Interactors

Brahm Capoor
brahm@stanford.edu

Learning goals for today

To learn how to use interactors in our programs

Learning goals for today

To learn how to use interactors in our programs

To go under the hood of a program

Learning goals for today

To learn how to use interactors in our programs

To go under the hood of a program

To see how we can use Computer Science to understand people

‘...a device that [...] had about a hundred tiny flat press buttons and a screen about four inches square on which any one of a million “pages” could be summoned at a moment’s notice. It looked insanely complicated, and [...] had the words DON’T PANIC printed on it in large friendly letters’

‘...a device that [...] had about a hundred tiny flat press buttons and a screen about four inches square on which any one of a million “pages” could be summoned at a moment’s notice. It looked insanely complicated, and [...] had the words DON’T PANIC printed on it in large friendly letters’

- Douglas Adams, *The Hitchhiker’s Guide to the Galaxy*

How do we interact with programs?

How do we interact with programs?

As Console Programs

How do we interact with programs?

As Console Programs

```
public class myProgram extends ConsoleProgram {...}
```

How do we interact with programs?

As Console Programs

```
public class myProgram extends ConsoleProgram {...}
```

Using our Mouse and Keyboard

How do we interact with programs?

As Console Programs

```
public class myProgram extends ConsoleProgram {...}
```

Using our Mouse and Keyboard

```
public void mouseMoved(MouseEvent e){...}
```

How do we interact with programs?

As Console Programs

```
public class myProgram extends ConsoleProgram {...}
```

Using our Mouse and Keyboard

```
public void mouseMoved(MouseEvent e){...}
```

Using UI Elements (buttons, sliders, text fields)

How do we interact with programs?

As Console Programs

```
public class myProgram extends ConsoleProgram {...}
```

Using our Mouse and Keyboard

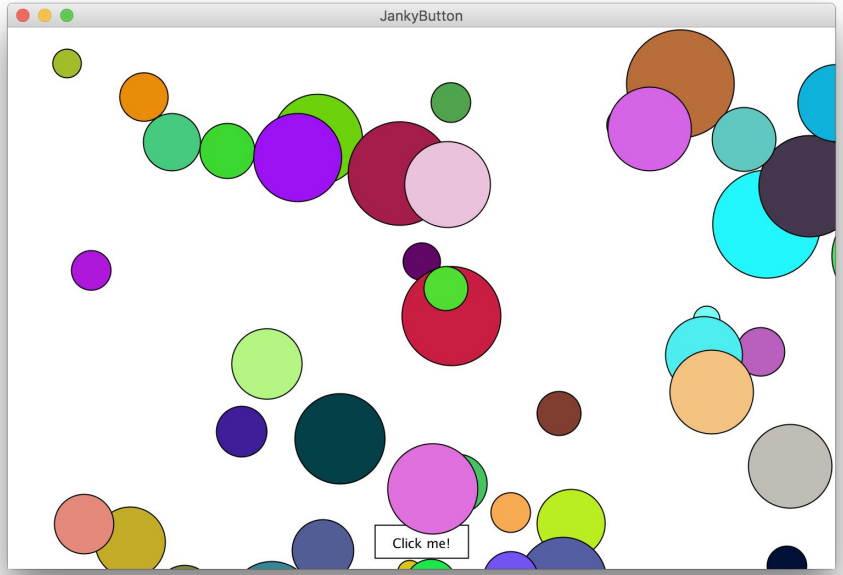
```
public void mouseMoved(MouseEvent e){...}
```

Using UI Elements (buttons, sliders, text fields)

```
// ¯\_(ツ)_/¯
```

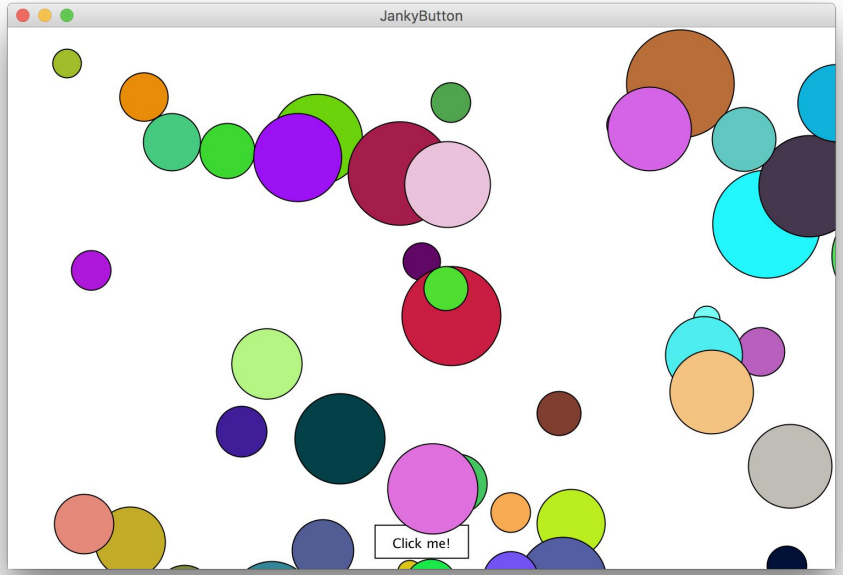
Using the tools we already have, how could we make a button?

What's wrong with this approach to making buttons?



What's wrong with this approach to making buttons?

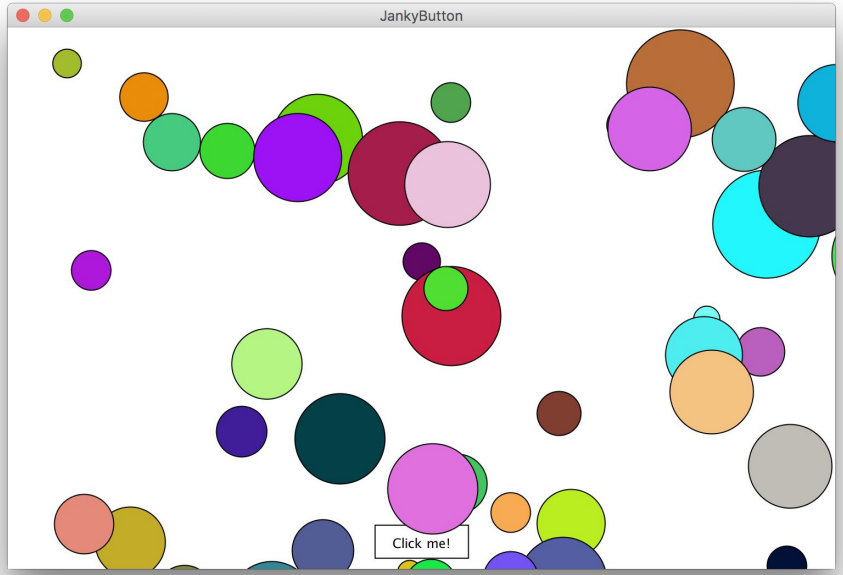
Not a separate part of the interface



What’s wrong with this approach to making buttons?

Not a separate part of the interface

Doesn’t give any indication that it was clicked

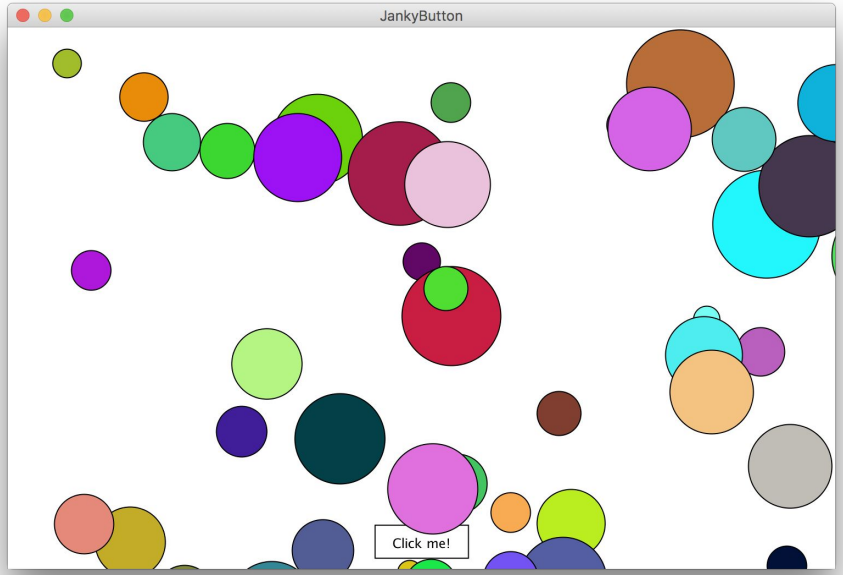


What's wrong with this approach to making buttons?

