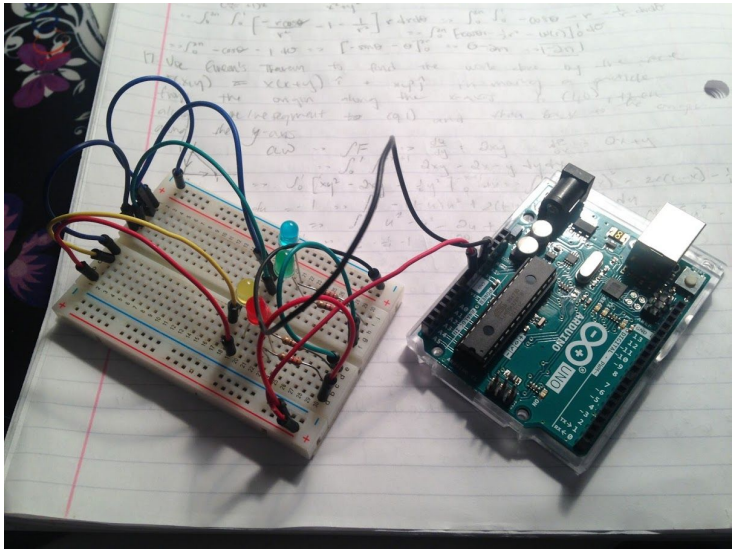
Embedded System Workshops

01. Blinking LEDs

CCA Girls Who Code

Project Overview

- Purpose:
  - Introduce circuits, proper circuit design, and circuit elements
  - Learn the Arduino IDE
  - Learn to send digital outputs
- Projects
  - Single LED ⇒ Multiple LED circuit
- Grab your kit, and let's get started!



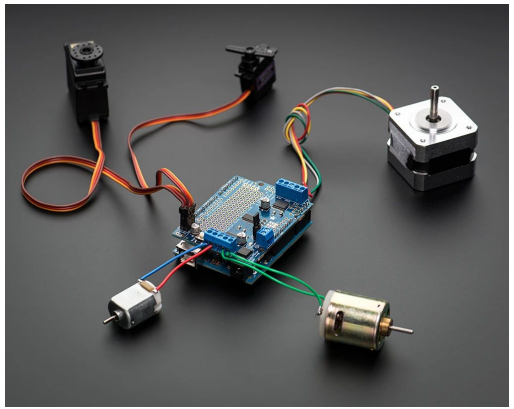
Parts List

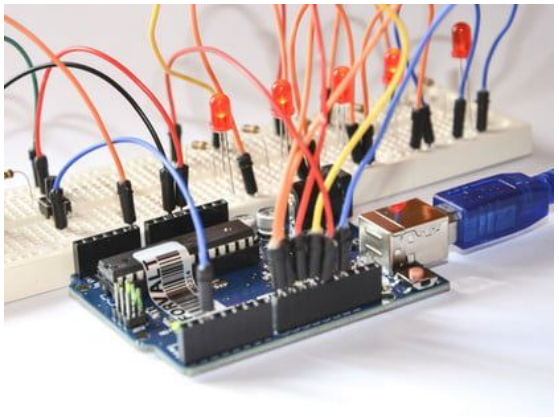
Below is the list of parts we'll be using during this lesson

- Arduino UNO R3 Controller Board
- USB Cable
- Breadboard
- LEDs (all colors!)
- 220Ω Resistors
- Male-male jumper wires

What is Arduino?

- A small microcontroller used for a variety of applications
- Can be programmed using C and C++ programming languages
- Open source; many Arduino-compatible and Arduino-derived boards exist

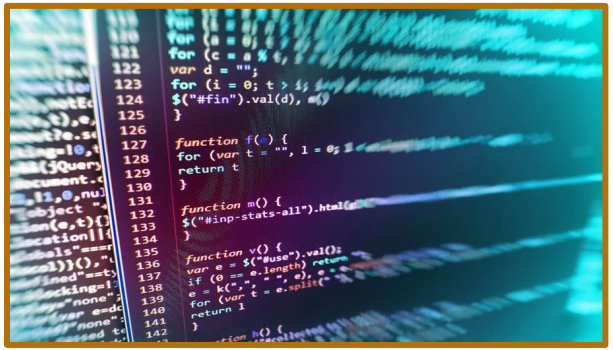




What is C++?

