

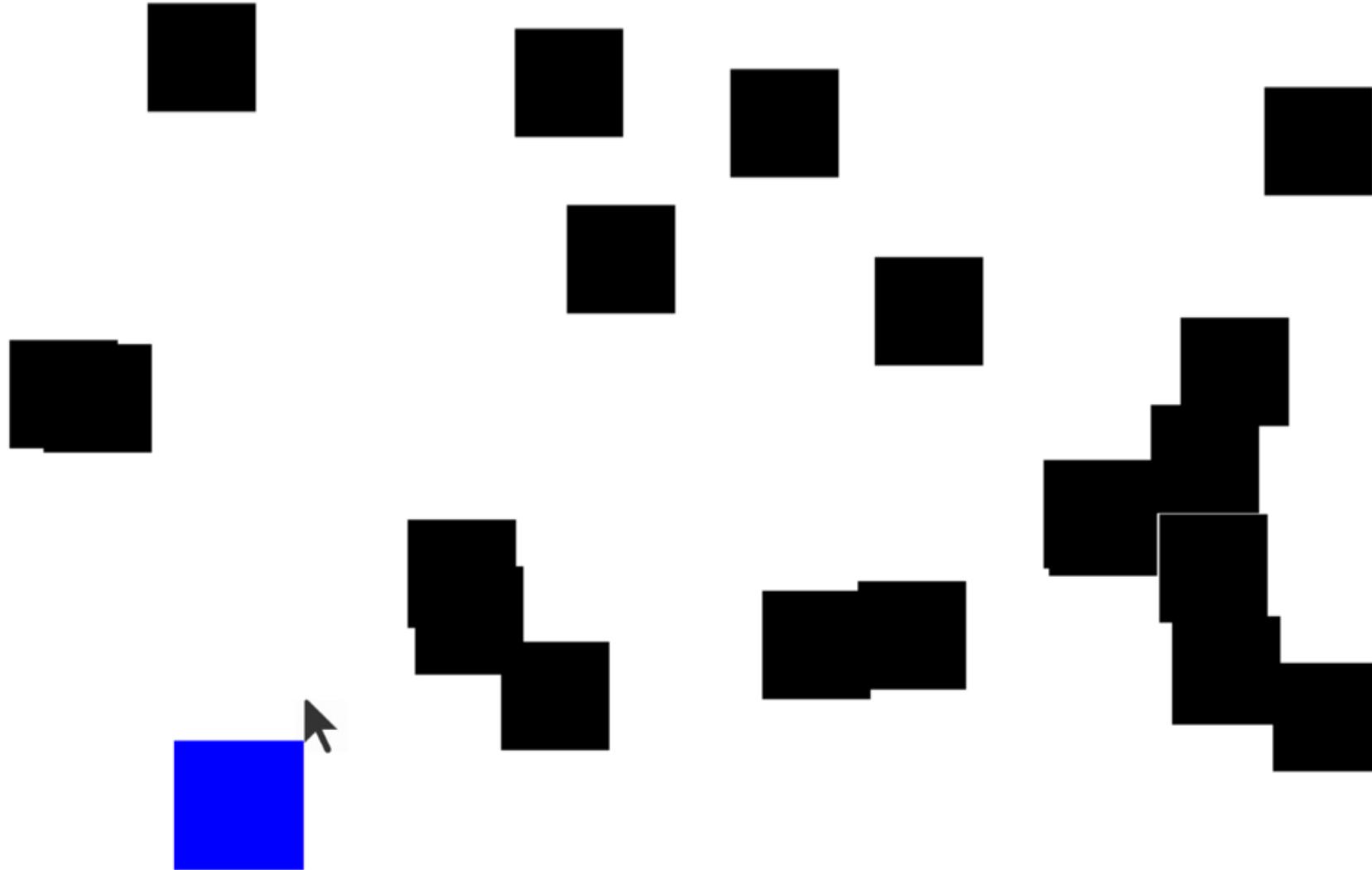
A photograph of a concert crowd from behind, with many hands raised in the air. The scene is lit with warm, orange-yellow stage lights, creating a festive atmosphere. A blue rectangular border surrounds the text area in the center.

