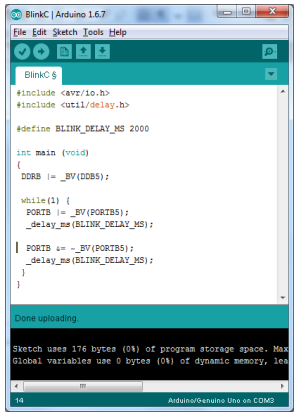

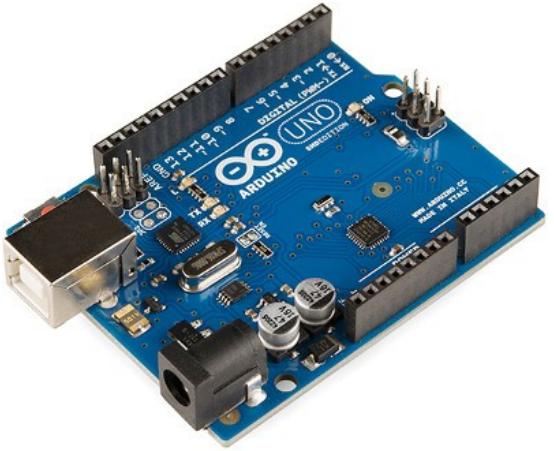

Arduino - Basics

Programming, Electronics, and Giant Killer Robots*

* Giant Killer Robots may be omitted due to budget constraints.

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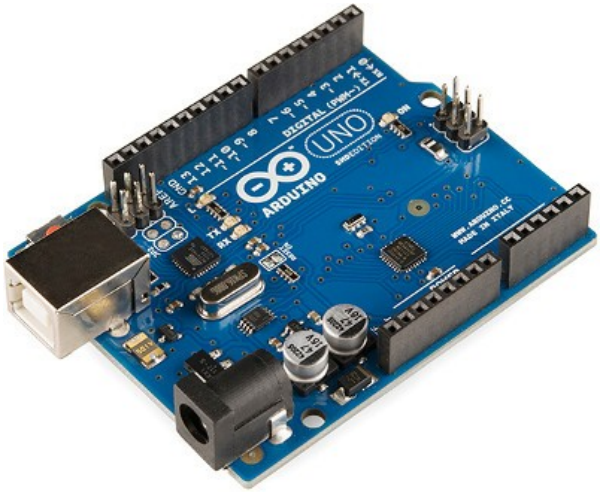
Before we start...

- We believe in open access to knowledge
- All our slides are shared online for free
- You can print it, share it, modify it, use it to run your own courses
- This current set of slides can be found here
  (* You can also find the URL on your hand-out)

Slides available at: http://a9i.sg/westwood

What is an Arduino?



Short Answer:
This is an Arduino...

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What is an Arduino?

- First we'll need to know what is a "micro-controller"

ATtiny 85

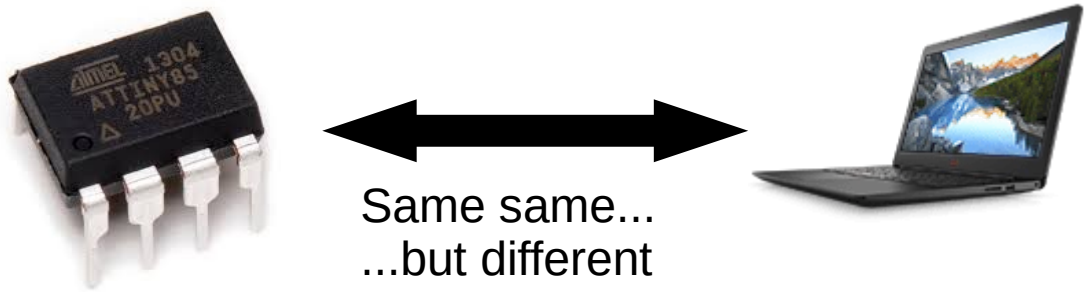
ATmega 328

What is an Arduino?

Micro-controllers are...

Like a miniature computers...

- Contains processor, RAM, storage, and more
- Can be programmed like a computer



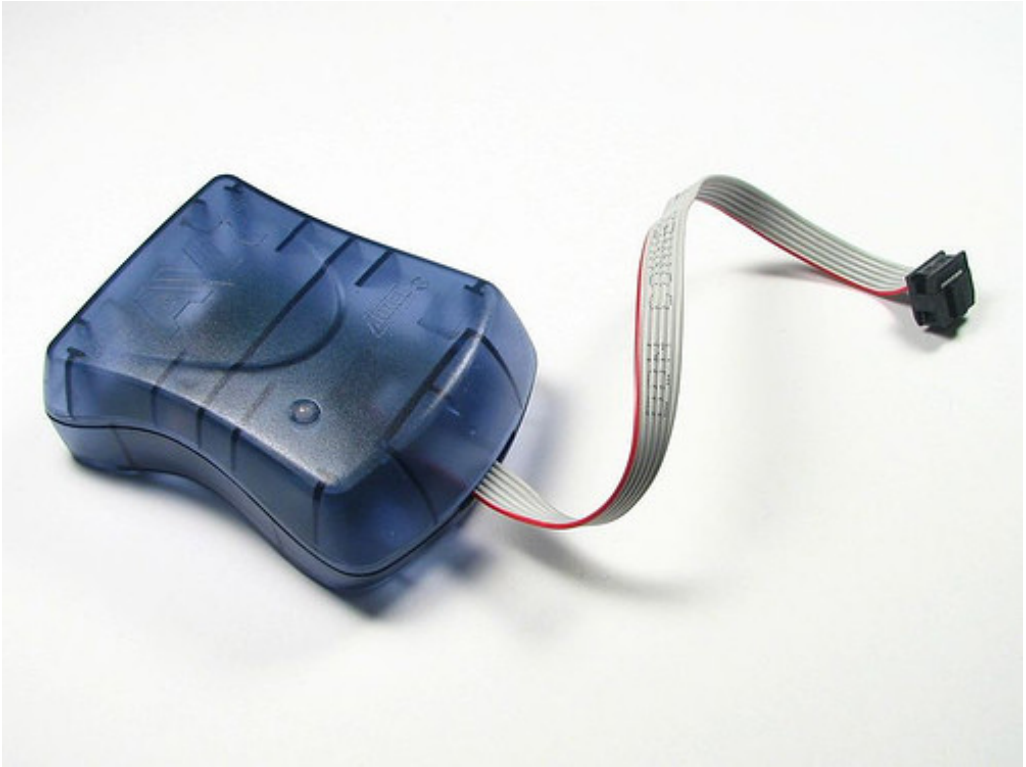
Unlike a computer...

- Provides direct electrical connection to external devices
- Can’t run Minecraft or Fortnite...

What is an Arduino?

Micro-controllers can be a pain…

- Require a special device to program...



AVRISP (In-System Programmer)

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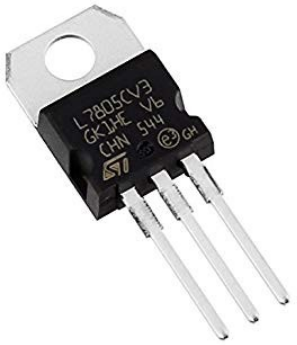
What is an Arduino?

Micro-controllers can be a pain…

- Require external parts to work (eg. voltage regulator, crystal oscillator, decoupling capacitors)



Voltage Regulator
(...this is the simple type)

Crystal Oscillator

Capacitor

What is an Arduino?

So what is an Arduino?

- Combines a micro-controller with all the other components into a single device

What is Arduino IDE?

IDE – Integrated Development Environment
You can do all of these under one roof:

- *write code*
- *build/link program*
- *run and test it*

In the olden days, these tasks were done by different software (text editor, compiler/linker, and then run it as a standalone executable...

Arduino IDE – just what you think...

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What is Arduino IDE?

Build/Run code

Build Log (compiler errors, comm erros)

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What is Arduino IDE?