Not a separate part of the interface

Doesn't give any indication that it was clicked

Looks pretty bad



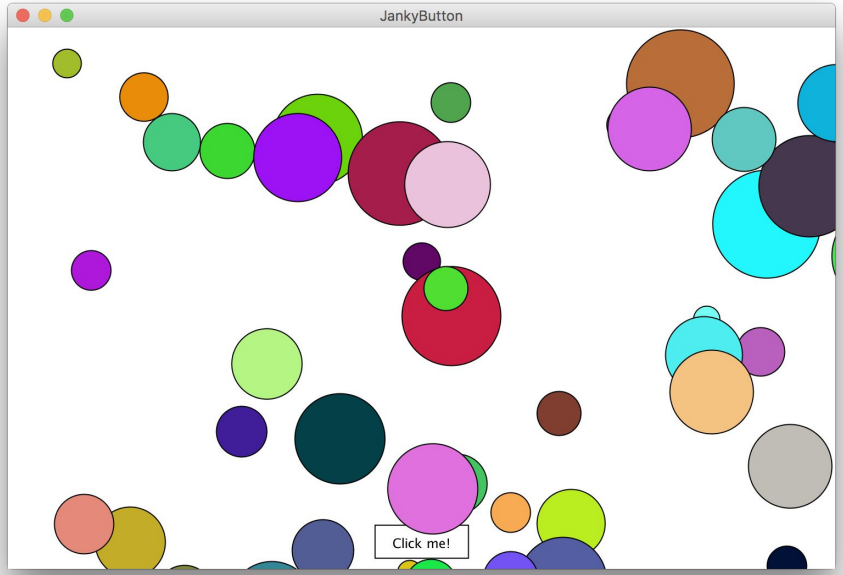
What's wrong with this approach to making buttons?

Not a separate part of the interface

Doesn't give any indication that it was clicked

Looks pretty bad

Inconsistent with other programs



What's wrong with this approach to making buttons?

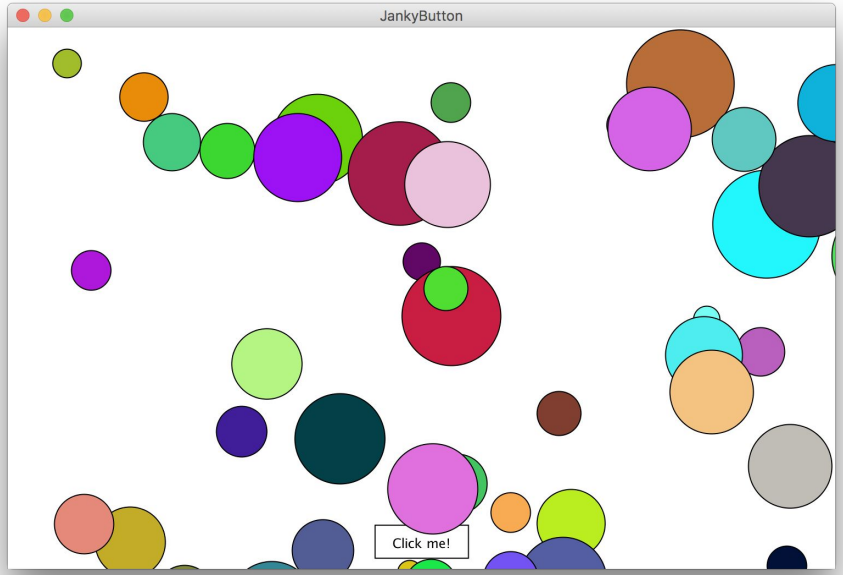
Not a separate part of the interface

Doesn't give any indication that it was clicked

Looks pretty bad

Inconsistent with other programs

Can't use it in `ConsolePrograms`



What's wrong with this approach to making buttons?

Not a separate part of the interface

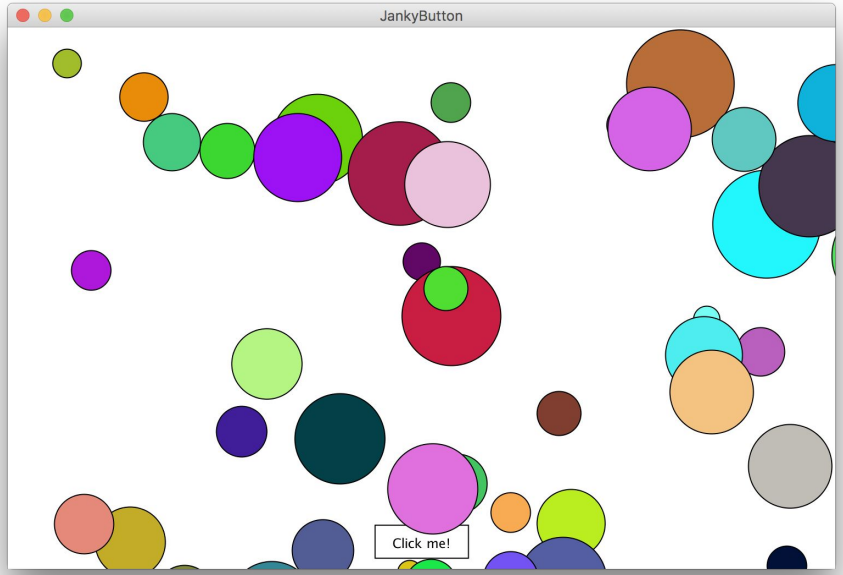
Doesn't give any indication that it was clicked

Looks pretty bad

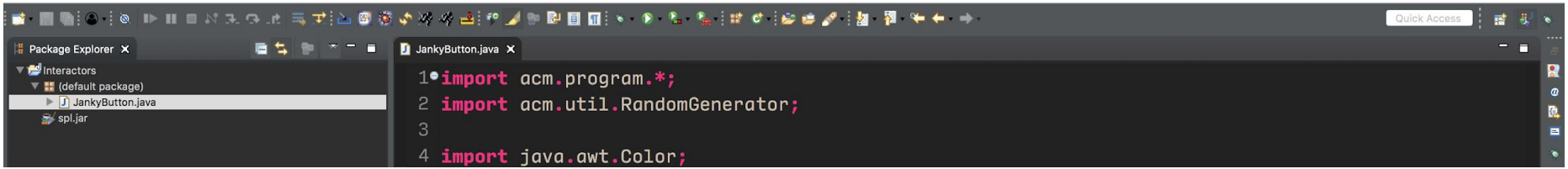
Inconsistent with other programs

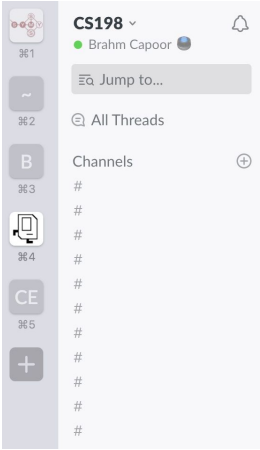
Can't use it in `ConsolePrograms`

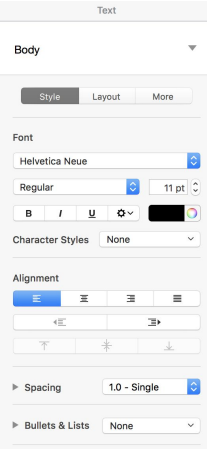
Lots of work to create

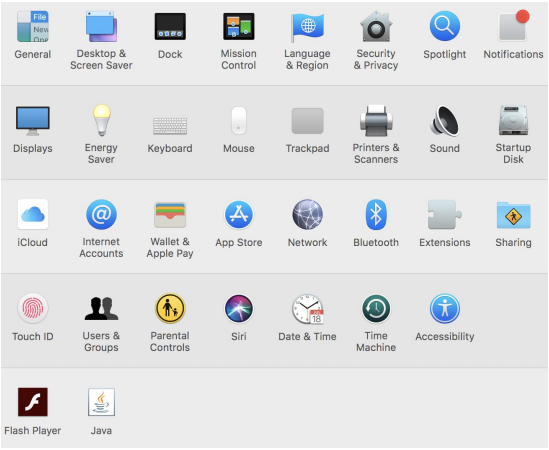


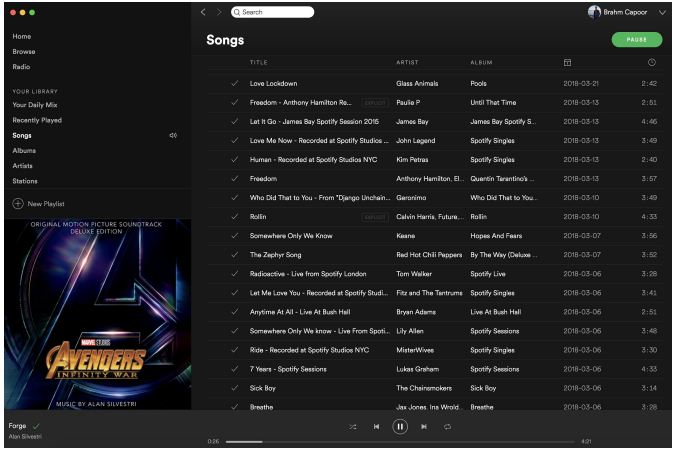
Making these interfaces would be devastating





