ARDUINO *for* SUSTAINABLE DEVELOPMENT

HELLO!

Jen Brown

Emerging Technologies Coordinator

jcb2257@columbia.edu

ref-sci@columbia.edu

1.

WHAT IS AN ARDUINO?

(Hint: just a mini computer of sorts)

Raspberry Pi:

- Computer running a full linux OS and capable of using expandable memory (micro SD cards).
- **Great for:** simultaneously running or managing complex computing tasks, powering networked computing projects.

Arduino Uno:

- CPU housed on a single integrated circuit (microprocessor); no OS or GUI (desktop); executes *one* file ("sketch") at a time.
- **Great for:** projects that feature repetitive, immutable tasks; sensors and devices collecting data from real-world surroundings.

HOW DOES IT WORK?

Turns input (touch, data, etc.) into output (turning on a motor, updating a social media feed, etc.)

BOARDS:

ENTRY LEVEL	ARDUINO UNO, ARDUINO 101, ARDUINO PRO, ARDUINO PRO MINI, ARDUINO MICRO, ARDUINO NANO, ARDUINO STARTER KIT, ARDUINO BASIC KIT, ARDUINO MOTOR SHIELD
ENHANCED FEATURES	ARDUINO MEGA, ARDUINO ZERO, ARDUINO DUE, ARDUINO PROTO SHIELD
INTERNET OF THINGS	ARDUINO YÚN, ARDUINO MKR1000, ARDUINO ETHERNET SHIELD, ARDUINO GSM SHIELD, ARDUINO WIFI SHIELD 101
WEARABLE	ARDUINO GEMMA, LILYPAD ARDUINO USB, LILYPAD ARDUINO MAIN BOARD, LILYPAD ARDUINO SIMPLE, LILYPAD ARDUINO SIMPLE SNAP
3D PRINTING	MATERIA 101

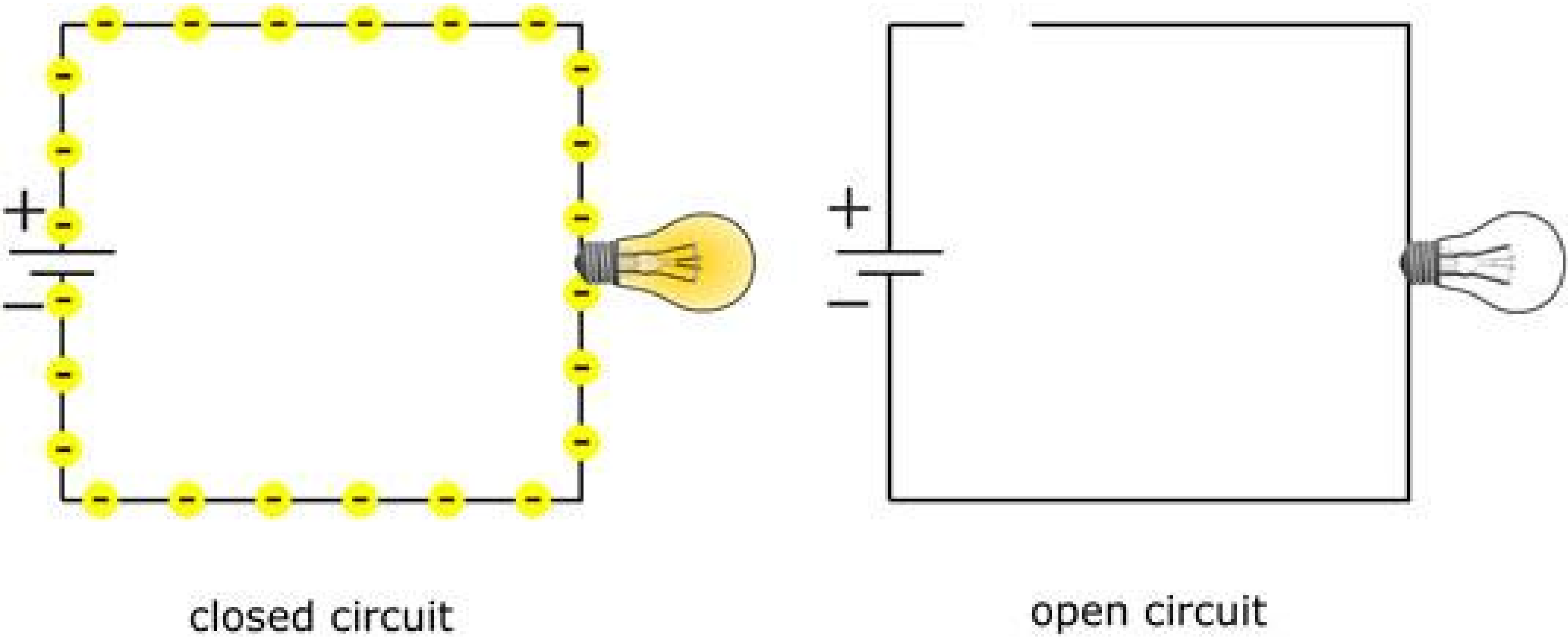
ARDUINO UNO

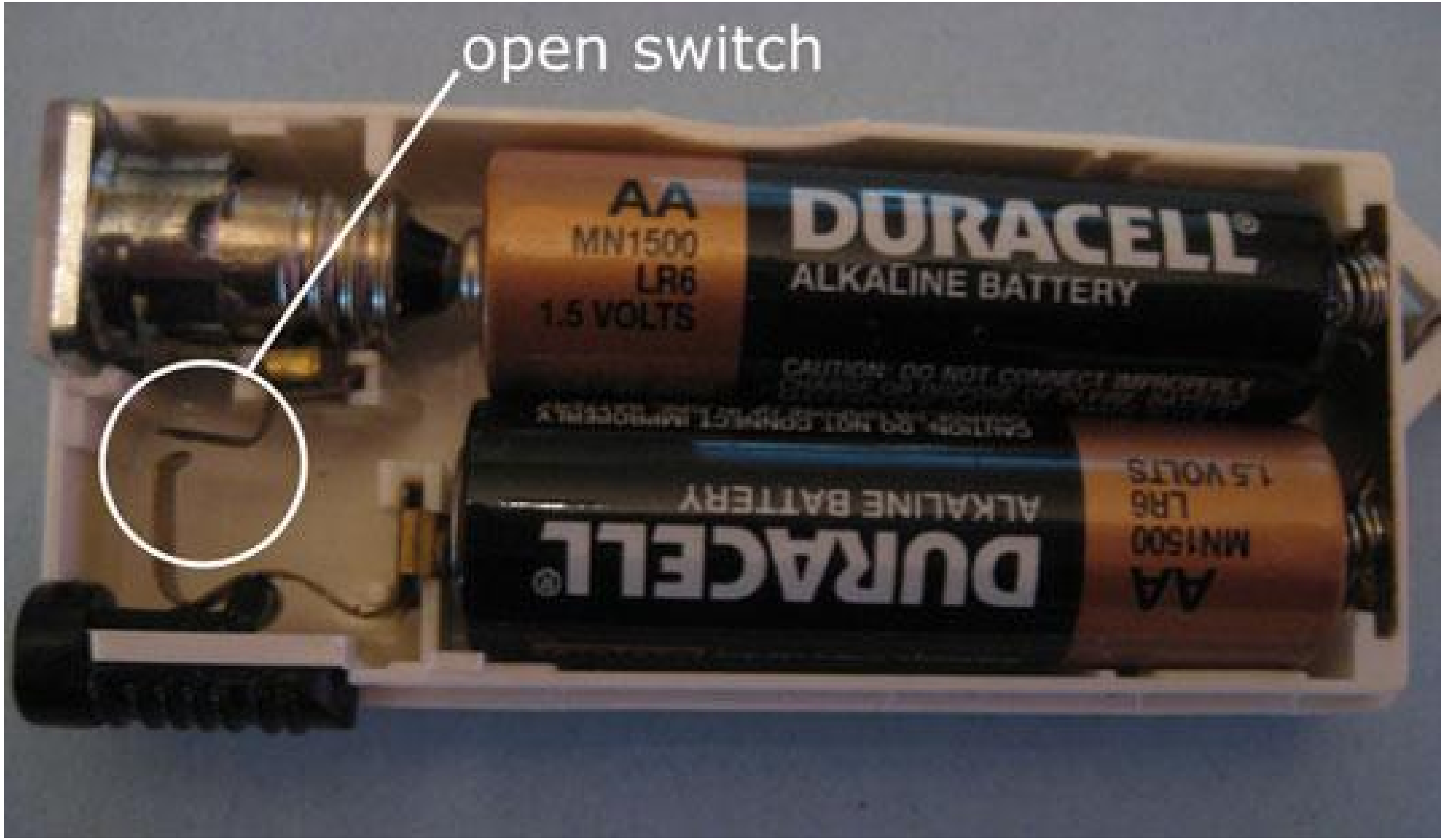
- Atmega328P -- this is the processor of the chip.
  - Flash storage and RAM in the KB range
- 14 digital output/input pins
  - (~) for Pulse Width Modulation
- 6 analog input/output pins
- USB connection
- Power jack
- Reset button

