Instance Variables and Interactive Graphics Programs

Reading:

Art & Science of Java, Ch. 10.1-10.4

Learning Goals

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

Plan for today

- Announcements
- Review: Animation
- Null
- Event-driven programming
- Instance Variables

Null

- **`null`**: A special constant value meaning, "no object."
  - `getElementAt` returns `null` if no object is at that position.
  - You can check for `null` using the `==` and `!=` operators.

```
GObject mole = getElementAt(x, y);
if (mole != null) {
    remove(mole);
}
```

Events

- Program launches

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

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public void run() {
    // Java runs this when program launches
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    // Java runs this when mouse is clicked
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Events

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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: ClickForFace

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

public class ClickForFace extends GraphicsProgram {

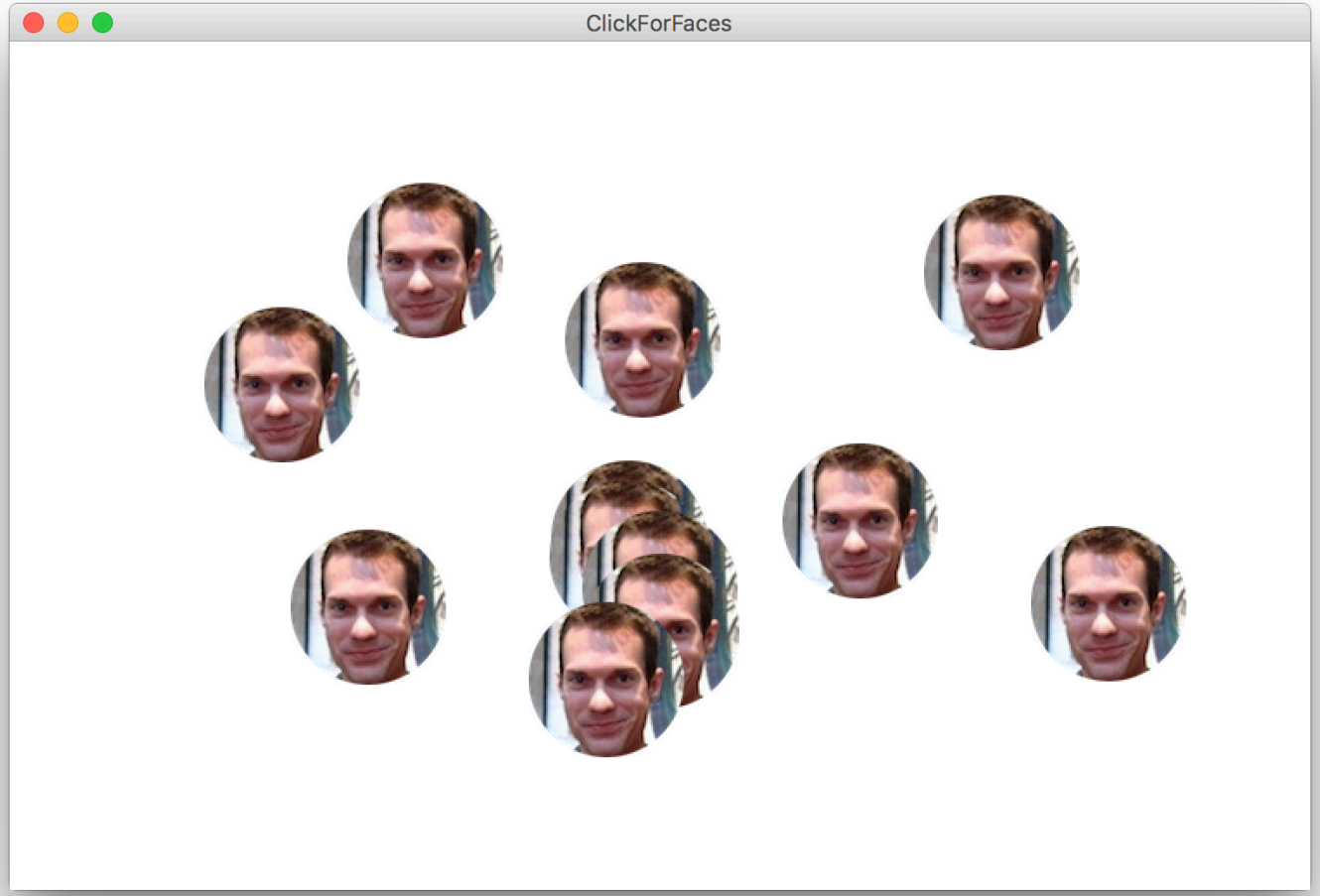
    // Add a face at 50, 50 on mouse click
    public void mouseClicked(MouseEvent event) {
        GImage face = new GImage("res/martyFace.png",
            50, 50);
        add(face);
    }
}
```

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: ClickForFaces



Example: ClickForFaces