C++ is a popular programming language used for a variety of things, such as

- Embedded systems
- Developing system and desktop applications
- Developing operating systems such as Apple's OS X and Microsoft's Windows
- Compiler production
- Open source software



Basic Circuit Design

A circuit forms a loop that electricity can flow through. Electricity will always flow from high voltage to low voltage.

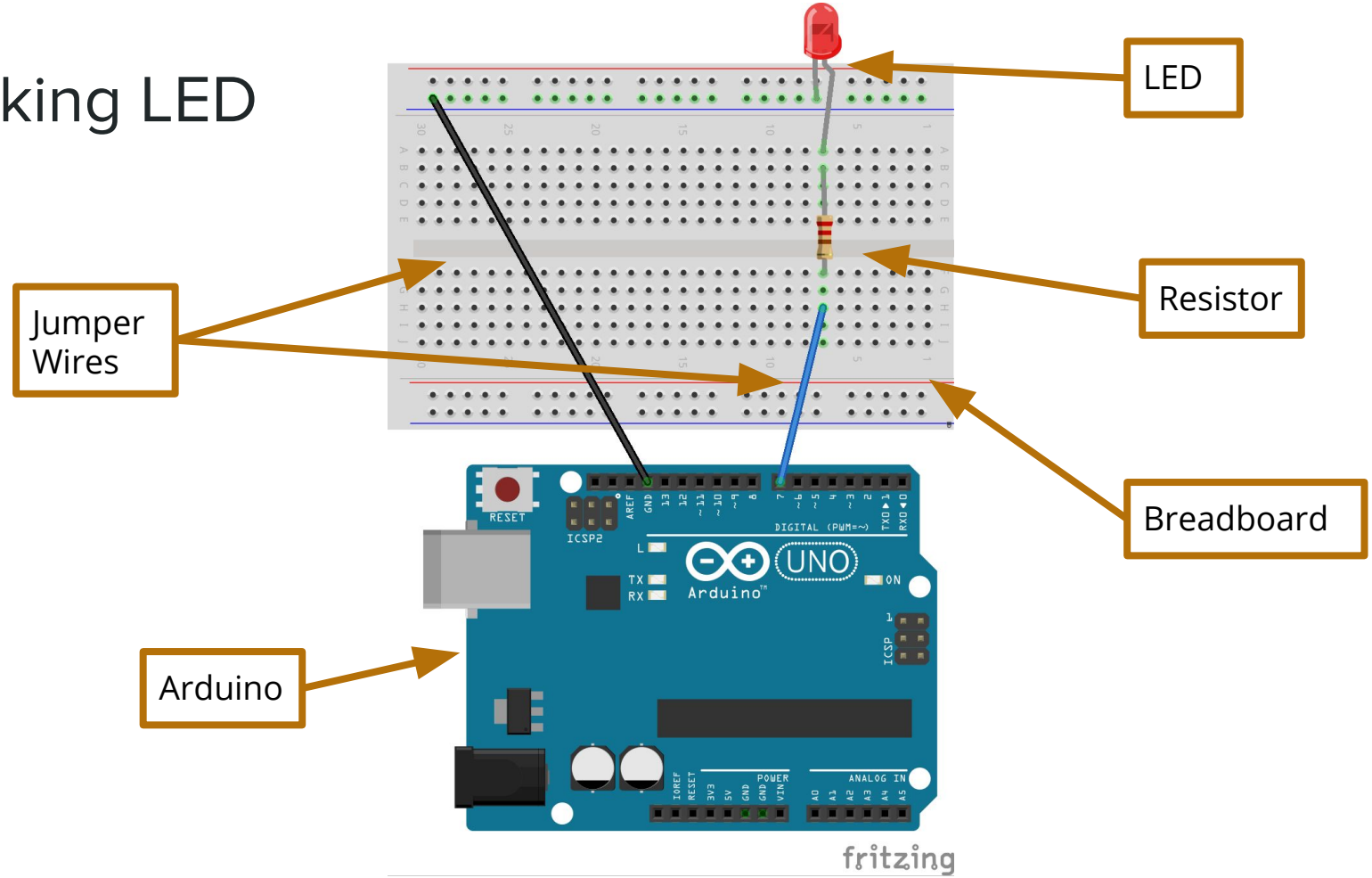
Circuit Elements:

- Voltage source: This is what provides the power to any circuit. Arduino has two voltage sources: 5 volts and 3.3 volts. Any of the pins can set to 3.3v using the code.
- Ground: The lowest voltage point in a circuit. All circuits should be designed to end at a ground pin.
- Loads: Anything that causes resistance in the circuit, such as actual resistors, LED lights, motors, screens, etc.

