be able to update its position with `Button`s
  - instead: create a `Pane` to contain `Ellipse` and add the `Pane` as child of root! Can adjust `Ellipse` within its `shapePane` independently!

Scene graph hierarchy



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Aside: `PaneOrganizer` Class (3/3)

- This makes use of the built-in layout capabilities available to us in JavaFX!
- Also makes symmetry between the panel holding a shape (in Cartoon, this panel will hold composite shapes that you'll make) and the panel holding our buttons
- Note: this is only one of *many* design choices for this application!
  - keep in mind all of the different layout options when designing your programs!
  - using absolute positioning for entire program is most likely *not* best solution—where possible, leverage power of layout managers (`BorderPane`, `HBox`, `VBox`,…)

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`MovingShapeApp`: update to `BorderPane`

4a. Change root to a `BorderPane`

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();




        new ShapeMover(_root);
    }

    public Pane getRoot() {
        return _root;
    }
}
```


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`MovingShapeApp`: update to `BorderPane`

4a. Change root to a `BorderPane`

4b. Create a `Pane` to contain `Ellipse`. To add `shapePane` to center of `BorderPane`, call `setCenter(shapePane)` on root

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();

        // setup shape pane
        Pane shapePane = new Pane(););
        _root.setCenter(shapePane);


        new ShapeMover(_root);
    }

    public Pane getRoot() {
        return _root;
    }
}
```


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MovingShapeApp: creation of ButtonPane (1/2)

4c. Instantiate a new HBox, then add it as child of BorderPane, in bottom position

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();

        // setup shape pane
        Pane shapePane = new Pane();
        _root.setCenter(shapePane);

         HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);

        new ShapeMover(_root);
    }

    public Pane getRoot() {
        return _root;
    }
}
```

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MovingShapeApp: creation of ButtonPane (2/2)

4c. Instantiate a new HBox, then add it as child of BorderPane, in bottom position

4d. Modify the argument of ShapeMover to take in the shapePane and the buttonPane instead of the root Pane

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();

        // setup shape pane
        Pane shapePane = new Pane();
        _root.setCenter(shapePane);

         HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);

        new ShapeMover(shapePane, buttonPane);
    }

    public Pane getRoot() {
        return _root;
    }
}
```

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MovingShapeApp: Ellipse in the shapePane

4e. In the ShapeMover class, add the ellipse as a child of the shapePane instead of root

- note: none of the code in our `setupShape()` method needs to be updated since it accesses `_ellipse` directly… with this redesign, `_ellipse` now is just **graphically** contained within a different `Pane` (the `shapePane`) and now in the center of the `root` because we called `setCenter(shapePane)`
- and `ShapeMover` can still access the ellipse because it remains its instance variable!
  - this could be useful if we want to change any properties of the `Ellipse` later on, e.g., updating its x and y position, or changing its color
  - illustration of graphical vs. logical containment

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {

        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(buttonPane);
    }

    /* setupShape elided!  This method sets the color and
     * initial position of the ellipse
     */
}
```

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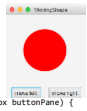
MovingShapeApp: setupButtons() method (1/4)

4f. In the ShapeMover class, create a method called setupButtons() which takes in the buttonPane and instantiate two Buttons



```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {

        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(buttonPane);
    }

    // setupShape elided!

    private void setupButtons(HBox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");


    }
}
```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MovingShapeApp: setupButtons() method (2/4)

4f. In the ShapeMover class, create a method called setupButtons() which takes in the buttonPane and instantiate two Buttons

4g. Add the Buttons as children of the new HBox

- order matters when adding children to Panes. For this HBox, b1 will be to the left of b2 because it is added first in the list of arguments in addAll(…)

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {

        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(buttonPane);
    }

    // setupShape elided!

    private void setupButtons(HBox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");
        buttonPane.getChildren().addAll(b1, b2);


    }
}
```


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MovingShapeApp: setupButtons() method (3/4)

4h. Set horizontal spacing between Buttons as you like

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {

        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(buttonPane);
    }

    // setupShape elided!