```
public class ClickForFaces extends GraphicsProgram {

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

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

Example: ClickForFaces

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    public void mouseClicked(MouseEvent event) {
        // Get information about the event
        double mouseX = event.getX();
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        // Add a face at the mouse location
        GImage face = new GImage("res/martyFace.png",
            mouseX, mouseY);
        add(face);
    }
}
```
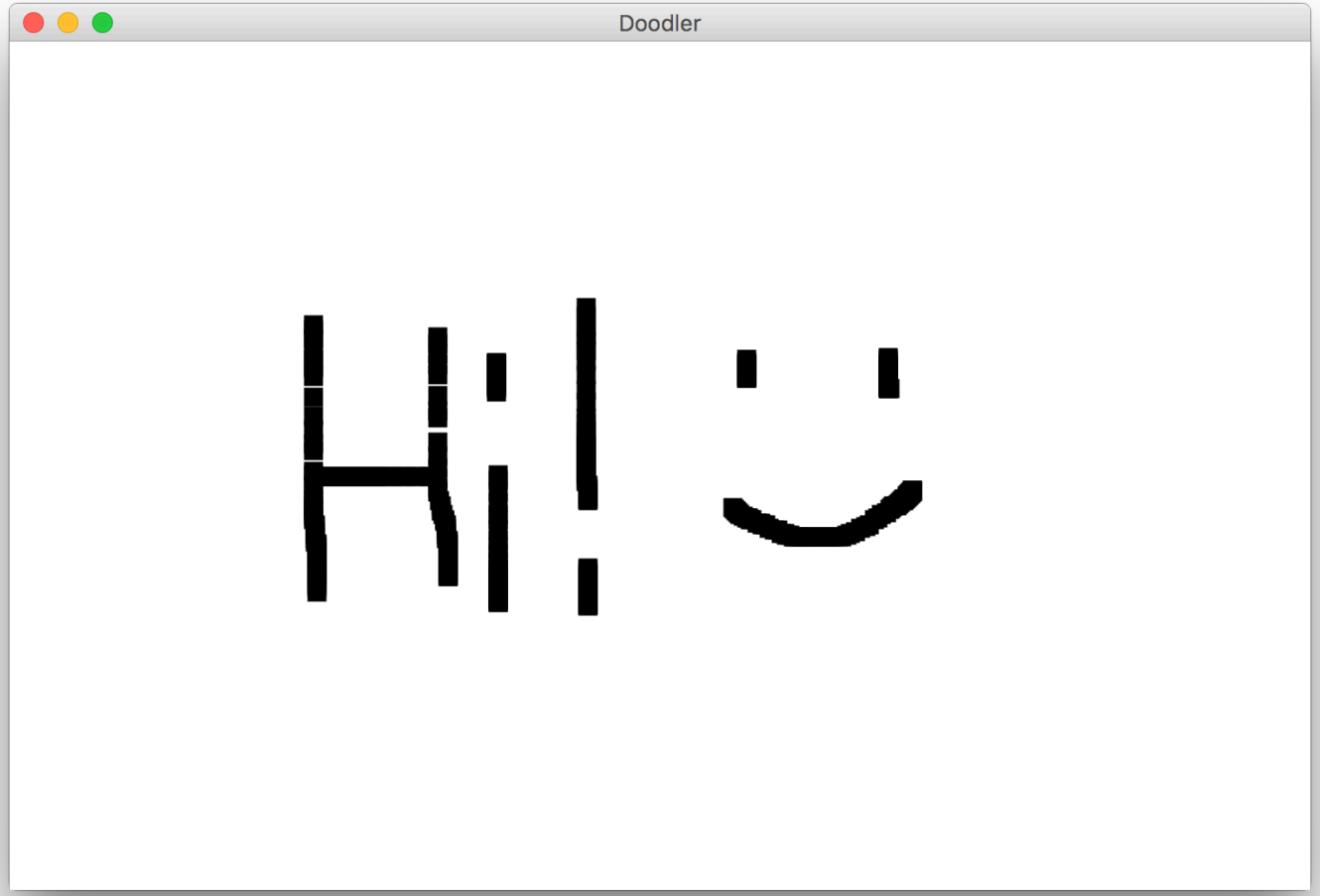

Event methods

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

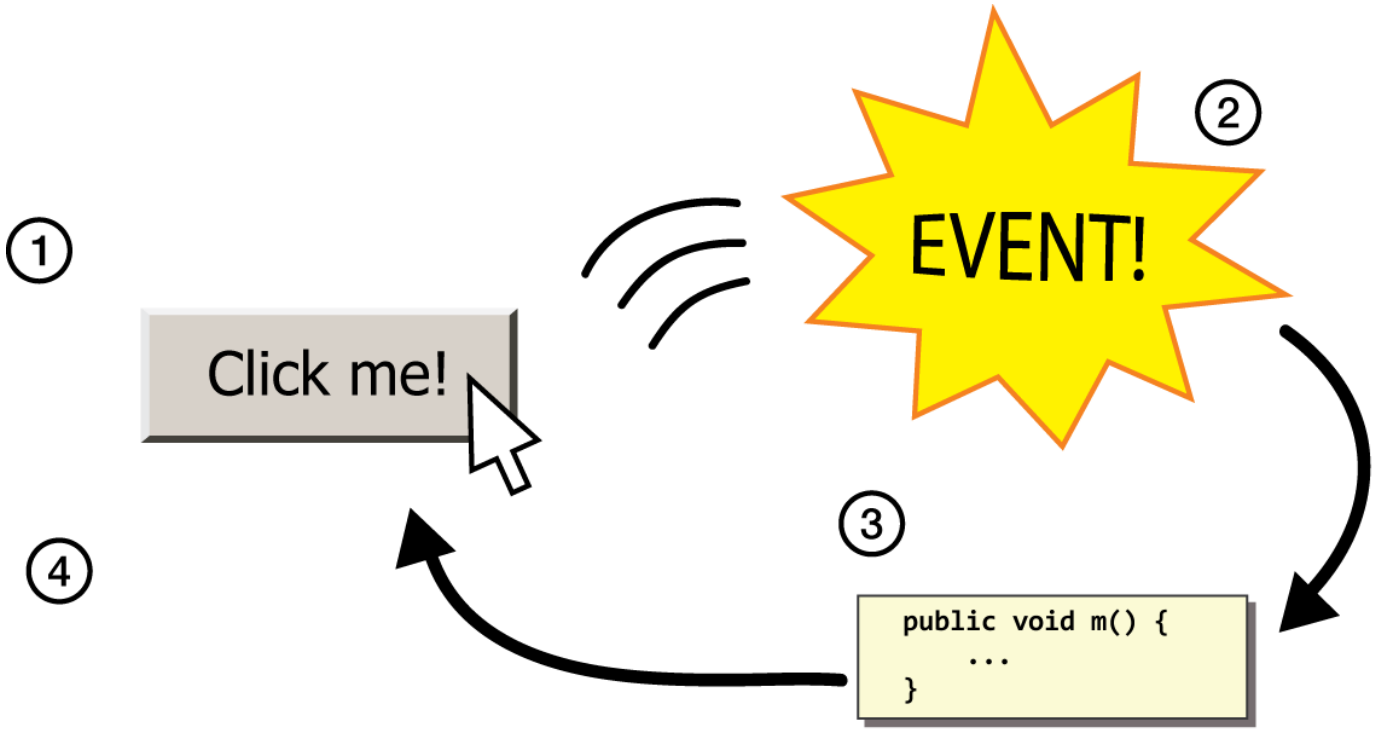
Method	Description
