Events

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Catch Me If You Can
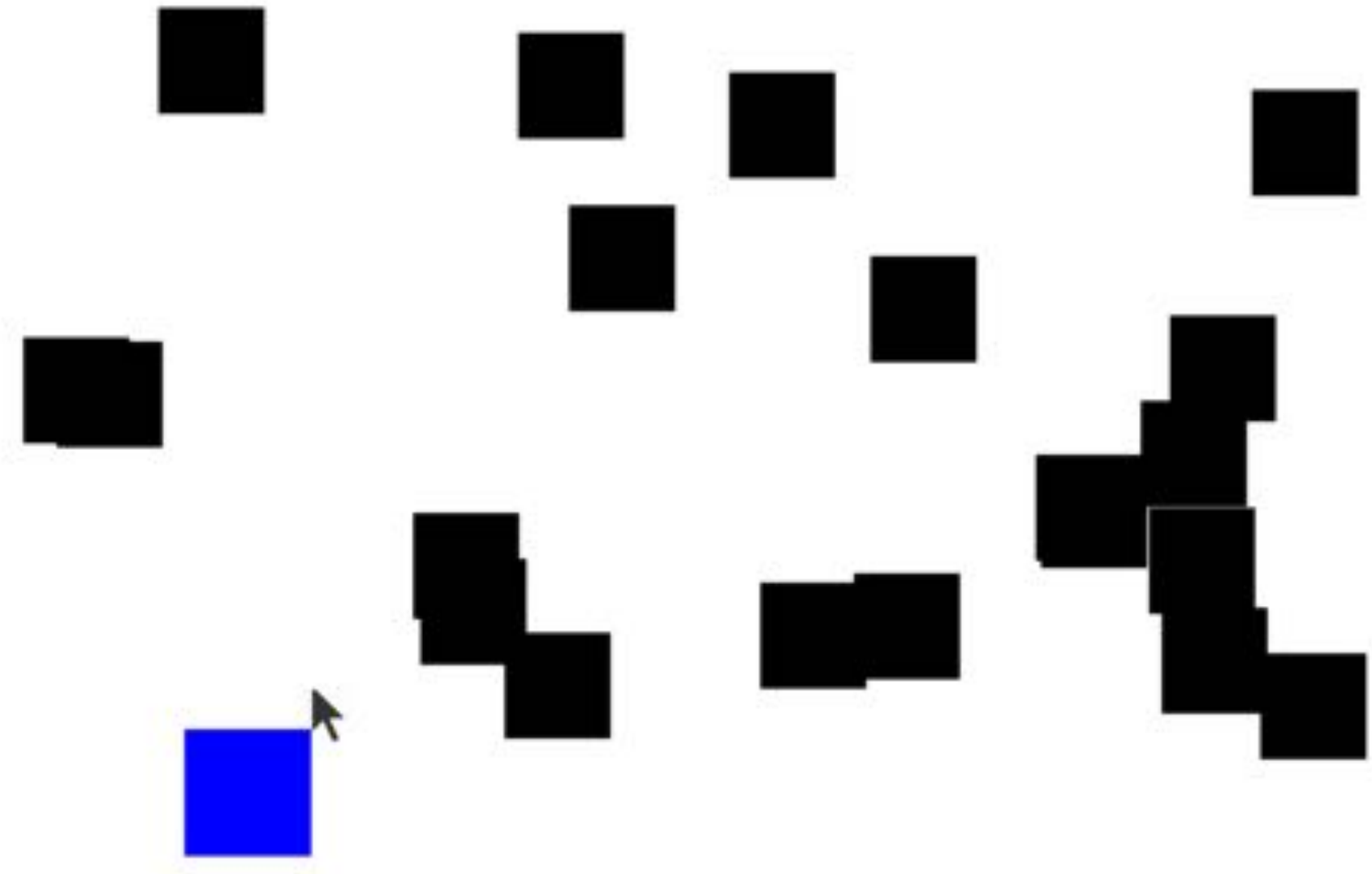
We've Gotten Ahead of Ourselves

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

Novelty

New Commands

- `rg.nextInt(max);`
- `addMouseListeners();`
- `getElementAt(x, y);`
- `remove(obj);`