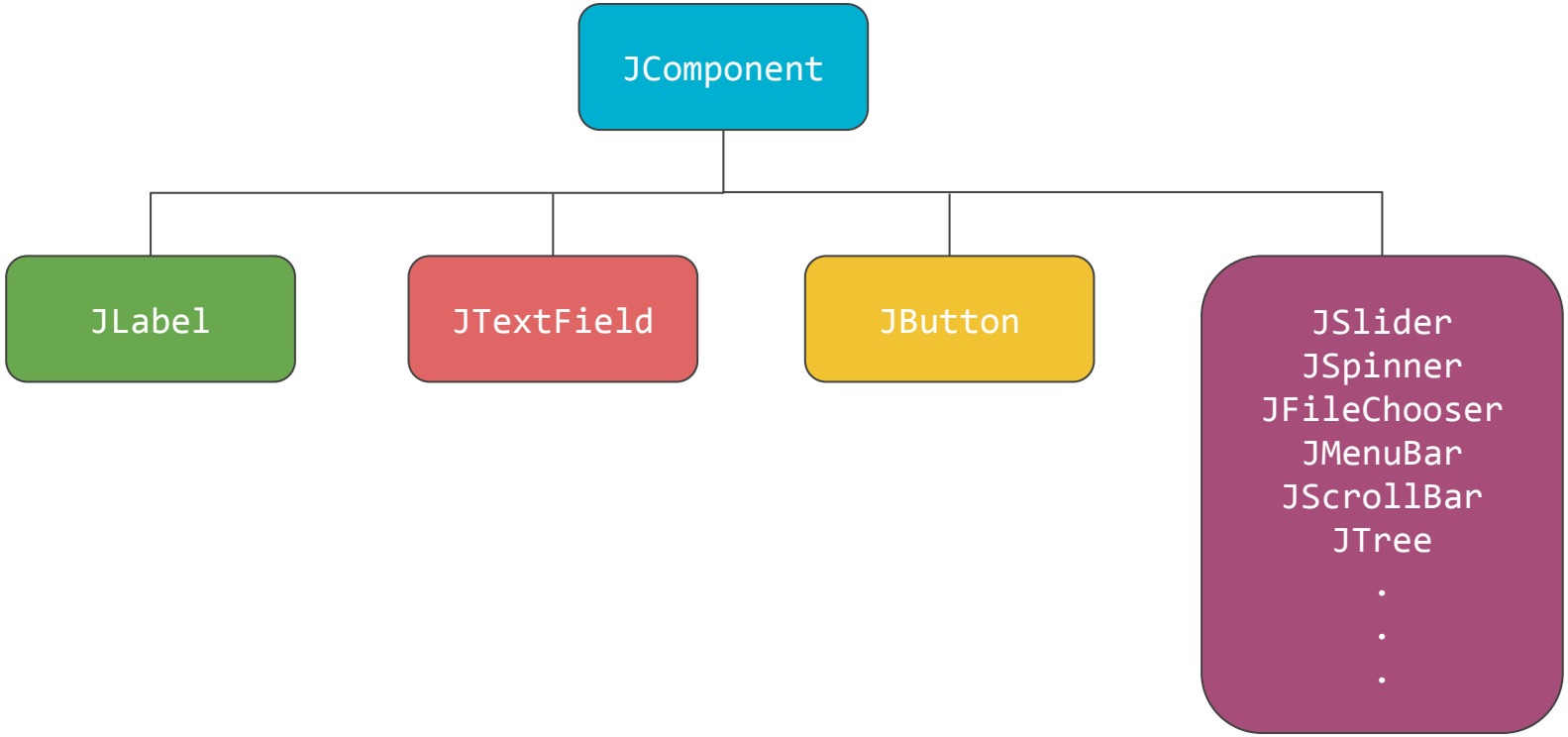




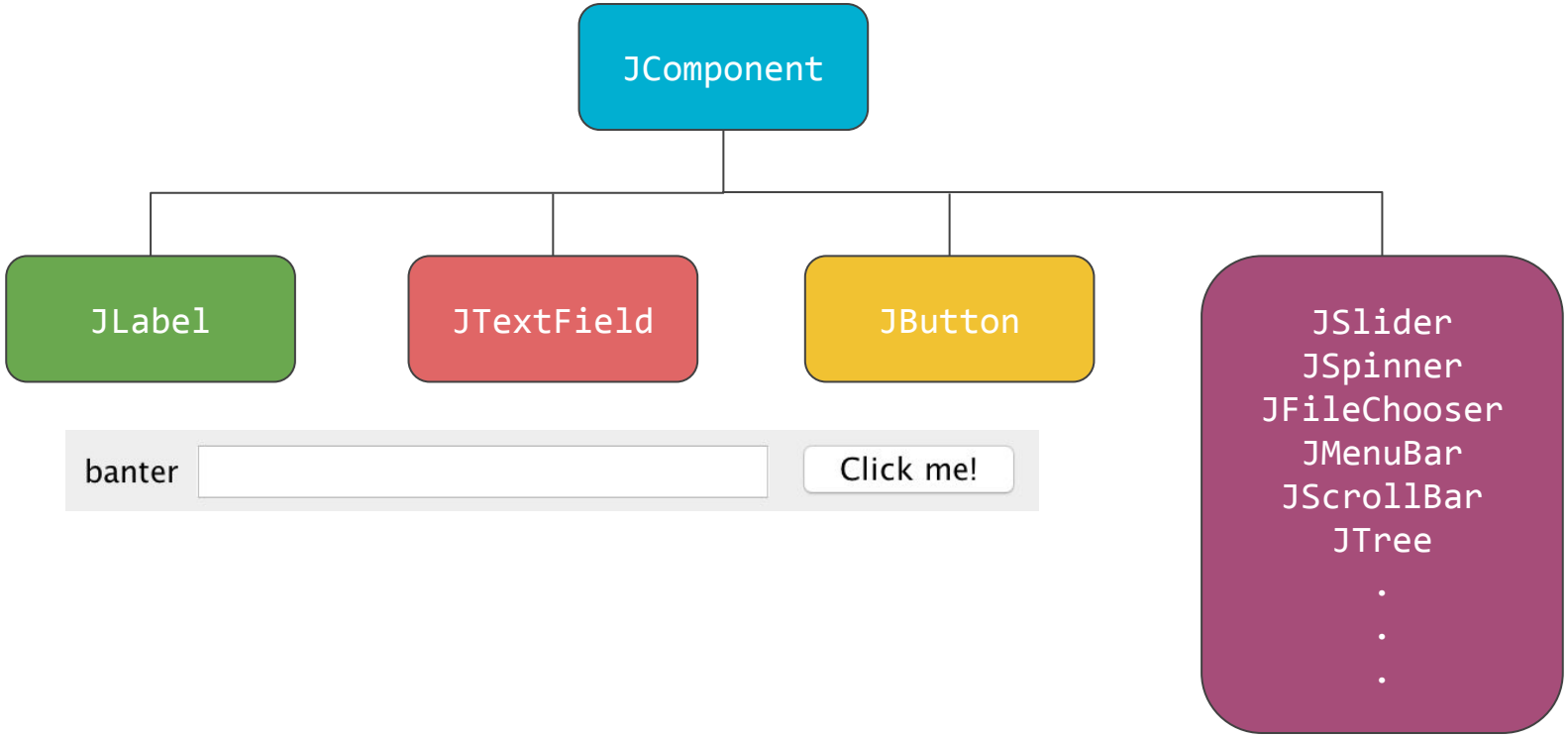


Programming is about standing on the shoulders of giants

Meet today's giant



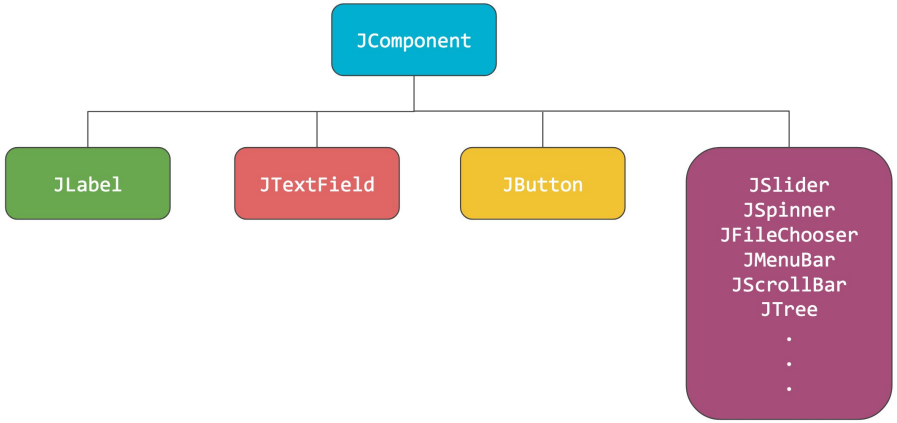
Meet today's giant



JComponents

Java handles how they look

You handle how they work



Our first JComponents

```
JLabel label = new JLabel("banter");

JTextField field = new JTextField(20);    // 20 characters wide

JButton button = new JButton("Click me");

// how do we add these to the window?
```

