Wiring a button and LED

And connecting to Adafruit IO

IOT Oct 31, 2023

Our data transmission is slow!!!

- Our cloud computers on **Adafruit IO** limit our data to 60 per minute
- We are only going to transmit small packets of information

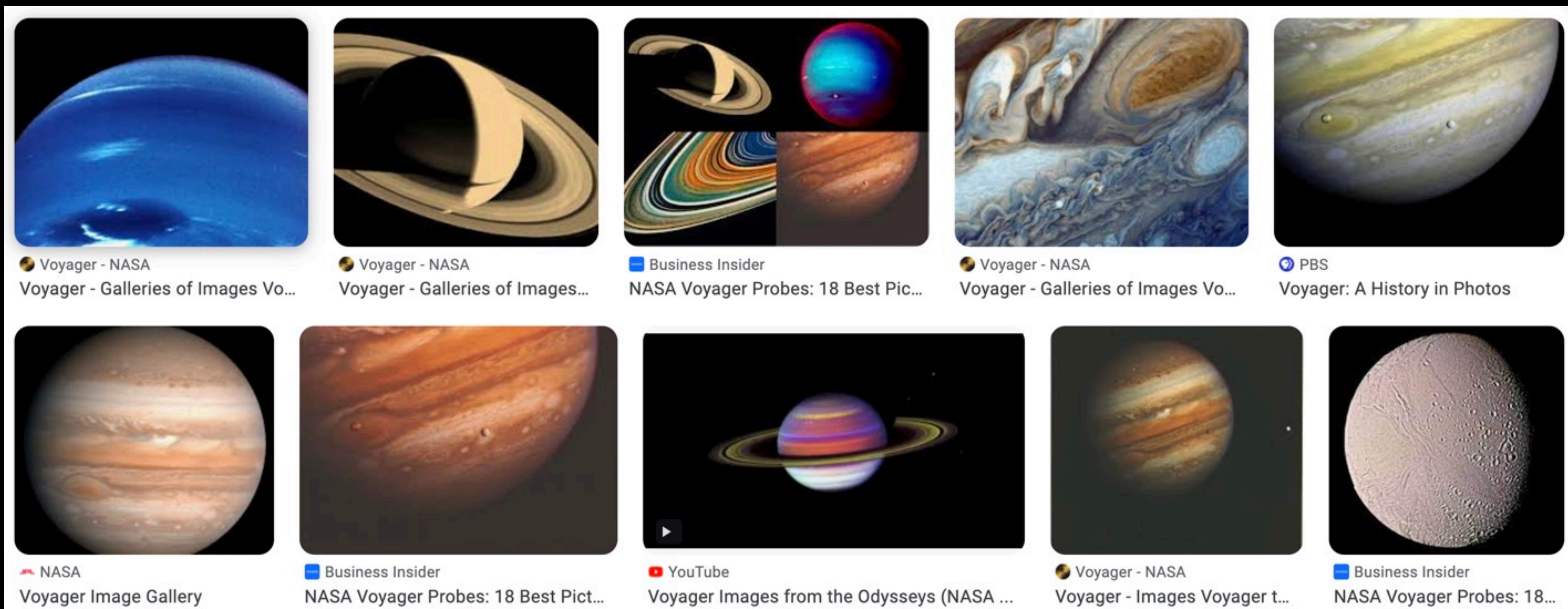
Nano 1 State


```
"time": 01:27:03
"date": 2023-10-31
"buttonpresses": 7
"now": 1577838715
"wifiConnected": True
"buttonstate": False
"rgbled": 0
```

Voyager 1 and 2 (NASA) 1977

Voyager 1 and 2 (NASA) 1977

Primary mission: Collect data including pictures



Just Google It!

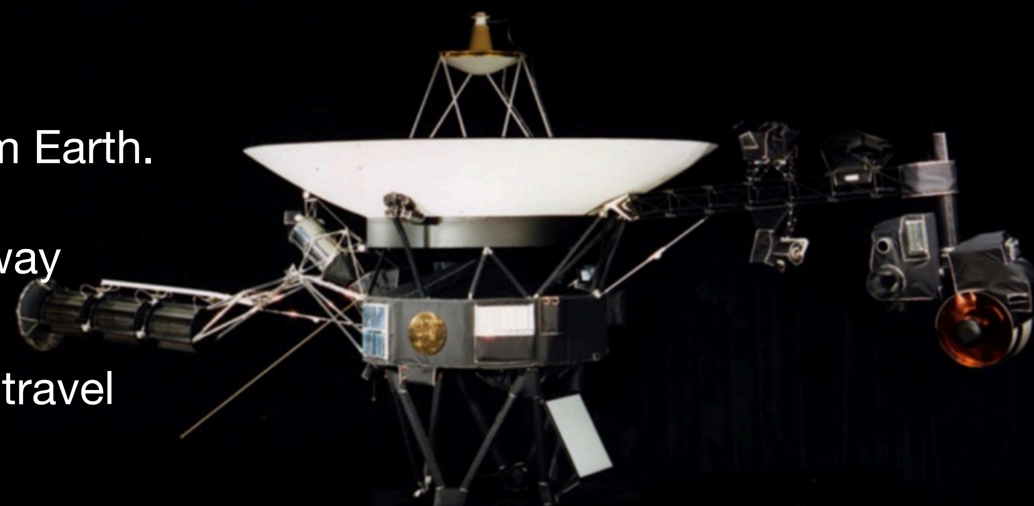
Voyager 1 and 2 (NASA) 1977

Voyager 1 is currently **15 billion miles** from Earth.

This mornng was 15,079,868,948 miles away

It takes light >20 hours and 33 minutes to travel that distance

That means it takes roughly **two days to send a message to Voyager 1 and get a response**



A 45 year old IOT
Very far away
Lots of thing collecting data
Transmitting data back to earth

https://voyager.jpl.nasa.gov/mission/status/

Voyager 1 and 2 (NASA) 1977

Very slow computers and data transmission

The computers aboard the Voyager probes each have 69.63 kilobytes of memory, total. That's about enough to store **one average internet jpeg image file**.

~3,000,000 times less memory than your phone

The probes' scientific data is encoded on old-fashioned digital **8-track tapes** rather than whatever solid state drive your laptop or phone is currently using.