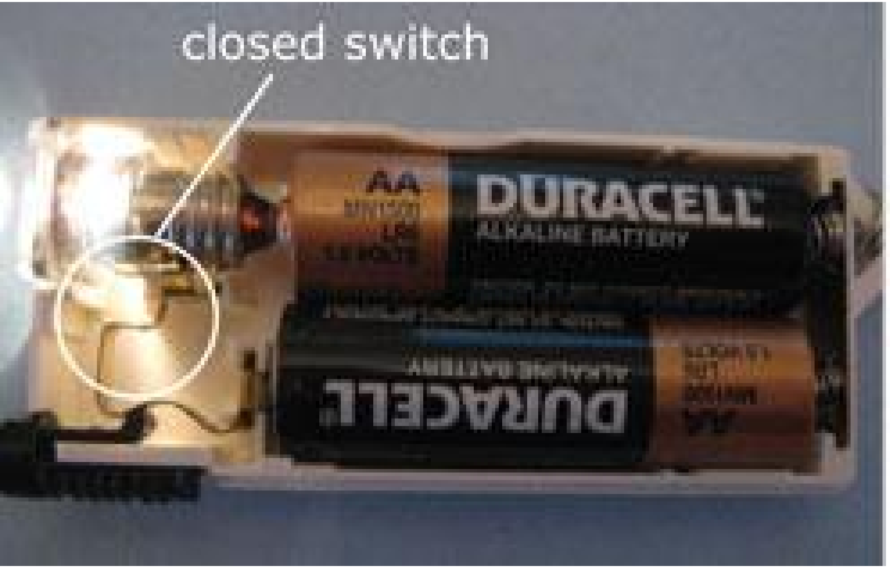
CIRCUITS

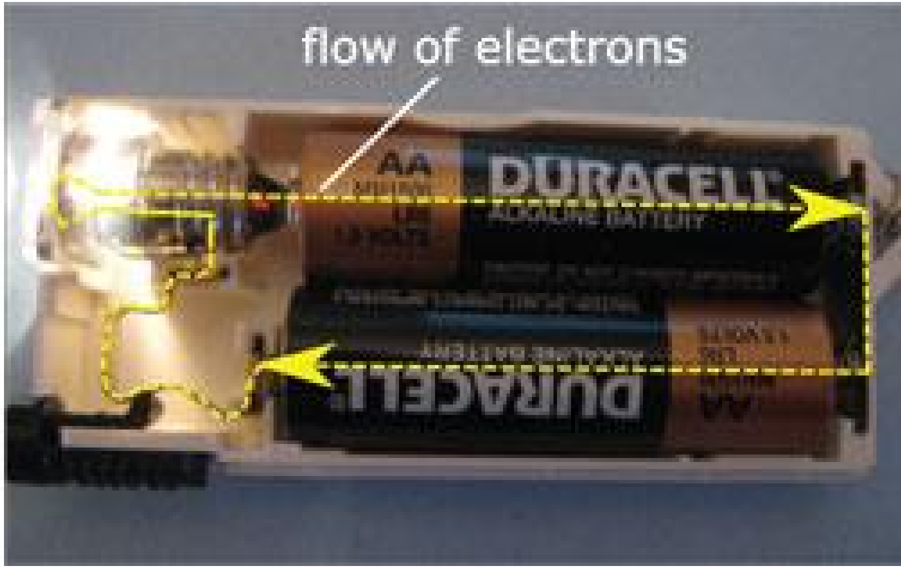
A closed, never-ending loop of conductive material; electrons flow through, creating current.

Circuits can be **open** or **closed**, depending on gaps or incorrect connections you've made. Works best when using a **switch** to open and close the circuit on command.