Regions in a window

Java divides every window into 5 regions

Regions in a window

Java divides every window into 5 regions

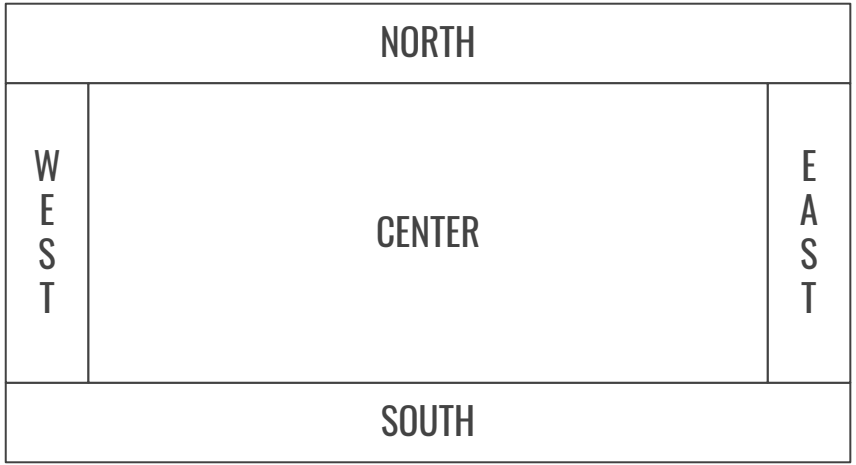
Center: your `ConsoleProgram` or `GraphicsProgram`

Regions in a window

Java divides every window into 5 regions

Center: your `ConsoleProgram` or `GraphicsProgram`

The other regions only show up when you add things to them



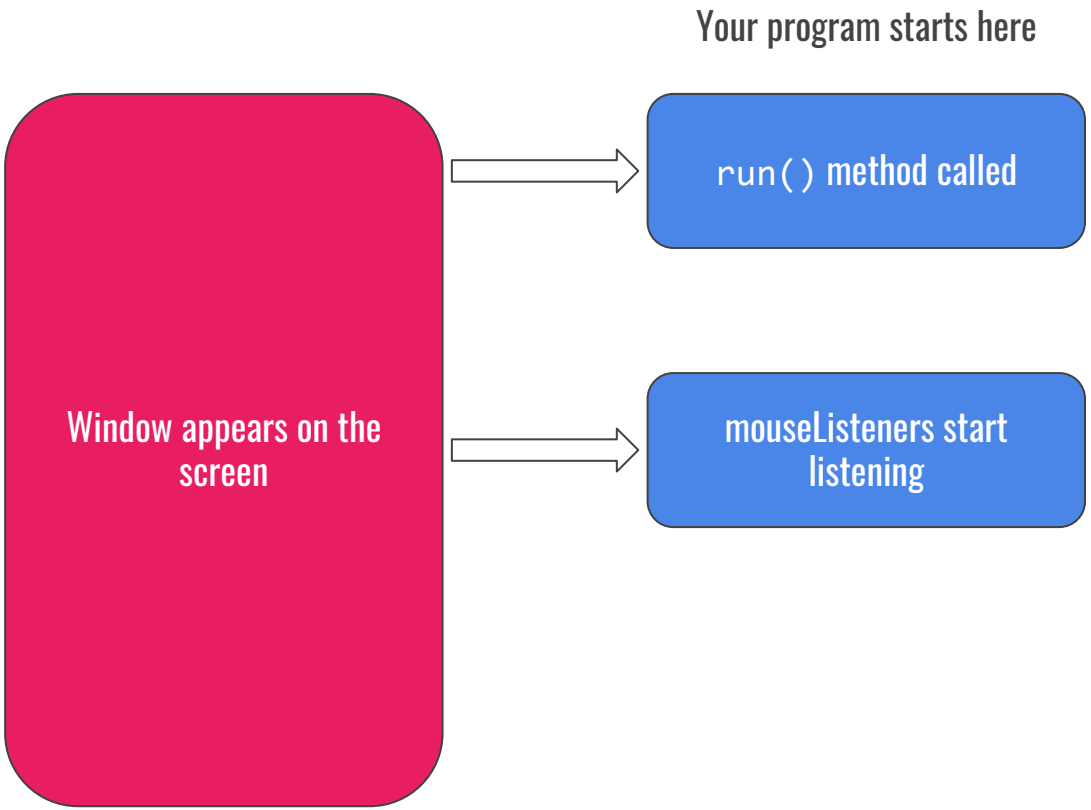
Putting JComponents on the window

```
JLabel label = new JLabel("banter");

JTextField field = new JTextField(20);    // 20 characters wide

JButton button = new JButton("Click me");

add(label, SOUTH);
add(field, SOUTH);
add(button, SOUTH);
```

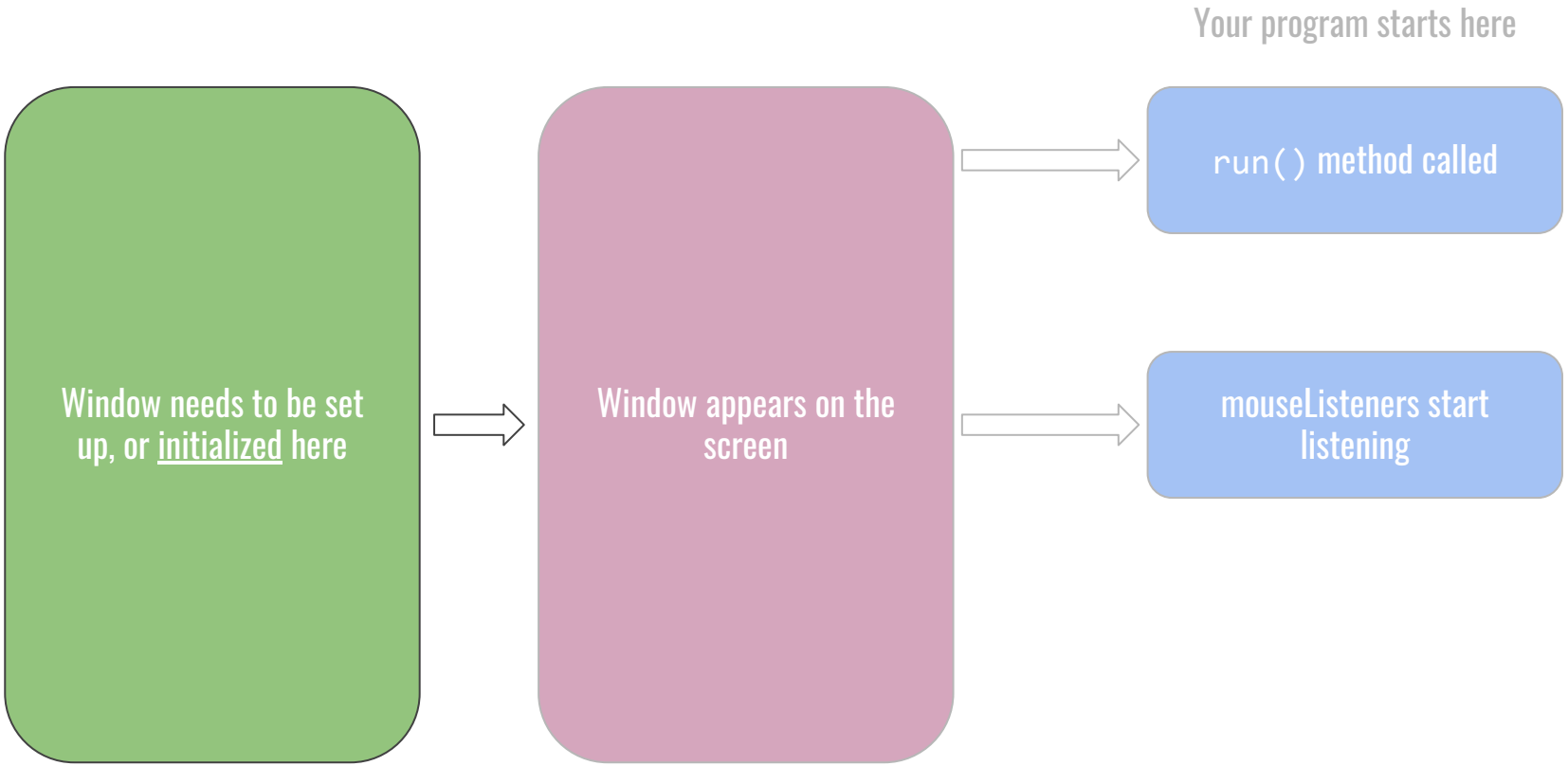
Java automatically arranges the components in the SOUTH region for you

