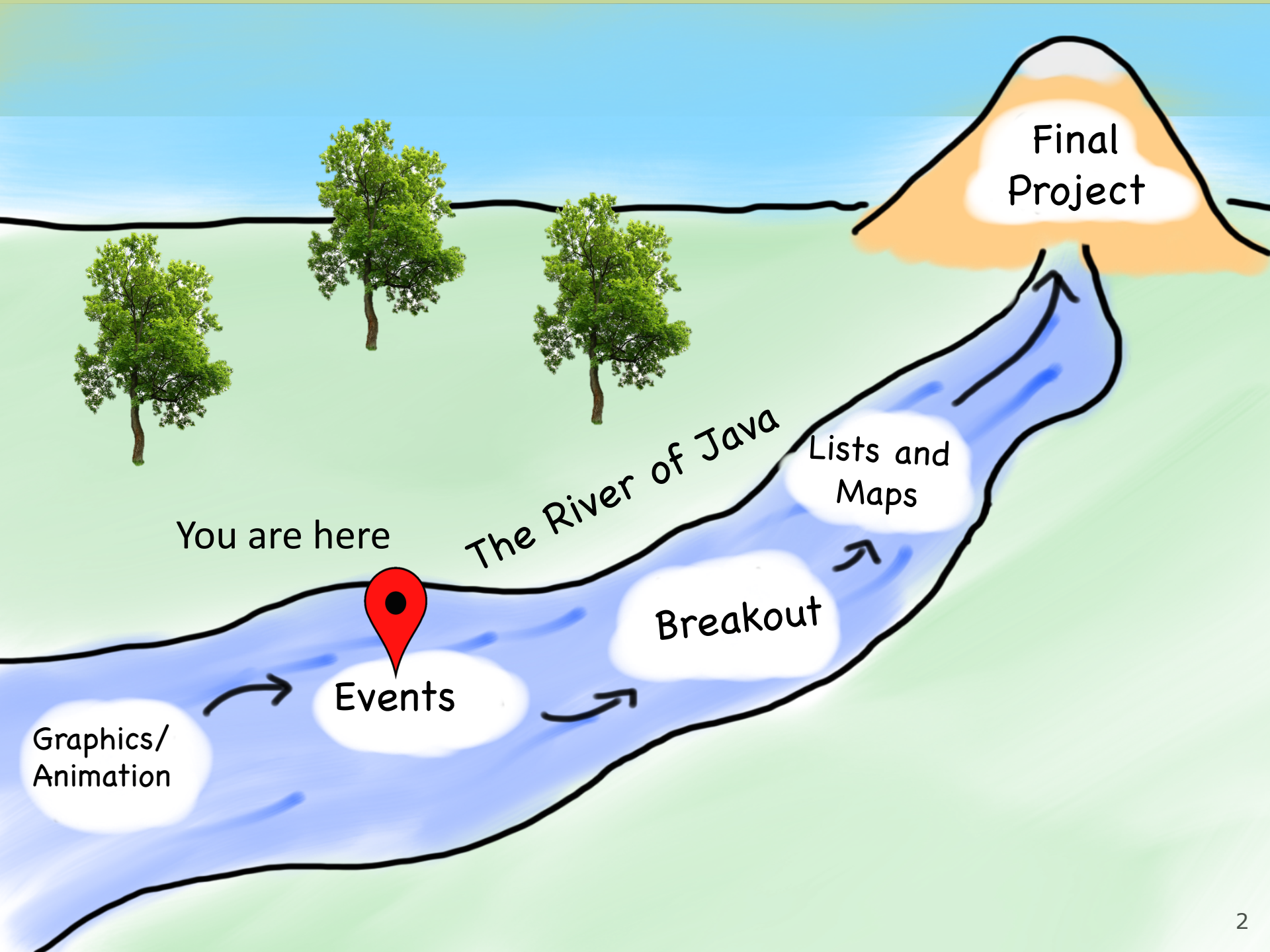
Events


Final Project
The River of Java
You are here
Lists and Maps
Breakout
Events
Graphics/ Animation

Learning Goals

- Learn to respond to mouse events in **`GraphicsPrograms`**
- Learn to use *instance variables* to store information outside of methods

Plan for Today

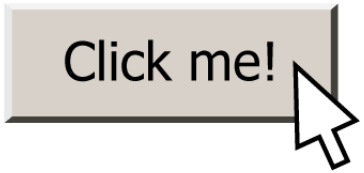
- Event-driven programming
- *Demo:* Click for Daisies
- *Demo:* Doodler
- Instance Variables
- **`null`** and **`getElementAt`**
- *Demo:* Whack-a-Mole

Plan for Today

- **Event-driven programming**
- *Demo:* Click for Daisies
- *Demo:* Doodler
- Instance Variables
- `null` and `getElementAt`
- *Demo:* Rubbish Sweeper

Events

- **event**: Some external stimulus that your program can respond to.



