## Review

- **`setup()`** & **`draw()`**
- The event loop
- **`mouseX`**, **`mouseY`**
- Mouse and Keyboard interactions
- Arcs, curves, bézier curves, custom shapes
- Programming principals
  - Syntax is important
  - Reference manuals are your friend
  - Don't be afraid to try different things

## Text

```
text(theString, x, y);
```

- Draws *theString* on the sketch at (x, y)
- A string is represented by ""
- `text("CS110 is fun!", width/2, height/2);`

```
textSize(size);
```

- Sets the current font size

```
random(high);
random(low, high);
```

Generate a random number in the range *low* (or 0) to *high*

```
print(something);
println(something);
```

Print something to the Processing console.

## randomEllipse

```
void setup() {
  size(500, 500);
}

void draw(){
  fill(random(255), random(255), random(255));
  ellipse(mouseX, mouseY, 30, 30);
}
```

## Variables

- A location where data is stored
- A variable name is declared as a specific data type
- Names must begin with a letter, "_" or "$" and can container letters, digits, "_" and "$"

```
boolean isTuesday = true;
int i;
int j = 12;
float fSize = 10.0;
color _red = color(255,0,0);
String name123 = "Fred";
PImage img;
```

## Variable Uses

- Refer to a value throughout your program
  - but allow it to be changed
  - As temporary storage for a intermediate computed result
  - To parameterize – instead of hardcoding coordinates
- Special variables (preset variables)
  - **`width, height`**
  - **`mouseX, mouseY, pmouseX, pmouseY`**
- Assigned with a single =
  - known as the assignment operator
  - left side and right side are not equal

## Primitive Data Types

| Type | Range | Default | Bytes |
|---|---|---|---|
| boolean | { true, false } | false | ? |
| byte | { 0..255 } | 0 | 1 |
| int | { -2,147,483,648<br>.. 2,147,483,647 } | 0 | 4 |
| long | { -9,223,372,036,854,775,808<br>.. 9,223,372,036,854,775,807 } | 0 | 8 |
| float | { -3.40282347E+38<br>.. 3.40282347E+38 } | 0.0 | 4 |
| double | *much larger/smaller* | 0.0 | 8 |
| color | { #00000000 .. #FFFFFFFF } | *black* | 4 |
| char | *a single character* 'a', 'b', … | '\u0000' | 2 |

## Other "things" …

| Type | Range | Default | Bytes |
|---|---|---|---|
| String | a series of chars in quotes “abc” | null | ? |
| PImage | an image | null | ? |
| PFont | a font for rendering text | null | ? |
| … | | | |

```
String message = "Hello World!";
```

## Data Type Conversion

- Types must match
- If variable types on the two sides of an assignment do not match, one must be converted
  - automatic conversion
  - explicit conversion (casting)

```
float f = 10.0;
int i = 5;

f = i;                  // auto conversion
//i = f;                // Throws a runtime error
i = int(f);
```

## Mixing types and Integer Division

- 3*1.5
  - value?
  - type?
- 3/2
- 2/3
- x/y

## Images

**`save(filename);`**
**`loadImage(`*`filename`*`);`**

- Loads an image from a file in the sketch folder.
- Or in the *data* subfolder.
- Must be assigned to a variable of type **`PImage`**.

**`image(`*`img, X, Y, [X2, Y2]`*`);`**

- Draws the image *img* on the canvas at X, Y
- Optionally fits image into box X,Y and X2,Y2 (resize)

**`imageMode(CORNER);`**

- X and Y define the upper left corner
- X2 and Y2 define width and height.