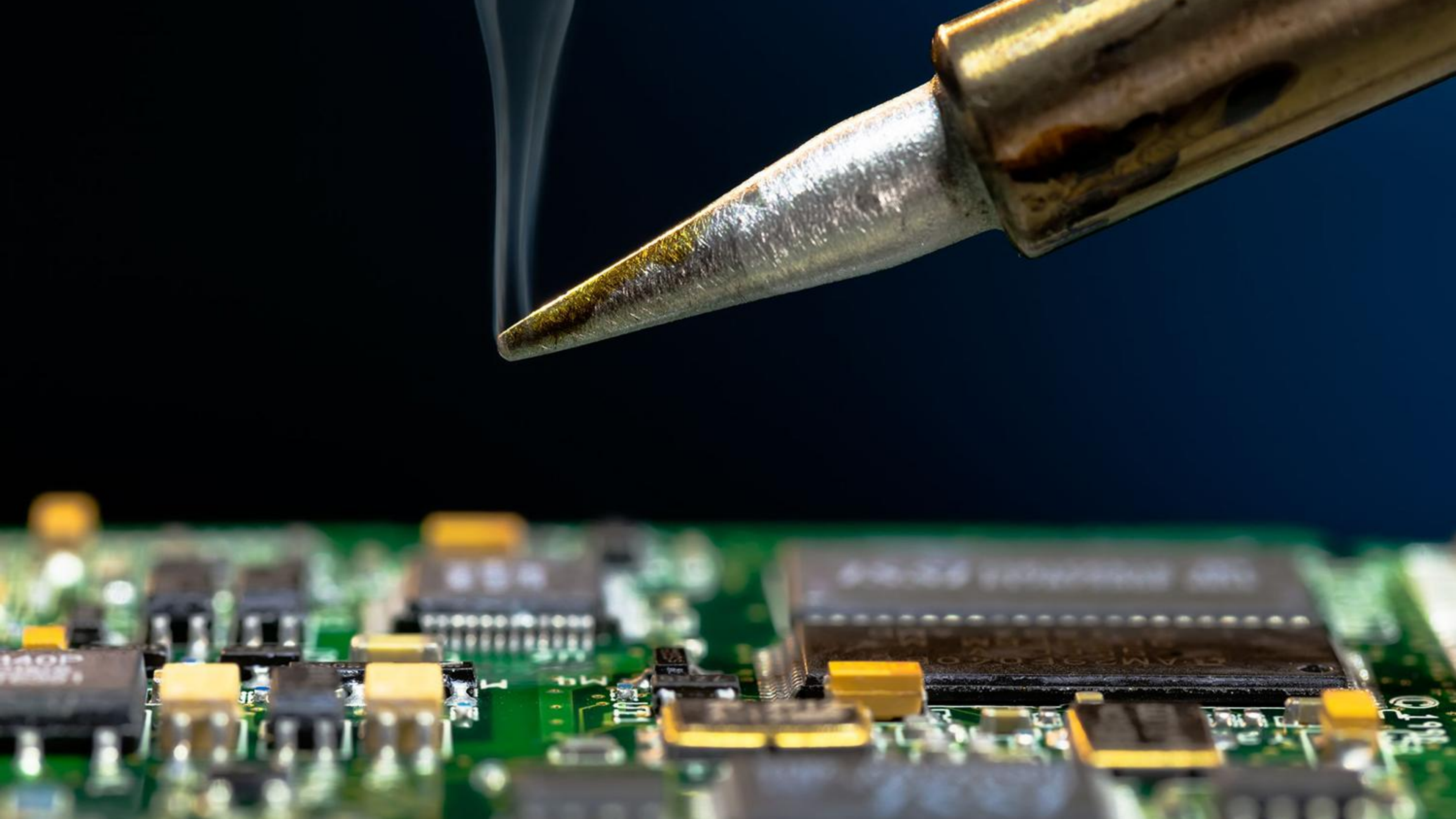

open switch
AA
MN1500
LR6
1.5 VOLTS
DURACELL
ALKALINE BATTERY


closed switch
DURACELL
ALKALINE BATTERY
AA
DURACELL
ALKALINE BATTERY
AA


flow of electrons
DURACELL
ALKALINE BATTERY
AA
DURACELL
ALKALINE BATTERY

CREATING CIRCUITS

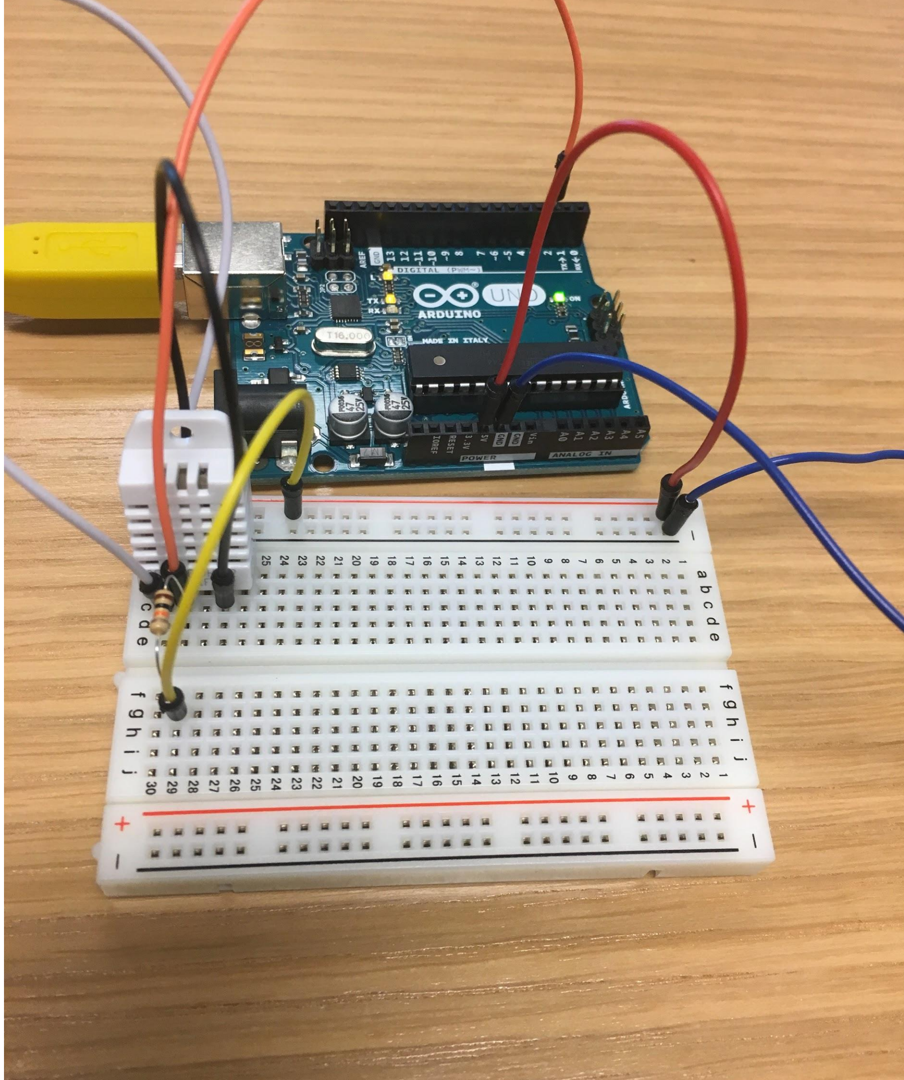
Permanent method vs prototyping



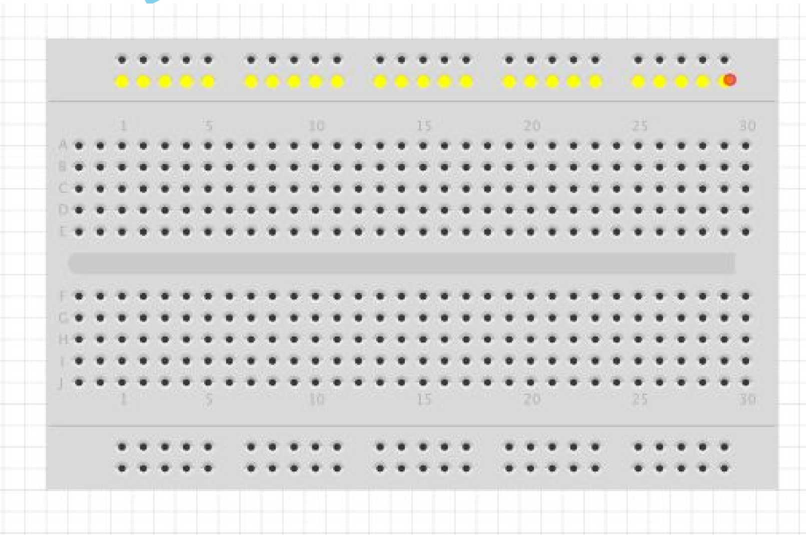
SOLDERLESS BREADBOARDS

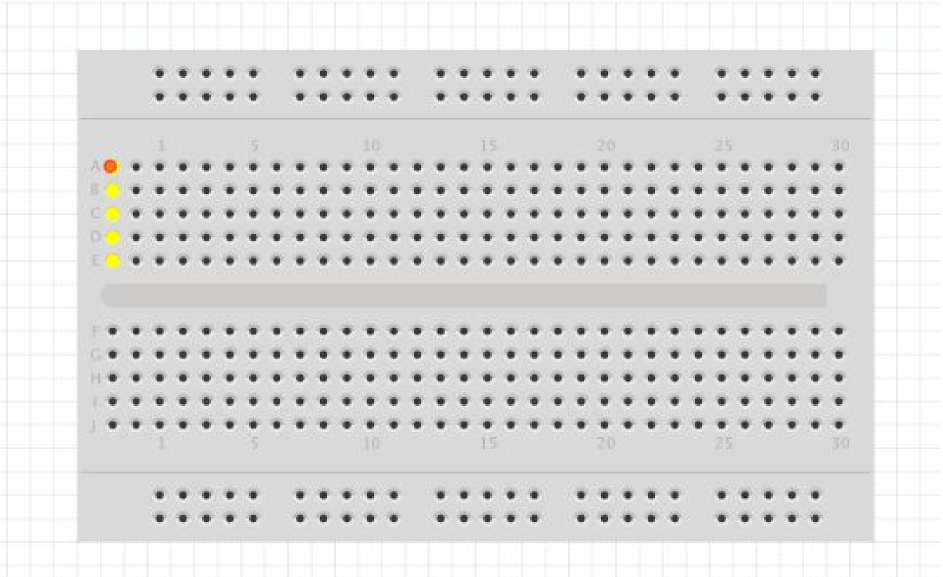
- Flexible -- can connect and disconnect sensors or add-ons using "jumper wires"

- <u>Great for:</u> prototyping projects. (Con: it's flimsy and clunky; not what you'd want for a finished product.)



Solderless Breadboards





Current flows through the double-rail on either side of the board horizontally, but the rails corresponding to “a”, “b”, “c” and so forth flow vertically.

MINI PROJECT

Grabbing temperature and humidity readings with a sensor.

RULES of the Road

TRY NOT TO

1. **Bend or force objects**

(A *little* force is fine, but if it's tight fitting or you're having trouble, call me over.)