Transmits data at 160 bits per second, 38,000 times slower than a 5G connection

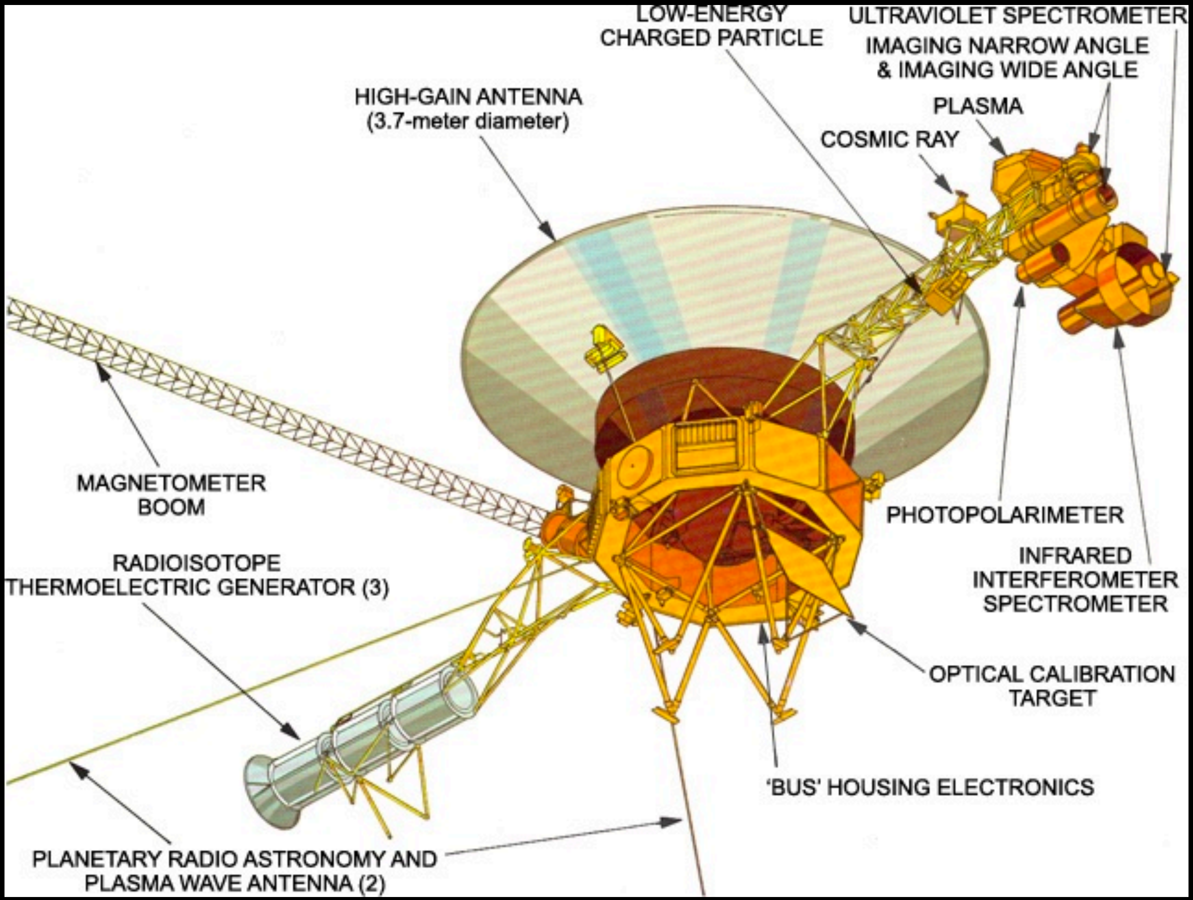
The Voyager computers can execute about 81,000 instructions per second. A modern graphic card can compute at 10 Tera-flops, 10 Trillion per second. That is 123,456,790 times faster than Voyager

The Voyager probes are always sending out a signal. Voyager 1 has a 22.4-Watt transmitter – something equivalent to a **refrigerator light bulb** – but by the time its beacon reaches us, the power has been reduced to roughly 0.1 billion-billionth of a Watt. NASA has to use its largest antenna, a 70-meter dish, or combine two 34-meter antennas, just to hear Voyager.

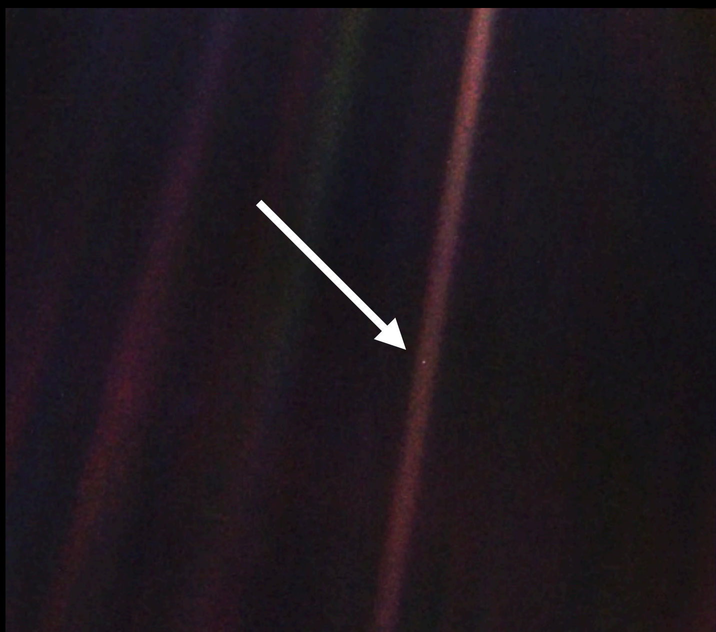
https://voyager.jpl.nasa.gov/mission/status/

Voyager 1 and 2 (NASA) 1977

PACKED WITH
LOTS OF
THINGS

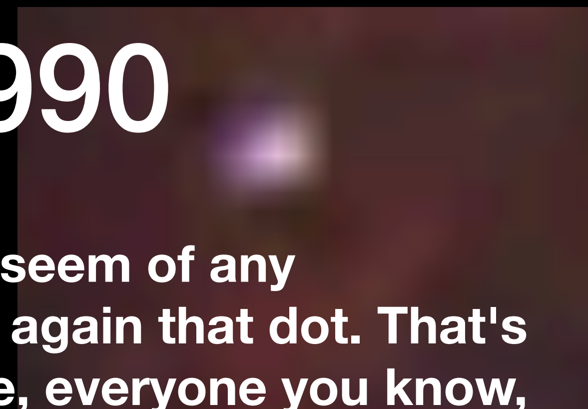


The “Pale Blue Dot” 1990



Before turning off the cameras to save power, Voyager
turned toward the earth to take this photo