- Opensource
- Can communicate with all kinds of Arduino-based boards
- Available at **https://ardunio.cc**
  (...don’t worry, we’ll show you the link again later)

Arduino IDE Uses C/C++

Why learn C/C++?

- C has been around since the 70's and still very popular.
- A lot of IoT/real-time devices are built using C. Also a lot of physical device drivers.

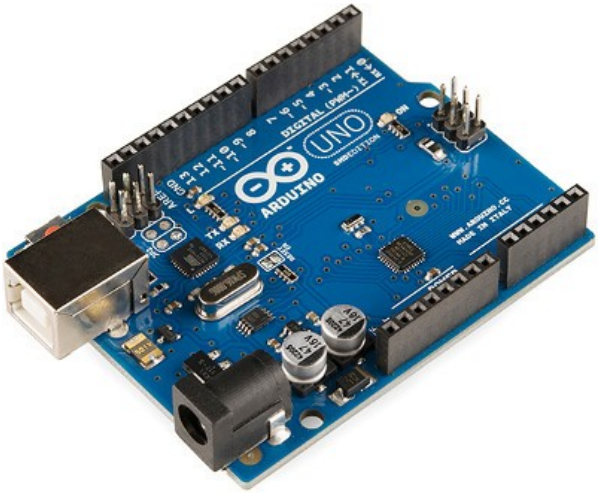
```
void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  delay(1000);
}
```

Arduino IDE → Arduino

- Code is compiled to “machine language” (something the Arduino controller can understand)
- Then uploaded to the Arduino
- And runs directly on the Arduino

Convert to Arduino code and upload



Runs on Arduino

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Getting Started

(The fun part...)

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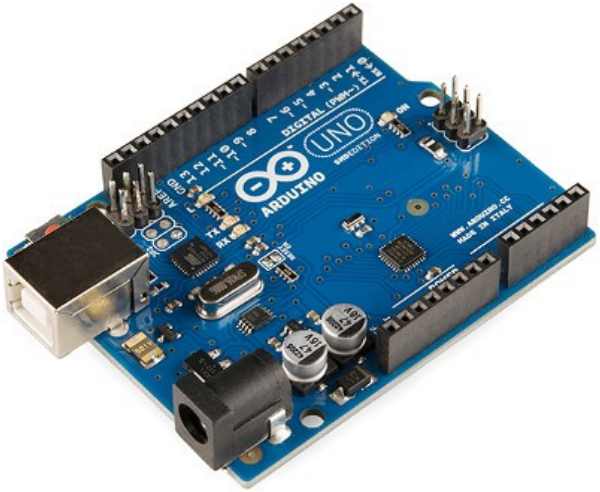
Physical Connection



Some of the LED on the Arduino should light up after connection

This end to computer

This end to Arduino

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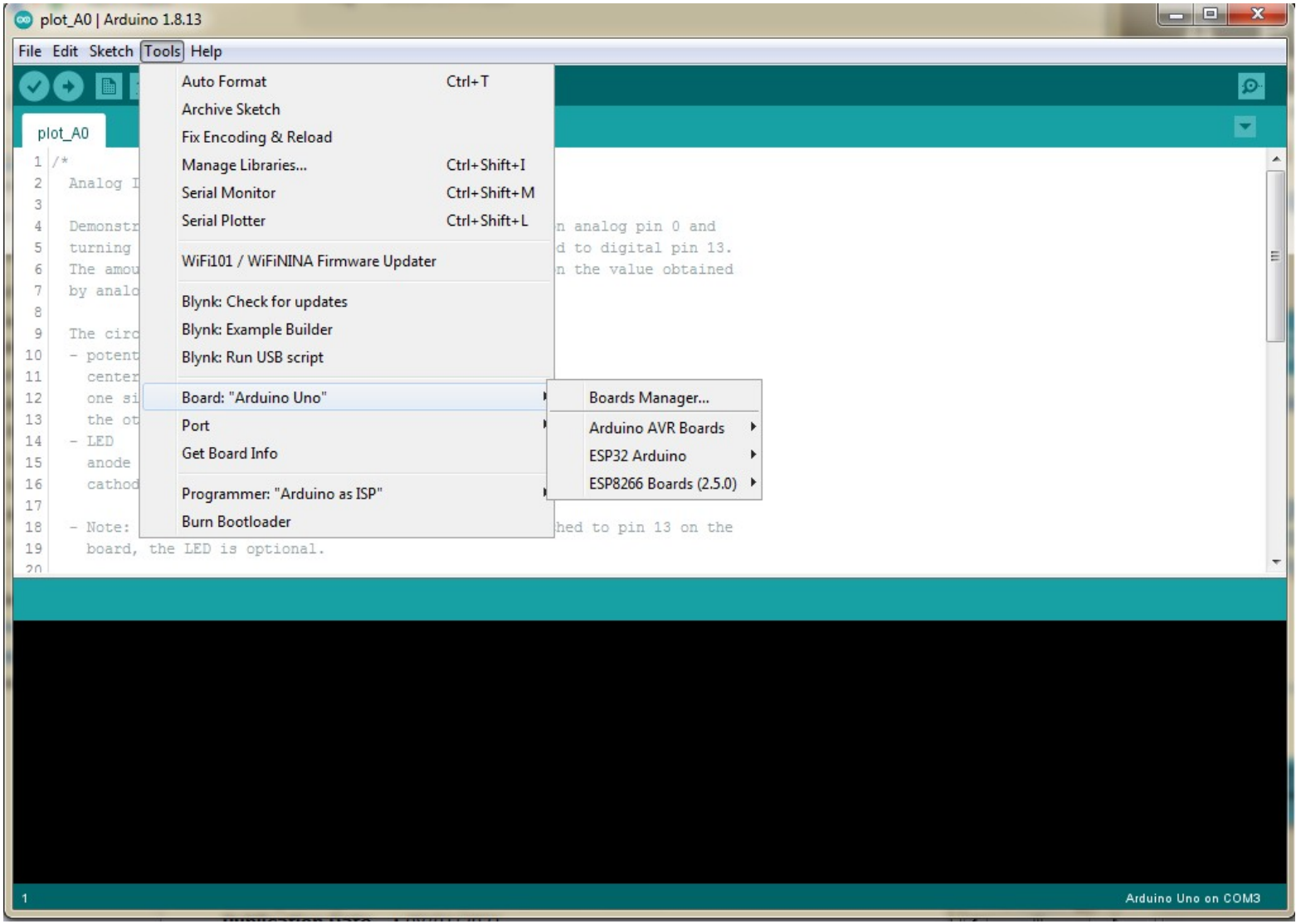
Run Arduino IDE