New Ideas

- The Listener Model
- Instance Variables
- **null**

Random Numbers

```
● ● ●            ManyRandomsSoln [completed]
Generating random numbers
6
1
5
1
6
6
5
5
5
4
2
2
4
5
6
6
4
6
6
3
```

```java
// this variable can make random numbers
RandomGenerator rg = new RandomGenerator();


// make a random number between 0 and 5
int randNum = rg.nextInt(6);
```

Random Numbers Theory

Next random number

Last random number

$$X_{n+1} = (aX_n + c) \% m$$

```
// actual code from the java library
int nextseed = (oldseed * multiplier + addend) % max;
```

Fun fact: the first random number comes from the CPU clock

* Just for fun. Not on exams or psets…

Random Numbers

```
ManyRandomsSoln [completed]
Generating random numbers
6
1
5
1
6
6
5
5
5
4
2
2
4
5
6
6
4
6
6
3
```
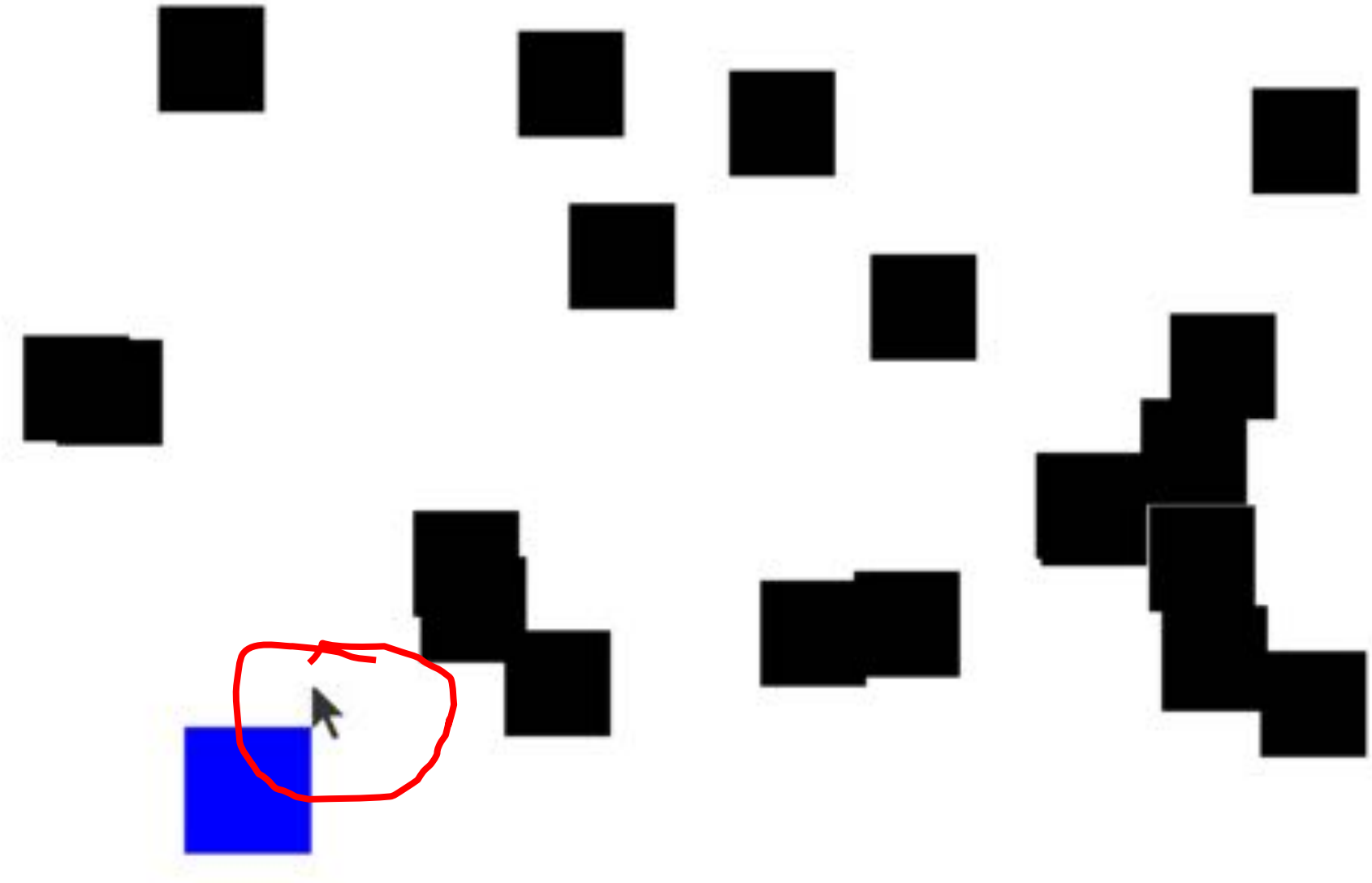
```
// this variable can make random numbers
RandomGenerator rg = new RandomGenerator();


// now each run will be the same…
rg.setSeed(0);



// make a random number between 0 and 5
int randNum = rg.nextInt(6);
```