- **event-driven programming**: A coding style (common in graphical programs) where your code is executed in response to user events.

Events

- Program launches

Events

- Program launches
- Mouse motion
- Mouse clicking
- Keyboard keys pressed
- Device rotated
- Device moved
- GPS location changed
- and more…

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Events

```
public void run() {
    // Java runs this when program launches
}
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Events

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public void run() {
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}

public void mouseClicked(MouseEvent event) {
    // Java runs this when mouse is clicked
}
```

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
}
```

Example: ClickForDaisy

```
import acm.program.*;
import acm.graphics.*;
import java.awt.*;
import java.awt.event.*;      // NEW

public class ClickForDaisy extends GraphicsProgram {

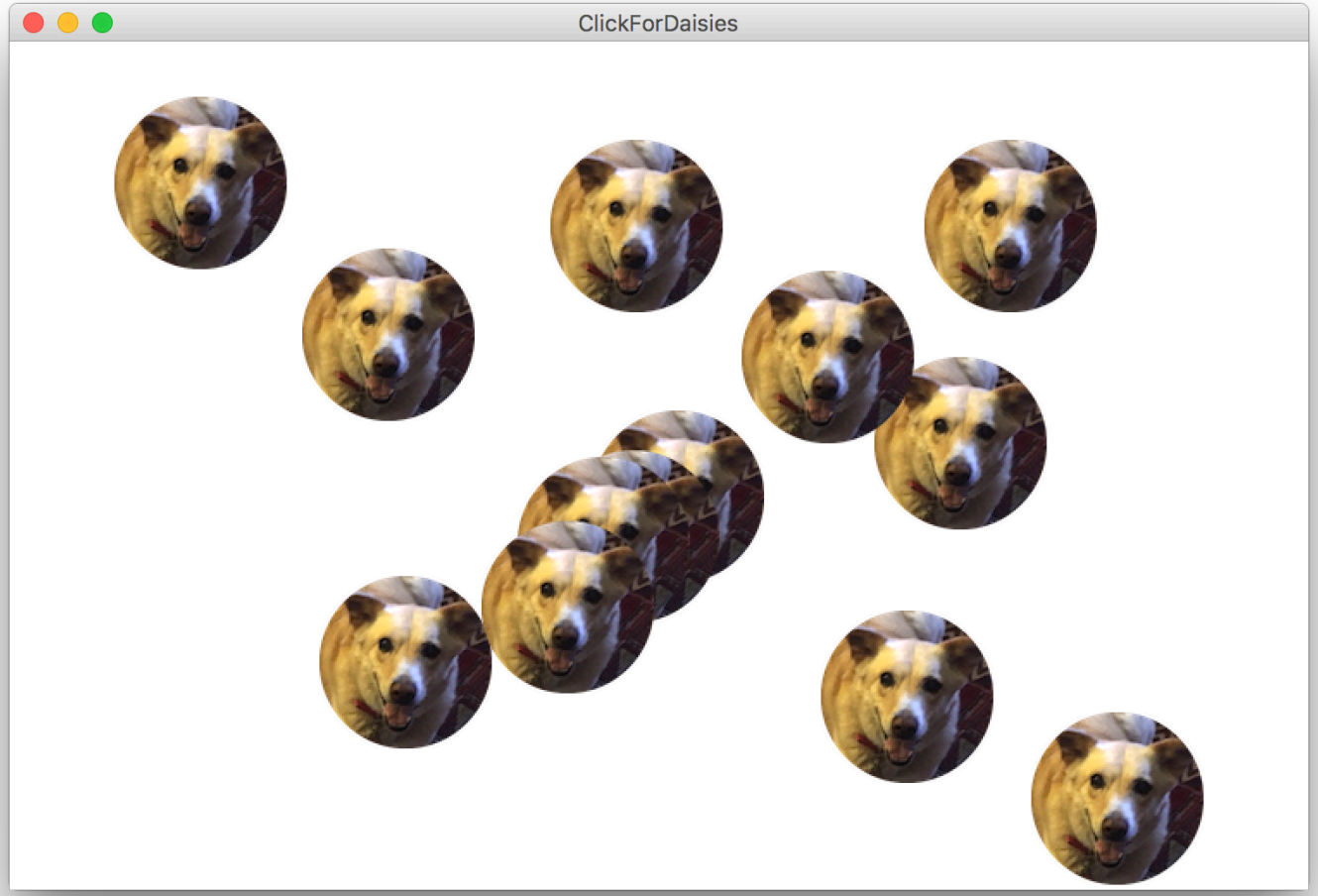
    // Add a Daisy image at 50, 50 on mouse click
    public void mouseClicked(MouseEvent event) {
       GImage daisy = new GImage("res/daisy.png", 50, 50);
       add(daisy);
    }
}
```

MouseEvent Objects

- A `MouseEvent` contains information about the event that just occurred:

Method	Description
`e.getX()`	the *x*-coordinate of mouse cursor in the window
`e.getY()`	the *y*-coordinate of mouse cursor in the window

Example: ClickForDaisies



Example: ClickForDaisies