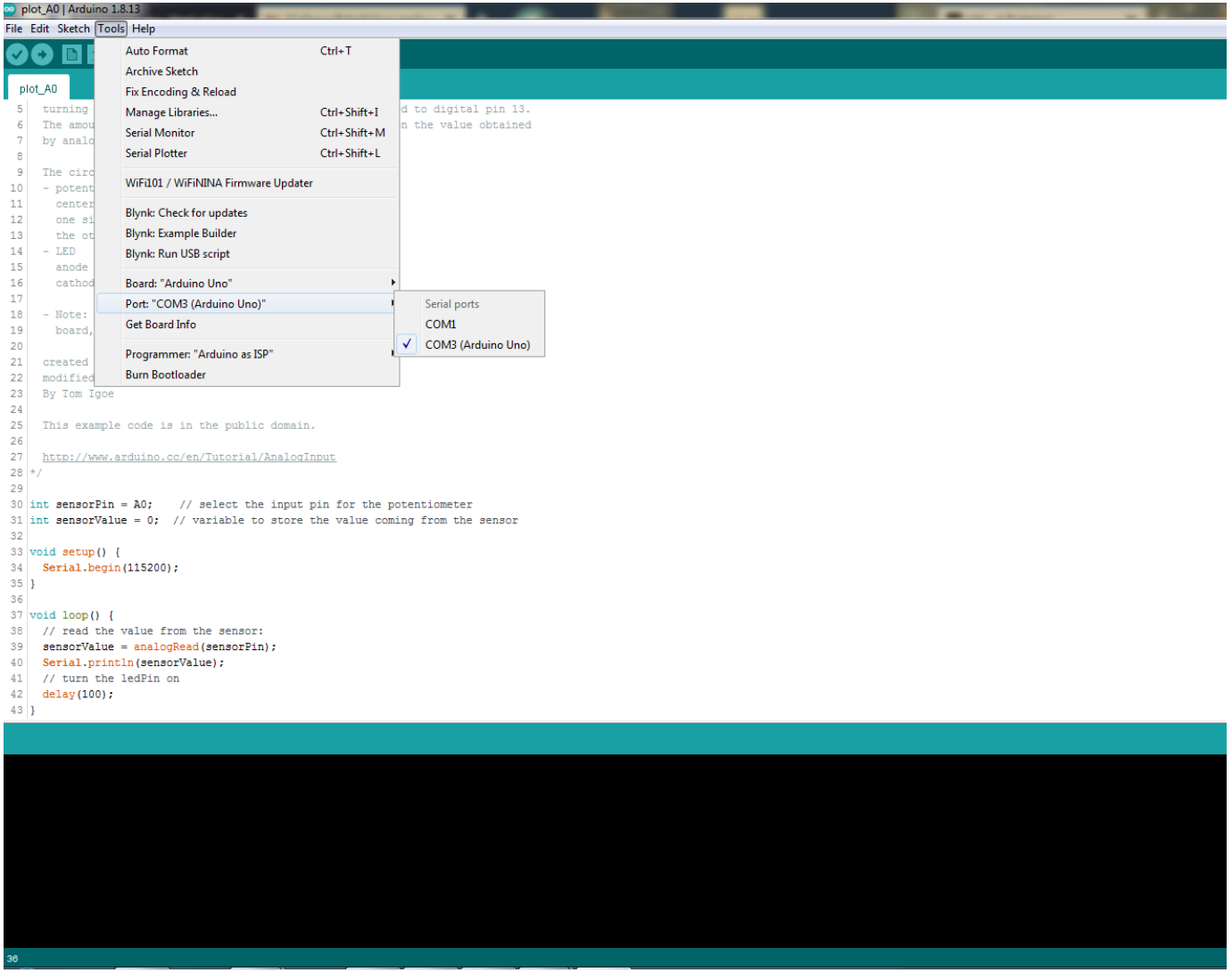
1) Look for this icon and run it 

2) Or go to Arduino Create (web version – will need to create Login & download Plugin)
https://create.arduino.cc/editor

Choose Board



Choose Port


plot_A0 | Arduino 1.8.13
File Edit Sketch Tools Help
plot_A0
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter Ctrl+Shift+L
WiFi101 / WiFiNINA Firmware Updater
Blynk: Check for updates
Blynk: Example Builder
Blynk: Run USB script
Board: "Arduino Uno"
Port: "COM3 (Arduino Uno)"
Get Board Info
Programmer: "Arduino as ISP"
Burn Bootloader
Serial ports
COM1
COM3 (Arduino Uno)
int sensorPin = A0; // select the input pin for the potentiometer
int sensorValue = 0; // variable to store the value coming from the sensor
void setup() {
Serial.begin(115200);
}
void loop() {
// read the value from the sensor:
sensorValue = analogRead(sensorPin);
Serial.println(sensorValue);
// turn the ledPin on
delay(100);
}

First Program - Blink

Make the Built-In LED blink slowly, forever...

```
// setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  // turn the LED on (HIGH is the voltage level)
  digitalWrite(LED_BUILTIN, HIGH);
  delay(1000);                       // wait for a second
  // turn the LED off by making the voltage LOW
  digitalWrite(LED_BUILTIN, LOW);
  delay(1000);                       // wait for a second
}
```

Test it out!

Exercise 1a
External LEDs

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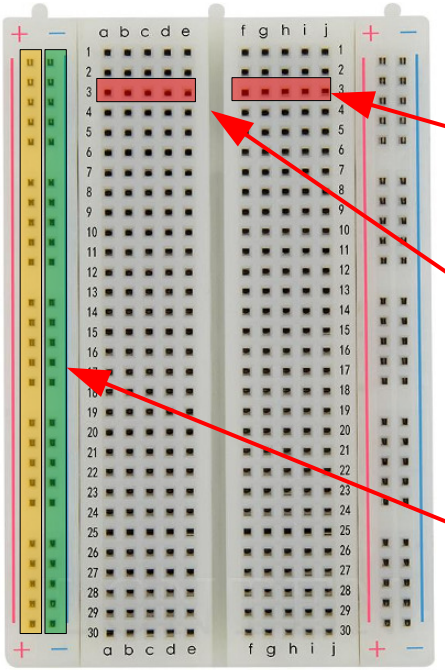
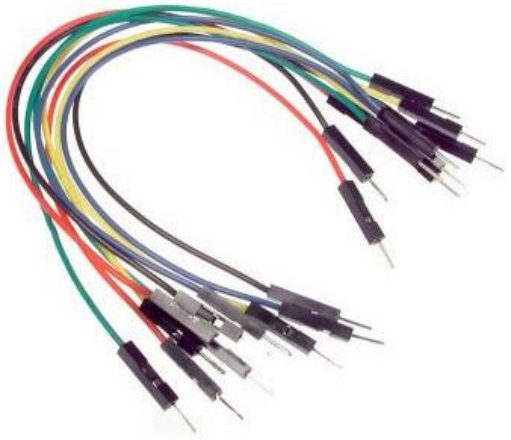
Breadboard

- Helps to make electrical connections
- Many components (eg. LEDs) can be plugged in directly
- Use dupont wires to make connections