    private void setupButtons(HBox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");
        buttonPane.getChildren().addAll(b1, b2);

        buttonPane.setSpacing(30);
    }

}
```


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MovingShapeApp: setupButtons() method (4/4)

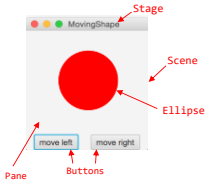
4h. Set horizontal spacing between Buttons as you like

4i. We will come back to the ShapeMover class in the next step in order to register Buttons with their EventHandlers, but first we should define the EventHandler

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {

        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);

        this.setupShape();
        this.setupButtons(buttonPane);
    }

    // setupShape elided!

    private void setupButtons(HBox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");
        buttonPane.getChildren().addAll(b1, b2);

        buttonPane.setSpacing(30);
    }

}
```


Process: MovingShapeApp

1. Write an App class that extends javafx.application.Application and implements start (standard pattern)
2. Write a PaneOrganizer class that instantiates root node and makes a public getRoot() method. In PaneOrganizer, create an Ellipse and add it as child of root Pane
3. Write a ShapeMover class which will be responsible for shape movement and other logic. It is instantiated in PaneOrganizer's constructor
4. Write setupShape() and setupButtons() helper methods to be called within ShapeMover's constructor. These will factor out code for modifying our sub-Panes
5. **Register Buttons with EventHandlers that handle Buttons' ActionEvents (clicks) by moving Shape correspondingly, within the ShapeMover class**



Aside: Creating EventHandlers

- Our goal is to register each button with an EventHandler
  - the "move left" Button moves the Ellipse left by a set amount
  - the "move right" Button moves the Ellipse right the same amount
- We could define two separate EventHandlers, one for the "move left" Button and one for the "move right" Button…
  - why might this not be the optimal design?
  - remember, we want to be efficient with our code usage!
- Instead, we can define one EventHandler
  - factor out common behavior into one class that will have two instances
  - specifics determined by parameters passed into the constructor!
  - admittedly, this is not an obvious design—these kinds of simplifications typically have to be learned…

MovingShapeApp: MoveHandler (1/3)

5a. Declare an instance variable `_distance` that will be initialized differently depending on whether the `isLeft` argument is `true` or `false`

NOTE: such methods returning a boolean are called predicates

```
public class ShapeMover {
    // other code elided

    public ShapeMover(Pane shapePane, HBox buttonPane) {
        // other code elided
    }

    private class MoveHandler implements EventHandler<ActionEvent> {
          private double _distance;

          public MoveHandler(boolean isLeft) {



          }

          public void handle(ActionEvent e) {

          }

    }

}
```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MovingShapeApp: MoveHandler (2/3)

5a. Declare an instance variable `_distance` that will be initialized differently depending on whether the `isLeft` argument is `true` or `false`

5b. Set `_distance` to 10 initially—if the registered `Button isLeft`, change `_distance` to -10 so the `Ellipse` moves in the opposite direction

```
public class ShapeMover {
    // other code elided

    public ShapeMover(Pane shapePane, Hbox buttonPane) {
        // other code elided
    }

    private class MoveHandler implements EventHandler<ActionEvent> {
          private double _distance;

          public MoveHandler(boolean isLeft) {
                _distance = 10;
                if (isLeft) {
                   _distance *= -1; //change sign
                }
          }

          public void handle(ActionEvent e) {

          }

    }

}
```


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MovingShapeApp: MoveHandler (3/3)

5a. Declare an instance variable `_distance` that will be initialized differently depending on whether the `isLeft` argument is `true` or `false`

5b. Set `_distance` to 10 initially – if the registered `Button isLeft`, change `_distance` to -10 so the `Ellipse` moves in the opposite direction

5c. Implement the handle method to move the `Ellipse` by `_distance` in the horizontal direction

```
public class ShapeMover {
    // other code elided

    public ShapeMover(Pane shapePane, HBox buttonPane) {
        // other code elided
    }

    private class MoveHandler implements EventHandler<ActionEvent> {
          private double _distance;

          public MoveHandler(boolean isLeft) {//constructor
                _distance = 10;
                if (isLeft) {
                   _distance *= -1;//change sign
                }
          }

          public void handle(ActionEvent e) {//called by JFX
                _ellipse.setCenterX(_ellipse.getCenterX()+_distance);
          }

    }

}
```


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MovingShapeApp: back to setupButtons()