Let’s `run()` with it

What we know so far



Diving under the hood

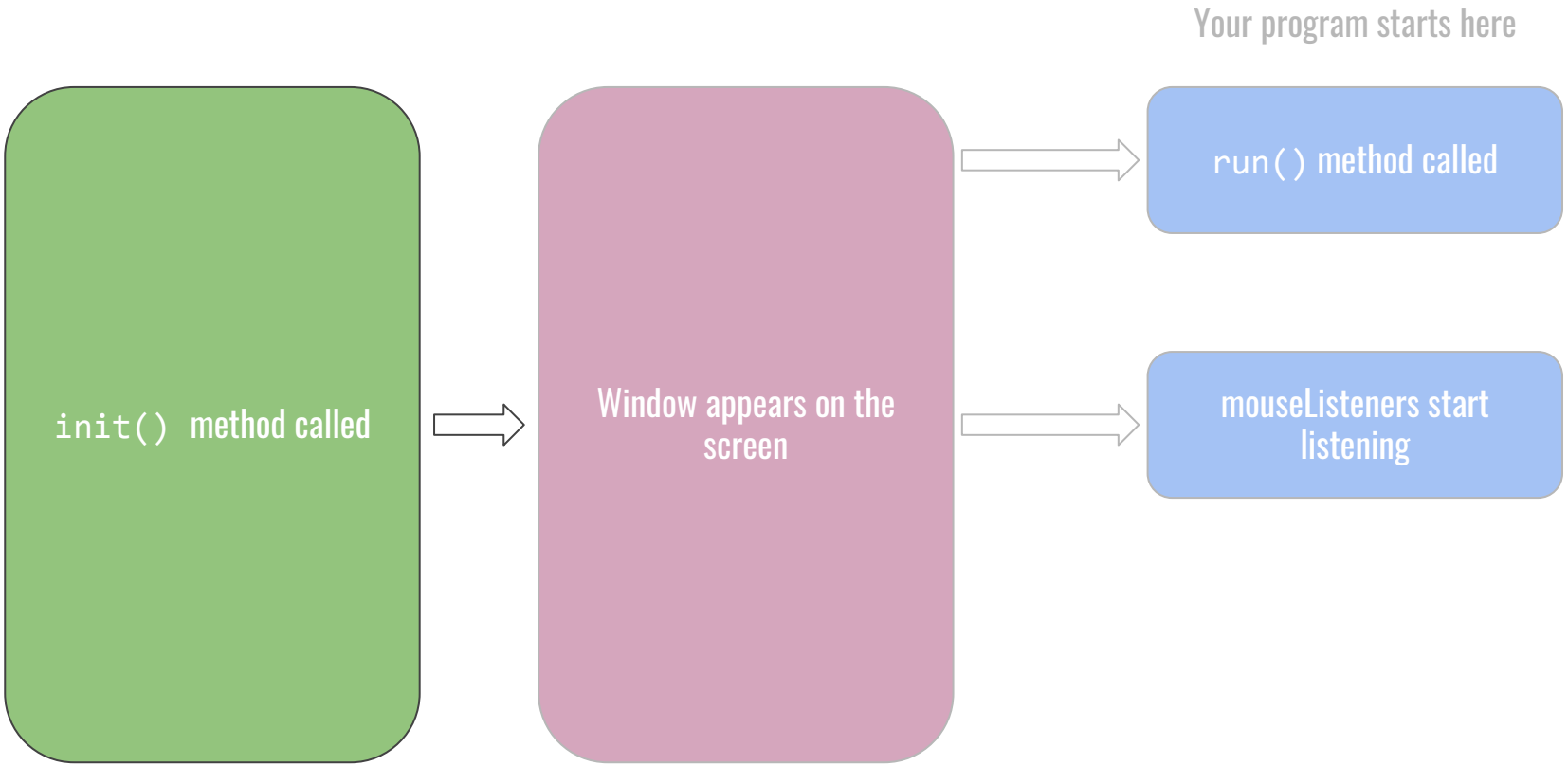


Diving under the hood

Your program starts here

```
public void init() {
    // Set up the window here
}
```

Diving under the hood



Let’s run with `init()`

Let's run with `init()`

`// (sorry)`

The takeaway: add JComponents in `init()`

How to use `JComponents`

How to use `JComponents`

Where else have our programs had to respond to user actions that could happen anytime?

How to use `JComponents`

Where else have our programs had to respond to user actions that could happen anytime?

Like `MouseListeners`, using components requires Event-Driven programming

How to use JComponents

Where else have our programs had to respond to user actions that could happen anytime?

Like MouseListeners, using components requires Event-Driven programming

```
public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    // Process command
}
```

```java
public void init() {





}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    // Process command
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");



    add(button, SOUTH);


}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    // Process command
}
```

```java
public void init() {
     JButton button = new JButton("Click me!");



     add(button, SOUTH);

     addActionListeners();              // start listening for user actions
}

public void actionPerformed(ActionEvent e){
     String command = e.getActionCommand();
     // Process command
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");



    add(button, SOUTH);

    addActionListeners();              // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    // Process command
}
```

```java
public void init() {
     JButton button = new JButton("Click me!");



     add(button, SOUTH);

     addActionListeners();              // start listening for user actions
}

public void actionPerformed(ActionEvent e){
     String command = e.getActionCommand();
     if (command.equals("Click me!")) {
          println("Button clicked!");
     }
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");
    // TODO:
    // Set up text field

    add(button, SOUTH);
    // TODO: Add text field to window
    addActionListeners();              // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals("Click me!")) {
        println("Button clicked!");
    }
}
```

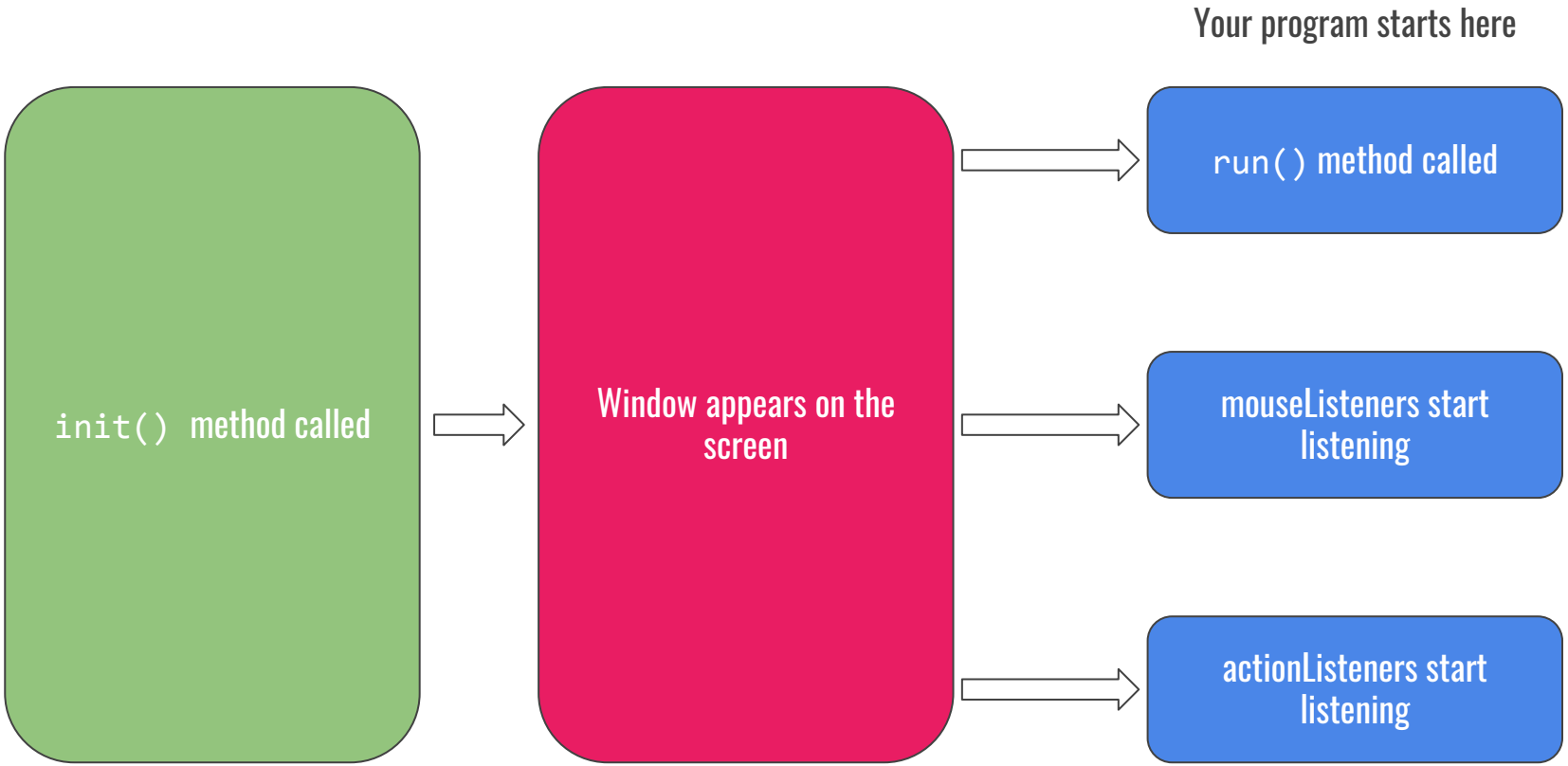
```java
public void init() {
    JButton button = new JButton("Click me!");
    field.addActionListener(this);      // enable pressing enter
    field.setActionCommand("Typed");    // set the field's action command

    add(button, SOUTH);
    // TODO: Add text field to window
    addActionListeners();               // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals("Click me!")) {
        println("Button clicked!");
    }
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");
    field.addActionListener(this);      // enable pressing enter
    field.setActionCommand("Typed");    // set the field's action command

    add(button, SOUTH);
    add(field, SOUTH);
    addActionListeners();               // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals("Click me!")) {
        println("Button clicked!");
    }
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");
    field.addActionListener(this);      // enable pressing enter
    field.setActionCommand("Typed");    // set the field's action command

    add(button, SOUTH);
    add(field, SOUTH);
    addActionListeners();               // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals("Click me!")) {
        println("Button clicked!");
    }
    // TODO:
    // Deal with action from field
}
```

```java
public void init() {
    JButton button = new JButton("Click me!");
    field.addActionListener(this);      // enable pressing enter
    field.setActionCommand("Typed");    // set the field's action command

    add(button, SOUTH);
    add(field, SOUTH);
    addActionListeners();               // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals("Click me!")) {
        println("Button clicked!");
    }
    if (command.equals("Typed")) {
        println(field.getText());       // needs to be an instance variable
    }
}
```

Diving under the hood



Let’s make something cool!