Dupont wires
The colors doesn't matter; they all work the same

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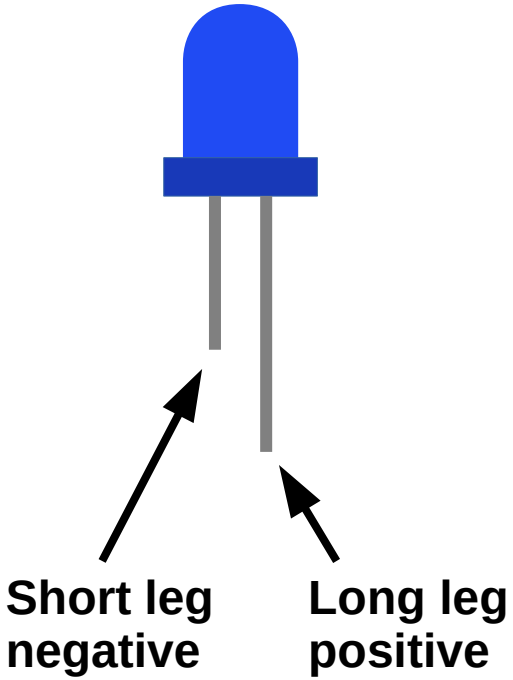
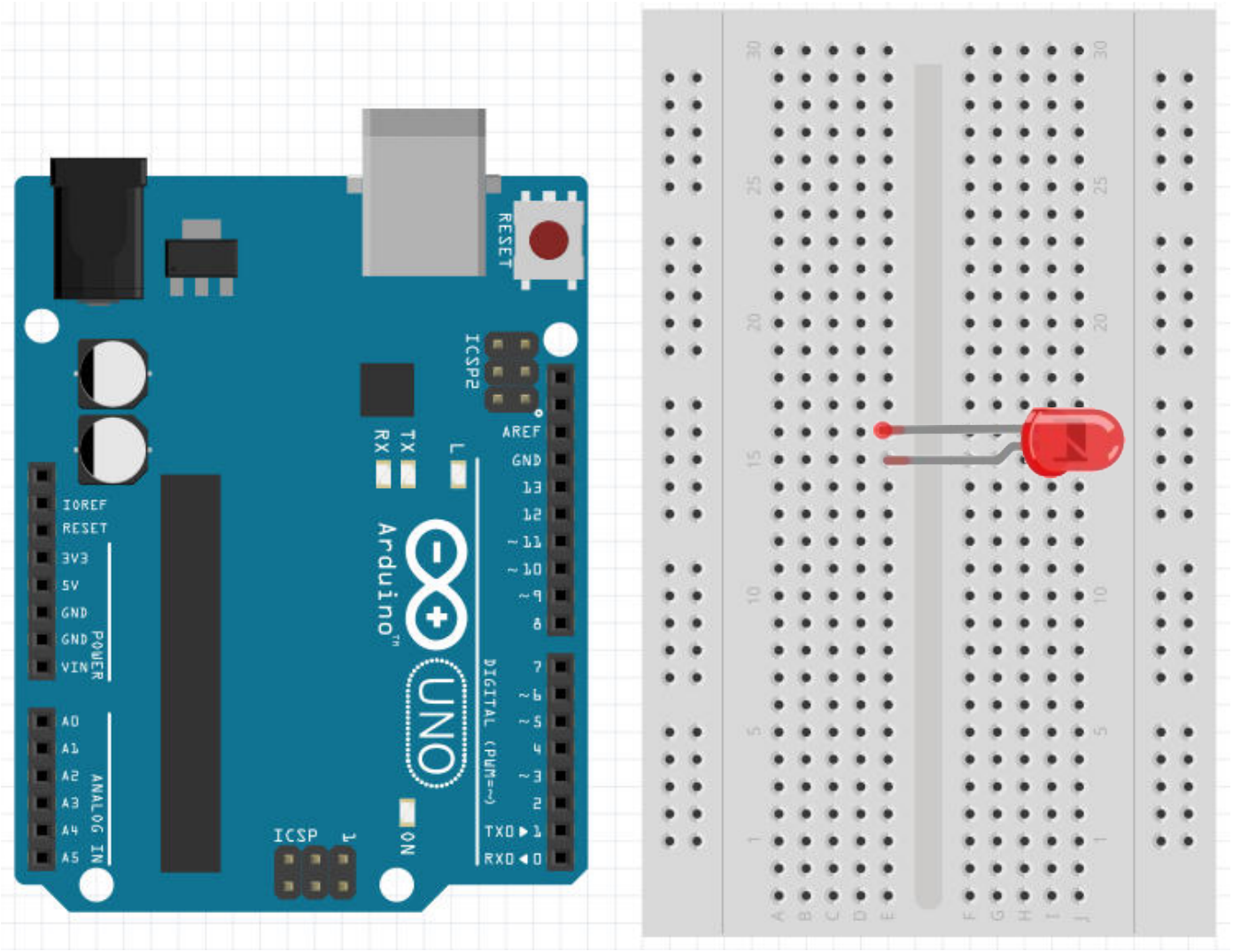
LED

- Light Emitting Diode
- Longer leg connects to positive
- Shorter leg connects to ground (0V)
- **Doesn’t work if connected in reverse**



Connecting an LED

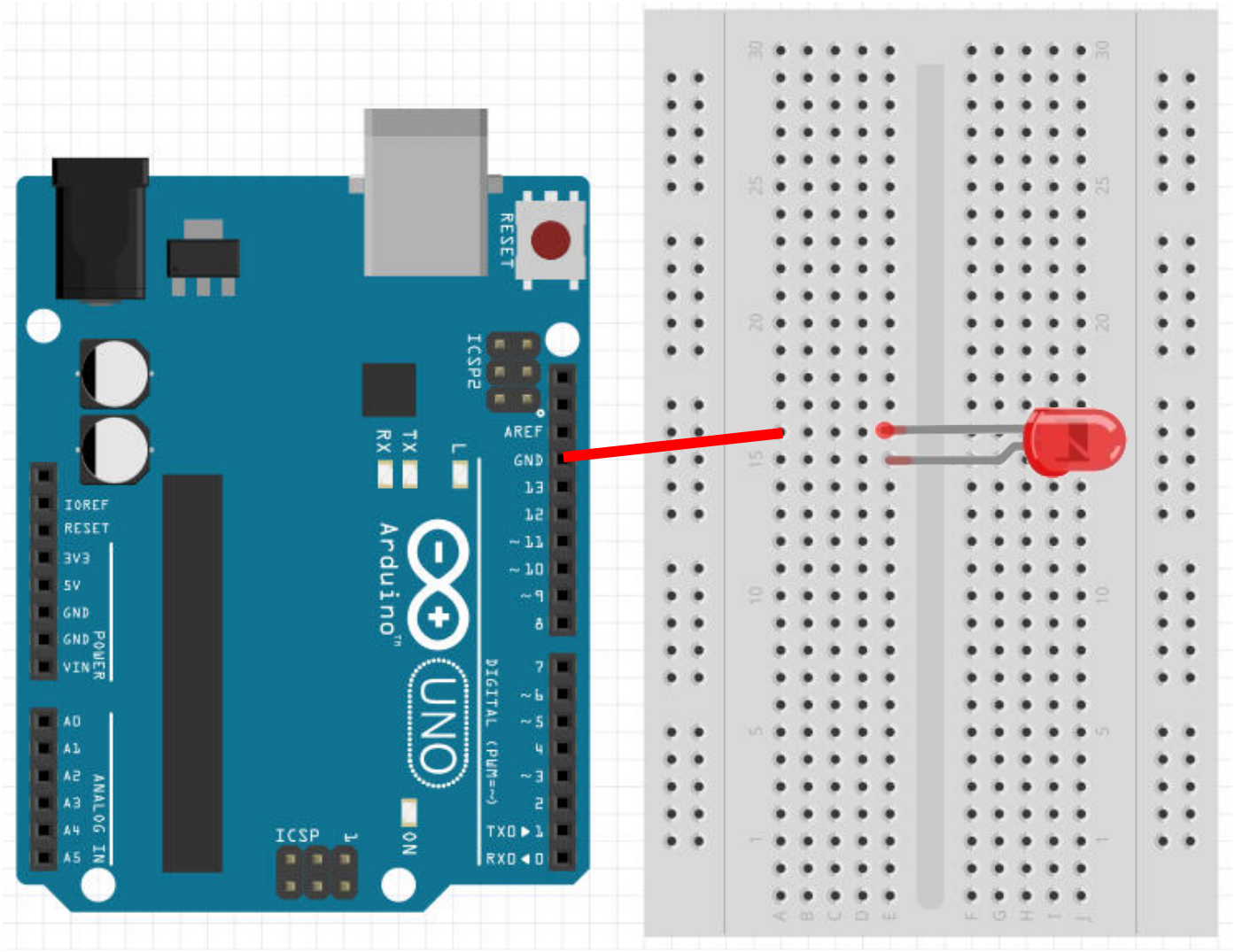


Important!!!
Take note of which leg of the LED is longer

In this example, the bottom leg is longer.