```
public class ClickForDaisies extends GraphicsProgram {

   // Add a Daisy image where the user clicks
   public void mouseClicked(MouseEvent event) {
     // Get information about the event
     double mouseX = event.getX();
     double mouseY = event.getY();

     // Add Daisy at the mouse location
     GImage daisy = new GImage("res/daisy.png", mouseX, mouseY);
     add(daisy);
   }
}
```

Example: ClickForDaisies

```
public class ClickForDaisies extends GraphicsProgram {

   // Add a Daisy image where the user clicks
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     // Add Daisy at the mouse location
     GImage daisy = new GImage("res/daisy.png", mouseX, mouseY);
     add(daisy);
   }
}
```

Types of Mouse Events

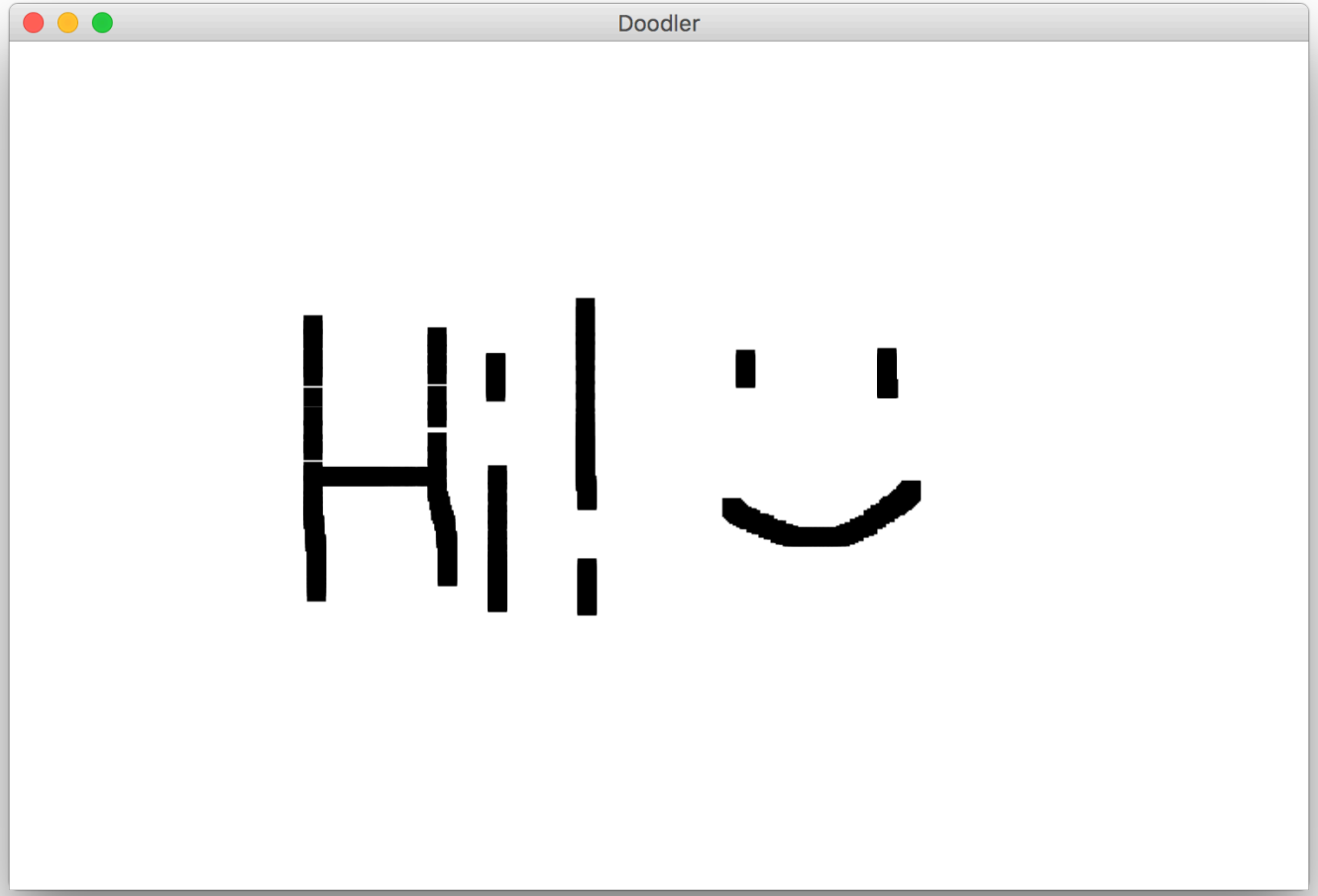
- There are many different types of mouse events.
  - Each takes the form:
    `public void` ***`eventMethodName`***`(MouseEvent event) { ...`

Method	Description
`mouseMoved`	mouse cursor moves
`mouseDragged`	mouse cursor moves while button is held down
`mousePressed`	mouse button is pressed down
`mouseReleased`	mouse button is lifted up
`mouseClicked`	mouse button is pressed and then released
`mouseEntered`	mouse cursor enters your program's window
`mouseExited`	mouse cursor leaves your program's window

Plan for Today

- Event-driven programming
- *Demo:* Click for Daisies
- ***Demo:*** **Doodler**
- Instance Variables
- `null` and `getElementAt`
- *Demo:* Whack-a-Mole

Coding Together: Doodler



Doodler