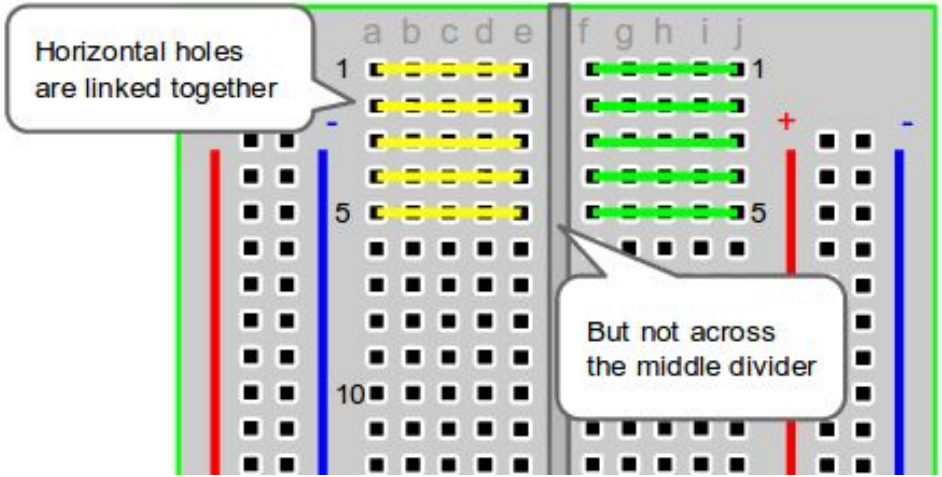
Possible Safety Hazards:

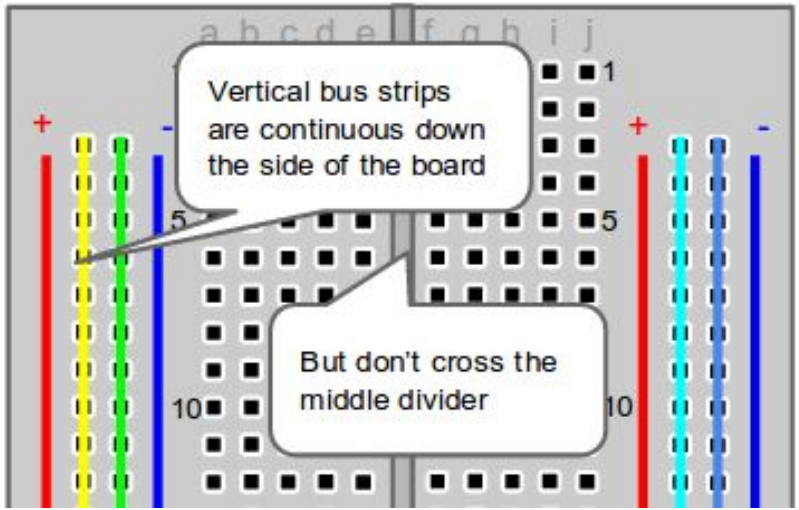
- High Currents:
  - If the current in a circuit is too high due to inadequate or nonexistent resistors, it can damage parts in a circuit, such as LEDs, Motors, or the Arduino itself (this is why circuit breakers exist).
- Short Circuit:
  - An electrical short occurs when the electrical current can take a much lower resistance path than what is intended, causing much higher currents than what is intended and potentially damaging parts of the circuit.
  - To prevent this from occurring, make sure all your wires are where you intend for them to go before powering the circuit on.