Long leg : Positive
Short leg : Gnd

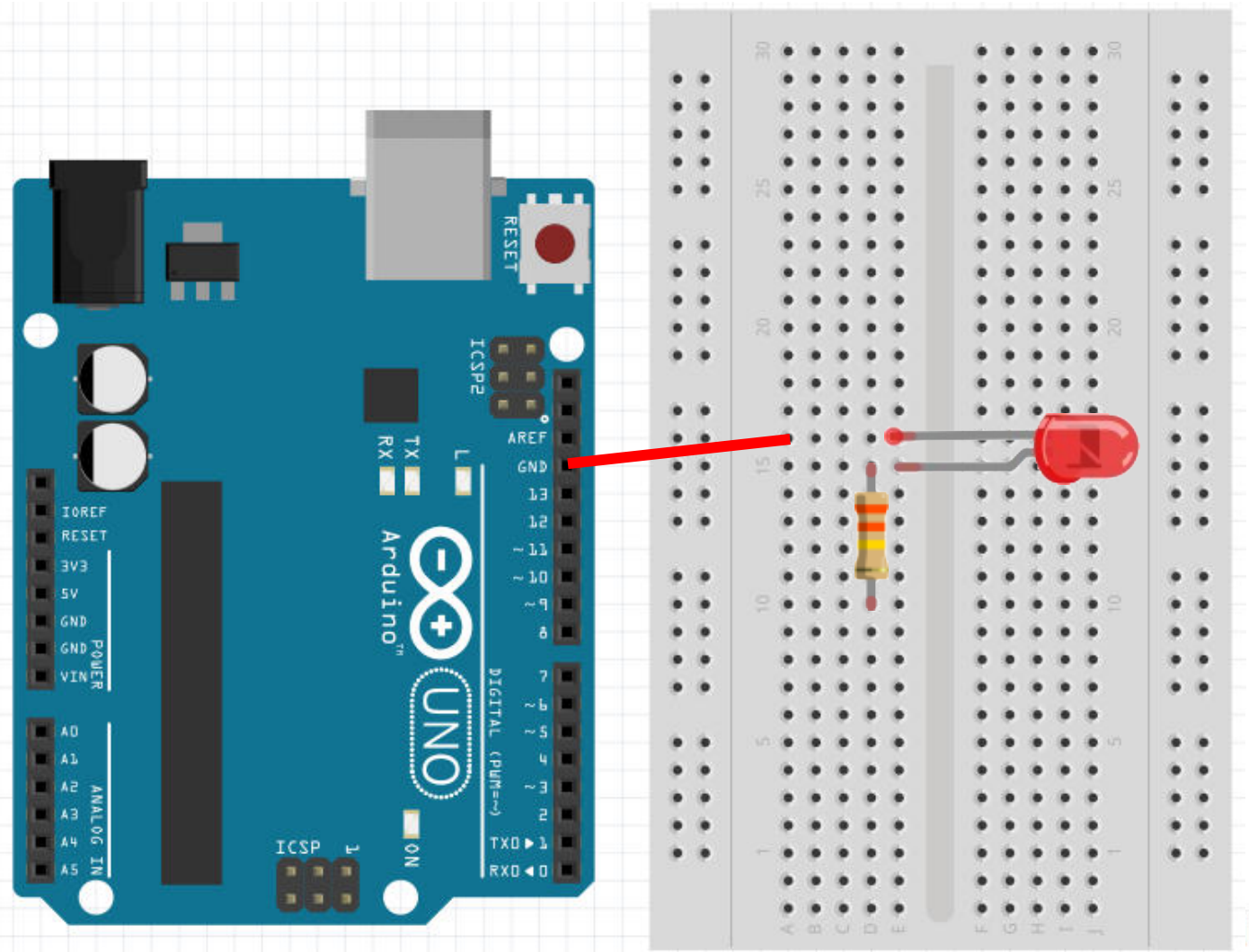
Connecting an LED



Connect a wire from “GND” to the shorter LED leg.

*** My shorter leg is on top.**

Connecting an LED



Add a 330 ohm resistor.

Connect one end to the long LED leg, and the other end to an empty row.

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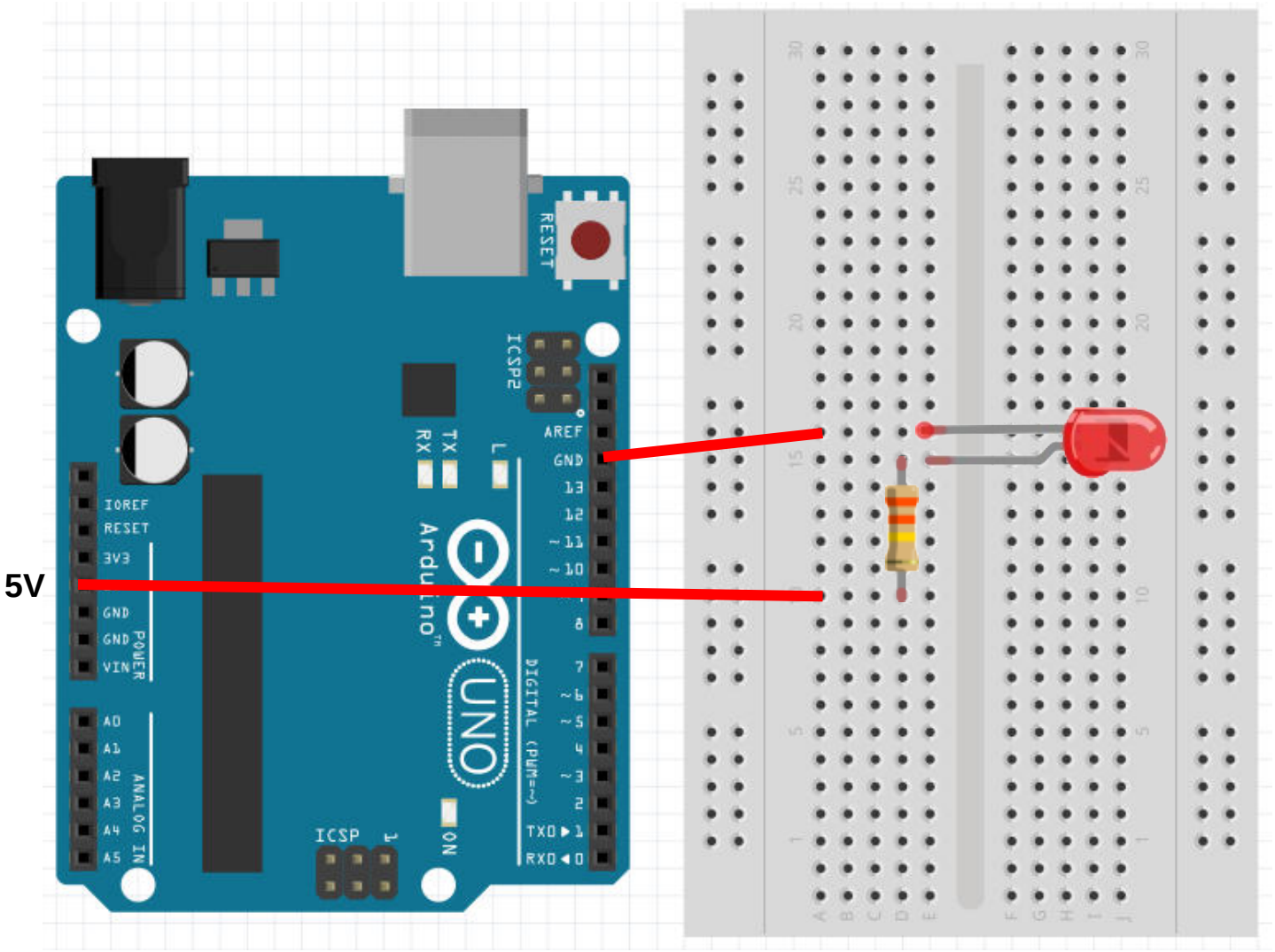
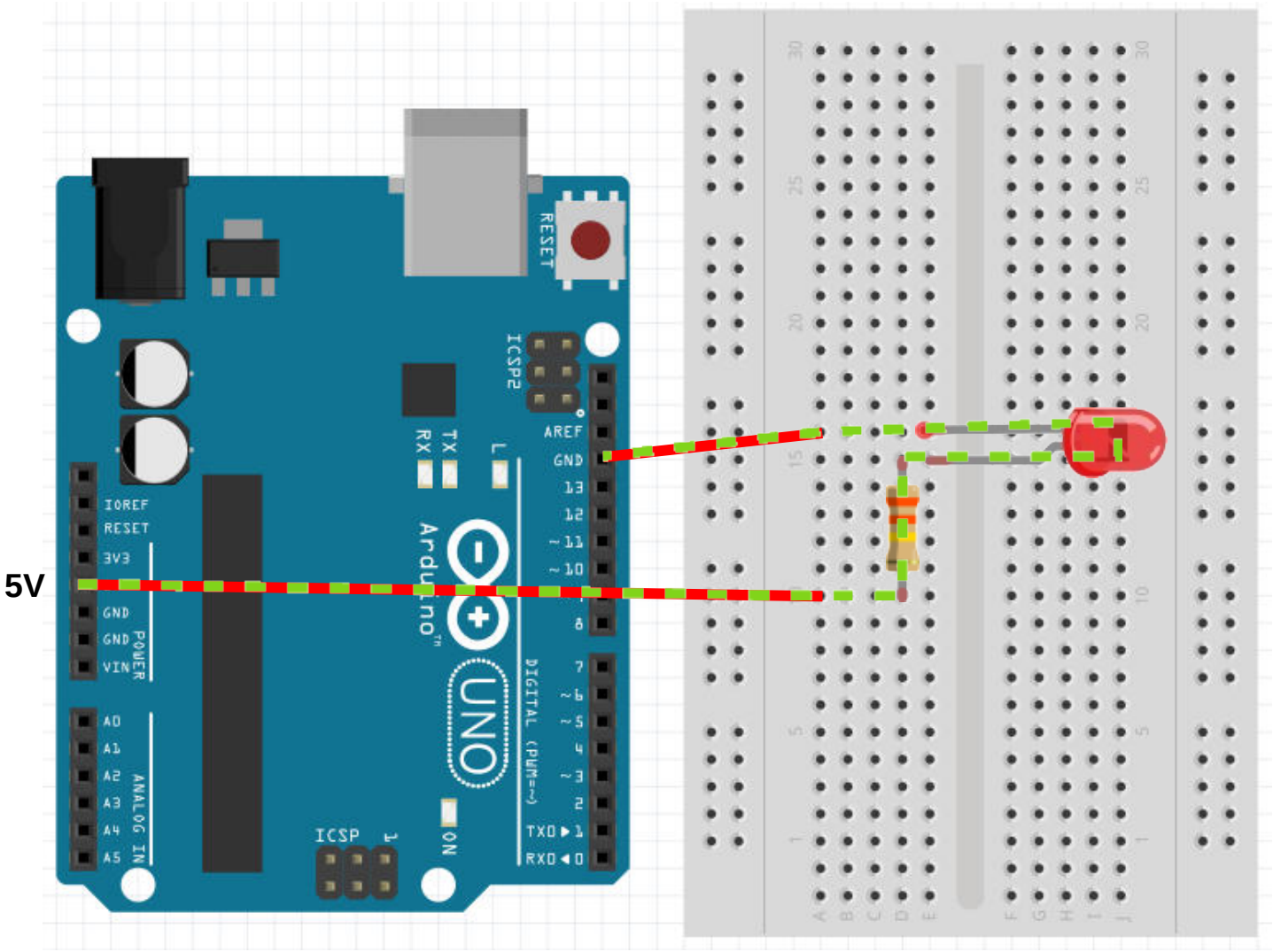
Connecting an LED