Catch Me If You Can

Mouse Events

```java
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

```java
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
}
```

The Listener Model

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public void run() {
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    // Java runs this when mouse is moved
}
```
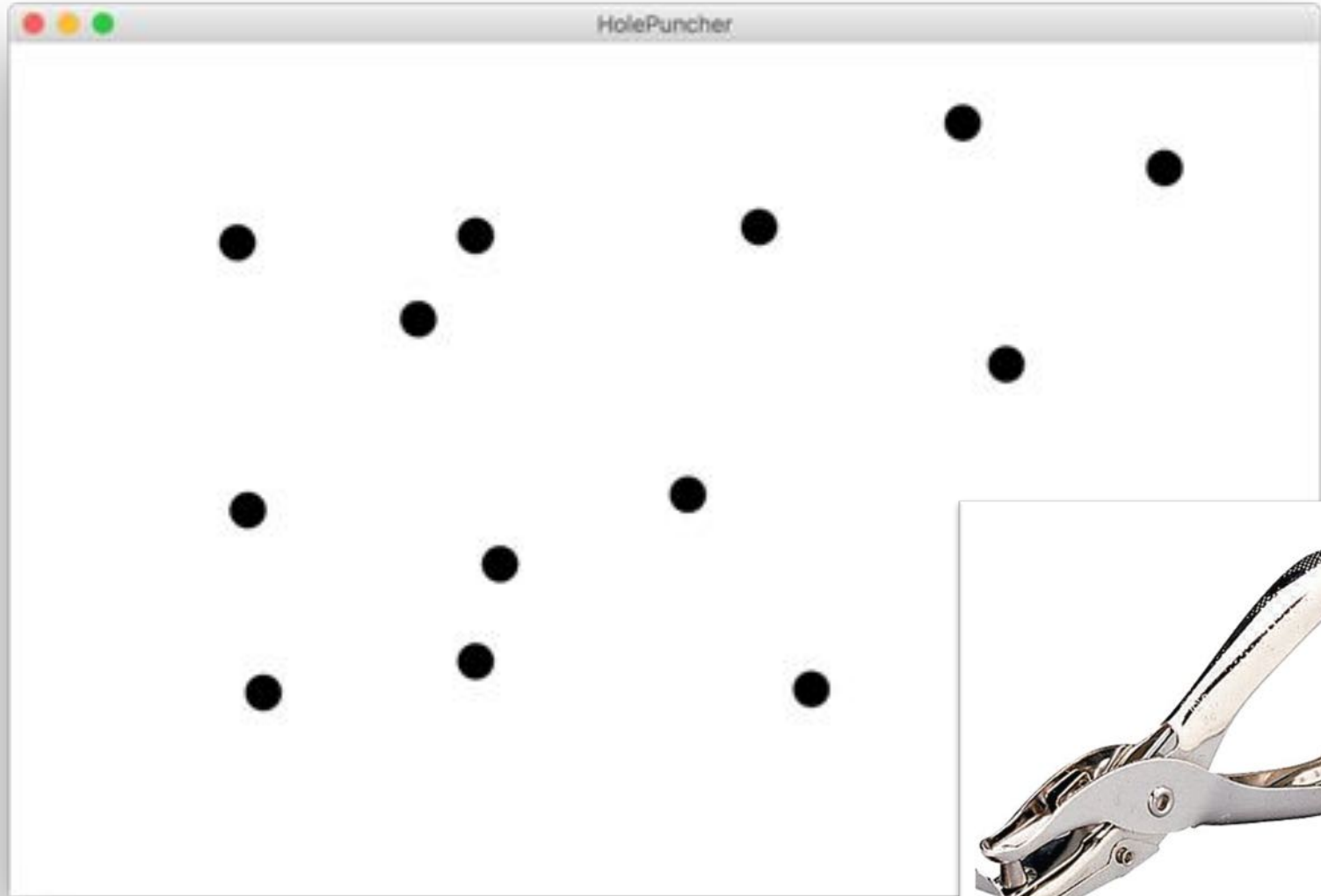
Examples