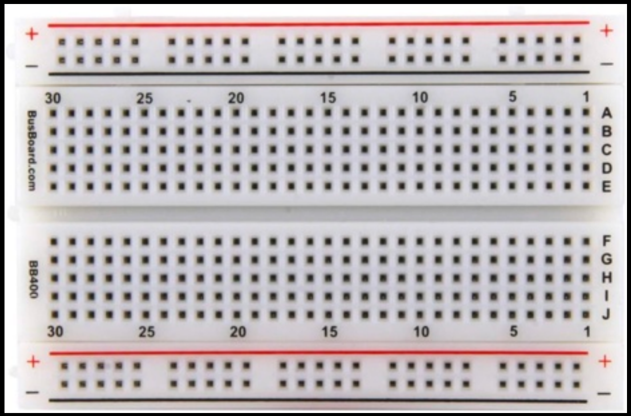
The “Pale Blue Dot” 1990

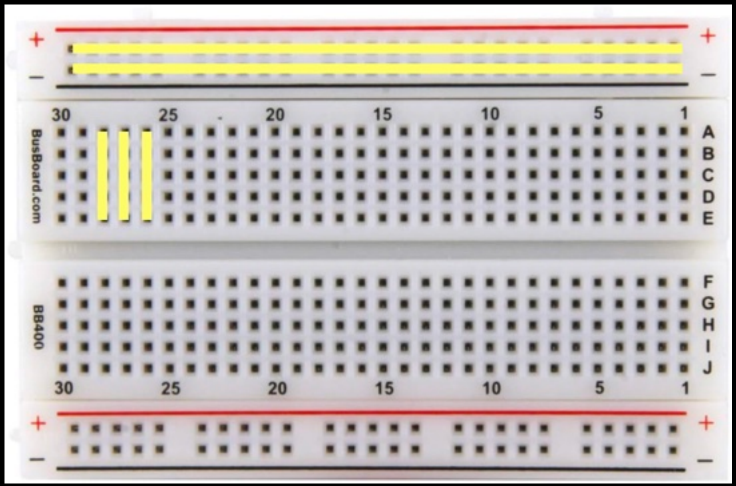


From this distant vantage point, the Earth might not seem of any particular interest. But for us, it's different. Consider again that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there – **on a mote of dust suspended in a sunbeam.**

- Carl Sagan

Breadboard basics





A breadboard is what we use to wire all our things together including the Arduino.

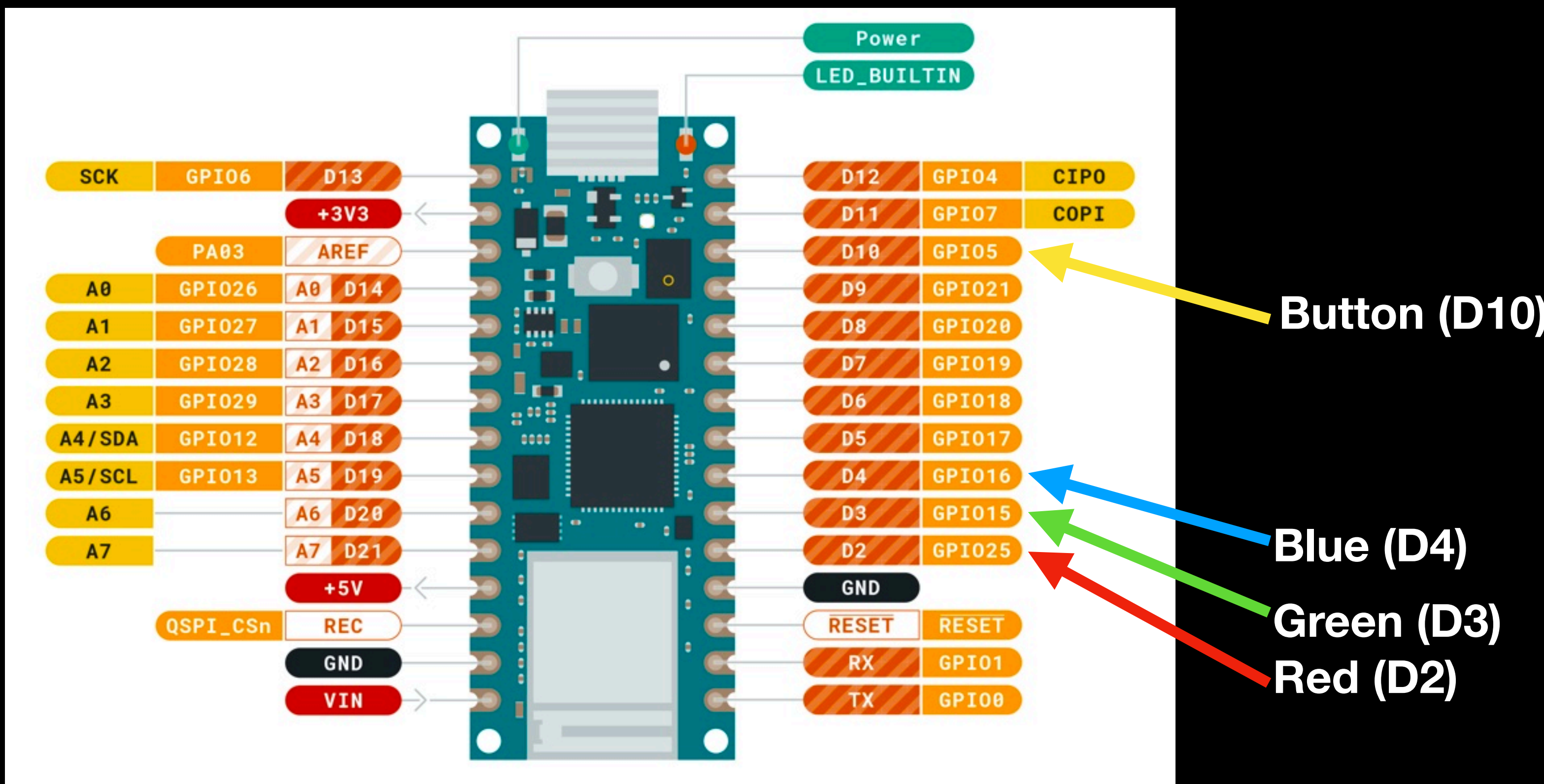
We have marked the pin holes that are electrically connected (yellow).