Connect the other end of the resistor to the “5V” pin

The LED should light up immediately!

Connecting an LED

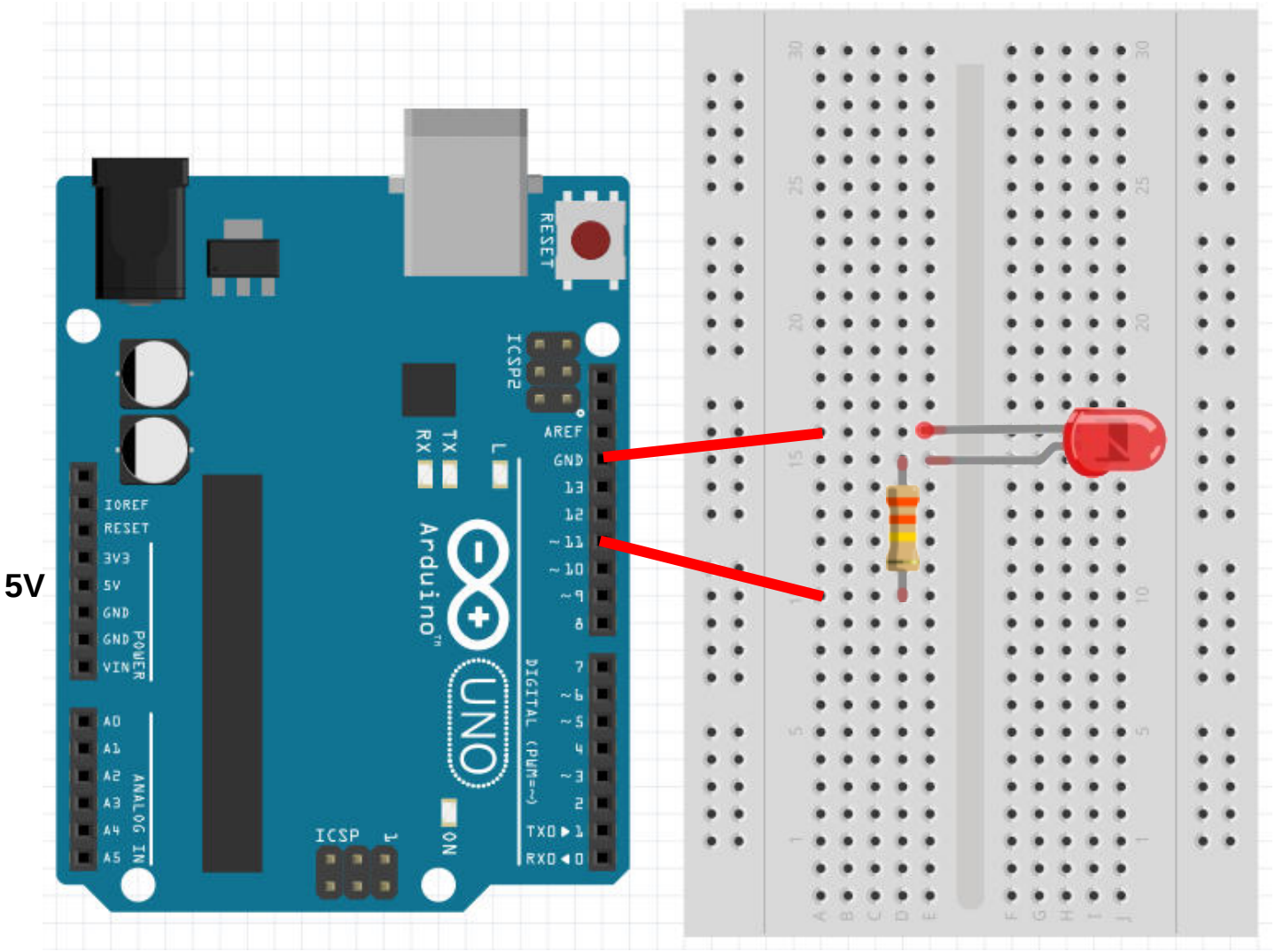


This is how the electricity is flowing

From…

- **5V to…**
- **Resistor to…**
- **LED to…**
- **GND**

Connecting an LED



Controlling the LED

To control the LED, we need to connect it to an output pin instead of 5V.

- **Disconnect it from 5V.**
- **Connect it to Pin 11.**

Challenges

1) Modify your earlier program to control the external LED instead of the internal LED.

2) Program the connected LED blink continuously

Why the resistor?

- Arduino pins provide **5V**
- Different color LEDs require different voltages
  - Red, Yellow, Infra-red: **1.8V**
  - Blue, White, UV: **3.3V**
  - Green: Depends. Try **1.8V** first.
- **Resistor helps to reduce the voltage**
- What happens when you connect 5V to a Red LED without a resistor?