The xkcd Color survey: what names do people give colors?

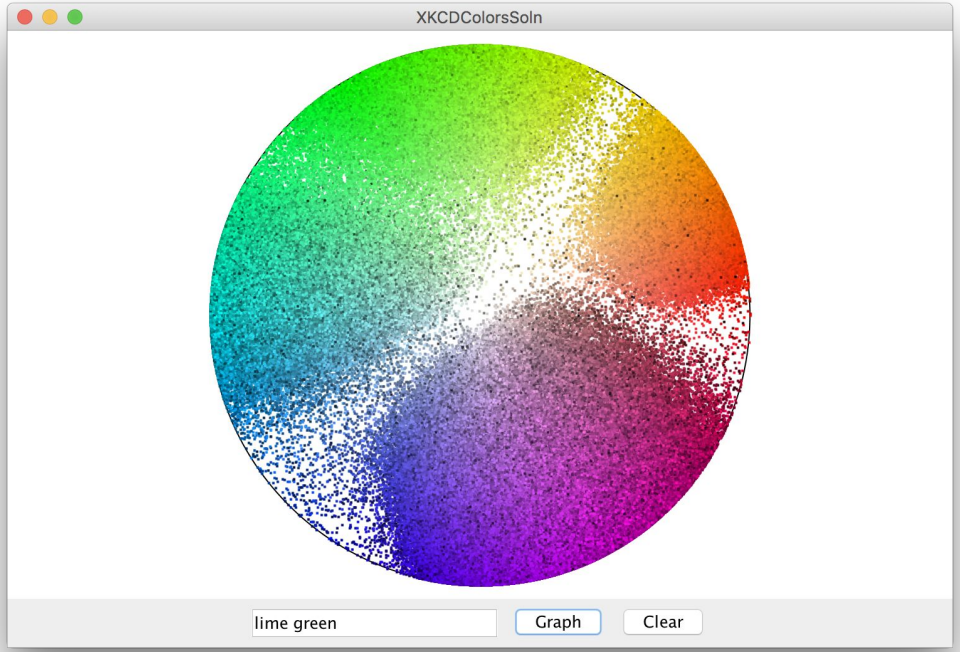
Dataset: 2.85 million RGB colors + names

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

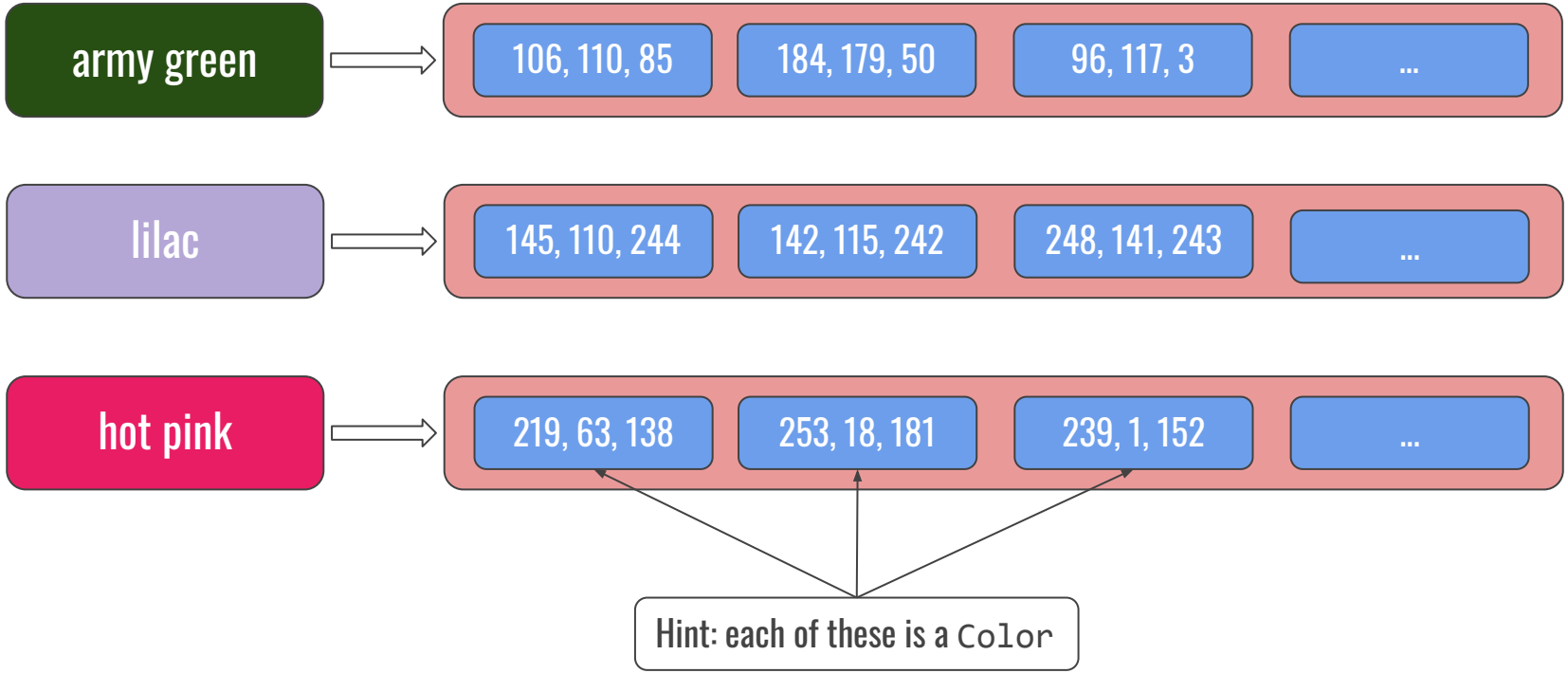
This is a lot of data

```
11401401  midnight blue
11401402  19
11401403  14
11401404  78
```

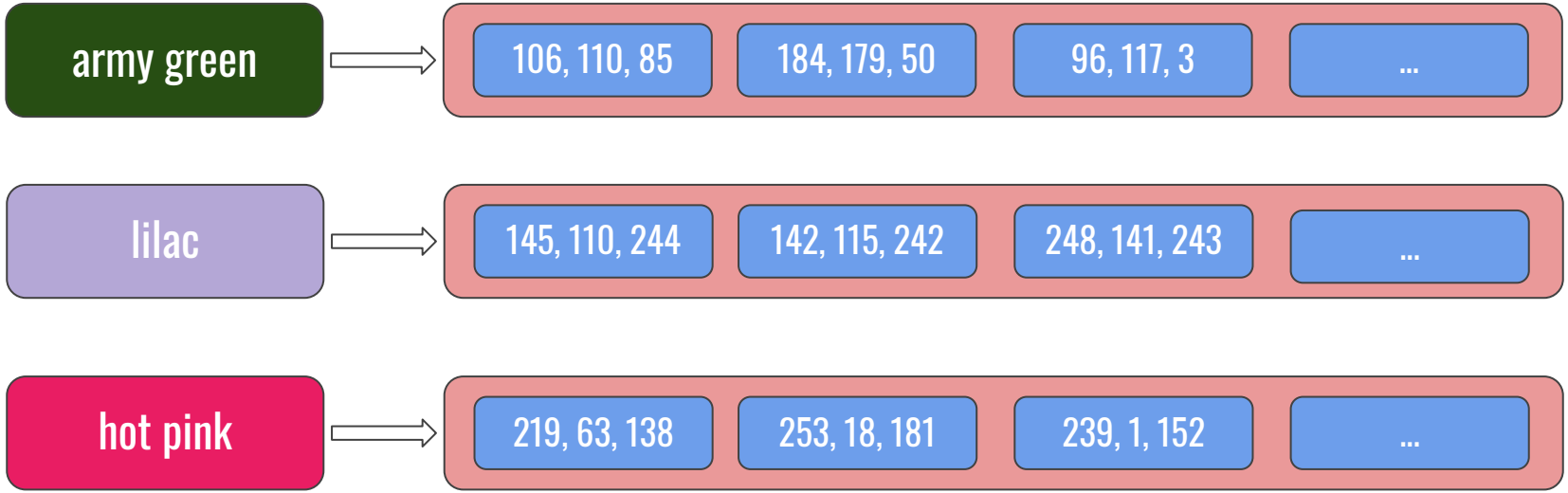
A cool visualization!



Milestone 1: How do we represent this data?