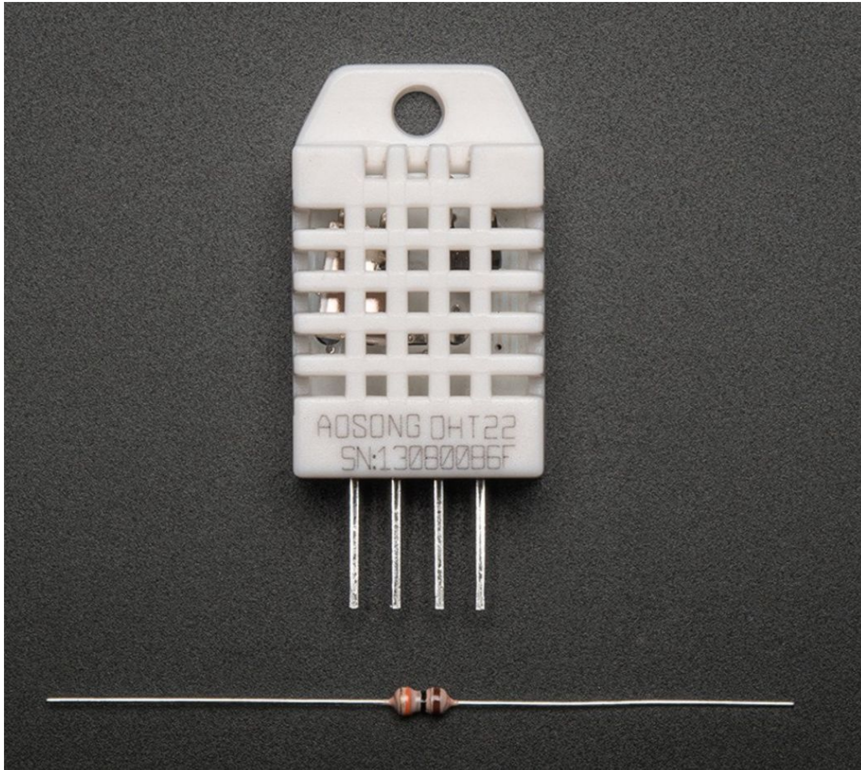
2. **Don't plug or unplug while connected to power**

(Safety first!)

Sensor

DHT22 - Adafruit Temperature + Humidity Sensor

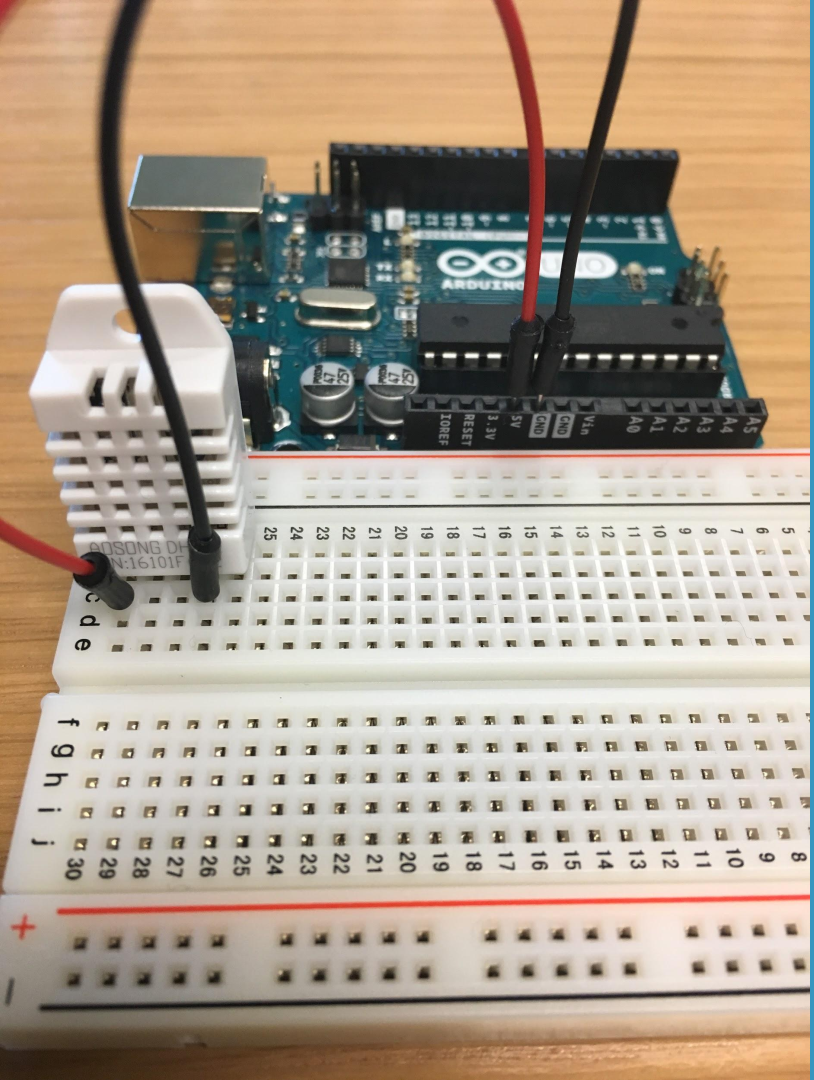
- ❏ Good for 0-100% humidity readings with 2-5% accuracy
- ❏ Good for -40 to 80°C temperature readings ±0.5°C accuracy
- ❏ No more than 0.5 Hz sampling rate (once every 2 seconds)



Jumper Wires

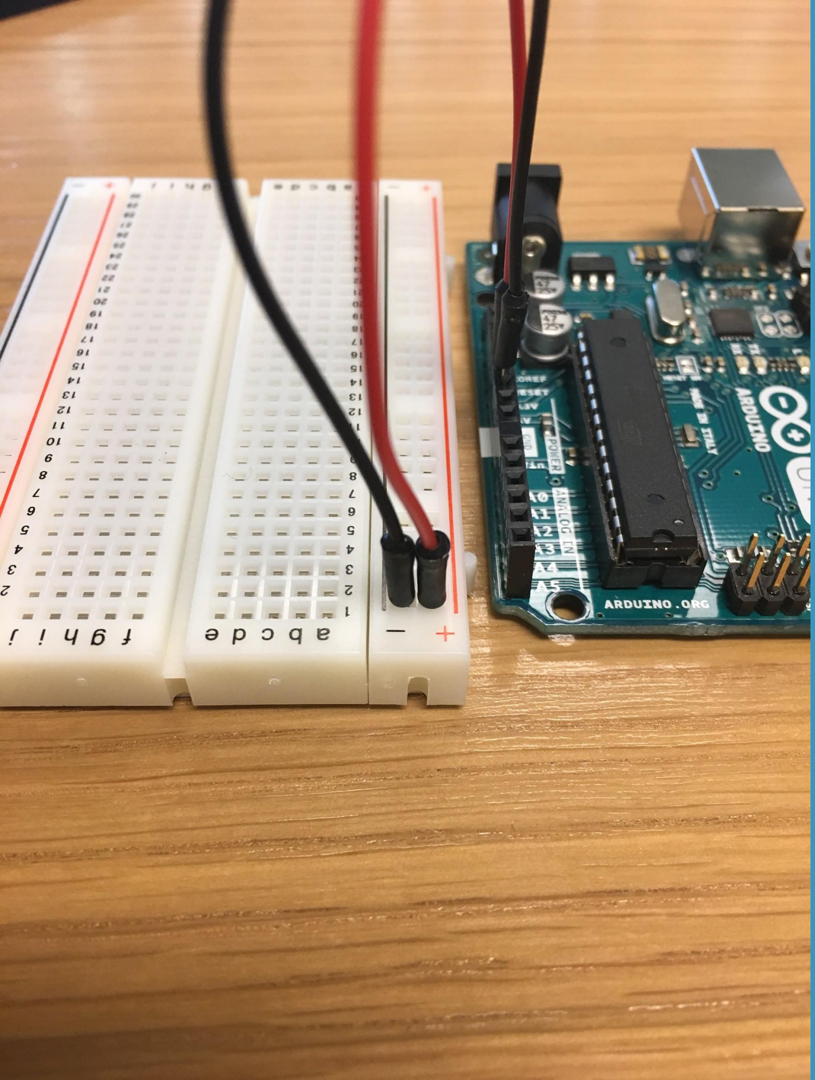
*Note: colors mean absolutely nothing; each wire does the same thing.