Blinking LED



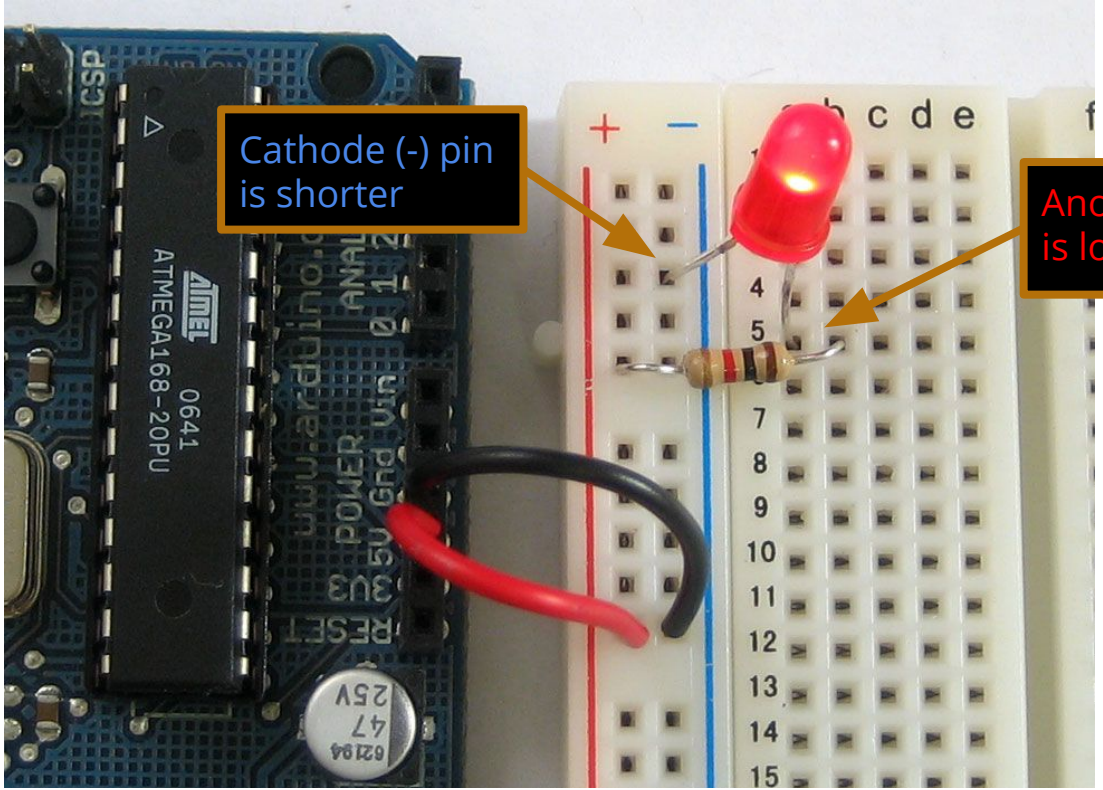
Breadboards Explained





Tip: It is good practice to have your power input connected to the red/positive rail and your ground pin connected to the blue/negative rail.