`mouseMoved`	mouse cursor moves
`mouseDragged`	mouse cursor moves while button is held down
`mousePressed`	mouse button is pressed down
`mouseReleased`	mouse button is lifted up
`mouseClicked`	mouse button is pressed and then released
`mouseEntered`	mouse cursor enters your program's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

Example: Doodler



The event cycle

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

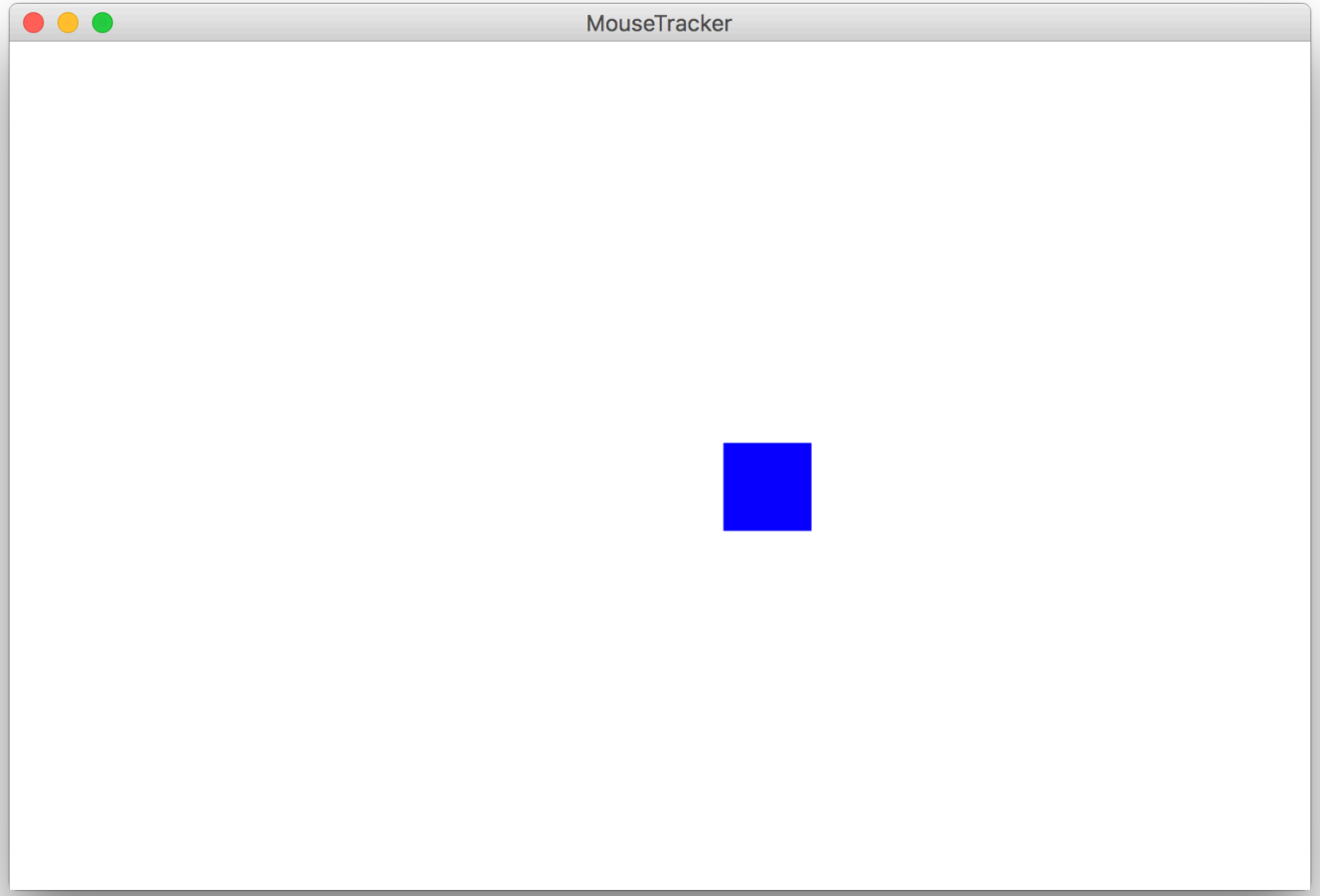
- Graphics review
- Event-driven programming
- Announcements
- Fields

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).
  - *Overuse of instance variables:* Because they have a large scope, it is considered bad style to use too many instance variables, or to make something an instance variable that could instead be a local variable, parameter, return, etc.
    - **DO NOT USE INSTANCE VARIABLES ON HANGMAN!!**

Example: MouseTracker



Putting it all together

Whack-A-Mole

Let's use instance variables and mouse events to make Whack-A-Mole!

- A mole should appear every second at a random location
- If the user clicks a mole, remove it and increase their score by 1
- There should be a GLabel in the left corner showing their score

Exception

- If the user clicks an area with no mole, the program crashes.
  - A program crash in Java is called an **exception**.
  - When you get an exception, Eclipse shows red error text.
  - The error text shows the line number where the error occurred.
  - Why did this error happen?
  - How can we avoid this?