HARDWARE SETUP



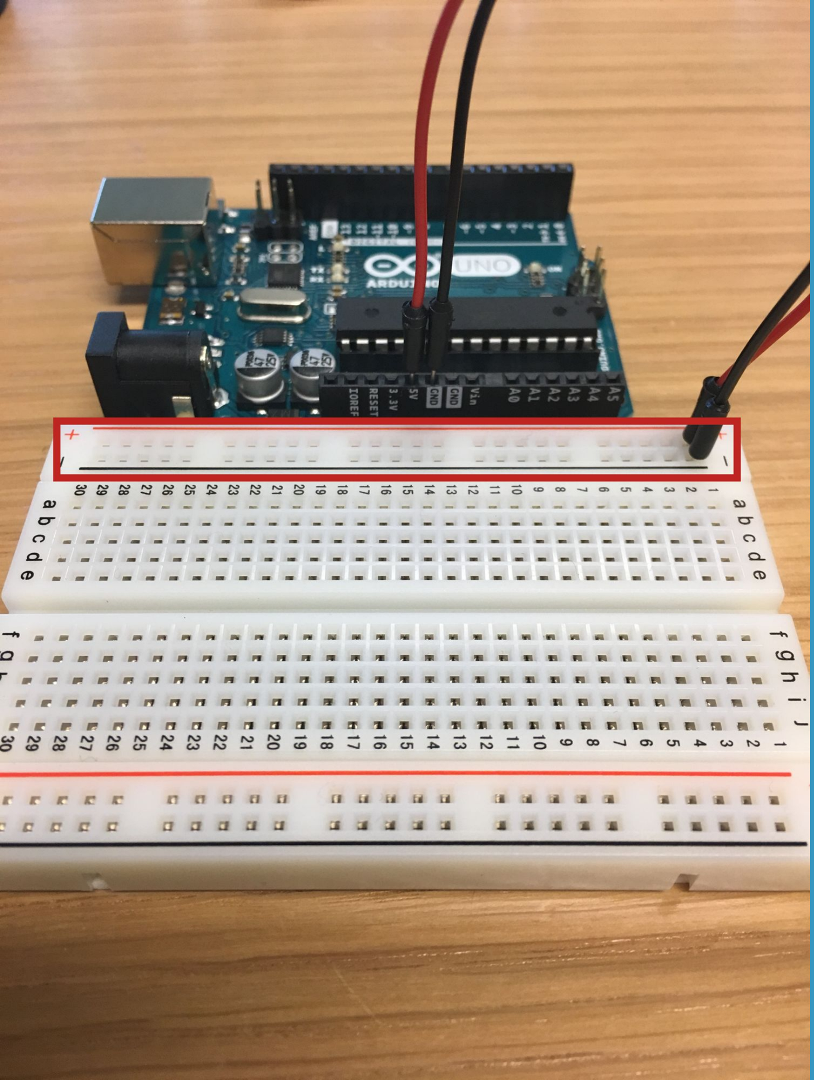
STEP ONE: POWER AND GROUND OUR CIRCUIT

<u>Option 1</u>



POWER AND GROUNDING OUR CIRCUIT

Option 2

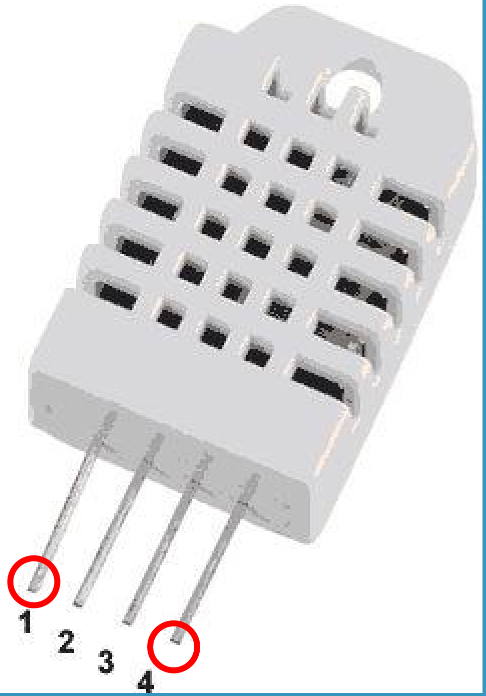


POWERING MULTIPLE INPUTS

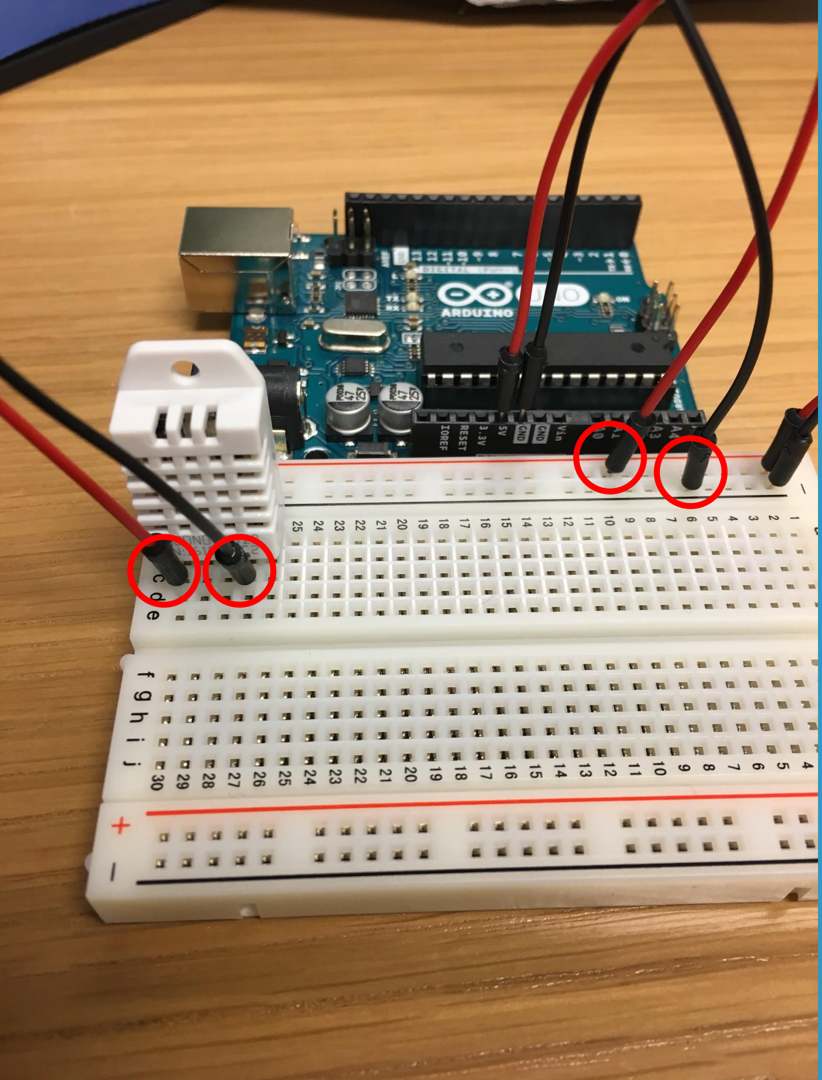
Makes every pin in the corresponding strip capable of powering or grounding our circuit.

SENSOR PINS

DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND



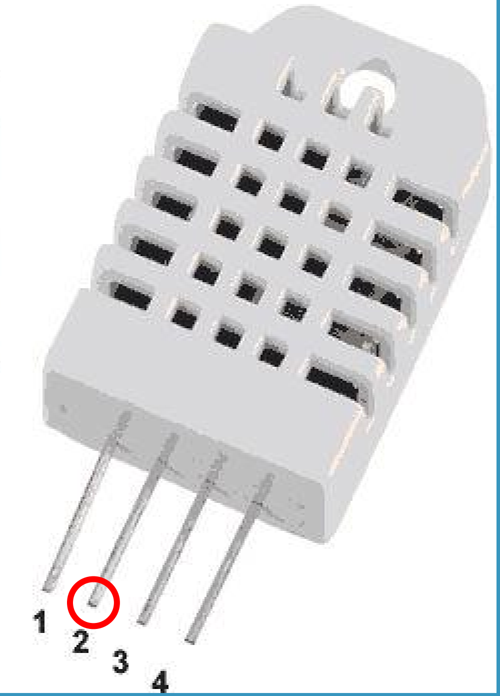
- “VCC” means “power”; we’ll use 5 volts to power this.
- Ignore pins 2 and 3 for now.
- “GND” means “ground”.