Register Buttons with their EventHandlers by calling setOnAction() and passing in our instances of MoveHandler, which we just created!

```
public class ShapeMover {
    private Ellipse _ellipse;

    public ShapeMover(Pane shapePane, HBox buttonPane) {
        _root = new BorderPane();

        // setup of shape elided!

        this.setupButtons(buttonPane);
    }
    // setupShape elided!
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");
        buttonPane.getChildren().addAll(b1, b2);

        buttonPane.setSpacing(30);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
                    This is where we set isLeft
// MoveHandler elided!
}
```


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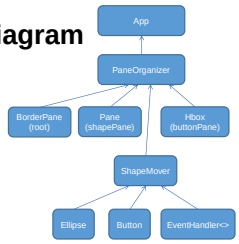
Logical Containment Diagram

- Note this is quite different from the Scene Graph, which only handles graphical containment
- PaneOrganizer contains three Panes (root, shapePane, buttonPane) and the ShapeMover
  - Notice PaneOrganizer Delegates the handling of graphical shapes to ShapeMover
- ShapeMover contains an Ellipse, Buttons, and an EventHandler (MoveHandler)



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The Whole App

```
package MovingShape;
// imports for the App class
import javafx.application.Application;
import javafx.scene.Scene;
import javafx.stage.Stage;
// imports for the PaneOrganizer class
import javafx.scene.layout.*;
import javafx.scene.shape.Ellipse;
// imports for the ShapeMover class
import javafx.scene.paint.Color;
import javafx.event.*;
import javafx.geometry.Pos;
import javafx.scene.control.Button;

public class App extends Application {
    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();
        Scene scene = new Scene(organizer.getRoot(), 200, 130);
        stage.setScene(scene);
        stage.setTitle("MovingShape");
        stage.show();
    }

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

public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();
        Pane shapePane = new Pane();
        _root.setCenter(shapePane);
        HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);
        new ShapeMover(shapePane, buttonPane);
    }
    public Pane getRoot() {
        return _root;
    }
```

```
public class ShapeMover {
    private Ellipse _ellipse;
    public ShapeMover(Pane shapePane, Hbox buttonPane) {
        _ellipse = new Ellipse(50, 50);
        shapePane.getChildren().add(_ellipse);
        this.setupShape();
        this.setupButtons(buttonPane);
    }
    private void setupShape() {
        _ellipse.setFill(Color.RED);
        _ellipse.setCenterX(100);
        _ellipse.setCenterY(50);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("move left");
        Button b2 = new Button("move right");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(30);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    private class MoveHandler implements EventHandler<ActionEvent> {
        private double _distance;
        public MoveHandler(boolean isLeft) {
            _distance = 10;
            if (isLeft) {
                _distance *= -1;
            }
        }
        public void handle(ActionEvent event) {
            _ellipse.setCenterX(_ellipse.getCenterX() + _distance);
        }
    } // end of private MoveHandler class
} // end of ShapeMover class
```


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Reminder: `Constants` Class

- In our `MovingShapeApp`, we've been using absolute numbers in various places
  - not very extensible! what if we wanted to quickly change the size of our `Scene` or `Shape` to improve compile time?
- Our `Constants` class will keep track of a few important numbers
- For our `MovingShapeApp`, make constants for width and height of the `Ellipse` and of the `Pane` it sits in, as well as the start location and distance moved

```
public class Constants {
    // units all in pixels
    public static final double X_RAD = 50;
    public static final double Y_RAD = 50;
    public static final double APP_WIDTH = 200;
    public static final double APP_HEIGHT = 130;
    public static final double BUTTON_SPACING = 30;
    /* X_OFFSET is the graphical offset from the edge
    of the screen to where we want the X value of the
    Ellipse */
    public static final double X_OFFSET = 100;
    public static final double Y_OFFSET = 50;
    public static final double DISTANCE_X = 10;
}
```


Lecture Question

When should you define a value in a `Constants` class?

A. When you use the value in more than one place.

B. Whenever the value will not change throughout the course of the program.

C. When the value is nontrivial (i.e., not 0 or 1)

D. All of the above.

no more literal numbers = much better design!