The top row is all connected together. We use this for voltage to power our things. Notice the red '+'.

The second row is all connected together. We use this for ground of each of our things. Notice the blue '-'. Remember: All things need to be connected to ground!

Each vertical row is connected together (with a break in the middle).

Arduino Nano rp2040 connect



My code on the Arduino specifies these pins

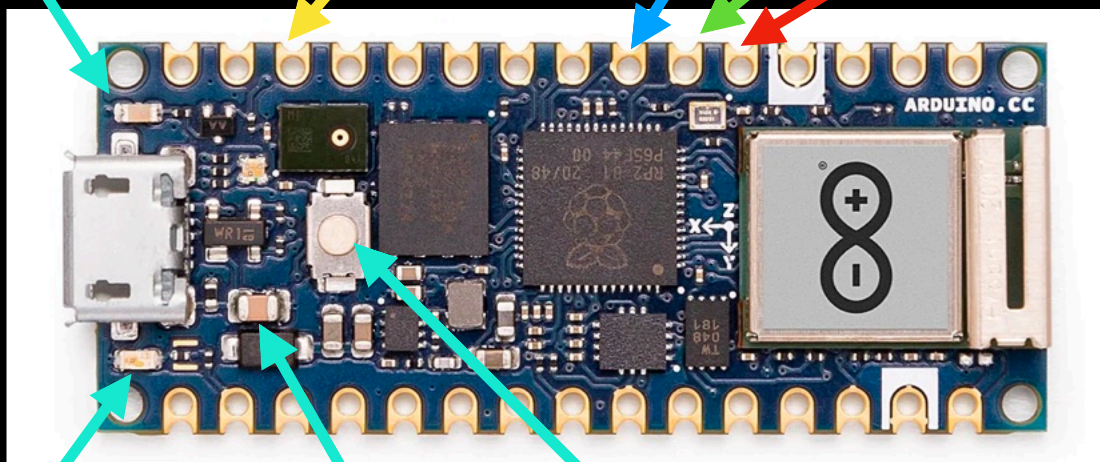
Button (D10)

Red LED
On while connecting to wifi

Blue (D4)

Green (D3)

Red (D2)



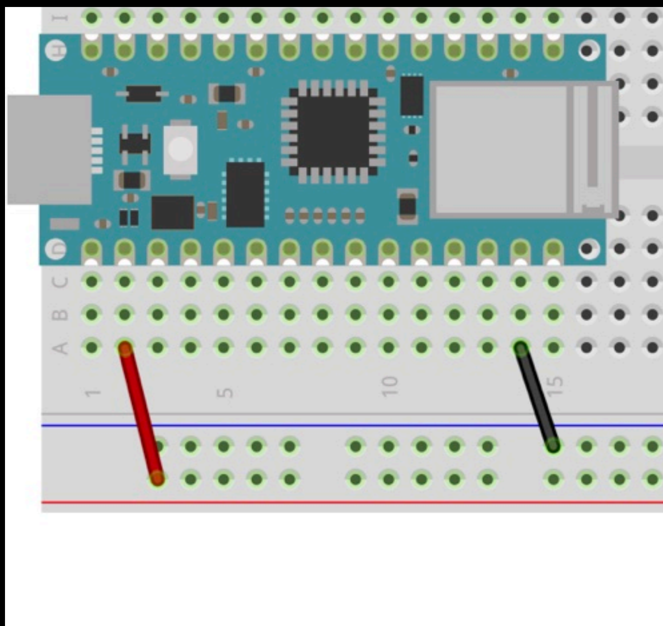
<u>Also included are built in:</u>
Gyroscope
Accelerometer
Microphone

Next class!

Reset button in case there is mission failure

Power LED (Green)

Built in RGB LED
Green when connected to Wifi



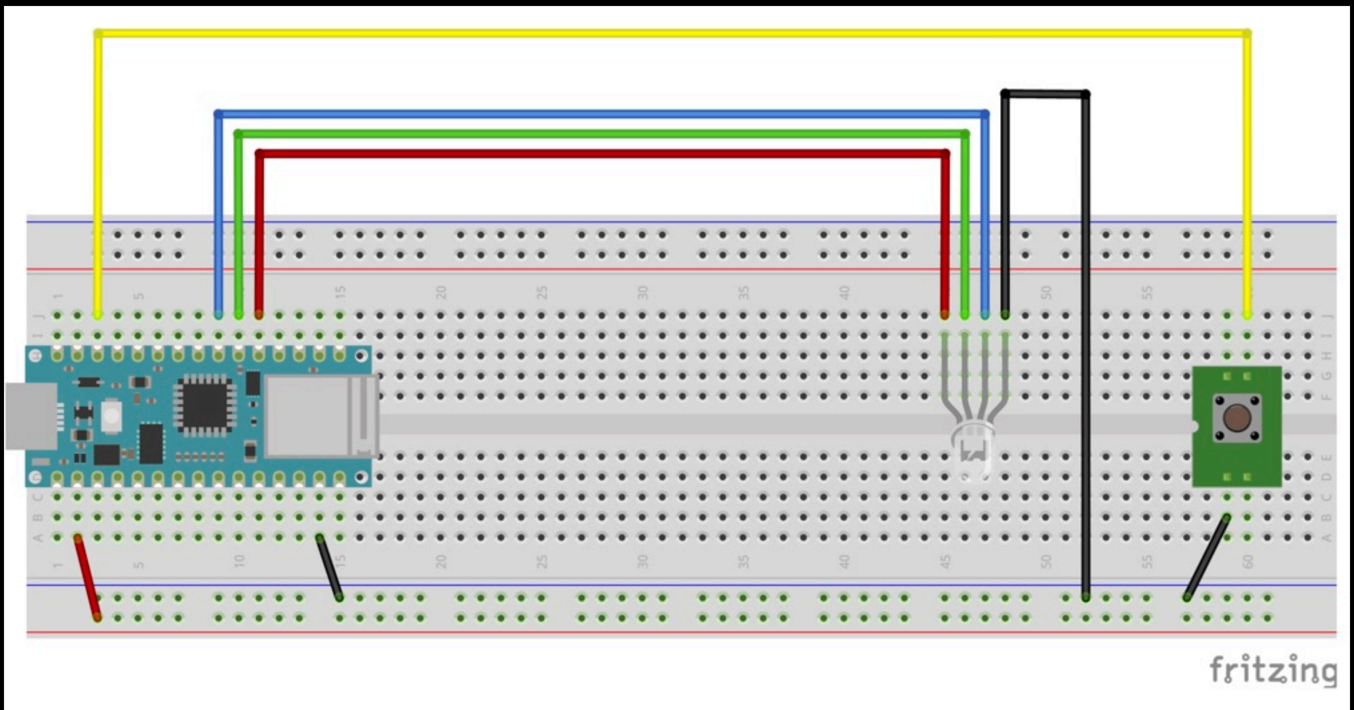
We will start with the arduino inserted into the breadboard.