## Image Example

```
imageExample
   └ imageExample.pde
   └ data
        └ natura-morta.jpg
```

```
PImage img;

void setup(){
  size(500, 400);
  img = loadImage("natura-morta.jpg");
  image(img, 50, 40);
}
```

## Conditionals: if-statement

```
if (boolean_expression) {
   statements;
}
```

What does this do?

```
void draw() {
   if (mouseX > 50 && mouseY > 50) {
      ellipse( mouseX, mouseY, 10, 10 );
   }
}
```

## Logical Expressions

`&&` logical conjunction (and)

- both expressions must be true for conjunction to be true

`||` logical disjunction (or)

- either expression must be true for disjunction to be true

`!` logical negation (not)

- true → false, false → true

## Relational Expressions

| | |
|---|---|
| < | less than |
| > | is greater than |
| <= | is less than or equal to |
| >= | is greater than or equal to |
| == | is equal |
| != | is not equal |

## Relational Expressions: Examples

```
1. if (true) { … }
2. if (10 > 10) { … }
3. if (10 >= 10) { … }
4. if ('a' == 'a’) { … }
5. if ('a' != 'a’) { … }
6. if ("Bryn Mawr" != "bryn mawr”) { … }
```

## Logical Expression Examples

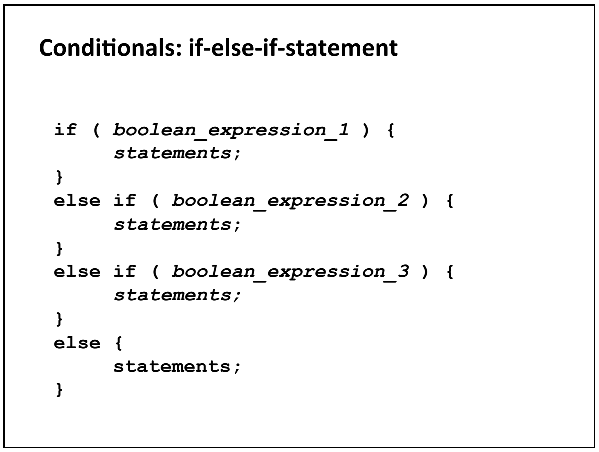
```
1. if ((2 > 1) && (3 > 4)) { … }
2. if (("blah" == "blah") && (1 + 2 == 3)) { … }
3. if (!false) { … }
4. if (!(1 < -1)) { … }
5. if (!(10 < 20) || false ) { … }
6. if (!(10 > 20) && (10 < 20)) { … }
7. if ((true || false) && true) { … }
8. if ((true && false) || true )) { … }
9. …
```

## Conditionals: if-else-statement

```
if ( boolean_expression ) {
  statements executed when boolean_expression is true;
}
else {
  statements executed when boolean_expression is false;
}
```

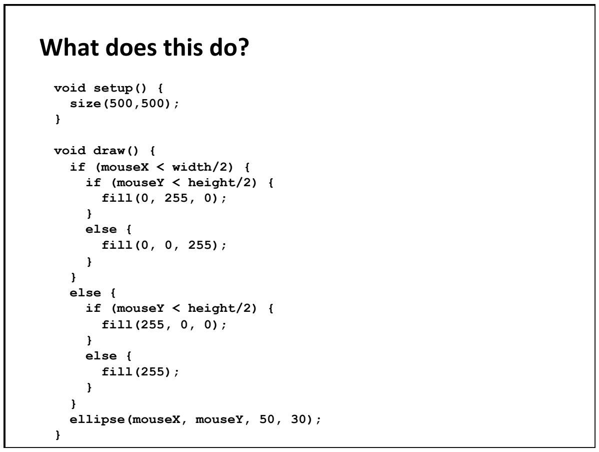
What does this do?

```
void draw() {
  if (mouseY < 50) {
     println("the sky");
  }
  else {
     println("the ground");
  }
}
```