Hole Puncher

Now With Dancing Children

Normal Program

Run Method

Normal Program

Run Method

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

Normal Program

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Normal Program

Run Method

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    }
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Normal Program

Run Method

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();`

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

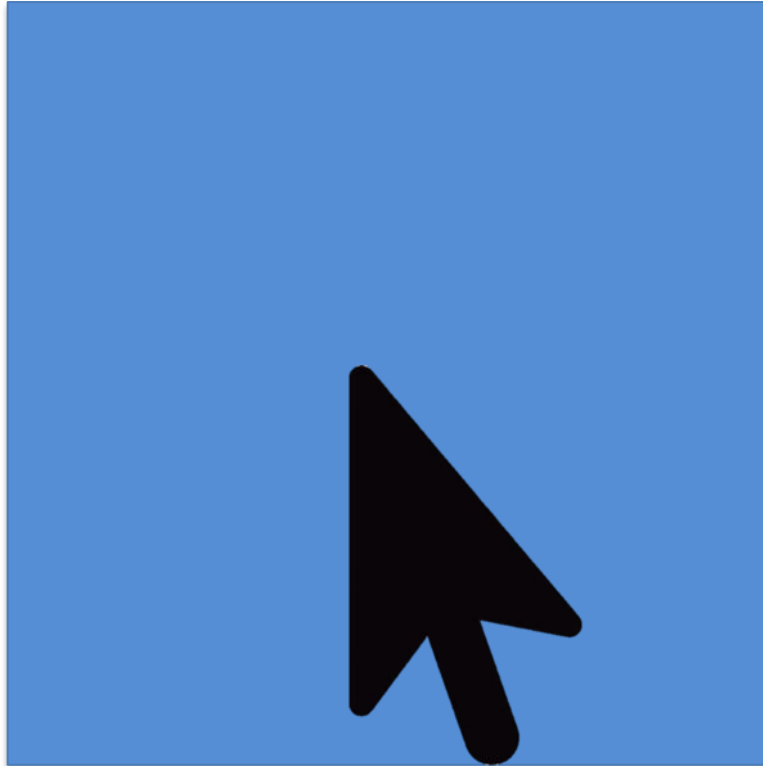Run Method   Mouse Moved Method   Mouse Listener

When done, Run continues.
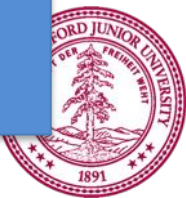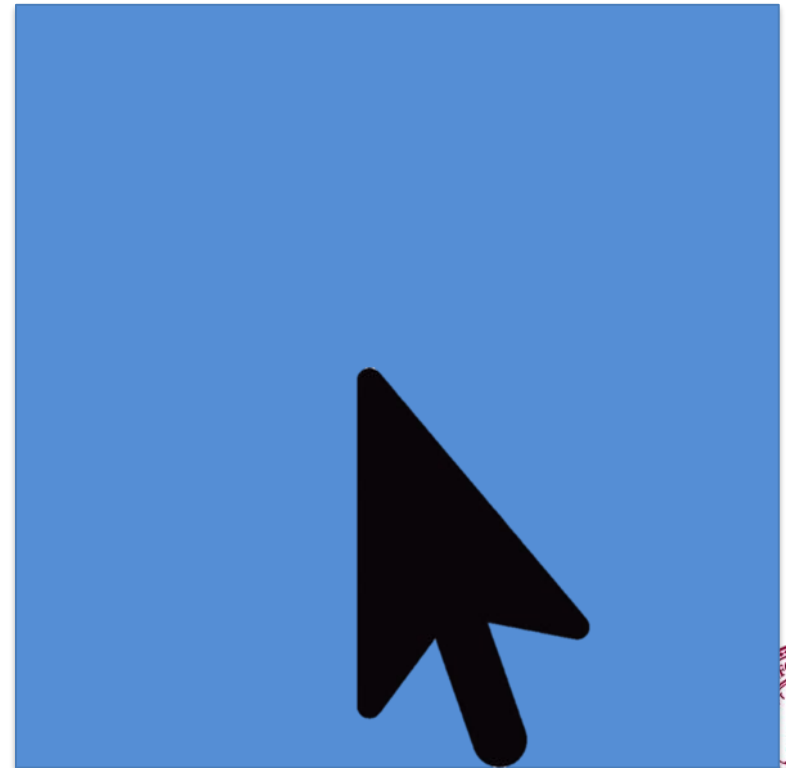
Run Method

Mouse Moved Method

Mouse Listener

Mouse Tracker

Mouse Tracker

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**

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

public void run() {
    square = makeSquare();
    addSquareToCenter();
    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!