CONNECT "VCC" AND "GND" TO POWER & GROUND ON YOUR BREADBOARD

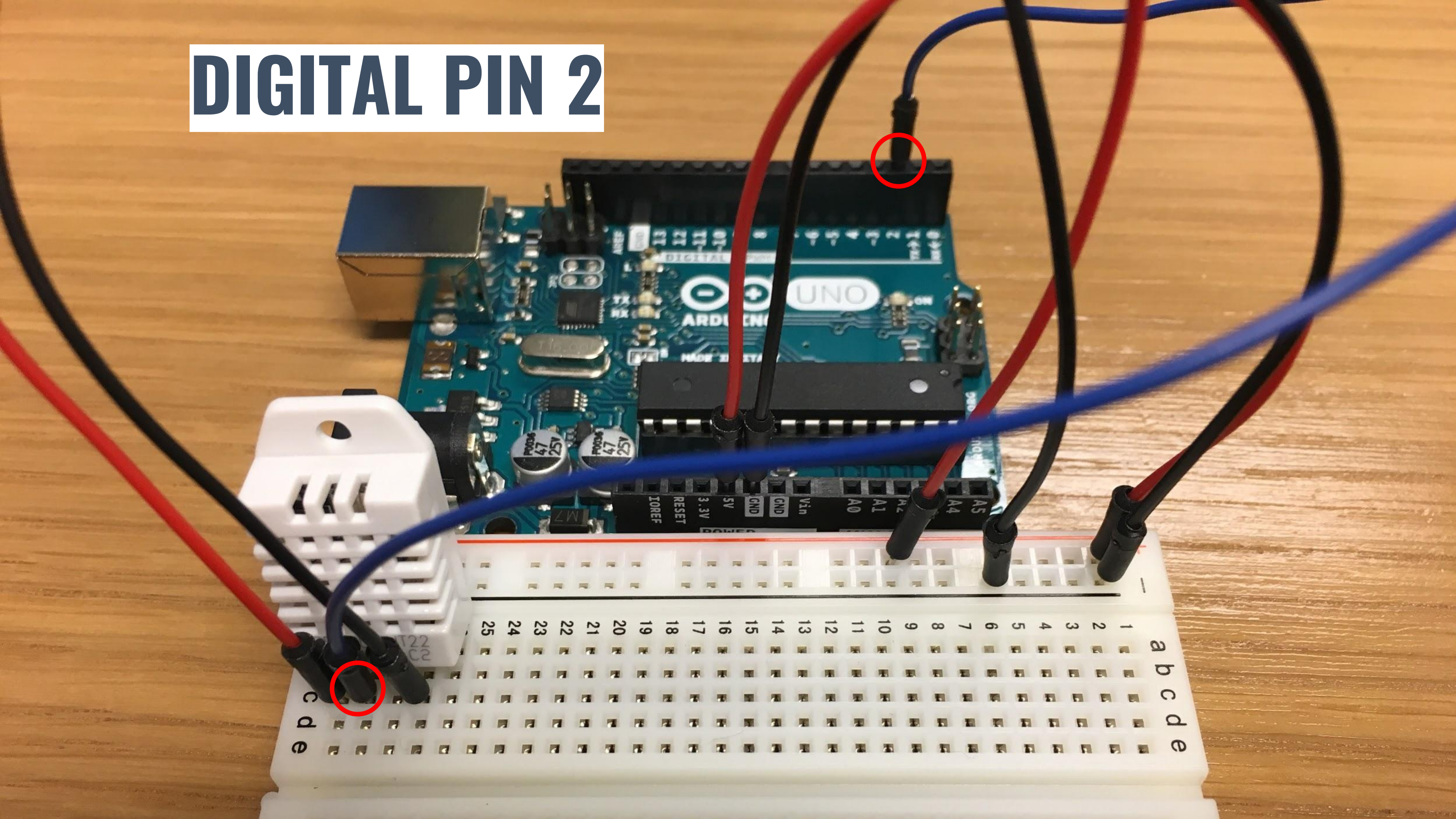
"Medium Pull Up" Resistor

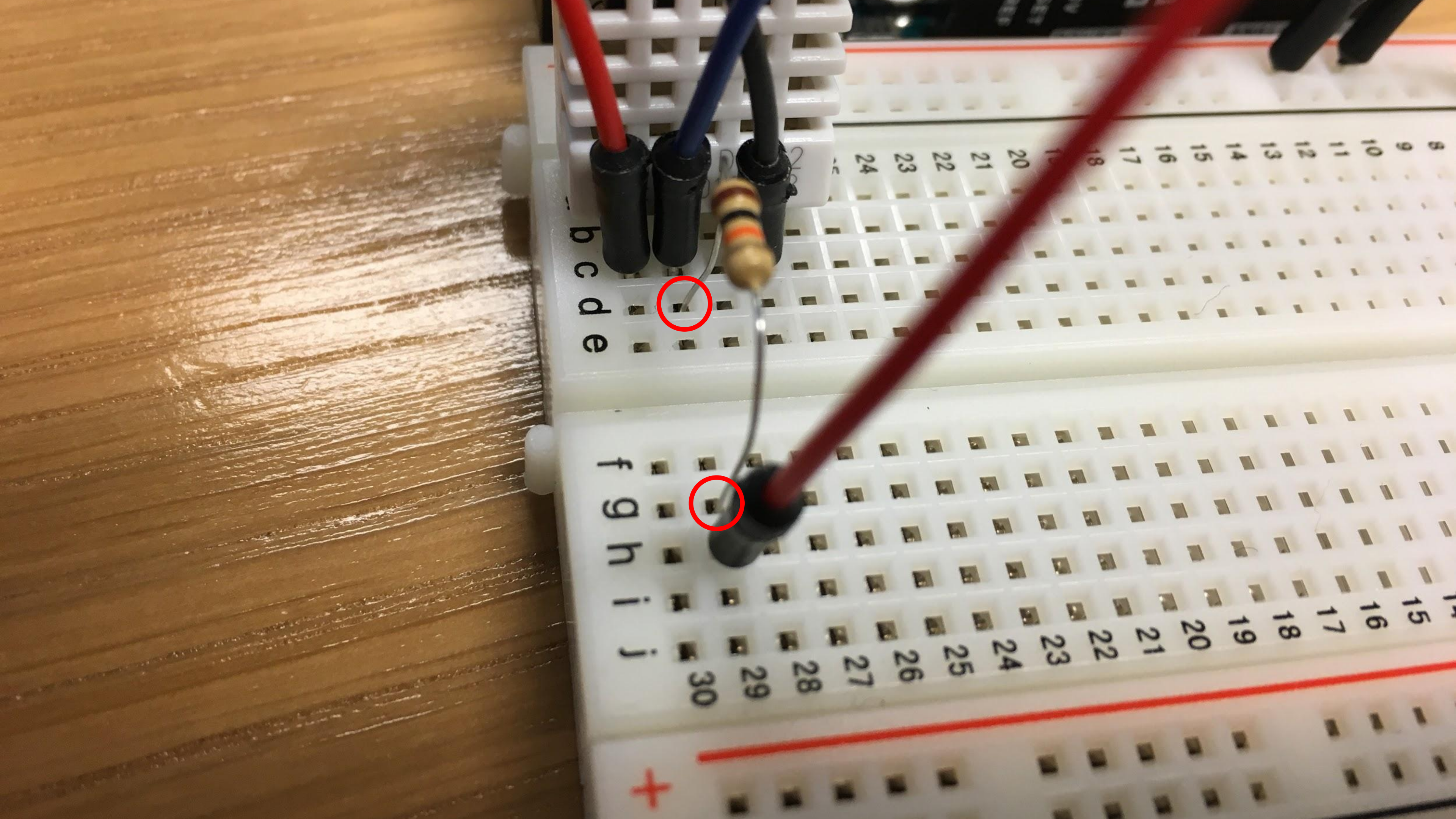
DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND



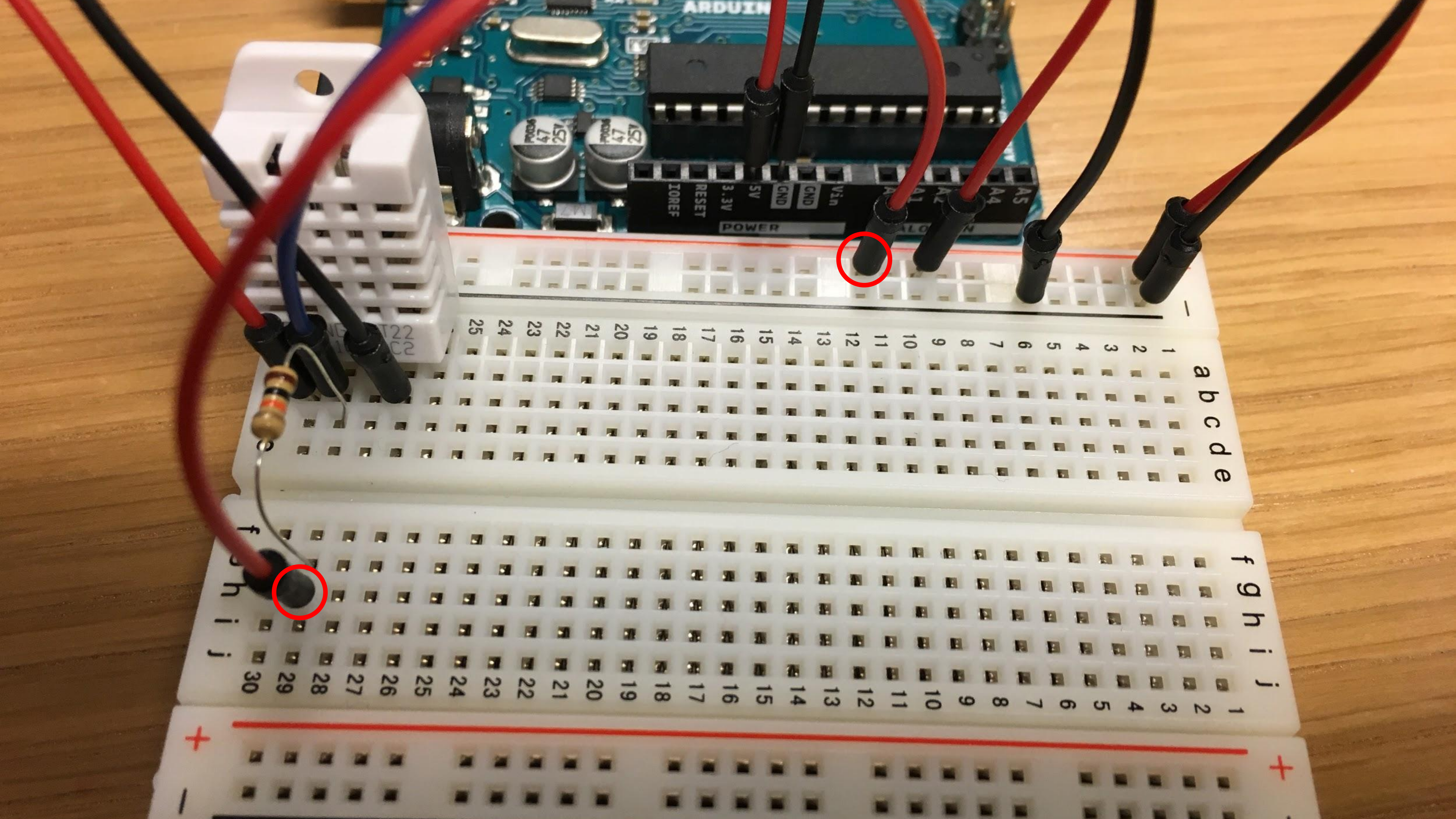
- Resistors literally "resist" the flow of electricity.
  - Normally directly connected between a "power" or "VCC" pin and the power on our Arduino.
- We have to prevent our "data" pin from "floating", which requires a resistor and additional power to get a proper recording.
- A sensor's "spec sheet" should tell you whether you need to worry about this.

DIGITAL PIN 2



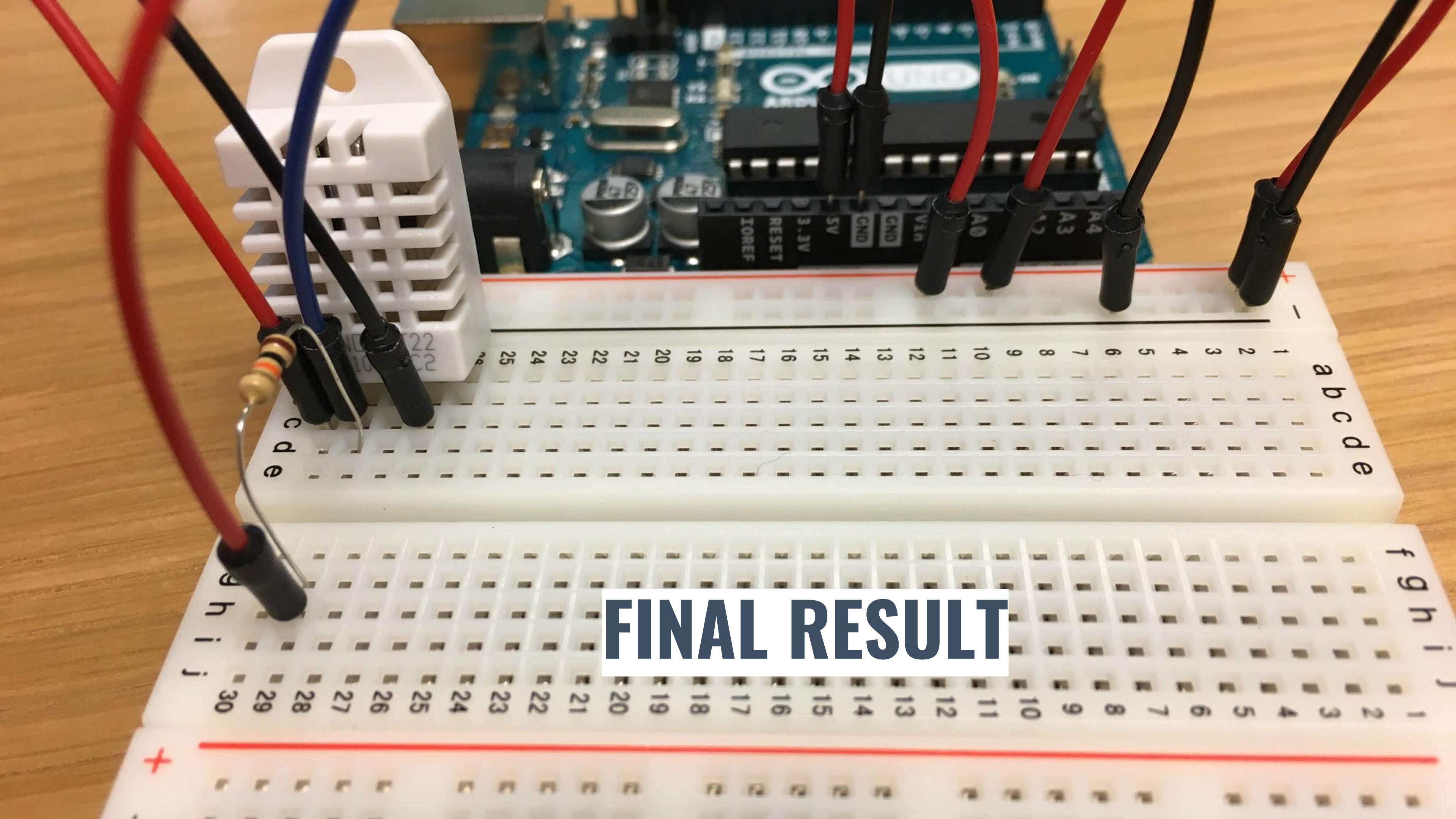


b c d e
f g h i j
24 23 22 21 20 18 17 16 15 14 13 12 11 10 9 8
30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15
+