```
private static final int SIZE = 10;
...

public void mouseDragged(MouseEvent event) {
    double mouseX = event.getX();
    double mouseY = event.getY();
    double rectX = mouseX – SIZE / 2.0;
    double rectY = mouseY – SIZE / 2.0;
    GRect rect = new GRect(rectX, rectY, SIZE, SIZE);
    rect.setFilled(true);
    add(rect);
}
```

Doodler

```
public void mouseDragged(MouseEvent event) {
    double mouseX = event.getX();
    double mouseY = event.getY();
    double rectX = mouseX - SIZE / 2.0;
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public void mouseDragged(MouseEvent event) {
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Doodler

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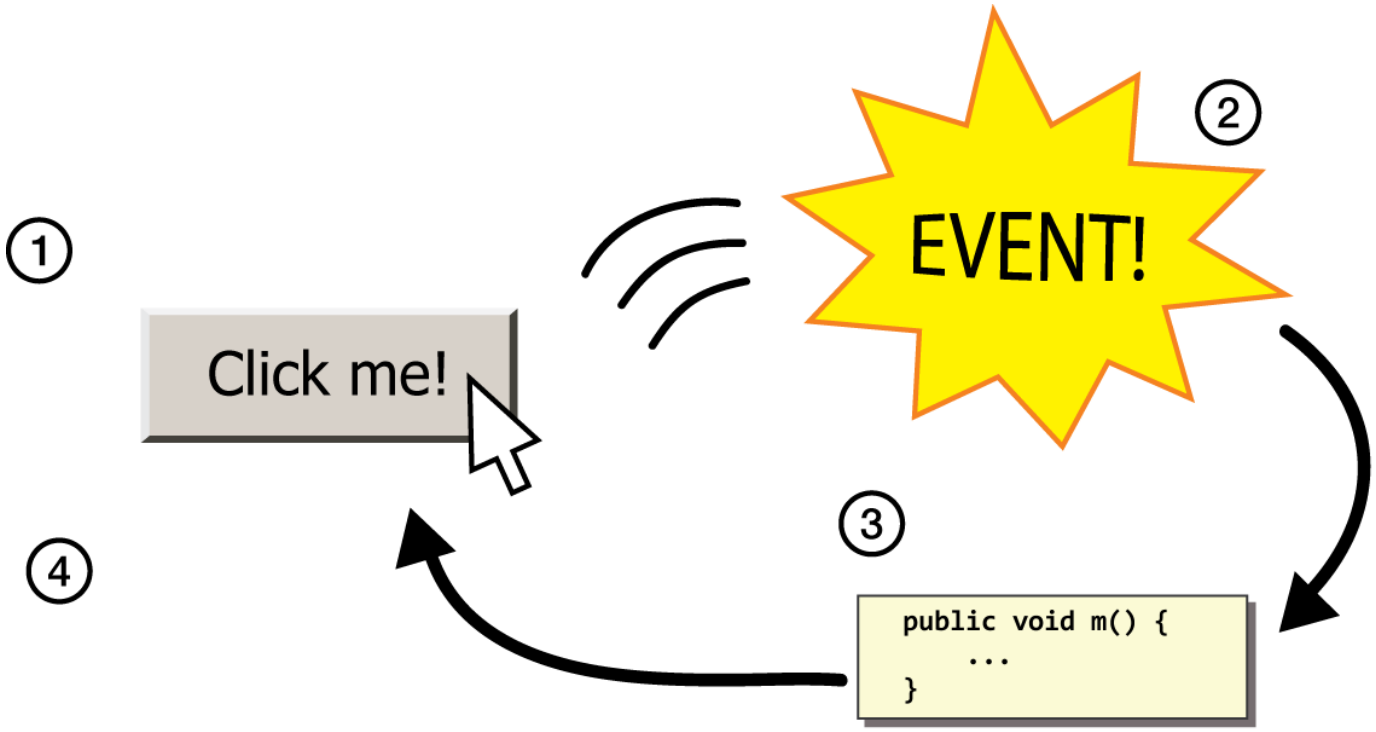
    GRect rect = new GRect(rectX, rectY, SIZE, SIZE);
    rect.setFilled(true);
    add(rect);
}
```

Recap: Events

1) User performs some action, like moving / clicking the mouse.
2) This causes an event to occur.
3) Java executes a particular method to handle that event.
4) The method's code updates the screen appearance in some way.



Revisiting Doodler