Events

Chris Piech

CS106A, Stanford University

Catch Me If You Can



We've Gotten Ahead of Ourselves



Source: The Hobbit

Start at the Beginning



Source: The Hobbit

Learning Goals

1. Write a program that can respond to mouse events
2. Use an instance variable in your program



Events

```
public void run() {  
    // Java runs this when program launches  
}  
  
public void mouseClicked(MouseEvent event) {  
    // Java runs this when mouse is clicked  
}  
  
public void mouseMoved(MouseEvent event) {  
    // Java runs this when mouse is moved  
}
```



The Listener Model

```
public void run() {  
    // 1. add mouse listeners  
    addMouseListeners();  
}  
  
public void mouseClicked(MouseEvent event) {  
    // Java runs this when mouse is clicked  
}  
  
public void mouseMoved(MouseEvent event) {  
    // Java runs this when mouse is moved  
}
```

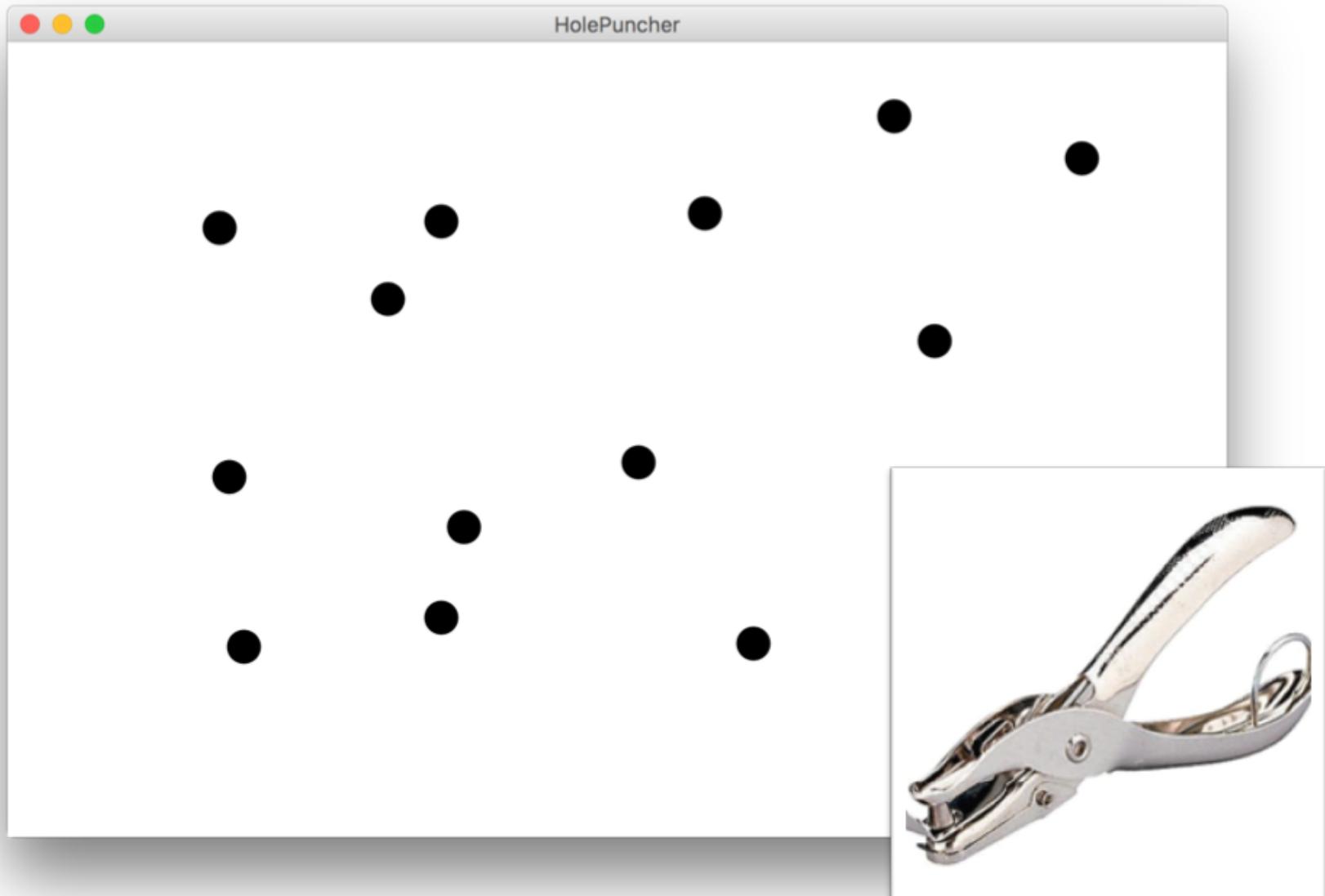


Examples

Mouse Location



Hole Puncher



Piech, CS106A, Stanford University



Now With Dancing Children

Normal Program

Run Method



Piech, CS106A, Stanford University



Normal Program

Run Method



```
public void run() {  
    while(true) {  
        update();  
        pause(DELAY);  
    }  
}
```



Normal Program

Run Method



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public void run() {  
    while(true) {  
        update();  
        pause(DELAY);  
    }  
}
```



Normal Program

Run Method



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Normal Program

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Normal Program

Run Method



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        update();  
        pause(DELAY);  
    }  
}
```



Normal Program

Run Method



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New Listener Characters

Mouse Listener



Mouse Moved Method



Program with a Mouse Method

Run Method

Mouse Moved Method



Program Starts Running

Run Method

Mouse Moved Method



Add Mouse Listener

Run Method



Mouse Moved Method



Mouse Listener



addMouseListeners();

François Fleuret, CS106B, Stanford University



Program Runs as Usual

Run Method



Mouse Moved Method



Mouse Listener



Mouse Moved!

Run Method



Mouse Moved Method



Mouse Listener



Calls Mouse Moved Method

Run Method



Mouse Moved Method



Mouse Listener



When done, Run continues.

Run Method



Mouse Moved Method



Mouse Listener



Keeps Doing Its Thing...

Run Method



Mouse Moved Method



Mouse Listener



Mouse Moved!

Run Method



Mouse Moved Method



Mouse Listener



Calls Mouse Moved Method

Run Method

Mouse Moved Method

Mouse Listener



When done, Run continues.