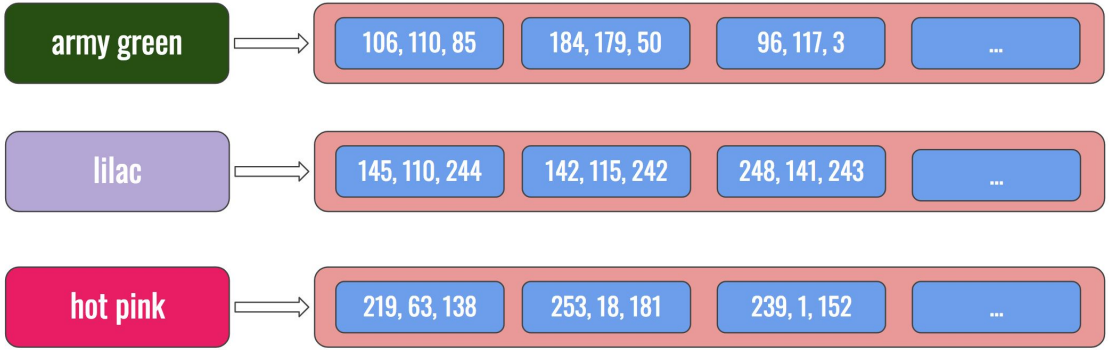
Milestone 1: How do we represent this data? ✓




```
HashMap<String, ArrayList<Color>> colorMap;
```

Milestone 2: How do we load data from the file?

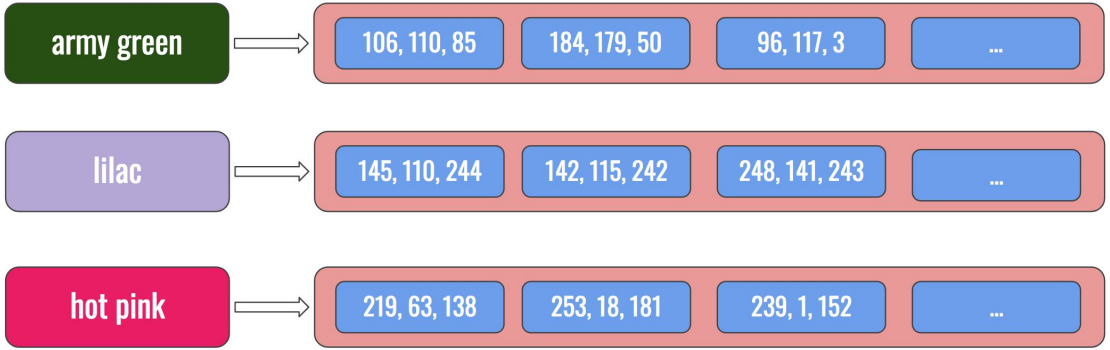
```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```




```java
private HashMap<String, ArrayList<Color>> readFile() {
    // fun Scanner shenanigans
}
```

Milestone 2: How do we load data from the file? ✓

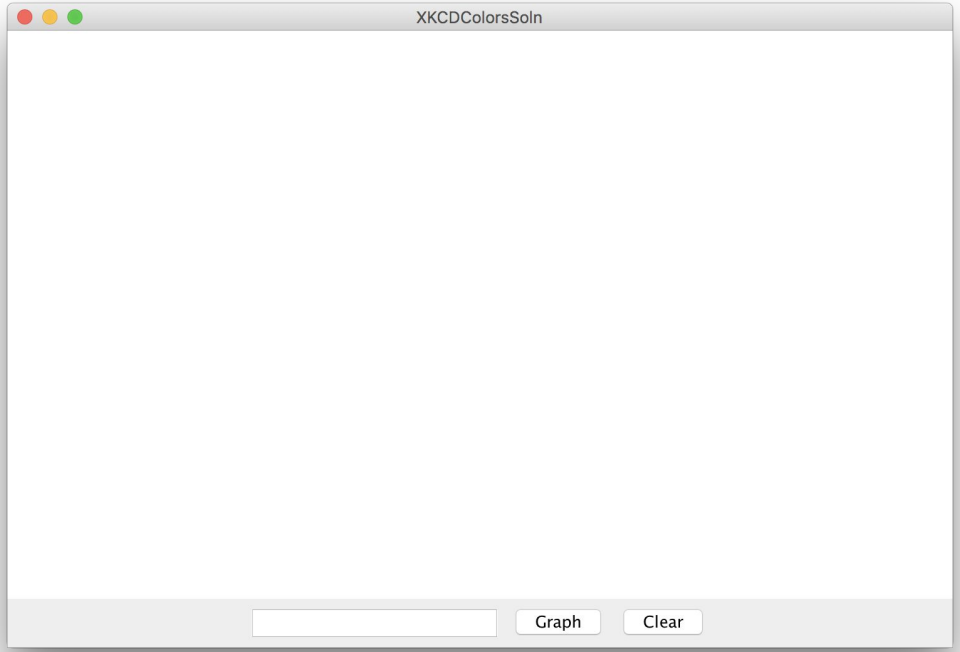
```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```




```java
private HashMap<String, ArrayList<Color>> readFile() {
    // fun Scanner shenanigans
}
```

Click here for an animation of the file reading

Milestone 3: How do we set up the interactors?



Milestone 4: How do we put all the pieces together?

Suppose you have a method

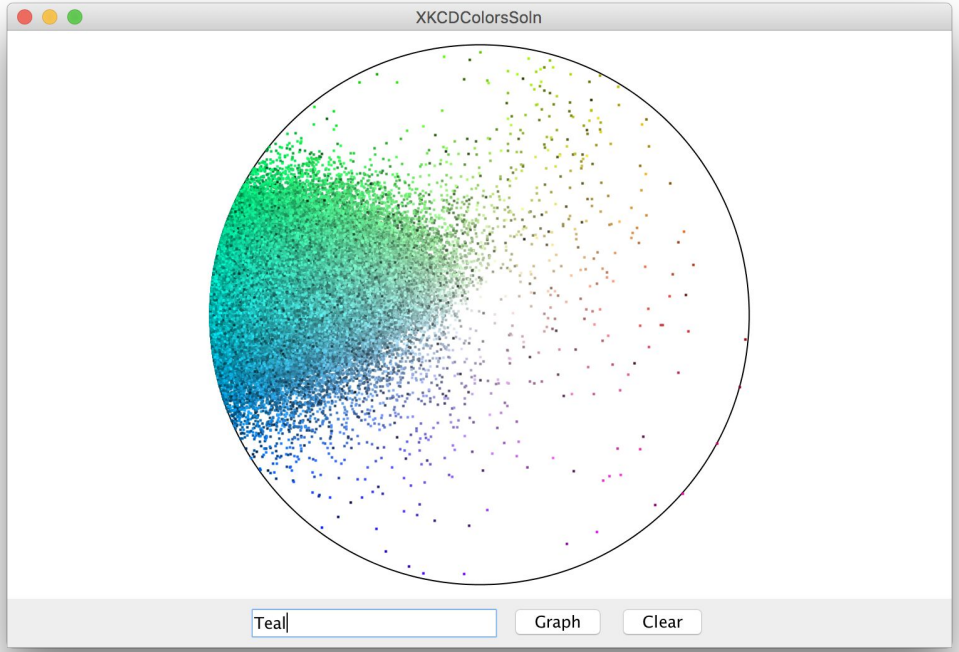
```
private void plotColor(Color color)
```

that puts a single color dot on the screen in the correct place

and another method

```
private void clearAll()
```

that removes all the colored dots



Computer Science helps us learn about people

xkcd's analysis of the results

Overflow slides

1. How do we plot a color?
2. A file reading demo

How do we plot a color in xkcd colors?

The HSB Color Space

```
// (you're not required to know this)
```

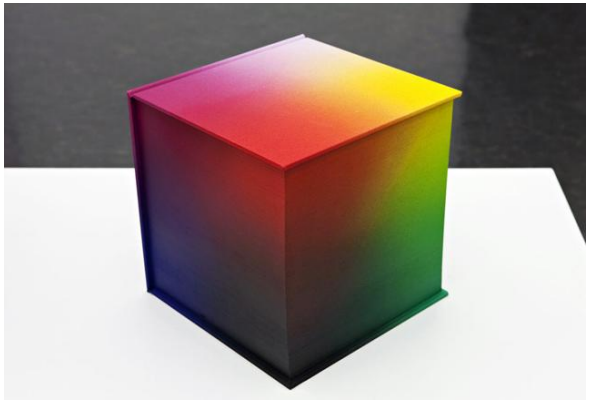
How do we plot a color?

We normally break colors into a red, green and blue component

You can think of each color as a point on a 3d graph with a red, green and blue axis

This graph is called the RGB Color Space

Each axis on the graph goes from 0 to 255



RGB Color Space Atlas

How do we plot a color?

We don't have to break a color into RGB values

RGB is easy for computers to understand, but not for humans

What does it mean for a color to be 127 / 255 red? ¯_(ツ)_/¯

We tend to think of a color in terms of its general color range, how vivid it is, and how bright it is.

How do we plot a color?

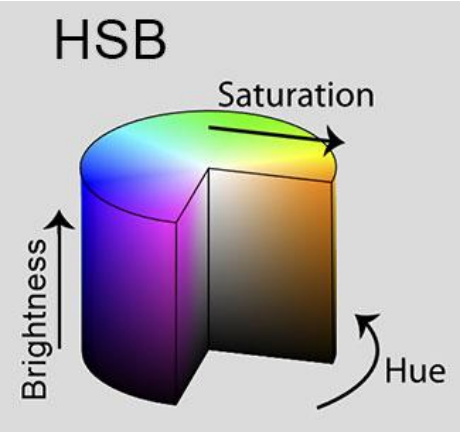
We can also break a color into these three components:

The color's hue represents its general color range (its location on the color wheel)

The color's saturation represents how vivid it is

The color's brightness represents how bright it is

Each color is a now a point in the HSB Color Space



source

How do we plot a color?