Exercise 1b
External Inputs

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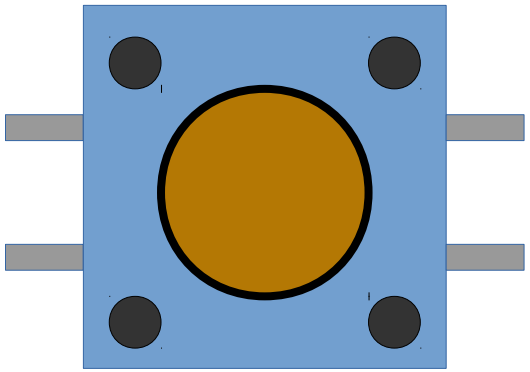
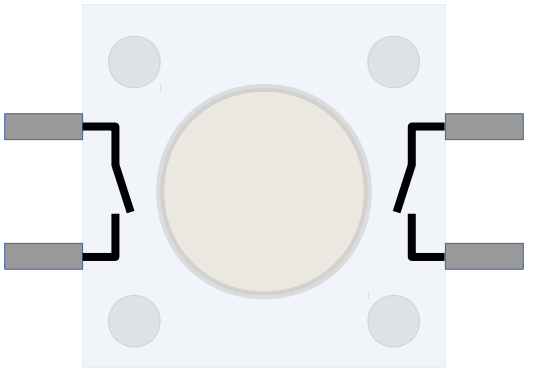
Push Button Switch

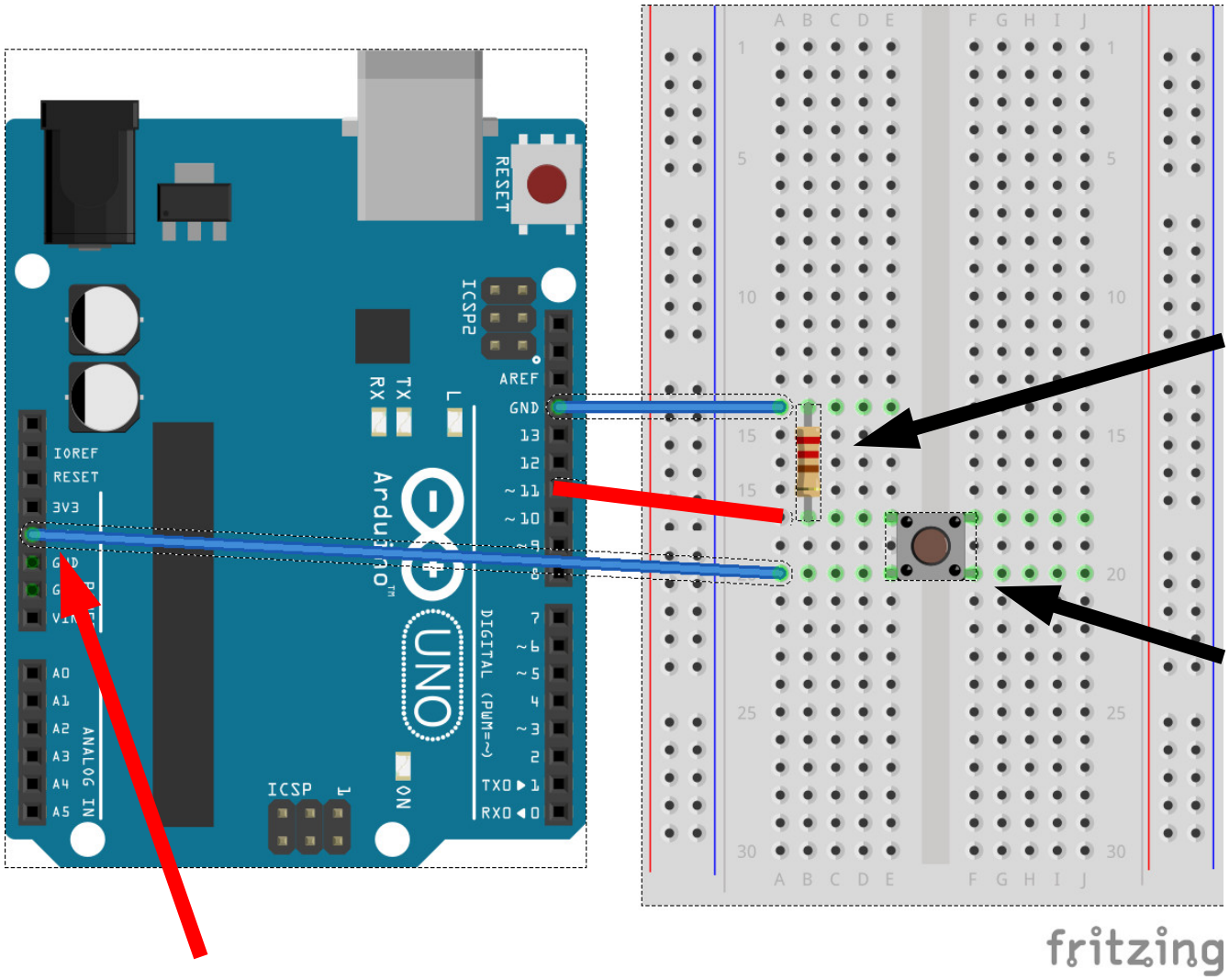


External View



Internal View

Connecting a Switch



Connected to 5V

Make these connections

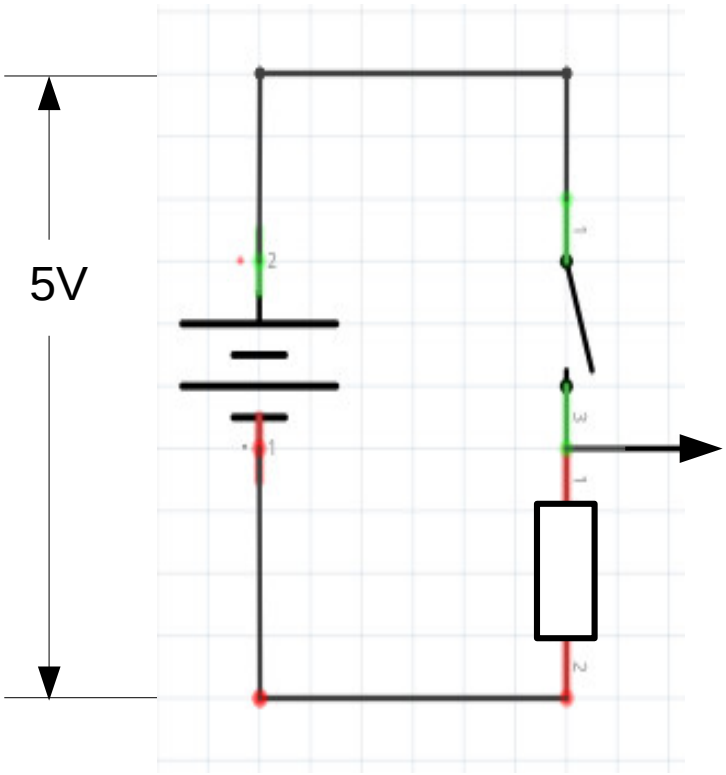
Resistor
Value isn't as important as before. Recommend to pick 1000 ohm, but most other values will do as well.

Push button switch
Connects the adjacent pins. Only need to use one side...

Connecting a Switch

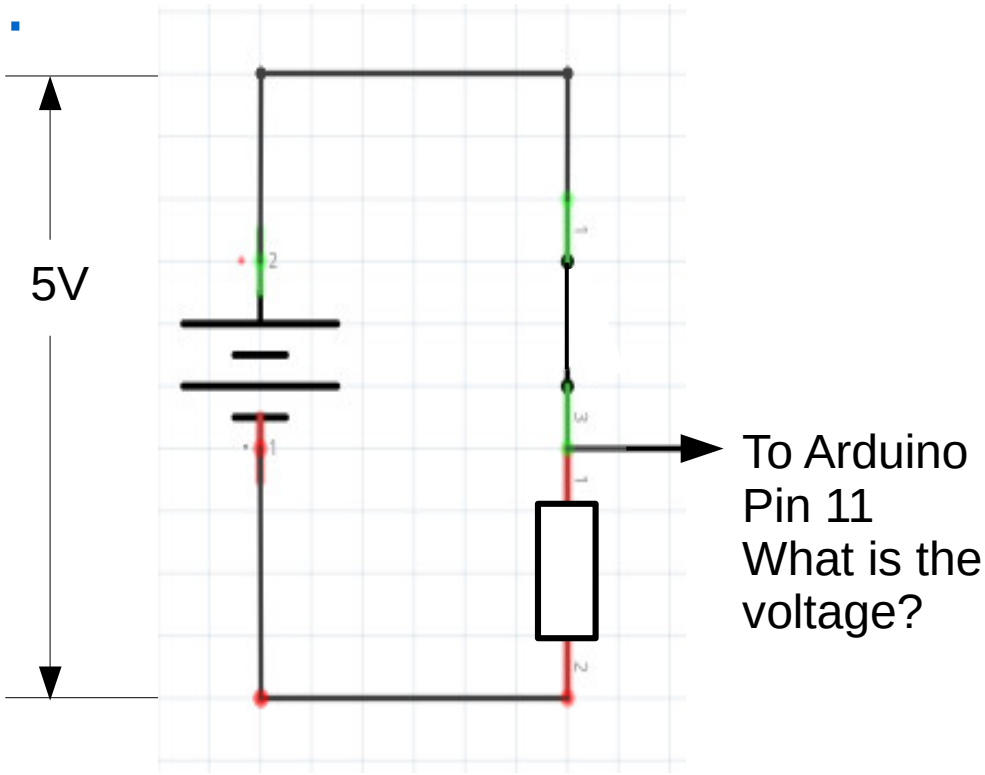
- When switch is open…
- Pin 11 is connected to 0V via the resistor
- Pin 11 not connected to 5V