Run Method



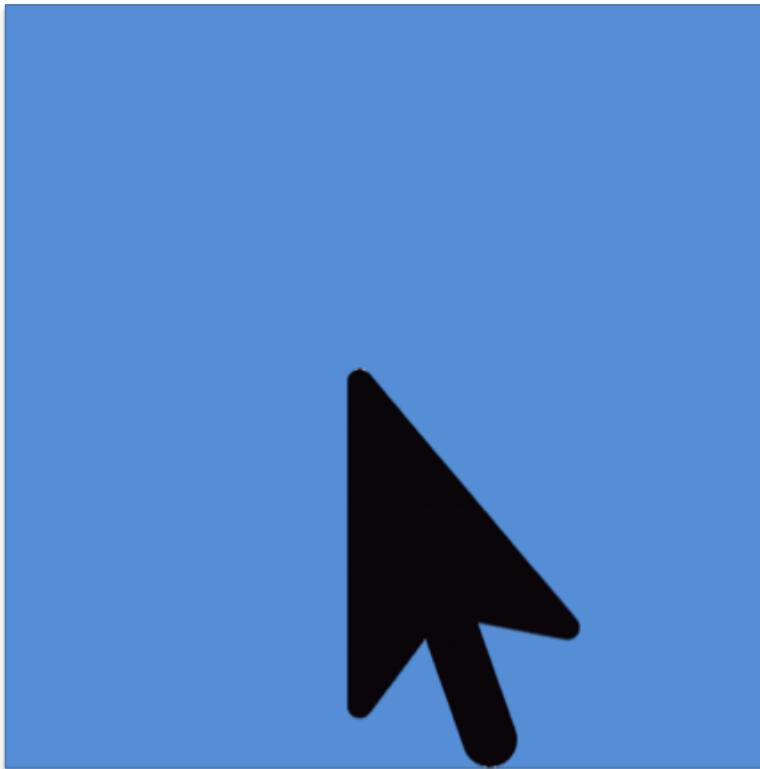
Mouse Moved Method



Mouse Listener



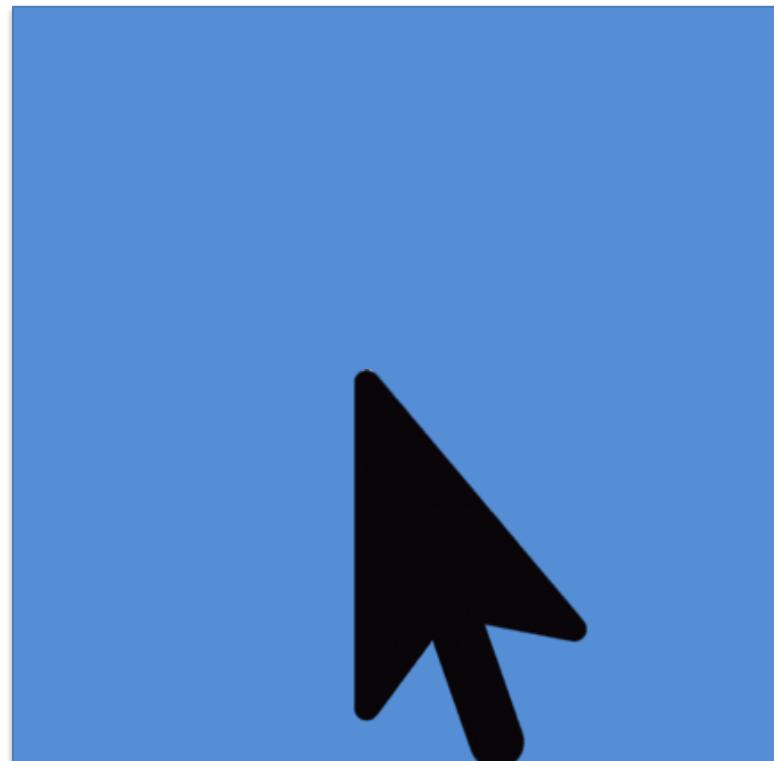
Mouse Tracker



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Mouse Tracker



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Instance Variables

1. Variables exist until their inner-most control block ends.
2. If a variable is defined outside all methods, its inner-most control block is the entire program!
3. We call these variables **instance variables**

```
public class MouseTrackerSoln extends GraphicsProgram {  
  
    /* Instance variable for the square to be tracked */  
    GRect square = null;  
  
    public void run() {  
        addSquare();  
        addMouseListeners();  
    }  
}
```