`Constants` class elided

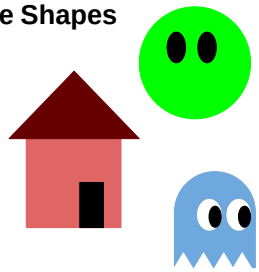

```
public class App extends Application {
    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();
        Scene scene = new Scene(organizer.getRoot(),
            Constants.APP_WIDTH, Constants.APP_HEIGHT);
        stage.setScene(scene);
        stage.setTitle("MovingShape");
        stage.show();
    }

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

public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();
        Pane shapePane = new Pane();
        _root.setCenter(shapePane);
        HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);
        new ShapeMover(shapePane, buttonPane);
    }
    public Pane getRoot() {
        return _root;
    }
}
```

The Whole App

```
public class ShapeMover {
    private Ellipse _ellipse;
    public ShapeMover(Pane shapePane, Hbox buttonPane) {
        _ellipse = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        shapePane.getChildren().add(_ellipse);
        this.setupShape();
        this.setupButtons(buttonPane);
    }
    private void setupShape() {
        _ellipse.setFill(Color.RED);
        _ellipse.setCenterX(Constants.X_OFFSET);
        _ellipse.setCenterY(Constants.Y_OFFSET);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("Move left");
        Button b2 = new Button("Move right");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(Constants.BUTTON_SPACING);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    private class MoveHandler implements EventHandler<ActionEvent> {
        private double _distance;
        public MoveHandler(boolean isLeft) {
            _distance = Constants.DISTANCE_X;
            if (isLeft) {
                _distance *= -1;
            }
        }
        public void handle(ActionEvent event) {
            _ellipse.setCenterX(_ellipse.getCenterX() + _distance);
        }
    } // end of private MoveHandler class
} // end of ShapeMover class
```

Creating Composite Shapes

- What if we want to display something more elaborate than a single, simple geometric primitive?
- We can make a **composite shape** by combining two or more shapes!

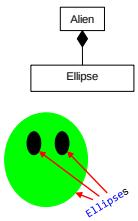


Specifications: `MovingAlien`

- Transform `MovingShape` into `MovingAlien`
- An alien should be displayed on the central `Pane`, and should be moved back and forth by `Button`s

`MovingAlien`: Design

- Create a class, `Alien`, to model a composite shape
- Define composite shape's capabilities in `Alien` class
- Give `Alien` a `setLocation()` method that positions each component (face, left eye, right eye, all `Ellipse`s)
  - another example of **delegation pattern**



Process: Turning `MovingShape` into `MovingAlien`

1. **Create `Alien` class to model composite shape, and add each component of `Alien` to `alienPane`'s list of children**
2. Be sure to explicitly define any methods that we need to call on `Alien` from within `AlienMover` (which used to be `ShapeMover`), such as *location setter/getter methods*!
3. Modify `AlienMover` to contain an `Alien` instead of an `Ellipse`

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`Alien` Class

- The `Alien` class is our composite shape
- It contains three `Ellipse`s—one for the face and one for each eye
- Constructor instantiates these `Ellipse`s, sets their initial sizes/colors, and adds them as children of the `alienPane`—which was passed in as a parameter
- Although `Alien` class deals with each component of the composite shape individually, every component should reside on the same pane as all other components
  - thus, must pass pane as a parameter to allow `Alien` class to define methods for manipulating composite shape in pane

```
public class Alien {
    private Ellipse _face;
    private Ellipse _leftEye;
    private Ellipse _rightEye;

    public Alien(Pane alienPane) {//Alien lives in passed Pane
        _face = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        _face.setFill(Color.CHARTREUSE);

       /*EYE_X and EYE_Y are constants referring to the width and
        height of the eyes, the eyes' location/center is changed later
        in the program.*/

        _leftEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _leftEye.setFill(Color.BLACK);
        _rightEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _rightEye.setFill(Color.BLACK);

        alienPane.getChildren().addAll(_face, _leftEye, _rightEye);
    }
}
```

Note: Order matters when you add children to a `Pane`! The arguments are added in that order graphically and if there is overlap, the shape later in the parameter list will lie wholly or partially on top of the earlier one. For this example, `_face` is added first, then `_leftEye` and `_rightEye` on top. The inverse order would be wrong!