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

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



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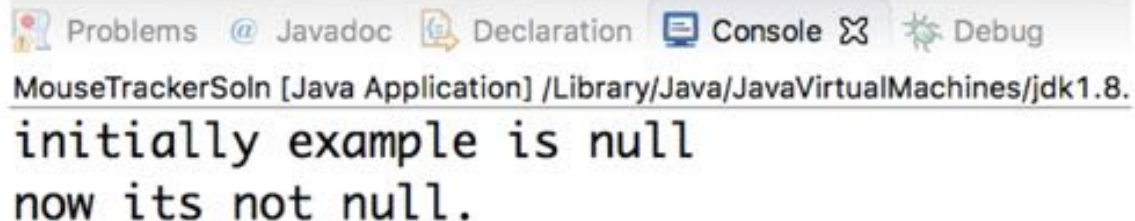
Null

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

```java
public void run() {
    GOval example = null;
    if(example == null) {
        println("initially example is null");
    }
    example = new GOval(5, 5);
    if(example != null) {
        println("now its not null.");
    }
}
```
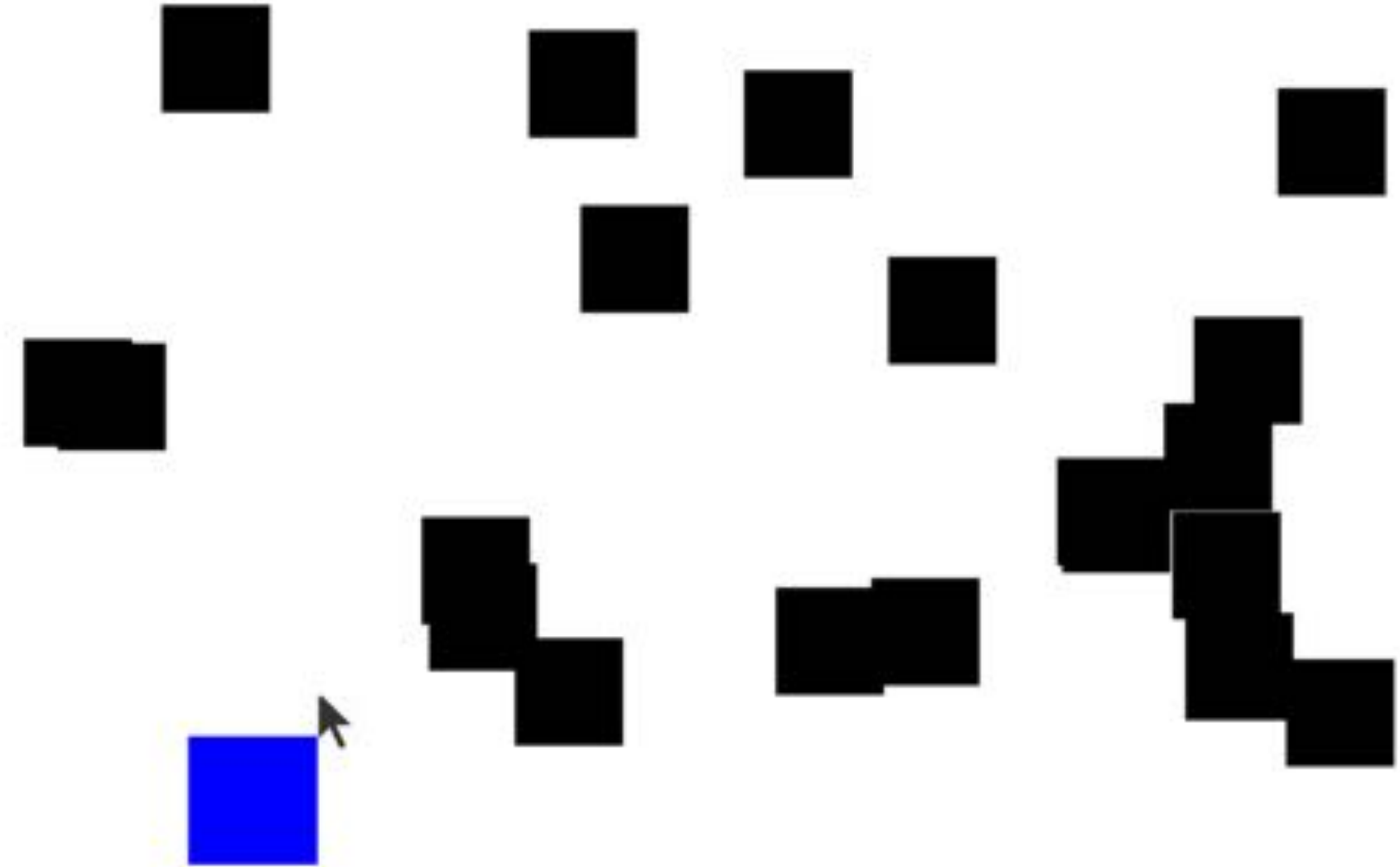
Problems   @ Javadoc   Declaration   Console ⊠   Debug