Note, the top pins are electrically isolated (not connected) to the bottom row of pins

I have connected power (red) to the bottom row

I have also connected ground (black) to the next row

I have written code that is loaded on the Arduino
1) On power up will eventually connect to wifi (on my phone) and RGB led will turn green.
2) Once you wire the button, pressing it will trasmit the data to the Adafruit IO cloud



Wiring a button

The button has four legs. When the button is pushed, it connects diagonal legs.

Connect one leg to ground.

Connect a diagonal leg to the Arduino Pin D10.

Remember: All your wires are the same. They are just different colors to tell them apart.

It is important what they are connected to!

Connecting to Adafruit IO

Each of your Arduino's has a "Thing ID"

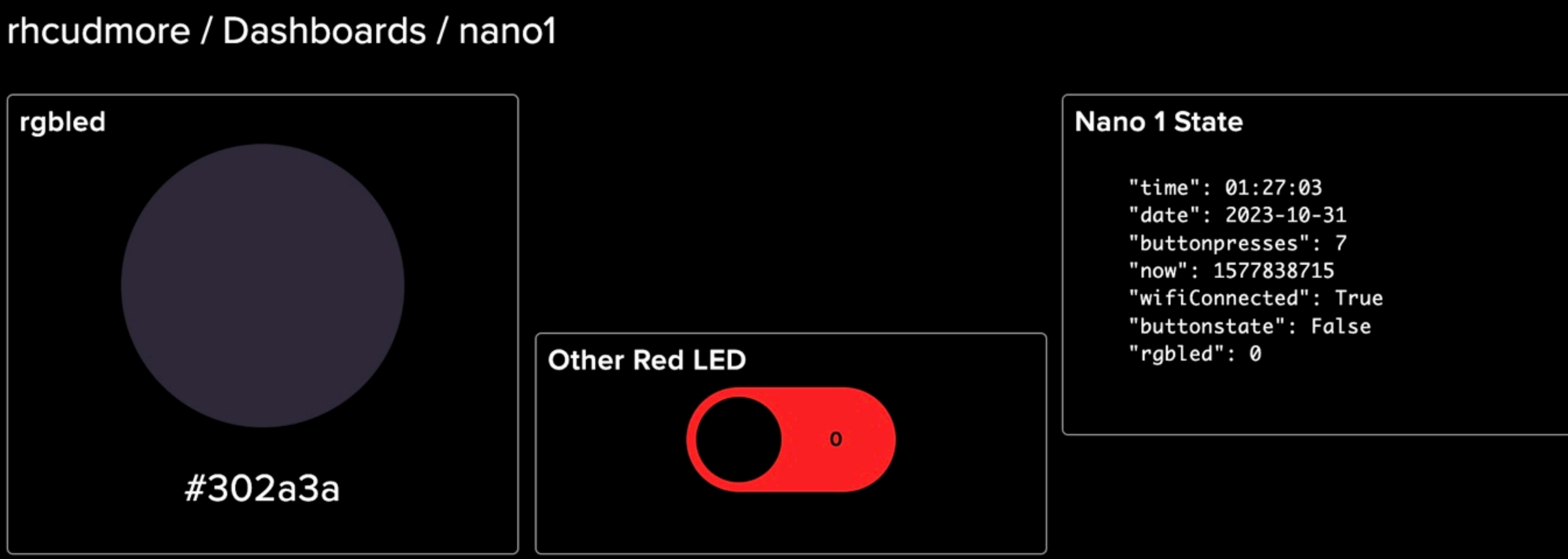
You can access each dashboard on the web

1) https://io.adafruit.com/rhcudmore/dashboards/nano1

2) https://io.adafruit.com/rhcudmore/dashboards/nano2

3) https://io.adafruit.com/cudmore/dashboards/nano3

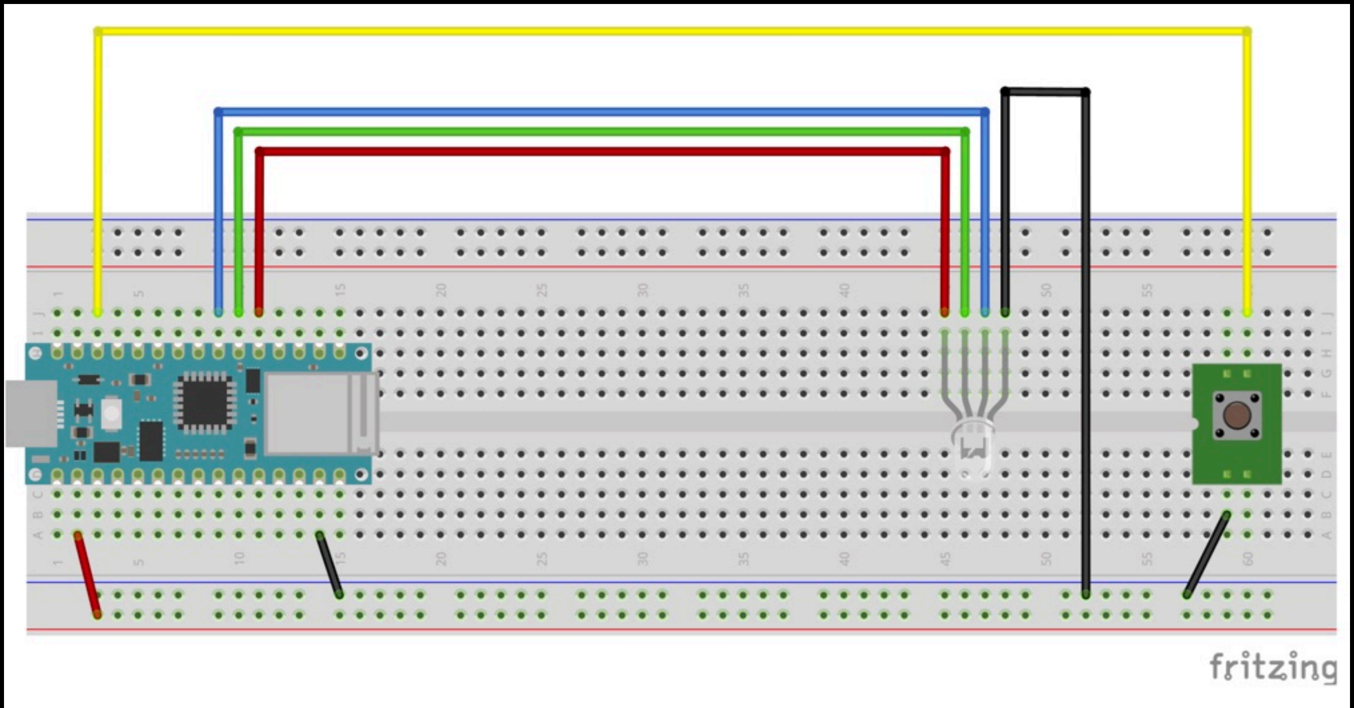
4) https://io.adafruit.com/cudmore/dashboards/nano4