```
public void mouseDragged(MouseEvent event) {
    double mouseX = event.getX();
    double mouseY = event.getY();
    double rectX = mouseX – SIZE / 2.0;
    double rectY = mouseY – SIZE / 2.0;
    GRect rect = new GRect(rectX, rectY, SIZE, SIZE);
    rect.setFilled(true);
    add(rect);
}
```

What if we wanted the *same* GRect to track the mouse, instead of making a new one each time?

Plan for Today

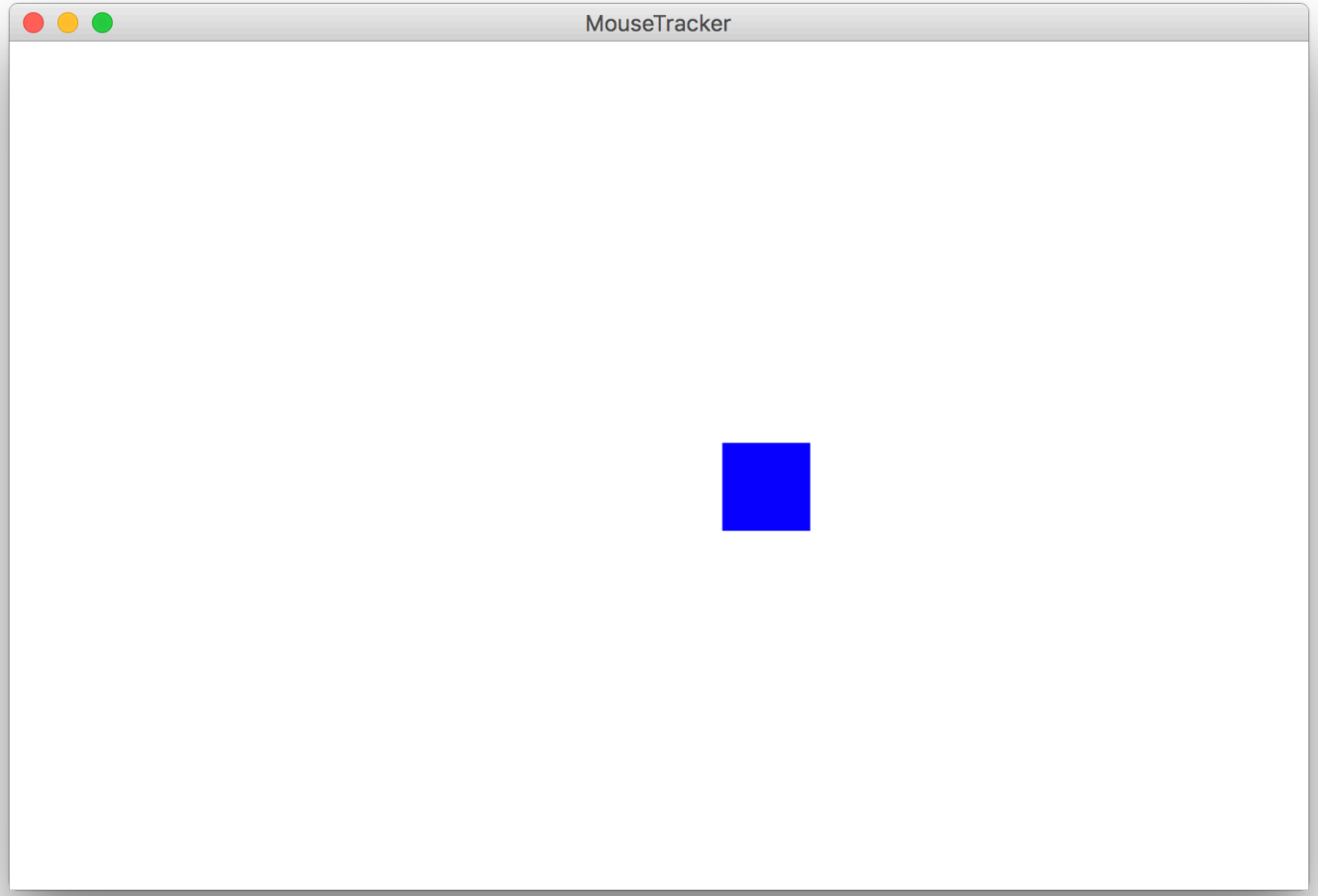
- Event-driven programming
- *Demo:* Click for Daisies
- *Demo:* Doodler
- **Instance Variables**
- `null` and `getElementAt`
- *Demo:* Whack-a-Mole

Instance Variables