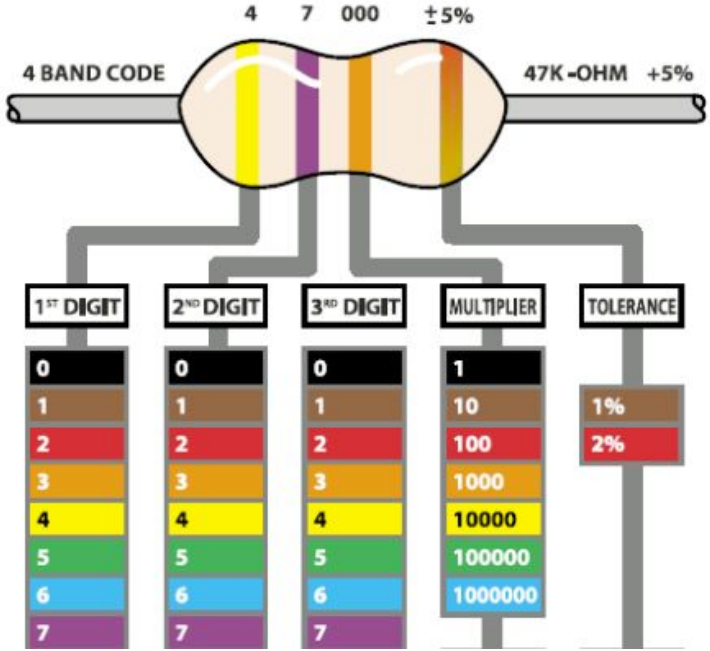
LEDs



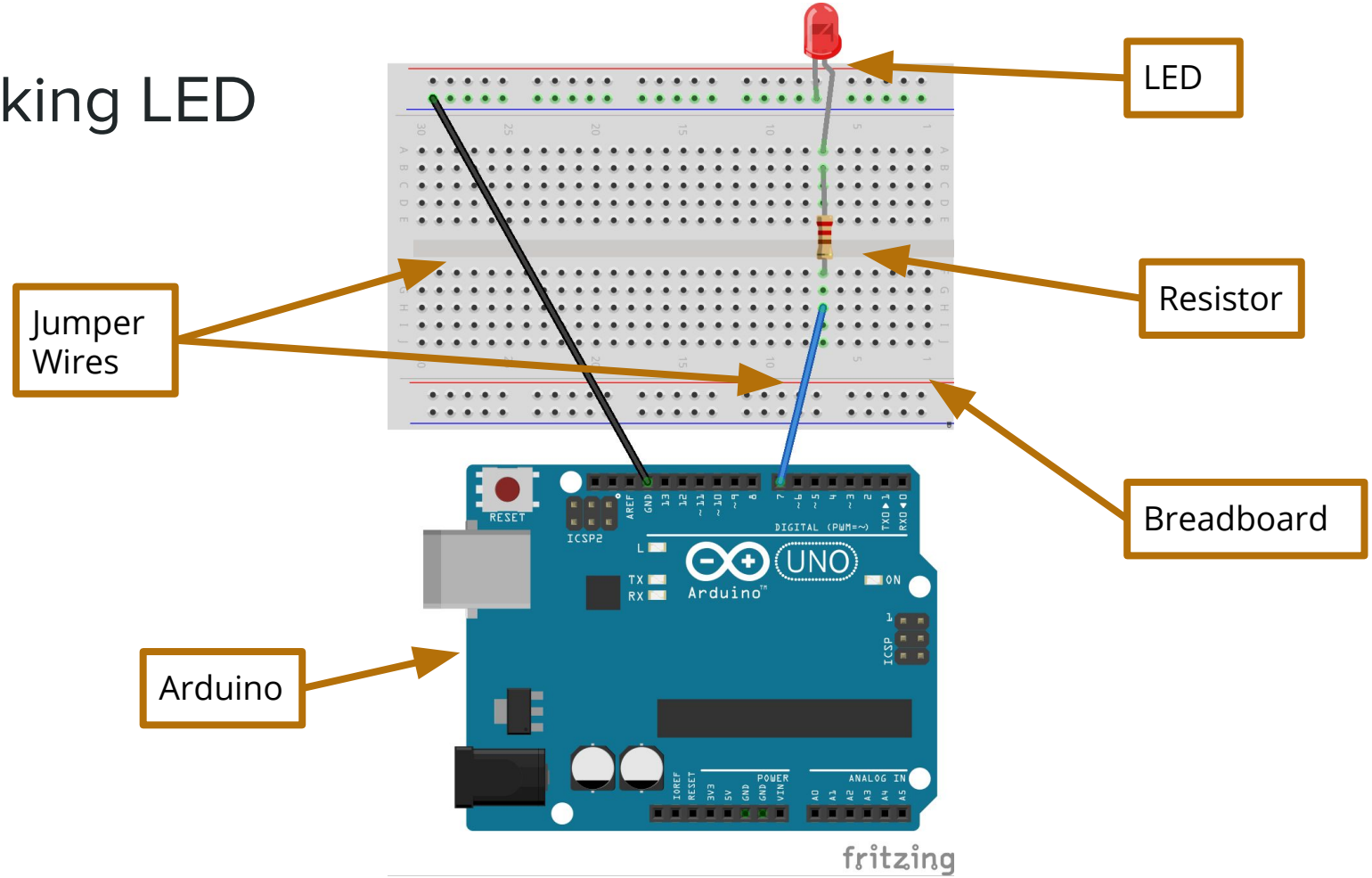
NOTE: Make sure the power input is connected to the Anode, and the ground pin is connected to the Cathode. Make sure you also have a resistor between either the power input and Anode, or the Cathode and ground pin. Failing to do either of these things can damage the LED or the Arduino.

Resistors

- Resistors slow the electric current, and control where and how fast the current flows
- Resistance value is measured in ohms Ω, which is represented by colored stripes on the body of the resistor
- Each stripe has a different value depending on the color and location as shown in the reference chart
- A potentiometer is a variable resistor

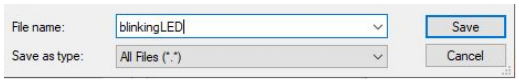


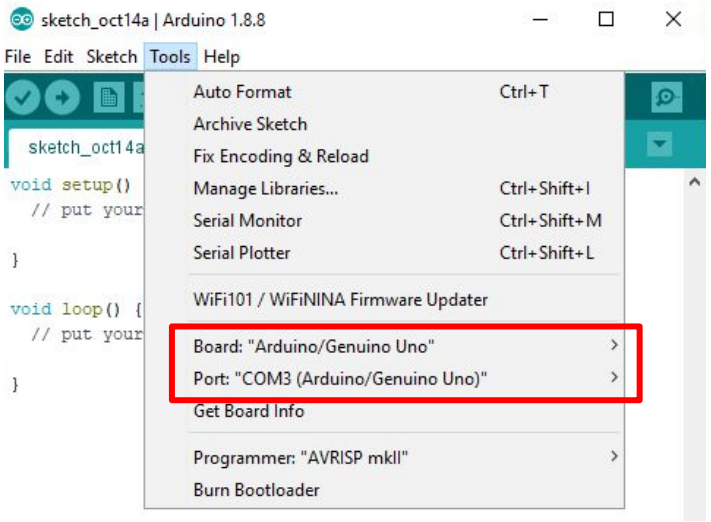
Blinking LED



Setting up Arduino (Desktop)