MouseTrackerSoln [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.

```
initially example is null
now its not null.
```

getElementAt

getElementAt

GObjects returned by getElementAt might be null!

```java
// 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
}
```
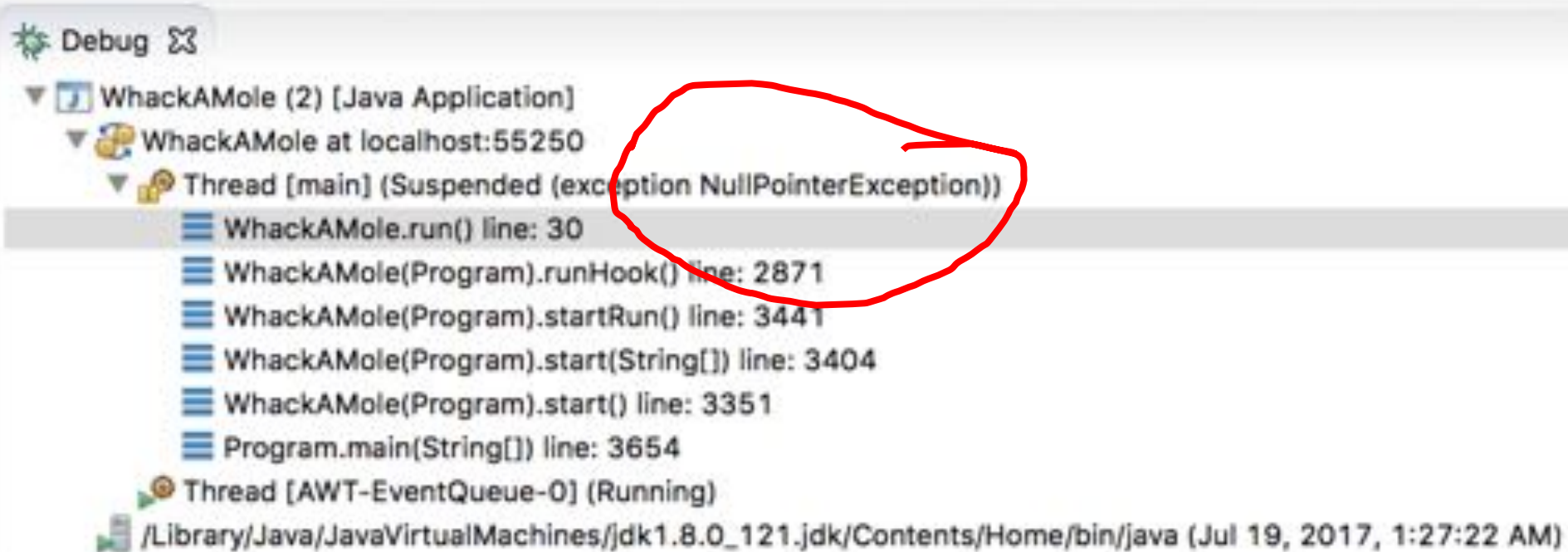
Null