```
private type name;  // declared outside of any method
```

- **Instance variable**: A variable that lives outside of any method.
  - The *scope* of an instance variable is throughout an entire file (class).
  - Useful for data that must persist throughout the program, or that cannot be stored as local variables or parameters (event handlers).
  - *It is bad style to overuse instance variables*

Example: MouseTracker



Plan for Today

- Event-driven programming
- *Demo:* Click for Daisies
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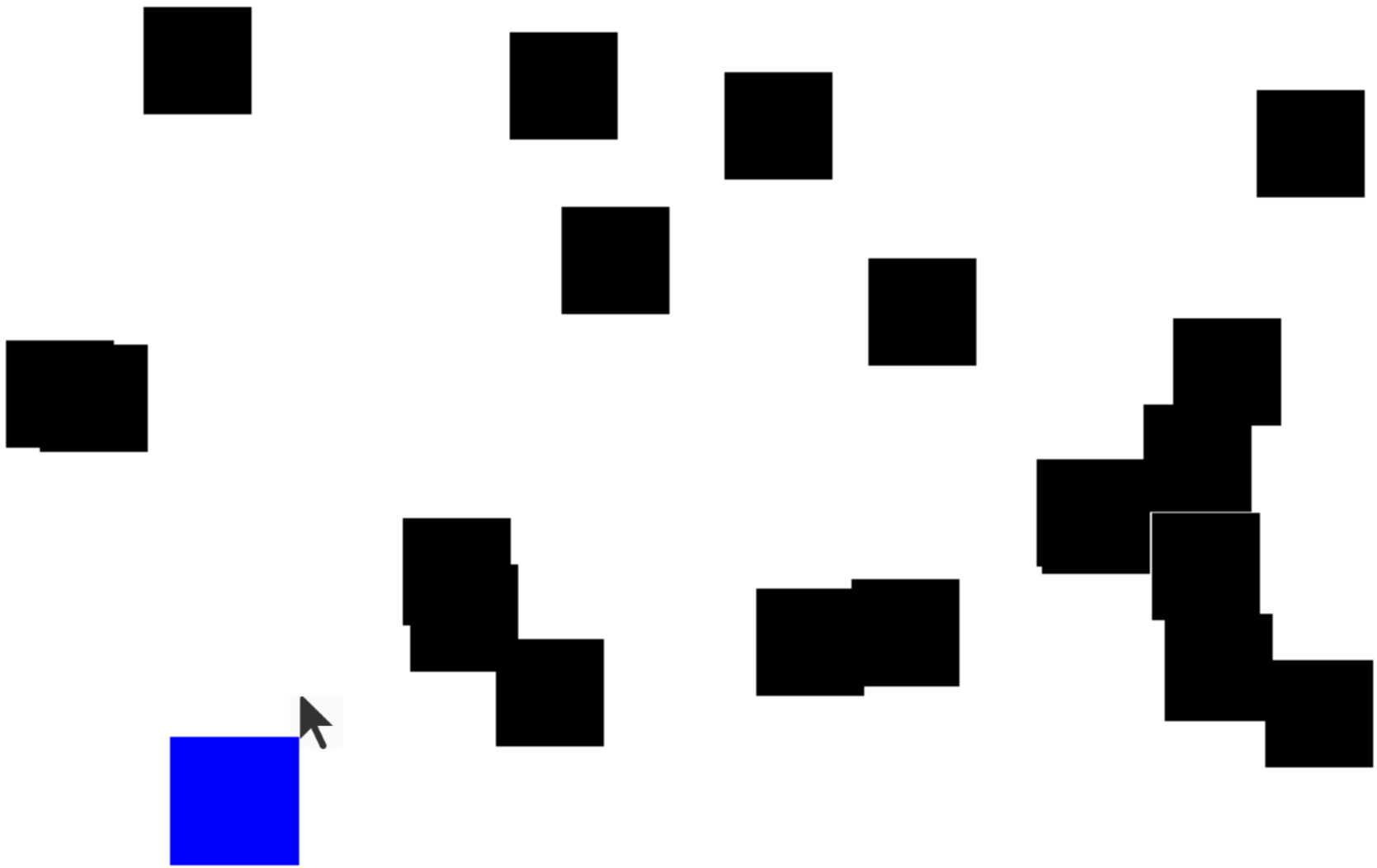
getElementAt



getElementAt

getElementAt returns the object at this location on the canvas