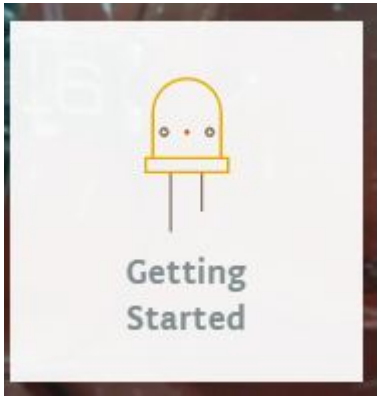
- Find and open Arduino on your desktop
- Click “File” in the top left corner and click save
- Save this tab as “blinkingLED”
- Connect the USB cord in your kit to the Arduino and the computer (USB port is on the left side of the monitor)
- Open the “Tools” Window and make sure the board has been recognized and the port is “COM3” with the name of the board after it





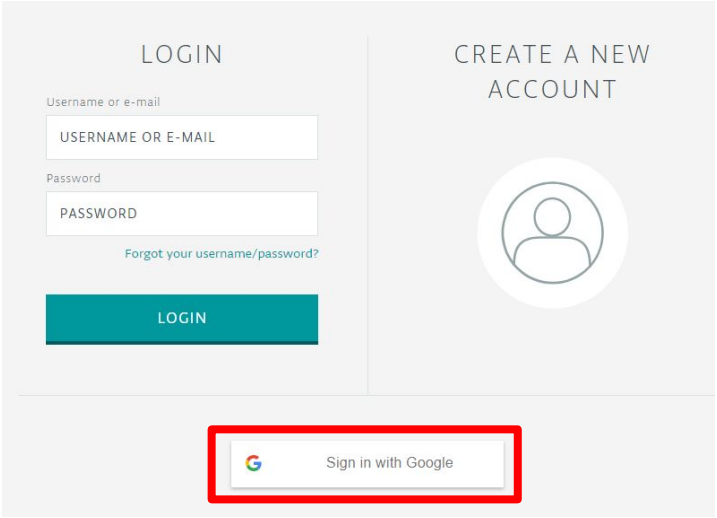
Setting up Arduino (Online Web Editor)

- Search up create.arduino.cc
- Click Getting Started
- Scroll all the way down and click “Set up the Arduino Plugin”
- Click Next and follow the steps to download the plugin



Setting up Arduino (Web)

- If it doesn't automatically bring you to the login screen, click the 9 dots in the upper left hand corner and click Arduino Web Editor.
- Click the Sign in with Google button
- Sign in with your Google account
  - You must use a personal email!



Getting Started (Web)

- Click “NEW SKETCH” in the top left corner
- Click on the sketch name and rename it “blinkingLED”
- Connect the USB cord in your kit to the Arduino and the computer
- The type of Arduino should have been recognized. If not, please type in chat.

Blinking LED Code

led is a variable of the data type **int**, meaning it is a integer value.

This corresponds to the **pin number** on the Arduino.

```
blinkingLEDdemo §

int led = 7;
void setup() {
  // put your setup code here, to run once:
  pinMode(led, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(led, HIGH);
  delay(1000);
  digitalWrite(led, LOW);
  delay(1000);
}
```

pinMode is a **function** that takes two parameters, led and OUTPUT. OUTPUT sets it so the LED is able to blink.