Hold down the button and eventually, the switch in the middle will turn on

You can get feedback in the "Nano State", look for changes in "buttonState"

You can also see the time update if your Arduino is connected (and its onboard RGB led is green)



Wiring a RGB LED

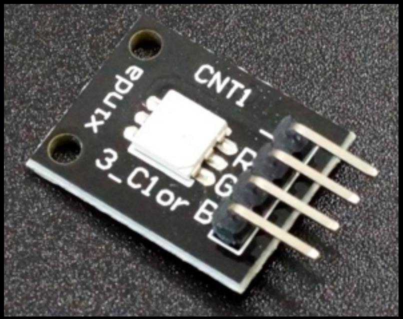
The RGB LED has four pins corresponding to:

Ground (-)
Red (R) to D2
Green (G) to D3
Blue (B) to D4

Why red, green, and blue? The RGB color model is an additive color model where different levels of red, green, and blue can create any color in the visible spectrum. This is used for displaying colors on a screen like you phone.

If each of R/G/B have equal amount the produced light is white. If all are off, there is no light.

There is another color space that specifies cyan/magenta/yellow and is used for printing a document. There are also the three primary colors for painting which are red, blue, yellow.



Once the RGB LED is wired

1) Holding your button will change its color

2) The color will be updated on Adafruit IO

3) I can then control your RGB LED thing from my dashboard

Things communicating with things

- Arduino 1 is connected to Arduino 2 through the internet
- Hold the button on Arduino 1 and see the red LED light up on Arduino 2
- Try the same for Arduino 2 to light the red LED on Arduino 1

1 -> 2

2 -> 1

- Arduino 3 is connected to Arduino 4 through the internet
- Hold the button on Arduino 3 and see the red LED light up on Arduino 4
- Try the same for Arduino 4 to light the red LED on Arduino 3

- 3 -> 4
- 4 -> 3

Thur Nov 2, 2023 - Building Day 2

Thur Nov 2, 2023 - Building Day 2

<u>Our code is now reporting</u>

- MAC address
- Wifi Hotspot
- IP
- Time is still wrong!

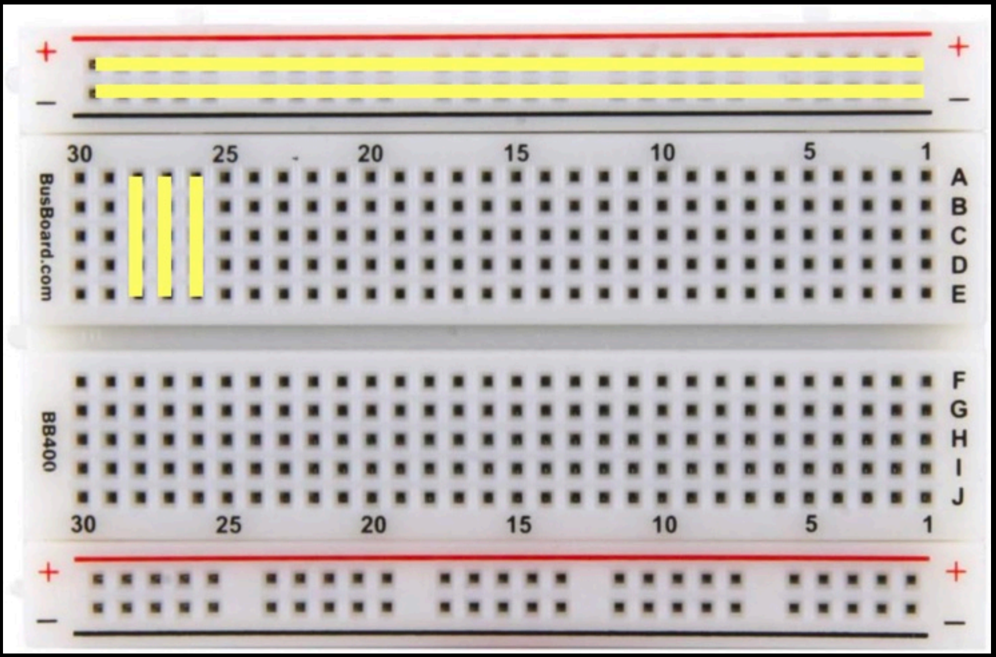
- Acceleration (still working on it)
  left/right, front/back, up/down
  “Meters per second square” (m/s^2)
  When not moving, acceleration is ~0
  Why is up/down always ~9.8


```
"MAC Address": 7c:02:a4:51:91:40
"wifiConnected": True
"wifihotspot": NETGEAR49
"IP": 192.168.1.37
"date": 2023-11-02
"time": 16:15:33
"rgbled": 0
"buttonstate": False
"buttonpresses": 0
"gyro": (0.00717767, -0.00992656, -0.00427606)
"acceleration": (0.124427, -0.124427, 9.8345)
"earthquakemagnitude": 0.248854
"potentiometer": 13763
```

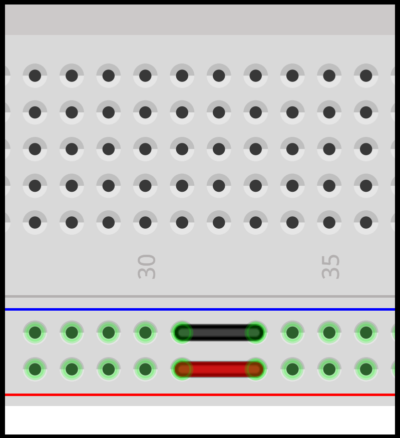

Gravity is measured as how fast objects accelerate towards each other. The average gravitational pull of the Earth is 9.8 meters per second squared (m/s2).