Voltage of pin 11
= 0 V
= False
= Low



Connecting a Switch

- When switch is closed…
- Pin 11 is connected to 0V via the resistor
- Pin 11 is connected to 5V **directly**



Voltage of pin 11
= 5 V
= True
= High

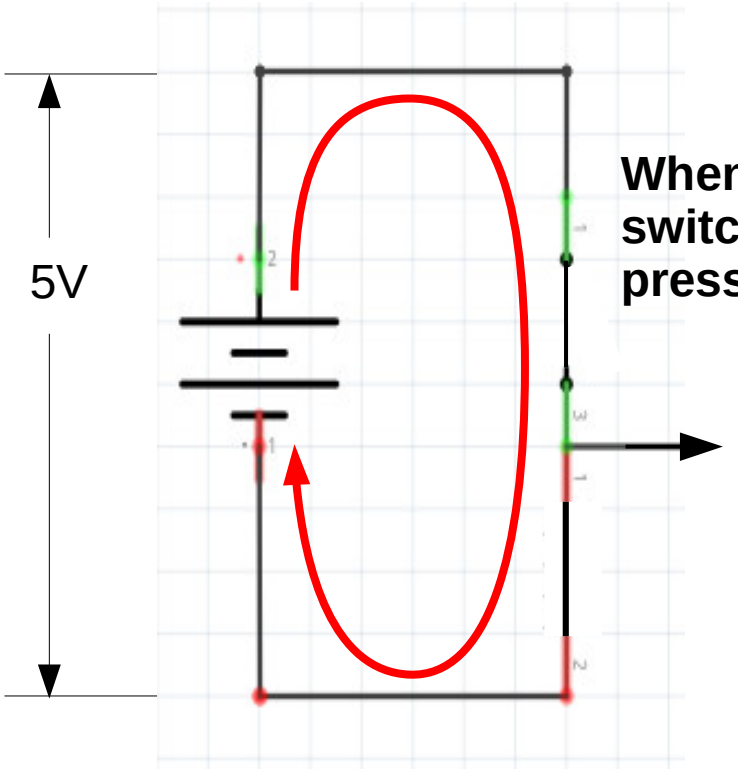
Connecting a Switch

- This resistor is call a **pull-down resistor**, because it pulls the voltage down to 0V when the switch is open

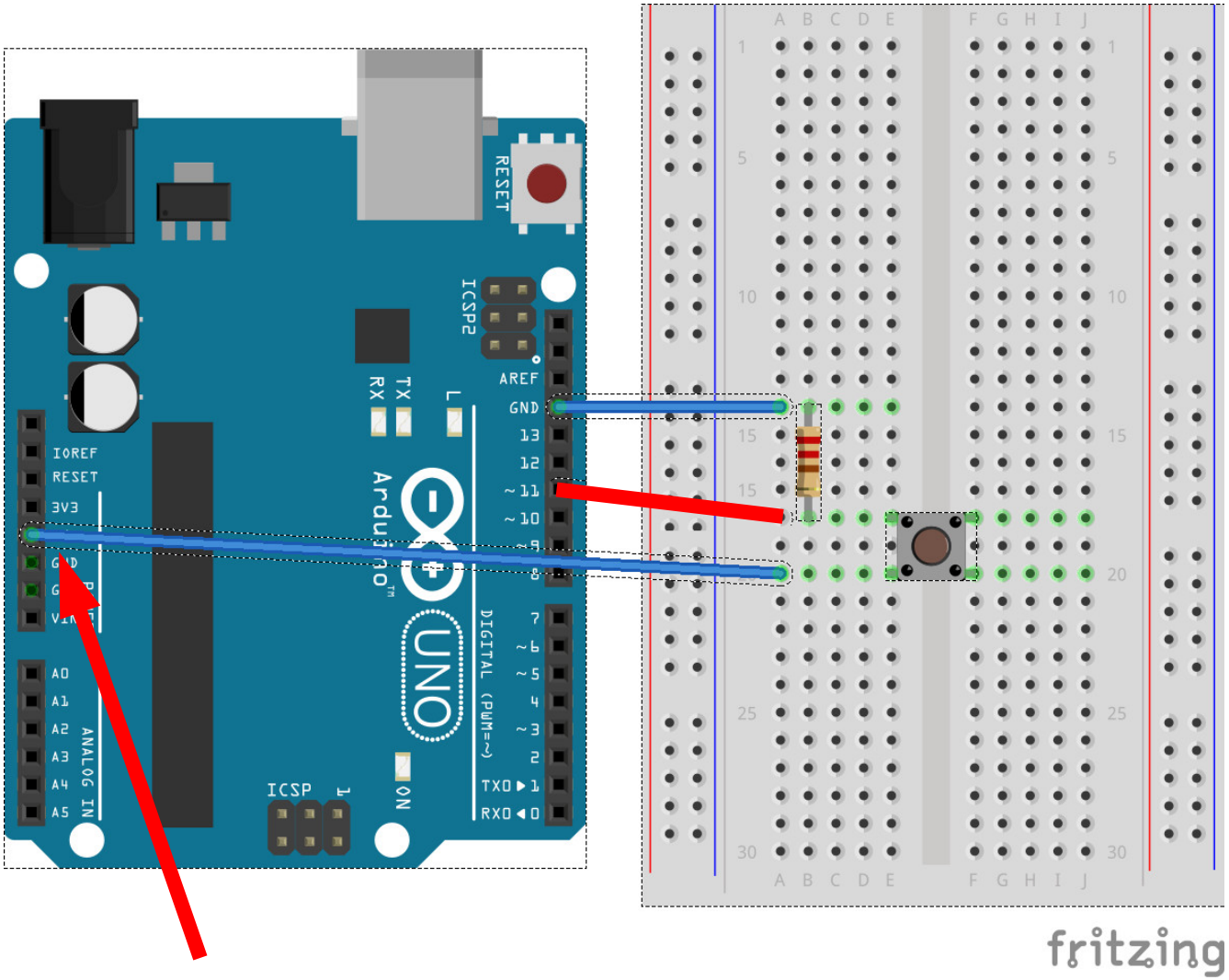
- We can also connect the resistor to 5V and the switch to Gnd. This is call a **pull-up resistor**.

Connecting a Switch

- Can we connect the switch to Gnd without a resistor?
  - NO! Without the resistor, we will have a short circuit when the switch is pressed



Connecting a Switch



Connected to 5V

Button Sample Code

```
// constants won't change. They're used here to set pin numbers:
const int buttonPin = 11;     // the number of the pushbutton pin (see connection above)
const int ledPin =  13;      // the number of the LED pin

// variables will change:
int buttonState = 0;         // variable for reading the pushbutton status

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop() {
  // read the state of the pushbutton value:
  buttonState = digitalRead(buttonPin);

  // check if the pushbutton is pressed. If it is, the buttonState is HIGH:
  if (buttonState == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);
  } else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

Challenges

1) Make an LED blink rapidly for 2 seconds when the button is pressed

2) Make an LED toggle between on and off when the button is pressed

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