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

```java
// 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!
}
```
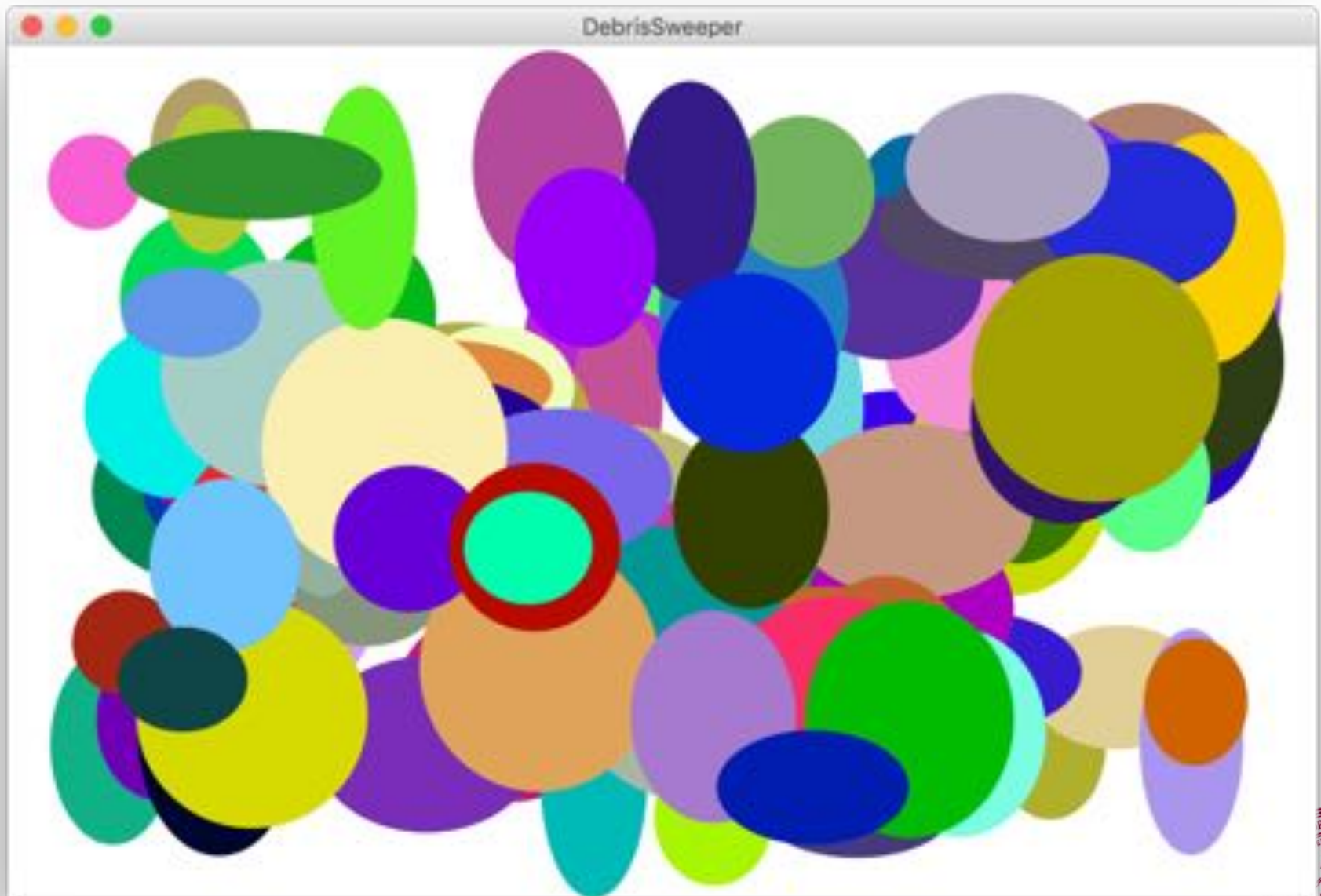
Null

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

Debris Sweeper

Novelty

New Commands

- `rg.nextInt(max);`

- `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(e)	Called when the user clicks the mouse
mousePressed(e)	Called when the mouse button is pressed
mouseReleased(e)	Called when the mouse button is released
mouseMoved(e)	Called when the user moves the mouse
mouseDragged(e)	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(*e***)**	Called when the user presses a key
keyReleased(*e***)**	Called when the key comes back up
keyTyped(*e***)**	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?