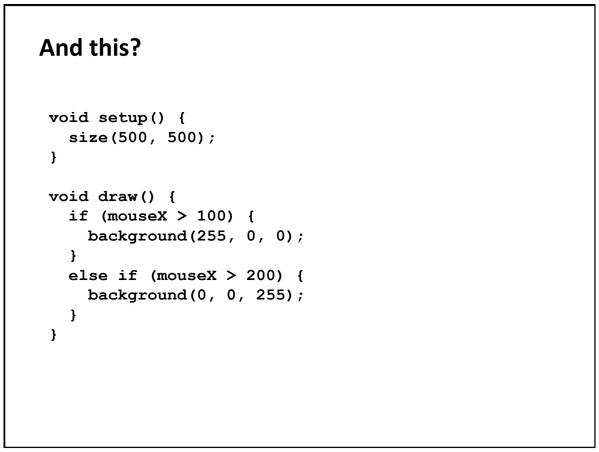
## Conditionals: if-else-if-statement

```
if ( boolean_expression_1 ) {
     statements;
}
else if ( boolean_expression_2 ) {
     statements;
}
else if ( boolean_expression_3 ) {
     statements;
}
else {
     statements;
}
```



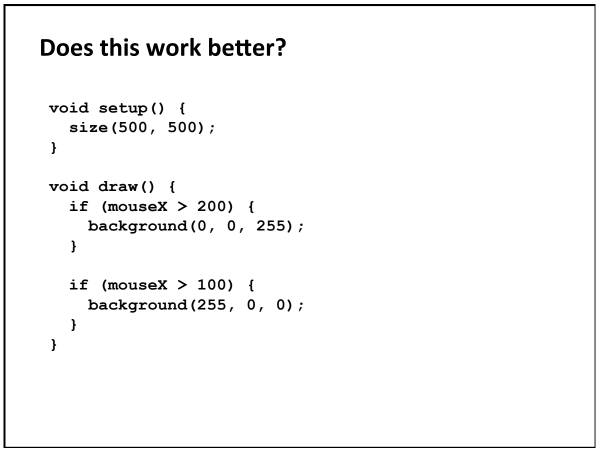
## What does this do?

```
void setup() {
  size(500,500);
}

void draw() {
  if (mouseX < width/2) {
    if (mouseY < height/2) {
      fill(0, 255, 0);
    }
    else {
      fill(0, 0, 255);
    }
  }
  else {
    if (mouseY < height/2) {
      fill(255, 0, 0);
    }
    else {
      fill(255);
    }
  }
  ellipse(mouseX, mouseY, 50, 30);
}
```



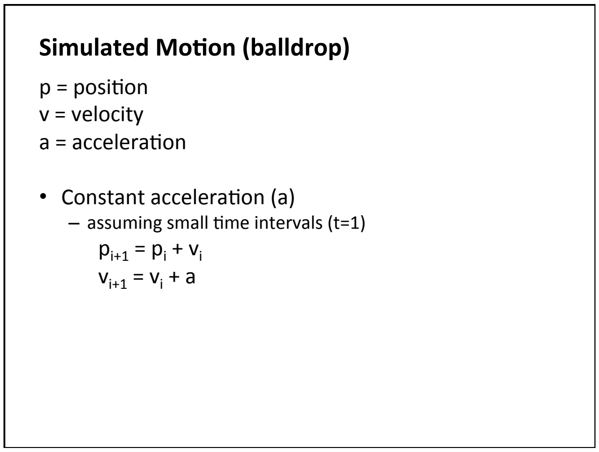
## And this?

```
void setup() {
  size(500, 500);
}

void draw() {
  if (mouseX > 100) {
    background(255, 0, 0);
  }
  else if (mouseX > 200) {
    background(0, 0, 255);
  }
}
```



## Does this work better?

```
void setup() {
  size(500, 500);
}

void draw() {
  if (mouseX > 200) {
    background(0, 0, 255);
  }

  if (mouseX > 100) {
    background(255, 0, 0);
  }
}
```



## Simulated Motion (balldrop)

p = position
v = velocity
a = acceleration

- Constant acceleration (a)
  - assuming small time intervals (t=1)

    $p_{i+1} = p_i + v_i$

    $v_{i+1} = v_i + a$