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Process: Turning `MovingShape` into `MovingAlien`

1. Create `Alien` class to model composite shape, and add each component of `Alien` to `alienPane`'s list of children
2. **Be sure to explicitly define any methods that we need to call on `Alien` from within `AlienMover` (which used to be `ShapeMover`), such as *location setter/getter methods*!**
3. Modify `AlienMover` to contain an `Alien` instead of an `Ellipse`

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Alien Class

- In MovingShapeApp, the following call is made from within our MoveHandler's handle method in order to move the Ellipse:

```
_ellipse.setCenterX(_ellipse.getCenterX() + _distance);
```

- Because we called JavaFX's getCenterX() and setCenterX(…) on our shape from within the ShapeMover class, we must now define our own equivalent methods such as setLocX(…) and getLocX() to set the Alien's location in the Alien class!
- This allows our Alien class to function like an Ellipse in our program!
- Note: most of the time when you are creating complex shapes, you will want to define a more extensive setLocation(double x, double y) method rather than having a separate method for the X or Y location

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MovingAlien: Alien Class (1/3)

2a. Define Alien's setXLoc(…) by setting center X of face, left and right eyes (same for setYLoc); note use of additional constants

- **note: relative positions between the Ellipses remains the same**

```
public class Alien {
    private Ellipse _face;
    private Ellipse _leftEye;
    private Ellipse _rightEye;

    public Alien(Pane alienPane) {
        _face = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        _face.setFill(Color.CHARTREUSE);
        _leftEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _leftEye.setFill(Color.BLACK);
        _rightEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _rightEye.setFill(Color.BLACK);

        alienPane.getChildren().addAll(_face, _leftEye, _rightEye);

    }

    public void setXLoc(double x) {
        _face.setCenterX(x);
        _leftEye.setCenterX(x - Constants.EYE_OFFSET);
        _rightEye.setCenterX(x + Constants.EYE_OFFSET);
    }


}
```


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MovingAlien: Alien Class (2/3)

2a. Define Alien's setXLoc(…)by using ellipse's setCenter()… on face, left and right eyes (same for setYLoc());

- note: relative positions between the Ellipses remains the same

2b. Define getXLoc() method: the horizontal center of the Alien will always be center of _face Ellipse

```
public class Alien {
    private Ellipse _face;
    private Ellipse _leftEye;
    private Ellipse _rightEye;

    public Alien(Pane alienPane) {
        _face = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        _face.setFill(Color.CHARTREUSE);
        _leftEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _leftEye.setFill(Color.BLACK);
        _rightEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _rightEye.setFill(Color.BLACK);

        alienPane.getChildren().addAll(_face, _leftEye, _rightEye);

    }

    public void setXLoc(double x) {
        _face.setCenterX(x);
        _leftEye.setCenterX(x - Constants.EYE_OFFSET);
        _rightEye.setCenterX(x + Constants.EYE_OFFSET);
    }

    public double getXLoc() {
        return _face.getCenterX();
    }
}
```


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MovingAlien: Alien Class (3/3)

2a. Define Alien's setXLoc(…)by setting center X of face, left and right eyes (same for setYLoc);
- note: relative positions between the Ellipses remains the same

2b. Define getXLoc() method: the horizontal center of the Alien will always be center of _face Ellipse

2c. Set starting X location of Alien in constructor!

```
public class Alien {
    private Ellipse _face;
    private Ellipse _leftEye;
    private Ellipse _rightEye;

    public Alien(Pane alienPane) {
        _face = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        _face.setFill(Color.CHARTREUSE);
        _leftEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _leftEye.setFill(Color.BLACK);
        _rightEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _rightEye.setFill(Color.BLACK);

        alienPane.getChildren().addAll(_face, _leftEye, _rightEye);
        this.setXLoc(Constants.START_X_OFFSET);
    }

    public void setXLoc(double x) {
        _face.setCenterX(x);
        _leftEye.setCenterX(x - Constants.EYE_OFFSET);
        _rightEye.setCenterX(x + Constants.EYE_OFFSET);
    }

    public double getXLoc() {
        return _face.getCenterX();
    }
}
```


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Lecture Question

Which House constructor makes the correct composite shape, given the rest of the program is set up correctly?