- * Instance variables have special meanings in programs with multiple files. For now you need to know that all methods can see them and that their initialization line is executed before run.



Instance Variables + Events

Often you need instance variables to pass information between the run method and the mouse event methods!

```
public class MouseTrackerSoln extends GraphicsProgram {

    /* Instance variable for the square to be tracked */
    GRect square = null;

    public void run() {
        square = makeSquare();
        addMouseListeners();
    }

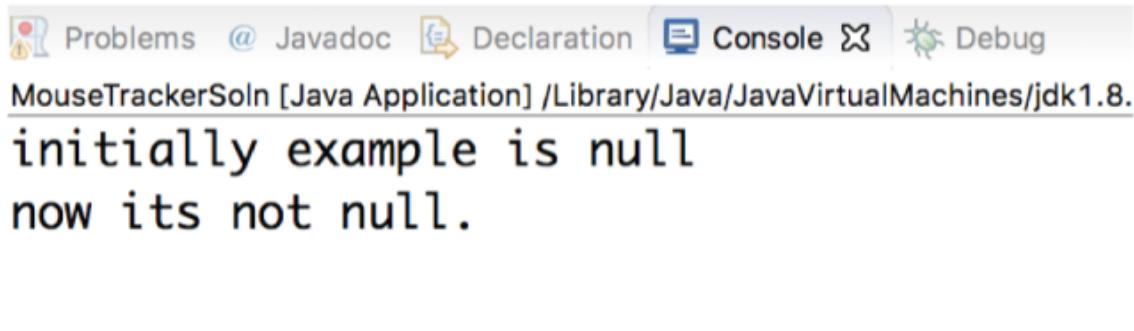
    public void mouseMoved(MouseEvent e) {
        int x = e.getX() - SQUARE_SIZE/2;
        int y = e.getY() - SQUARE_SIZE/2;
        square.setLocation(x, y);
    }
}
```