Thur Nov 2, 2023 - Building Day 2

Visualize connections on a breadboard with Fritzing

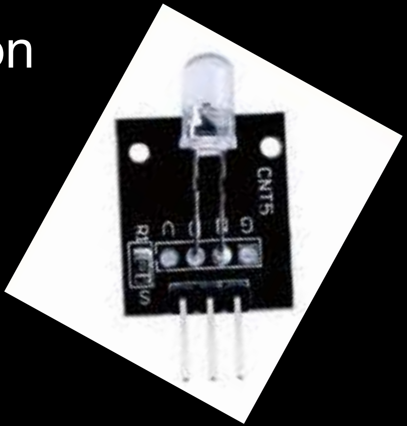


On longer breadboard, need to connect
- **left/right power**
- **left/right ground**

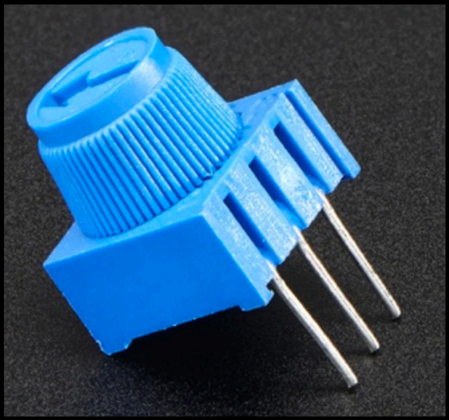


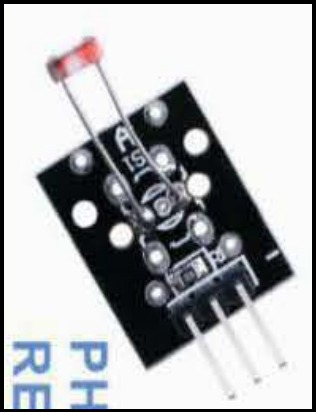
Thur Nov 2, 2023 - Building Day 2

- Add in a flash led to respond to our button

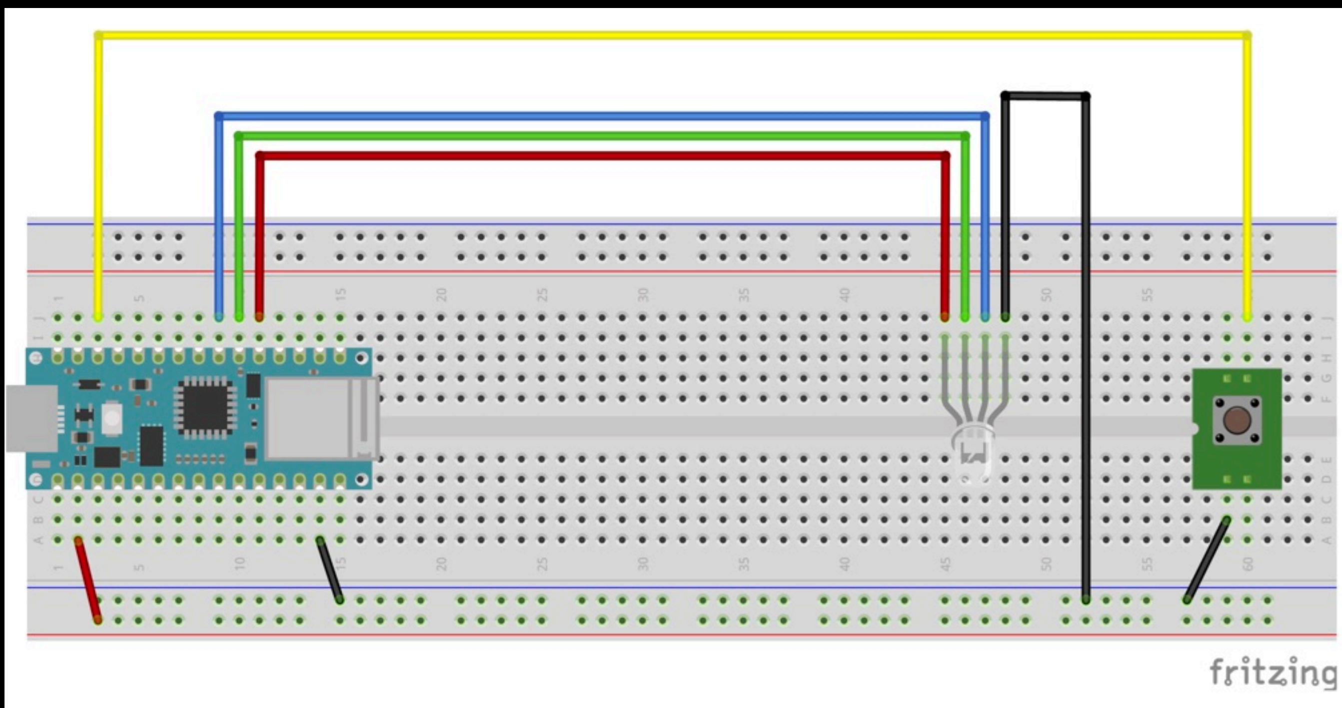


- Add in a potentiometer and/or a photoresistor





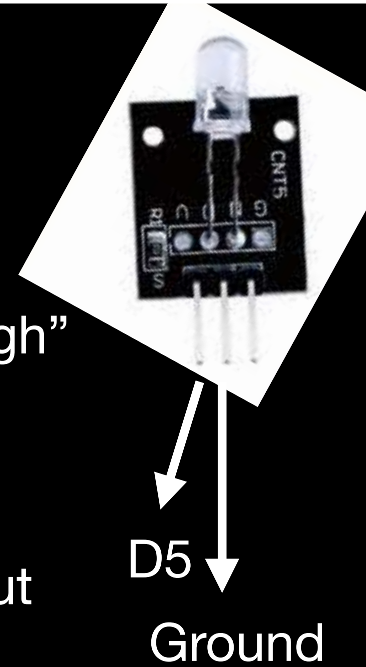
Button Review

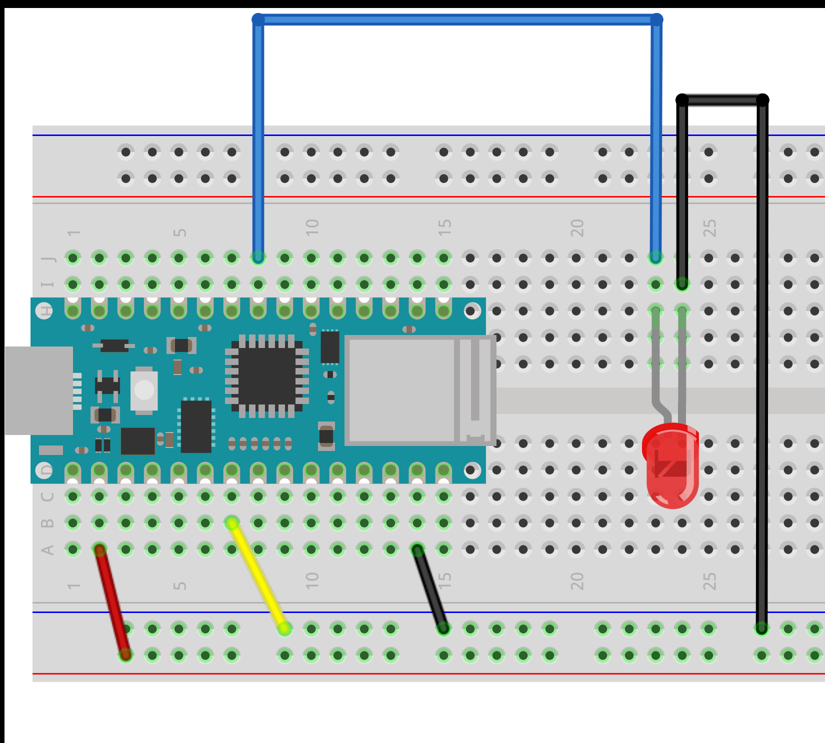


<u>Two wires</u>

One leg goes to ground
Diagonal leg goes to D10

7 Color Flash





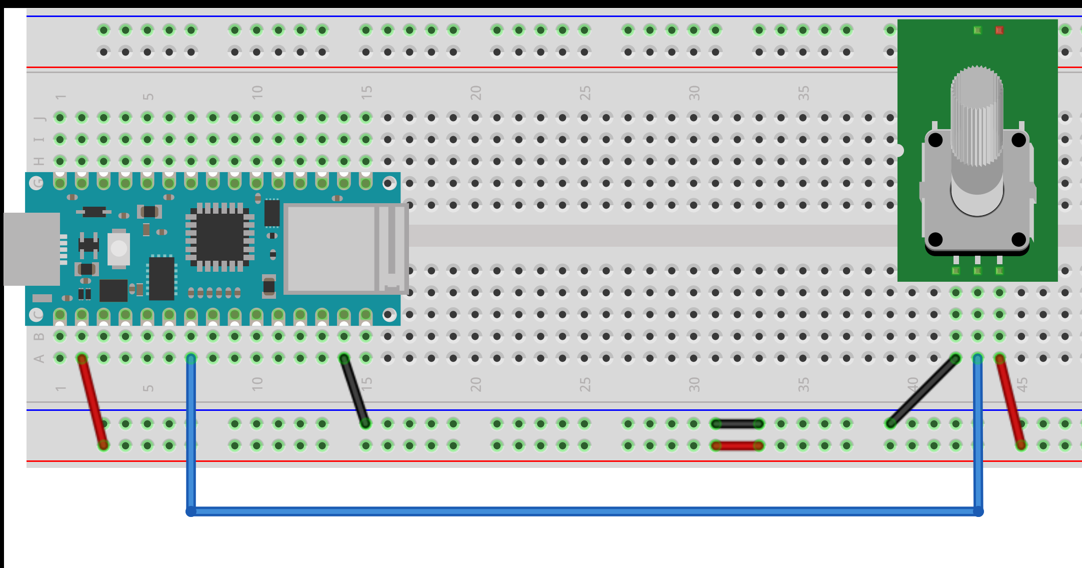
Cycle colors when digital pin is “high”
Our code connects this to our
Button

This is not connected to internet but designed to give local feedback

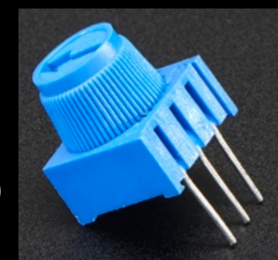
<u>Wiring has three wires</u>
- left: board DIO output (D5)
- middle: ground
- right: empty

Important: need to “short” Arduino pin A3 to ground

Potentiometer and Photo-Resistor



1) Potentiometer (volume)



<u>3 Wires</u>
Left pin to ground
Middle pin to A3 (analog input)
Right pin to power

If the potentiometer is backwards then just swap
Left pin to power
Right pin to ground

Once wired, 7-color-flash will light up when value goes above a threshold.

Potentiometer and Photo-resistor are both examples of variable resistors, they report the level by the amount of resistance, from low to high.

2) Photo-resistor (light levels)

<u>3 Wires</u>
Left pin to A3
Middle pin to ground
Right pin to power

Edge computing

- We can only transmit 30 numbers per second
- How does that effect

  Code for the button?

  Code for the potentiometer or photo-resistor

  Code for the gyroscope?

Basically, our code monitors the state, and only transmits when there is a change.

  Like when the button transitions from “off” to “on”.

  Or when there is a big change in potentiometer or light-levels

  Same for accelerometer

Over the Air (OTA) code updates

- Update the code on thing from a remote location. Also called OTA prgramming.
- Allows a potentially large network of “things” to be remotely updated (like a Lime Scooter). In comparison to having to physically plug in to the thing to update it
- Line does this over cellular networks.
- In our case would be over wifi
- **Bottom line**: Our Arduino’s don’t have this capability (yet). Because they are open source, somebody will eventually implement it!
- Thus, gets really **repetitive** (and **error prone**) having to copy/paste the code onto each Arduino.

Next Week

Coding basics

Examples of how I coded some of these things.

Why a lot of simple things need some logic or “edge computing”

3-4 people to bring in a laptop with “Visual Studio Code” app installed and configured. Instructions will be on Canvas (simple).