```
GObject objectHere = getElementAt(x, y);
```

getElementAt

getElementAt returns the object at this location on the canvas

```
GObject objectHere = getElementAt(x, y);
if (objectHere != null) {
      // do something with objectHere
} else {
      // null – nothing at that location
}
```

Null

Null is a special variable value that objects can have that means "nothing". Primitives cannot be null.

If a method returns an object, it can return **null** to signify "nothing". (just say `return null;`)

```
// may be a GObject, or null if nothing at (x, y)
GObject maybeAnObject = getElementAt(x, y);
```

Null

You can check if something is null using == and !=.

```
// 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
}
```

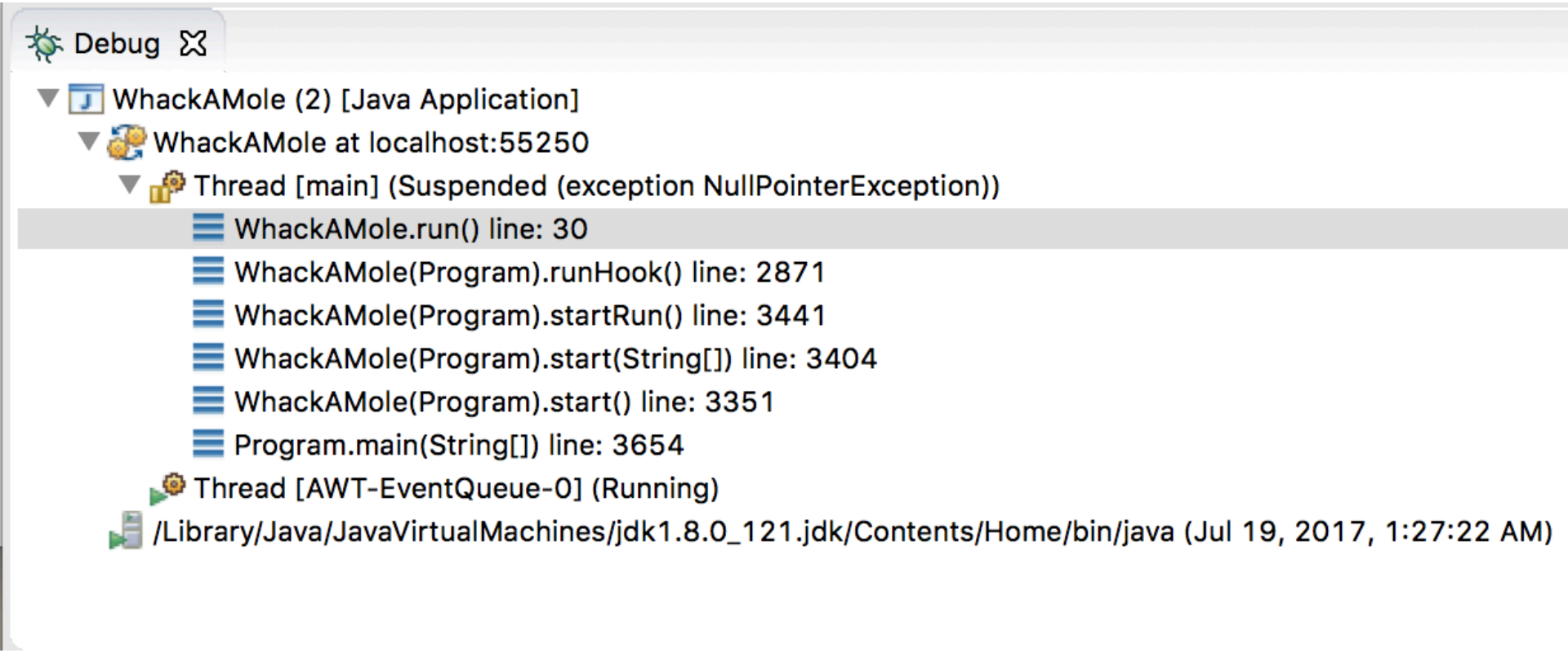
Null