A.

```
public House (Pane housePane) {
    _foundation = new Rectangle(Constants.X, Constants.Y);
    _window = new Rectangle(Constants.WIND_X, Constants.WIND_Y);
    _door = new Rectangle(Constants.DOOR_X, Constants.DOOR_Y);
    //code to fill _foundation, _window, _door elided
    housePane.getChildren().addAll(_foundation, _window, _door);
    this.setXLoc(Constants.INITIAL_X_OFFSET);
}
```

B.

```
public House () {
    _foundation = new Rectangle(Constants.X, Constants.Y);
    _window = new Rectangle(Constants.WIND_X, Constants.WIND_Y);
    _door = new Rectangle(Constants.DOOR_X, Constants.DOOR_Y);
    //code to fill _foundation, _window, _door elided
    new Pane().getChildren().addAll(_foundation, _window, _door);
    new Pane().setX(Constants.INITIAL_X_OFFSET);
}
```

C.

```
public House (Pane housePane) {
    _foundation = new Rectangle();
    _window = new Rectangle();
    _door = new Rectangle();
    //code to fill _foundation, _window, _door elided
    housePane.getChildren().addAll(_foundation, _window, _door);
    this.setXLoc(Constants.INITIAL_X_OFFSET);
}
```

D.

```
public House (Pane housePane) {
    _foundation = new Rectangle(Constants.X, Constants.Y);
    _window = new Rectangle(Constants.WIND_X, Constants.WIND_Y);
    _door = new Rectangle(Constants.DOOR_X, Constants.DOOR_Y);
    //code to fill _foundation, _window, _door elided
    this.setXLoc(Constants.INITIAL_X_OFFSET);
}
```


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Process: Turning MovingShape into MovingAlien

1. Create Alien class to model composite shape, and add each component of Alien to alienPane's list of children
2. Be sure to explicitly define any methods that we need to call on Alien from within AlienMover (which used to be ShapeMover), such as *location setter/getter methods*!
3. **Modify AlienMover to contain an Alien instead of an Ellipse**

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MovingAlien: PaneOrganizer Class

- Change the shapePane to be an alienPane (we could have called it anything!)

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();
        Pane alienPane = new Pane();
        _root.setCenter(alienPane);
        HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);
        new AlienMover(alienPane, buttonPane);
    }
    public Pane getRoot() {
        return _root;
    }
}
```


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MovingAlien: AlienMover Class (1/3)

- Only have to make a few changes to AlienMover!
- Instead of containing an Ellipse called _ellipse, contains an Alien called _alien
- Change shapePane to be an alienPane (we could have called it anything!)

```
public class AlienMover {
    private Alien _alien;
    public ShapeMover(Pane alienPane, Hbox buttonPane) {
        _alien = new Alien(alienPane);
        this.setupShape();
        this.setupButtons(buttonPane);
    }
    private void setupShape() {
        _ellipse.setFill(Color.RED);
        _ellipse.setCenterX(Constants.X_OFFSET);
        _ellipse.setCenterY(Constants.Y_OFFSET);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("Move Left!");
        Button b2 = new Button("Move Right!");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(Constants.BUTTON_SPACING);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    // private MoveHandler class elided!
}
```


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MovingAlien: AlienMover Class (2/3)

- setupShape() method is no longer needed, as we now setup the Alien within the Alien class
  - remember that we set a default location for the Alien in its constructor:

```
this.setXLoc(Constants.START_X_OFFSET);
```

```
public class AlienMover {
    private Alien _alien;
    public ShapeMover(Pane alienPane, Hbox buttonPane) {
        _alien = new Alien(alienPane);
        this.setupShape();
        this.setupButtons(buttonPane);
    }
    private void setupShape() {
        _ellipse.setFill(Color.RED);
        _ellipse.setCenterX(Constants.X_OFFSET);
        _ellipse.setCenterY(Constants.Y_OFFSET);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("Move Left!");
        Button b2 = new Button("Move Right!");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(Constants.BUTTON_SPACING);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    // private MoveHandler class elided!
}
```


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MovingAlien: AlienMover Class (3/3)

- Last modification we have to make is from within the `MoveHandler` class, where we will swap in `_alien` for `_ellipse` references
- We implemented `setXLoc(…)` and `getXLoc()` methods in `Alien` so `MoveHandler` can call them