Null

Objects have a special value called **null** which means this variable is not associated with a value yet.

```
public void run() {  
    G0val example = null;  
    if(example == null) {  
        println("initially example is null");  
    }  
    example = new G0val(5, 5);  
    if(example != null) {  
        println("now its not null.");  
    }  
}
```



The screenshot shows a Java application running in an IDE. The code defines a method named `run` that initializes a variable `example` to `null`, prints a message indicating it is initially null, then changes the variable to a new `G0val` object and prints a message indicating it is no longer null. The output window displays the printed messages: "initially example is null" followed by "now its not null."

```
Problems @ Javadoc Declaration Console Debug  
MouseTrackerS0l [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.  
initially example is null  
now its not null.
```



Null

GObjects returned by getElementAt might be null!

```
// may be a GObject, or null if nothing at (x, y)
GObject maybeAnObject = getElementAt(x, y);
if (maybeAnObject != null) {
    // do something with maybeAnObject
} else {
    // null - nothing at that location
}
```



Null

Calling methods on an object that is `null` will crash your program!

```
// may be a GObject, or null if nothing at (x, y)
GObject maybeAnObject = getElementAt(x, y);
if (maybeAnObject != null) {
    int x = maybeAnObject.getX(); // OK
} else {
    int x = maybeAnObject.getX(); // CRASH!
}
```



Null

Calling methods on an object that is **null** will crash your program! (throws a NullPointerException)