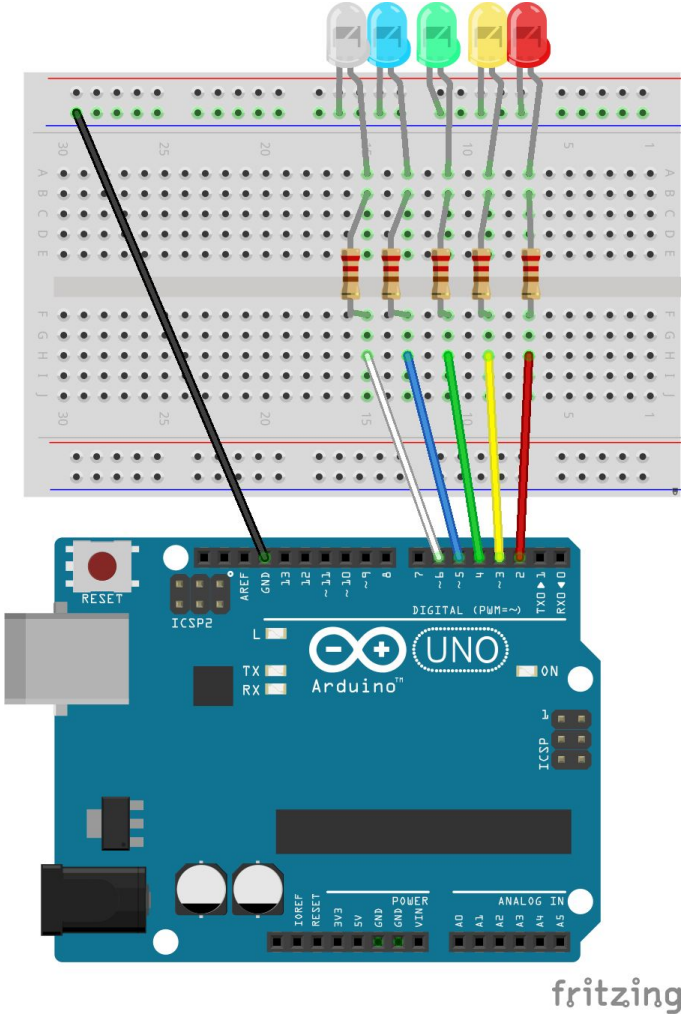
digitalWrite is a **function** that tells the LED to be in an “on” state (HIGH) or an “off” state (LOW)

To test your code, click the checkmark then the arrow!

More LEDs

Parts:

- Arduino
- Breadboard
- Jumper Wires
- Resistor
- LED



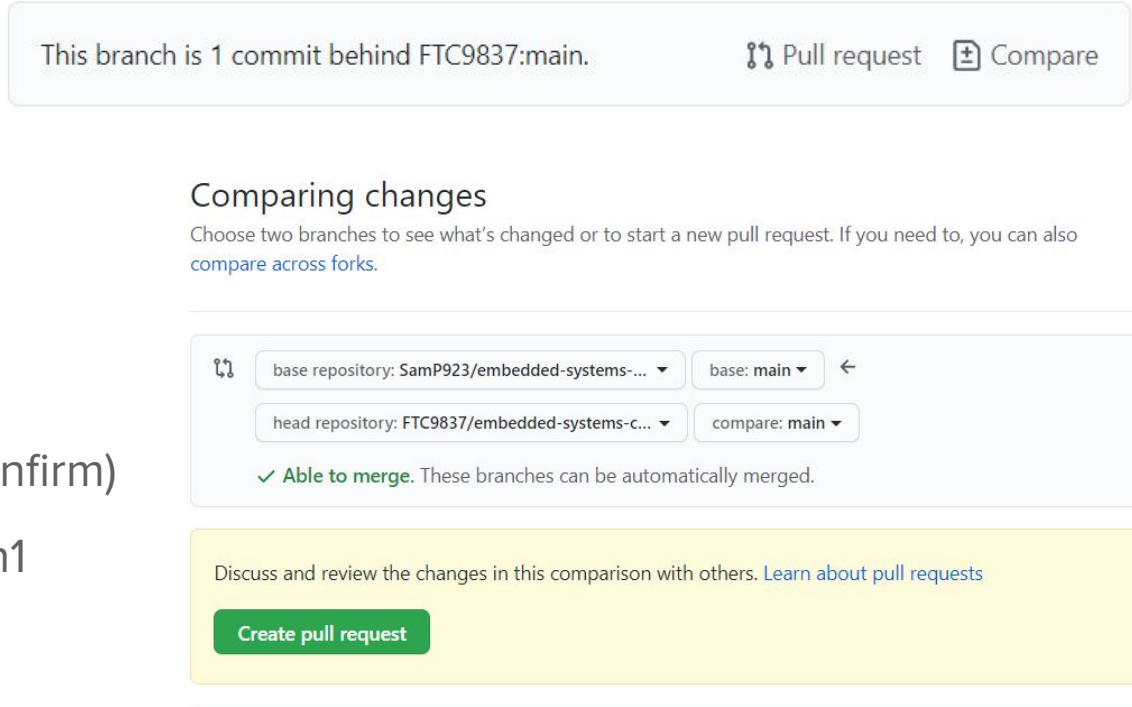
Code Setup

- Click “File” in the top left corner and click save
- Click “File” again and open a “New” sketch
- Save this as “flowingLED”