IOREF
RESET
3.3V
5V
GND
GND
Vin
POWER
A4
A5

FINAL RESULT

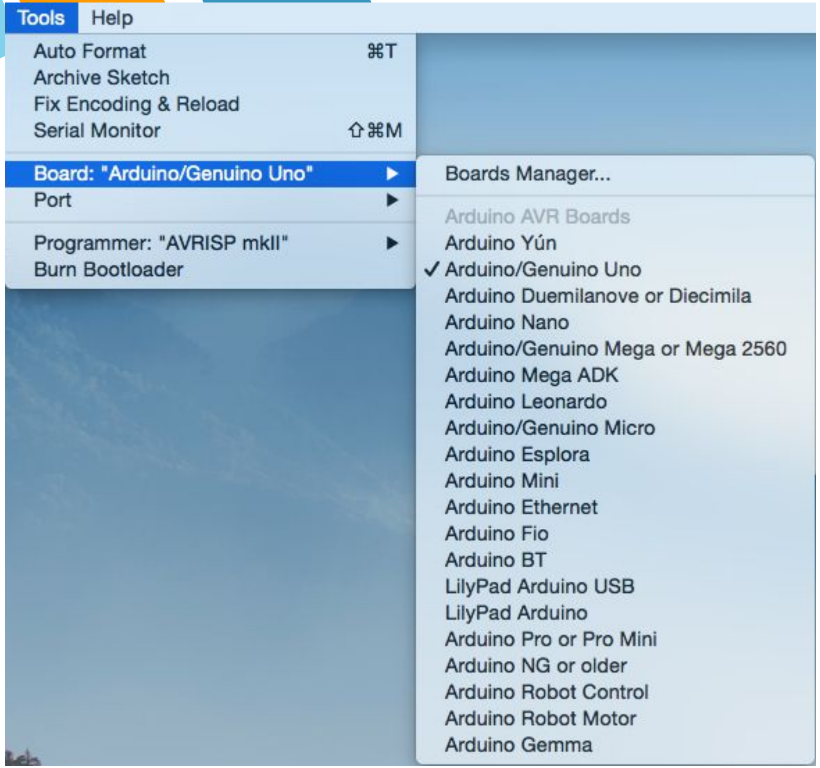


SOFTWARE SETUP

Arduino IDE:

bit.ly/1R2xniM

SETTINGS


Tools
Help
Auto Format ⌘T
Archive Sketch
Fix Encoding & Reload
Serial Monitor ⇧⌘M
Board: "Arduino/Genuino Uno"
Port
Programmer: "AVRISP mkII"
Burn Bootloader
Boards Manager...
Arduino AVR Boards
Arduino Yún
✓ Arduino/Genuino Uno
Arduino Duemilanove or Diecimila
Arduino Nano
Arduino/Genuino Mega or Mega 2560
Arduino Mega ADK
Arduino Leonardo
Arduino/Genuino Micro
Arduino Esplora
Arduino Mini
Arduino Ethernet
Arduino Fio
Arduino BT
LilyPad Arduino USB
LilyPad Arduino
Arduino Pro or Pro Mini
Arduino NG or older
Arduino Robot Control
Arduino Robot Motor
Arduino Gemma


Tools
Help
Auto Format ⌘T
Archive Sketch
Fix Encoding & Reload
Serial Monitor ⇧⌘M
Board: "Arduino/Genuino Uno"
Port: "/dev/cu.usbmodem1421 (Arduino/Genuino Uno)"
Programmer: "AVRISP mkII"
Burn Bootloader
Serial ports
/dev/cu.Bluetooth-Incoming-Port
/dev/cu.Bluetooth-Modem
✓ /dev/cu.usbmodem1421 (Arduino/Genuino Uno)

CODE

bit.ly/DHT22Code

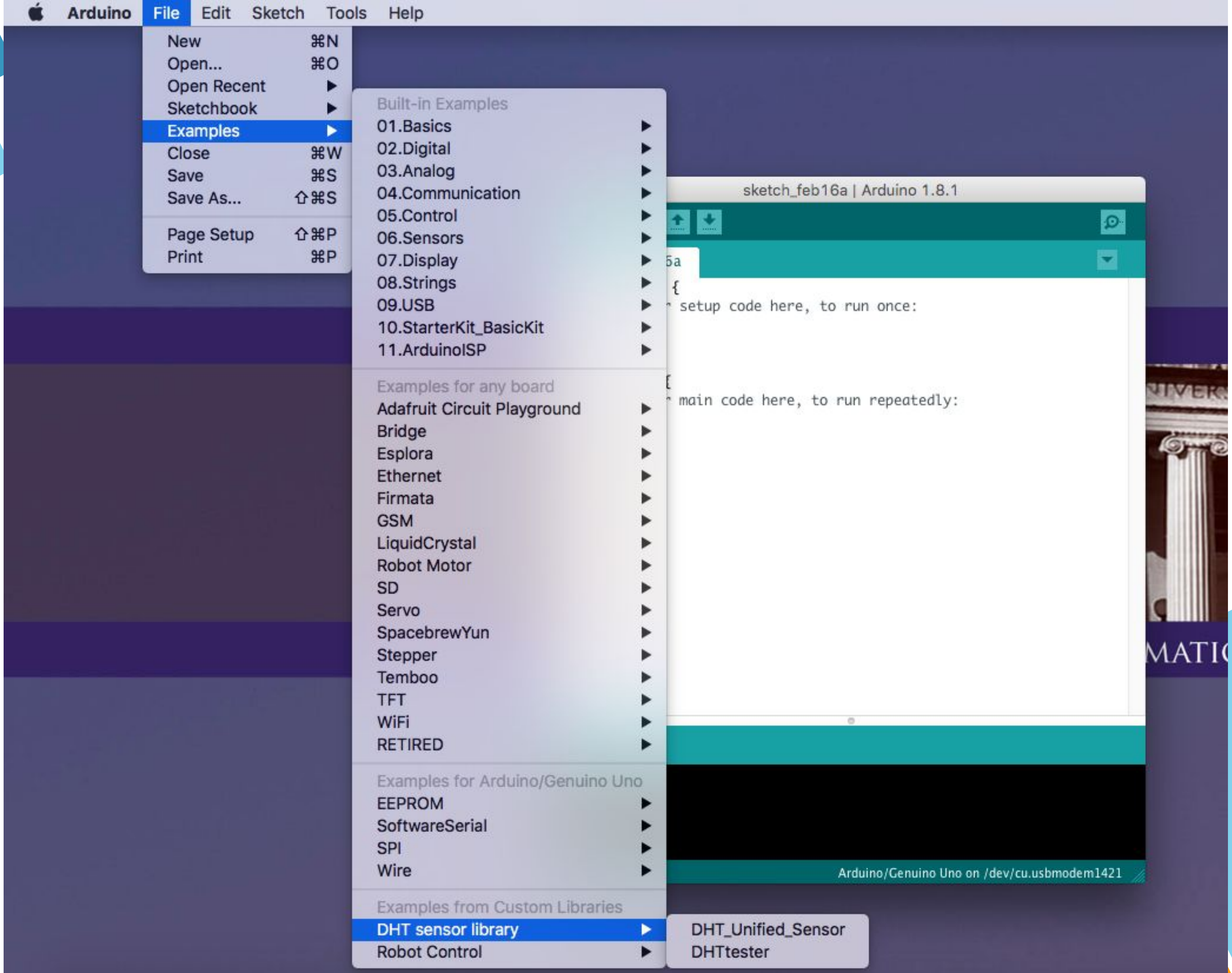
Place entire folder in the following path:

“Documents” → “Arduino” → “libraries”

RUNNING SAMPLE CODE

In the Arduino IDE:

“File” → “Examples” → “DHT Library” → “DHTtester”


Arduino File Edit Sketch Tools Help
New ⌘N
Open... ⌘O
Open Recent
Sketchbook
Examples
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Page Setup ⇧⌘P
Print ⌘P
Built-in Examples
01.Basics
02.Digital
03.Analog
04.Communication
05.Control
06.Sensors
07.Display
08.Strings
09.USB
10.StarterKit_BasicKit
11.ArduinoISP
Examples for any board
Adafruit Circuit Playground
Bridge
Esplora
Ethernet
Firmata
GSM
LiquidCrystal
Robot Motor
SD
Servo
SpacebrewYun
Stepper
Temboo
TFT
WiFi
RETIRED
Examples for Arduino/Genuino Uno
EEPROM
SoftwareSerial
SPI
Wire
Examples from Custom Libraries
DHT sensor library
Robot Control
DHT_Unified_Sensor
DHTtester
sketch_feb16a | Arduino 1.8.1
setup code here, to run once:
main code here, to run repeatedly:
Arduino/Genuino Uno on /dev/cu.usbmodem1421

USEFUL SENSORS

adafruit.com

sparkfun.com

ESSAY RESOURCES

Jim Crocamo

Operations and Undergraduate Coordinator, Science and Engineering Libraries

jc2120@columbia.edu

Amanda Bielskas

Head of Collection Development for Science and Engineering Libraries

asb2154@columbia.edu