Java gives us a method to break a color up into HSB Components:

```
float[] HSBComponents = Color.RGBtoHSB(color.getRed(), color.getGreen(), color.getBlue(), null);
```

`HSBComponents` has three elements, which are in order:

1. `color`'s hue
2. `color`'s saturation
3. `color`'s brightness

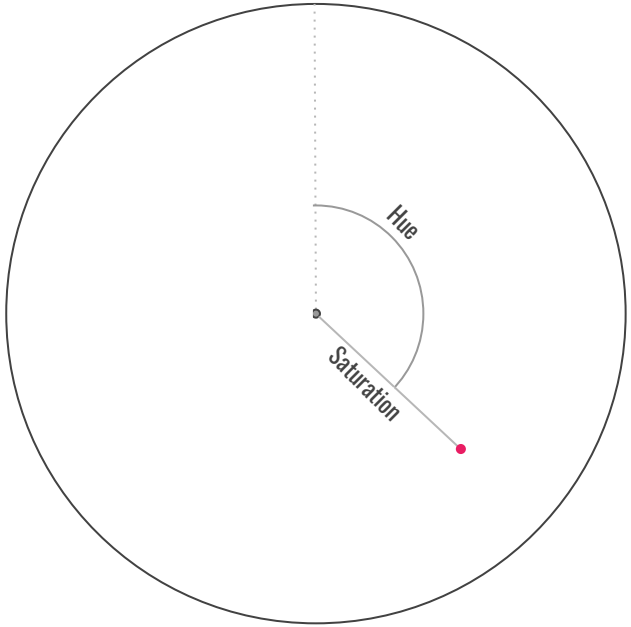
don't worry about the `float` data type!

(it's like a double, but for smaller numbers)

How do we plot a color?

We use the color's hue and saturation to figure out where in the circle the color's point goes

We color the point with its corresponding color, which captures brightness



How do we plot a color?

```
float[] components = Color.RGBtoHSB(color.getRed(),
                                    color.getGreen(),
                                    color.getBlue(),
                                    null);

double radius = getRadius() * components[1];
double theta = components[0] * Math.PI * 2.0;

double x = getWidth() / 2.0  + radius * Math.cos(theta);
double y = getHeight() / 2.0 - radius * Math.sin(theta);


GRect pt = new GRect(x, y, 1, 1);
pt.setFilled(true);
pt.setColor(color);
```

Get HSB Components from `color`

How do we plot a color?

```
float[] components = Color.RGBtoHSB(color.getRed(),
                                    color.getGreen(),
                                    color.getBlue(),
                                    null);

double radius = getRadius() * components[1];
double theta = components[0] * Math.PI * 2.0;

double x = getWidth() / 2.0  + radius * Math.cos(theta);
double y = getHeight() / 2.0 - radius * Math.sin(theta);


GRect pt = new GRect(x, y, 1, 1);
pt.setFilled(true);
pt.setColor(color);
```

radius is based on saturation (as a fraction of 100) and angle is based on hue (as a fraction of 360)

How do we plot a color?

```
float[] components = Color.RGBtoHSB(color.getRed(),
                                    color.getGreen(),
                                    color.getBlue(),
                                    null);

double radius = getRadius() * components[1];
double theta = components[0] * Math.PI * 2.0;

double x = getWidth() / 2.0  + radius * Math.cos(theta);
double y = getHeight() / 2.0 - radius * Math.sin(theta);


GRect pt = new GRect(x, y, 1, 1);
pt.setFilled(true);
pt.setColor(color);
```

Calculate exact position of the point on the screen using trigonometry

How do we plot a color?

```
float[] components = Color.RGBtoHSB(color.getRed(),
                                    color.getGreen(),
                                    color.getBlue(),
                                    null);

double radius = getRadius() * components[1];
double theta = components[0] * Math.PI * 2.0;

double x = getWidth() / 2.0  + radius * Math.cos(theta);
double y = getHeight() / 2.0 - radius * Math.sin(theta);


GRect pt = new GRect(x, y, 1, 1);
pt.setFilled(true);
pt.setColor(color);
```

Plot the point on the screen

How `colorMap` is made

A more detailed animation

back to main slides

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```java
Scanner sc = new Scanner(new File(COLORS_FILE));
HashMap<String, ArrayList<Color>> result =
      new HashMap<String, ArrayList<Color>>();

while (sc.hasNextLine()) {
   String colorName = sc.nextLine();
   String red = sc.nextLine();
   String green = sc.nextLine();
   String blue = sc.nextLine();

   int r = Integer.parseInt(red);
   int g = Integer.parseInt(green);
   int b = Integer.parseInt(blue);

   Color color = new Color(r, g, b);

   if (!result.containsKey(colorName)) {
      result.put(colorName, new ArrayList<Color>());
   }

   result.get(colorName).add(color);
}
```

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
while (sc.hasNextLine()) {
```

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String colorName = sc.nextLine();
```

<u>while loop variables</u>

colorName: “navy blue”\

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String red = sc.nextLine();
```

<u>while loop variables</u>

colorName: “navy blue”
red: “27”

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String green = sc.nextLine();
```

<u>while loop variables</u>

colorName: “navy blue”
red: “27”
green: “34”

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String blue = sc.nextLine();
```

<u>while loop variables</u>

colorName:	“navy blue”
red:	“27”
green:	“34”
blue:	“98”

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int r = Integer.parseInt(red);
```

<u>while loop variables</u>

colorName:	“navy blue”
red:	“27”
green:	“34”
blue:	“98”
r:	27

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int g = Integer.parseInt(green);
```

<u>while loop variables</u>

colorName:	“navy blue”
red:	“27”
green:	“34”
blue:	“98”
r:	27
g:	34

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int b = Integer.parseInt(blue);
```

<u>while loop variables</u>

colorName:	“navy blue”
red:	“27”
green:	“34”
blue:	“98”
r:	27
g:	34
b:	98

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
Color color = new Color(r, g, b);
```

<u>while loop variables</u>

colorName:	“navy blue”	
red:	“27”	color:
green:	“34”	
blue:	“98”	
r:	27	
g:	34	
b:	98	

<u>result</u>

NO KEYS

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```java
if (!result.containsKey(colorName)) {
    result.put(colorName, new ArrayList<Color>());
}
```

<u>while loop variables</u>

colorName:	“navy blue”	
red:	“27”	color:
green:	“34”	
blue:	“98”	
r:	27	
g:	34	
b:	98	

<u>result</u>

“navy blue”: {}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
result.get(colorName).add(color);
```

<u>while loop variables</u>

colorName:	“navy blue”		
red:	“27”	color:	
green:	“34”		
blue:	“98”		
r:	27		
g:	34		
b:	98		

<u>result</u>

“navy blue”: {}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
while (sc.hasNextLine()) {
```

result

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String colorName = sc.nextLine();
```

<u>while loop variables</u>

colorName: “blue”

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String red = sc.nextLine();
```

<u>while loop variables</u>

colorName: “blue”
red: “41”

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String green = sc.nextLine();
```

<u>while loop variables</u>

colorName: “blue”
red: “41”
green: “201”

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
String blue = sc.nextLine();
```

<u>while loop variables</u>

colorName:	“blue”
red:	“41”
green:	“201”
blue:	“234”

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int r = Integer.parseInt(red);
```

<u>while loop variables</u>

colorName:	“blue”
red:	“41”
green:	“201”
blue:	“234”
r:	41

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int g = Integer.parseInt(green);
```

<u>while loop variables</u>

colorName:	“blue”
red:	“41”
green:	“201”
blue:	“234”
r:	41
g:	201

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
int b = Integer.parseInt(blue);
```

<u>while loop variables</u>

colorName:	“blue”
red:	“41”
green:	“201”
blue:	“234”
r:	41
g:	201
b:	234

<u>result</u>

“navy blue”: {[redacted]}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
Color color = new Color(r, g, b);
```

<u>while loop variables</u>

colorName:	“blue”	color:	
red:	“41”		
green:	“201”		
blue:	“234”		
r:	41		
g:	201		
b:	234		

<u>result</u>

“navy blue”: {}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```java
if (!result.containsKey(colorName)) {
    result.put(colorName, new ArrayList<Color>());
}
```

<u>while loop variables</u>

colorName:	“blue”	color:	
red:	“41”		
green:	“201”		
blue:	“234”		
r:	41		
g:	201		
b:	234		

<u>result</u>

“navy blue”: {}
“blue”: {}

```
navy blue
27
34
98
blue
41
201
234
lime green
99
212
32
red brown
160
89
66
.
.
.
```

```
result.get(colorName).add(color);
```

<u>while loop variables</u>

colorName:	“blue”	color:	
red:	“41”		
green:	“201”		
blue:	“234”		
r:	41		
g:	201		
b:	234		

<u>result</u>

“navy blue”: {}
“blue”: {}

back to main slides