Grab the Starter Code from GitHub

If you haven't made the repository yet, check these slides

- Go to your repository (username/embedded-systems-course)
- Click "Compare"
- Switch the repos so yours is the base repository and FTC9837 is the head
- Create pull request (x2)
- Merge pull request (and confirm)
- You should have the lesson1 folder in your repository



Line LED Code

lowestPin and highestPin are both integers. The term “const” means this value is constant and cannot be changed.

lineLEDdemo

```
/*****************************************/
const int lowestPin = 2;//the lowest one attach to
const int highestPin = 7;//the highest one attach to
/*****************************************/
void setup()
{
  //set pins 2 through 7 as output
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    pinMode(thisPin,OUTPUT); //initialize thisPin as an output
  }
}
```

This for-loop iterates through the pins from **lowest** value to **highest** value pin and turns them **on**, waits .1 seconds, then turns it off.

```
void loop()
{
  //iterate over the pins
  //turn the led on from lowest to the highest
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    digitalWrite(thisPin,HIGH);//turn this led on
    delay(100);//wait for 100 microseconds
    digitalWrite(thisPin, LOW);//turn this led off
  }

  //turn the led on from highest to lowest
  for(int thisPin = highestPin;thisPin>=lowestPin;thisPin--)
  {
    digitalWrite(thisPin,HIGH);//turn this led on
    delay(100);//wait for 100 microseconds
    digitalWrite(thisPin,LOW);//turn this led off
  }
}
```

This for-loop iterates through the pins from **highest** value to **lowest** value pin and turns them **on**, waits .1 seconds, then turns it off.

[Click here for the repl.it file!]

Flowing LED Code

lowestPin and highestPin are both integers. The term “const” means this value is constant and cannot be changed.

flowingLEDdemo

```
/*****************************************/
const int lowestPin = 2;//the lowest one attach to
const int highestPin = 7;//the highest one attach to
/*****************************************/
void setup()
{
  //set pins 2 through 7 as output
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    pinMode(thisPin,OUTPUT); //initialize thisPin as an output
  }
}
```

This for-loop iterates through the pins from **lowest** value to **highest** value pin and turns them **on**.

This for-loop iterates through the pins from **highest** value to **lowest** value pin and turns them **on**.

```
void loop()
{
  //iterate over the pins
  //turn the led on from lowest to the highest
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    digitalWrite(thisPin,HIGH);//turn this led on
    delay(100);//wait for 100 microseconds
  }
  //fade from the highest to the lowest
  for(int thisPin = highestPin;thisPin>=lowestPin;thisPin--)
  {
    digitalWrite(thisPin,LOW);//turn this led off
    delay(100);//wait for 100 microseconds
  }

  //turn the led on from highest to lowest
  for(int thisPin = highestPin;thisPin>=lowestPin;thisPin--)
  {
    digitalWrite(thisPin,HIGH);//turn this led on
    delay(100);//wait for 100 microseconds
  }
  //fade from lowest to highest
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    digitalWrite(thisPin,LOW);//turn this led off
    delay(100);//wait for 100 microseconds
  }
}
```

This for-loop iterates through the pins from **highest** value to the **lowest** value pin and turns them **off**.

This for-loop iterates through the pins from **lowest** value to the **highest** value pin and turns them **off**.

[Click here for the repl.it file!]

Mystery Pattern

What do you think the code shown on the right does?

multi_LED_mystery

```
/*****************************************/
const int lowestPin = 2;//the lowest pin your LEDs have been attached to
const int highestPin = 7;//the highest pin your LEDs have been attached to
/*****************************************/

void setup()
{
  //set pins 2 through 7 as output
  for(int thisPin = lowestPin;thisPin <= highestPin;thisPin++)
  {
    pinMode(thisPin,OUTPUT); //initialize thisPin as an output
  }
}

void loop()
{
  //iterate over the pins
  //turn the led on from lowest to the highest
  for(int x = 2; x <= 3;x++){
    digitalWrite(x, HIGH);
    digitalWrite(x+2, HIGH);
    digitalWrite(x+4, HIGH);
    delay(200);
    digitalWrite(x, LOW);
    digitalWrite(x+2, LOW);
    digitalWrite(x+4, LOW);
  }
}
```

Thank you!

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