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)

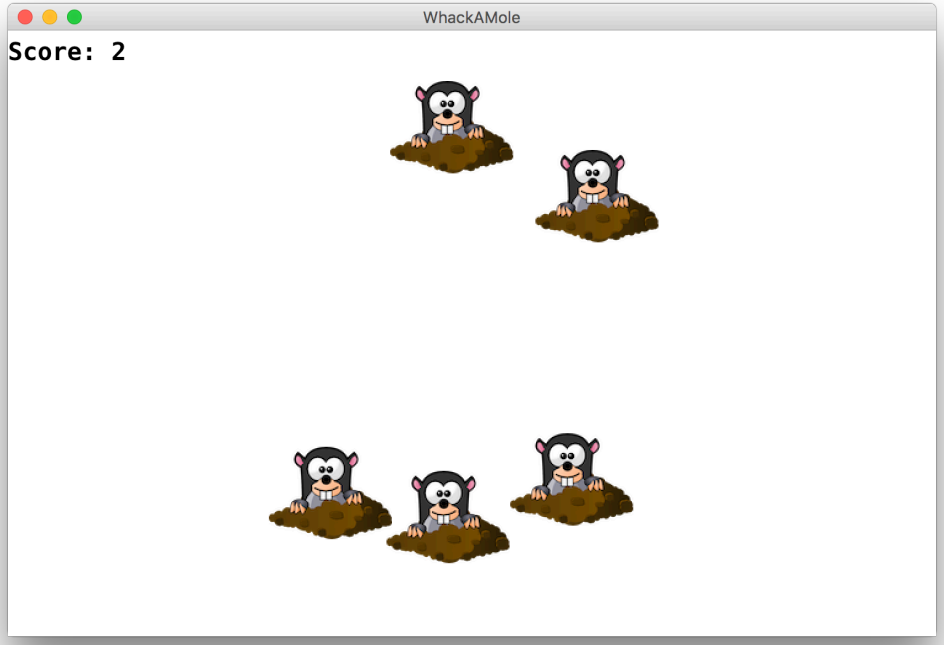


Putting it all together

Whack-A-Mole

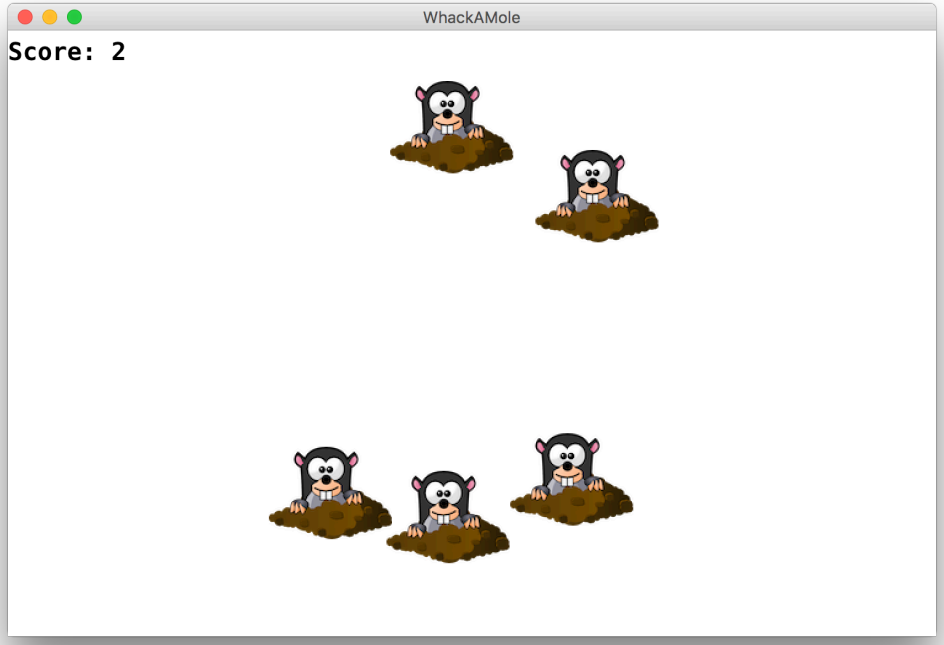
Let's make Whack-A-Mole!

- Moles should initially appear at random locations on the screen
- If the user clicks a mole, remove it



Whack-A-Mole

Let’s add to our program by continuously adding more moles as the game plays.



Normal Program

Run Method

Normal Program

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

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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

Recap

- Event-driven programming
- *Demo:* Click for Daisies
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- Instance Variables
- **`null`** and **`getElementAt`**
- *Demo:* Whack-a-Mole