Announcements

- Lab 4 due this week
- Lab 5 started this week – due after spring break
- Exam 3 after spring break.
Composition [Whole-Part relationship]

- One object (source) takes responsibility for creating the other (target)
- Use instance variable to hold onto the "part"

```java
public class Source {
    private Target part;
    public Source() {  // part = new Target();
        part = new Target();
    }
}
```
**Association**

"Knows a" relationship

Two objects that do work together

Source has an instance variable of type Target to communicate with.

```java
public class Source {
    private Target _associate;
    public Source(Target target) {
        _associate = target;
    }
}
```
GraphicsExample4

• Creates a shape that can be controlled by the button on the screen

• An example of using action listeners as well as the association relationship

NullPointerException

• Occurs when your code calls a method on a null reference

• A null reference is a reference that is declared, but never assigned an object
Lab 4: As skeleton is

Lab 4

- Notice that the reference for _column does not refer to any object
- That is why if you run the program without creating an object for the reference, a NullPointerException is thrown and the program doesn’t work
Changes to Lab 4

• Took the skeleton and moved the setUpButtons() method from App to Drawing
• Makes Lab 4 code look closer to what Lab 5 code would look like

Object Diagrams

• Let’s trace through the object diagrams for the GraphicsExample4 program the way it is currently.
GraphicsExample4

• When we select Run As -> Java Application, the method main is executed.
• In main, there is only one line of code

    new App();

There is no reference to the 
App object 
created, just 
the object. 
App has no instance 
variables, but 
as the App 
constructor is executed various 
local variables are created.
```java
JFrame frame = new JFrame();

containers, Column column = new containers, Column();
```
new Toplevel (column)

App
Frame

Frame

Column

TopLevel

ellipse
column

Note that this reference appears because of passing in constructor.

graphics, DrawingCanvas canvas = new graphics.

Drawing Canvas();

canvas
• _ellipse’s characteristics are set
• this.setUpButtons(column) is called
... button = new javax.swing.JButton("...");

button.addActionListener(new MoveUpAction(-ellipse));
When constructor called: Phenomenic ellipse created and value assigned to it
Changes to GraphicsExample4

• We want to add at least one more shape to the screen
• The user clicks on a shape and then the button will control the movement of the shape the user clicked upon
Changes to GraphicsExample4

• Then, we will implement a way for the user to add shapes to the screen and those to would be able to be clicked upon and moved by the button as well

What types of things do we need to add/change?

• Another shape
• A MouseListener for the shapes
• A way to keep track of which shape the user has clicked upon
  – That is probably similar to the holder for colors in Lab 5