```
public class AlienMover {
    private Alien _alien;
    public ShapeMover(Pane alienPane, Hbox buttonPane) {
        _alien = new Alien(alienPane);
        this.setupButtons(buttonPane);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("Move Left!");
        Button b2 = new Button("Move Right!");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(Constants.BUTTON_SPACING);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    private class MoveHandler implements EventHandler<ActionEvent> {
        private double _distance;
        public MoveHandler(boolean isLeft) {
            _distance = Constants.DISTANCE_X;
            if (isLeft) {
                _distance *= -1;
            }
        }
        public void handle(ActionEvent event) {
            _alien.setXLoc(_alien.getXLoc() + _distance);
        }
    }
}
```


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The Whole App

```
public class App extends Application {
    @Override
    public void start(Stage stage) {
        PaneOrganizer organizer = new PaneOrganizer();
        Scene scene = new Scene(organizer.getRoot(),
          Constants.APP_WIDTH, Constants.APP_HEIGHT);
        stage.setScene(scene);
        stage.setTitle("MovingAlien!");
        stage.show();
    }

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

```
public class PaneOrganizer {
    private BorderPane _root;

    public PaneOrganizer() {
        _root = new BorderPane();
        Pane alienPane = new Pane();
        _root.setCenter(alienPane);
        HBox buttonPane = new HBox();
        _root.setBottom(buttonPane);
        new AlienMover(alienPane, buttonPane);
    }
    public Pane getRoot() {
        return _root;
    }
}
```

```
public class Alien {
    private Ellipse _face;
    private Ellipse _leftEye;
    private Ellipse _rightEye;
    public Alien(Pane root) {
        _face = new Ellipse(Constants.X_RAD, Constants.Y_RAD);
        _face.setFill(Color.CHARTREUSE);
        _leftEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        _rightEye = new Ellipse(Constants.EYE_X, Constants.EYE_Y);
        this.setXLoc(Constants.START_X_OFFSET);
        root.getChildren().addAll(_face, _leftEye, _rightEye);
    }
    public void setXLoc(double x) {
        _face.setCenterX(x);
        _leftEye.setCenterX(x - Constants.EYE_OFFSET);
        _rightEye.setCenterX(x + Constants.EYE_OFFSET);
    }
    public double getXLoc() {
        return _face.getCenterX();
    }
}
```

```
public class AlienMover {
    private Alien _alien;

    public AlienMover(Pane alienPane, Hbox buttonPane) {
        _alien = new Alien(alienPane);
        this.setupButtons(buttonPane);
    }
    private void setupButtons(Hbox buttonPane) {
        Button b1 = new Button("Move Left!");
        Button b2 = new Button("Move Right!");
        buttonPane.getChildren().addAll(b1, b2);
        buttonPane.setSpacing(Constants.BUTTON_SPACING);
        b1.setOnAction(new MoveHandler(true));
        b2.setOnAction(new MoveHandler(false));
    }
    private class MoveHandler implements EventHandler<ActionEvent> {
        private double _distance;
        public MoveHandler(boolean isLeft) {
            _distance = Constants.DISTANCE_X;
            if (isLeft) {
                _distance *= -1;
            }
        }
        public void handle(ActionEvent event) {
            _alien.setXLoc(_alien.getXLoc() + _distance);
        }
    }
}
```


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Delegation: Creating Additional Classes

- Notice how we created another class for our Alien composite shape instead of simply adding each individual shape to `PaneOrganizer`.
- We also created a class called `AlienMover` to handle the "game logic", aka the problem-specific "program logic", so `PaneOrganizer` would not be too complicated
- As your programs get more complex (e.g., two shapes interacting with one another, shapes changing color, etc.), you may want to use this design. Making a separate class for problem-specific logic allows you to avoid complicating `PaneOrganizer`
  - Notice that for this example, all of the game logic exists in `AlienMover`; `PaneOrganizer` is only responsible for placing `Pane`s and other elements on the screen
  - this will make `PaneOrganizer` less cluttered and your whole program much easier to read
  - keep this in mind for your upcoming and current assignments!!!

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Lecture Question

What is the best practice for setting up graphical scenes (according to CS15)?

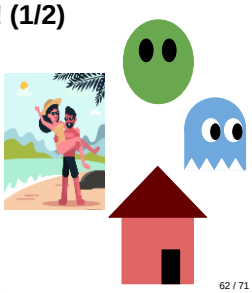
A. Absolutely position everything using trial and error, and use as few panes as possible.