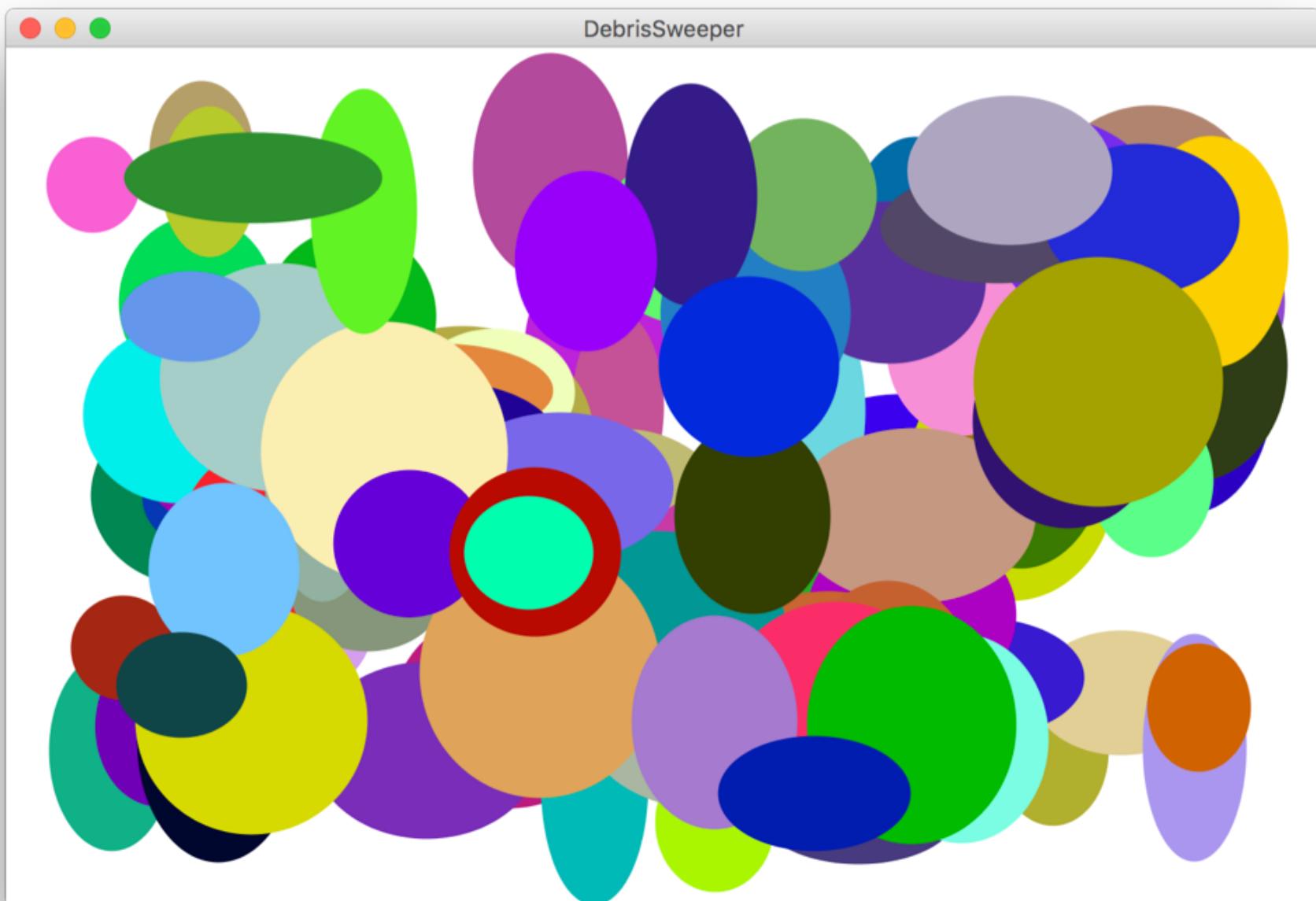
The screenshot shows the Java IDE's debugger interface. The title bar says "Debug". The left pane shows a tree view of the application: "WhackAMole (2) [Java Application] > WhackAMole at localhost:55250 > Thread [main] (Suspended (exception NullPointerException))". The right pane displays the stack trace for the suspended thread:

```
WhackAMole.run() line: 30
WhackAMole(Program).runHook() line: 2871
WhackAMole(Program).startRun() line: 3441
WhackAMole(Program).start(String[]) line: 3404
WhackAMole(Program).start() line: 3351
Program.main(String[]) line: 3654
```

Below the stack trace, another thread is listed: "Thread [AWT-EventQueue-0] (Running)". At the bottom, there is a status bar with the path "/Library/Java/JavaVirtualMachines/jdk1.8.0_121.jdk/Contents/Home/bin/java" and the timestamp "(Jul 19, 2017, 1:27:22 AM)".



Debris Sweeper



Piech, CS106A, Stanford University



New Concepts

New Commands

- `addMouseListeners();`
- `getElementAt(x, y);`
- `remove(obj);`

New Ideas

- The Listener Model
- Instance Variables
- `null`



Responding to Mouse Events

1. The **run** method should call **addMouseListeners**
2. Write definitions of any listener methods needed

mouseClicked(<i>e</i>)	Called when the user clicks the mouse
mousePressed(<i>e</i>)	Called when the mouse button is pressed
mouseReleased(<i>e</i>)	Called when the mouse button is released
mouseMoved(<i>e</i>)	Called when the user moves the mouse
mouseDragged(<i>e</i>)	Called when the mouse is dragged with the button down

The parameter *e* is **MouseEvent** object, which provides more data about event, such as the location of mouse.



Responding to Keyboard Events

1. The **run** method should call **addKeyListeners**
2. Write definitions of any listener methods needed

keyPressed(<i>e</i>)	Called when the user presses a key
keyReleased(<i>e</i>)	Called when the key comes back up
keyTyped(<i>e</i>)	Called when the user types (presses and releases) a key

The parameter *e* is a **KeyEvent** object, which indicates which key is involved.



And Here We Are...



Catch Me If You Can?