B. Have any shape be contained in its own pane, and only make classes for composite shapes of more than 5 shapes.

C. Use a top-level class, make classes for more complicated shapes, and store composite shapes, or just generally related objects, within panes.

Your Project: Cartoon! (1/2)

- You'll be building a JavaFX application that displays your own custom "cartoon", much like the examples in this lecture
- But your cartoon will be animated!



Your Project: Cartoon! (2/2)

- How can we animate our cartoon (e.g. make the cartoon move across the screen)?
- As in film and video animation, can create *apparent motion* with many small changes in position
- If we move fast enough and in small enough increments, we get smooth motion!
- Same goes for smoothly changing size, orientation, shape, etc.

Animation in Cartoon

- Use a `TimeLine` to create incremental change
- It'll be up to you to figure out the details… but for each repetition of the `KeyFrame`, your cartoon should move (or change in other ways) a small amount!
  - reminder: if we move fast enough and in small enough increments, we get smooth motion!

Announcements

- Cartoon has been released!
  - Early Handin: Monday, 3/1 at 11:59pm
  - On-Time Handin: Wednesday, 3/3 at 11:59pm
  - Late Handin: Friday, 3/5 at 11:59pm
- Top 6 Cartoons win a meal with Andy over zoom
- Cartoon check-ins Thursday-Saturday
  - Meet with your Section TAs to go over your design for Cartoon, if you have not yet!
  - Make sure you have reached the Cartoon checkpoint by your check-in

IT in the News

ft. Socially Responsible Computing!

Robotics🤖

- Definition: a machine that is controlled by computer(s) and can carry out complex actions (semi-) automatically
  - Not all robots are anthropomorphic!
- Types:
  - Pre-programmed (ex. mechanical assembly)
  - Autonomous (ex. Roomba vacuum)
  - Humanoid (ex. Sophia)
  - Tele-operated (ex. unmanned aeronautic vehicles (UAVs) aka drones)
  - Augmenting (ex. prosthetic limbs)



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UAVs: Positive use cases (medicine + supplies)

- Humanitarian/medical aid
  - **Rwanda**: UAVs (by drone startup Zipline) transport supplies in far less time than ground travel
    - example: blood transfusions take 6 minutes to deliver via drone, vs. 3 hours by car (>96% less time!)
- COVID-19 vaccine distribution
  - **February 2021:** Zipline announces plans to deliver all leading COVID vaccines in US, Rwanda, China, Nigeria, and more
    - could help those living in rural regions, "pharmacy deserts", to access vaccines more quickly!

Worker handling Zipline drone delivering PPE in North Carolina

source: TechCrunch, 2020

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UAVs: Positive use cases (documentation + activism)

- 2016-2017: drones used by protesters at Standing Rock, ND
  - revealed proximity of pipeline to tribe's water source
  - recorded police brutality + provided counter-evidence to law enforcement's false narratives


- May 2020: photographer George Steinmetz exposed NYC COVID "mass grave"
  - Hart Island = where city buried COVID victims whose bodies were not claimed for private burial
    - graves dug by Rikers Island jail inmates
  - NYPD confiscated drone + detained Steinmetz, resulted in legal battle


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UAVs: Negative use cases (CW: policing, war/conflict)

- Surveillance
  - Drones used for public **and private** surveillance, combined with other tech (facial recognition, terrain mapping technologies, cell signal trackers)
    - ex. FBI used drones in 2015 to surveil protestors in Baltimore
- Warfare
  - UAVs have been used by US military since ~2001 to surveil and perform unmanned strikes
  - Argument: use of drones saves lives of US soldiers
    - **but** distance also enables error, dehumanization of targets, "gamification" of warfare
    - up to 25% of victims are civilians, ~25% of civilian victims are children

Infrared camera footage of Freddie Gray protests, captured by FBI drone

source: ACLU

Robotics @ Brown!

- Faculty:
  - Stefanie Tellex
  - George Konidaris
  - Michael Littman
- Groups:
  - Humanity Centered Robotics Initiative
  - Humans 2 Robots Lab
  - Intelligent Robot Lab
  - RLAB (reinforcement learning & adaptive behavior) group

Learn more @ robotics.cs.brown.edu

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