Rev4: 23-Dec-2023

# *LED Strips for Everyone Everywhere*


## Mitch Altman

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Inventor of **TV-B-Gone** universal remote controls
Co-founder of **3Ware** (successful Silicon Valley startup)
Pioneer of **VR** (in the mid-1980s)
Founding mentor at **HAX** (1st and biggest hardware accelerator)
Co-founder of **Noisebridge** (San Francisco hackerspace)

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flickr: **maltman23**
WeChat: **mitchaltman**


CORNFIELD ELECTRONICS

# *LED Strips for Everyone Everywhere*

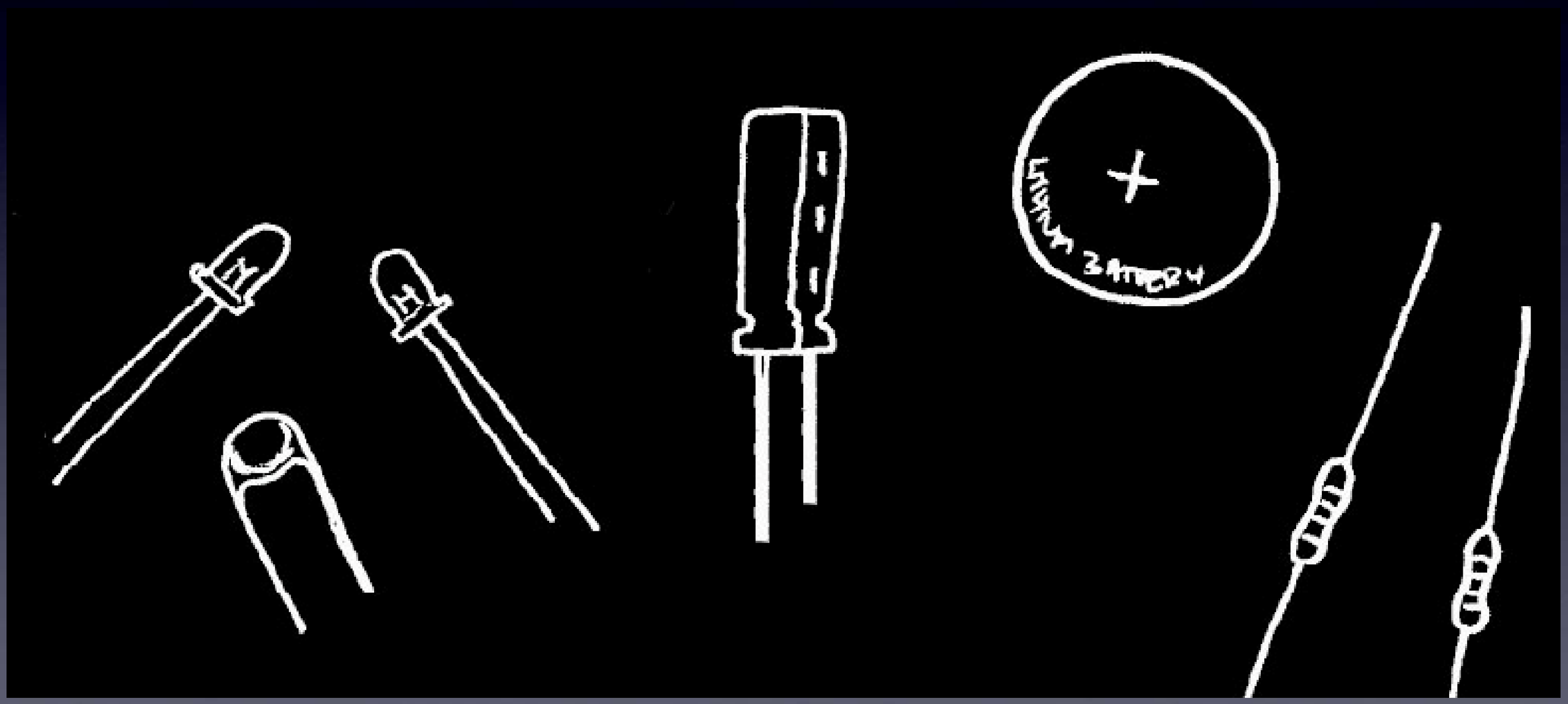
# Syllabus

- Intro to LEDs
- A bit about electronics
- RGB color theory
- A bit about Arduino
- PWM basics
- Programming RGB LED strips
- Ordering RGB LED strips

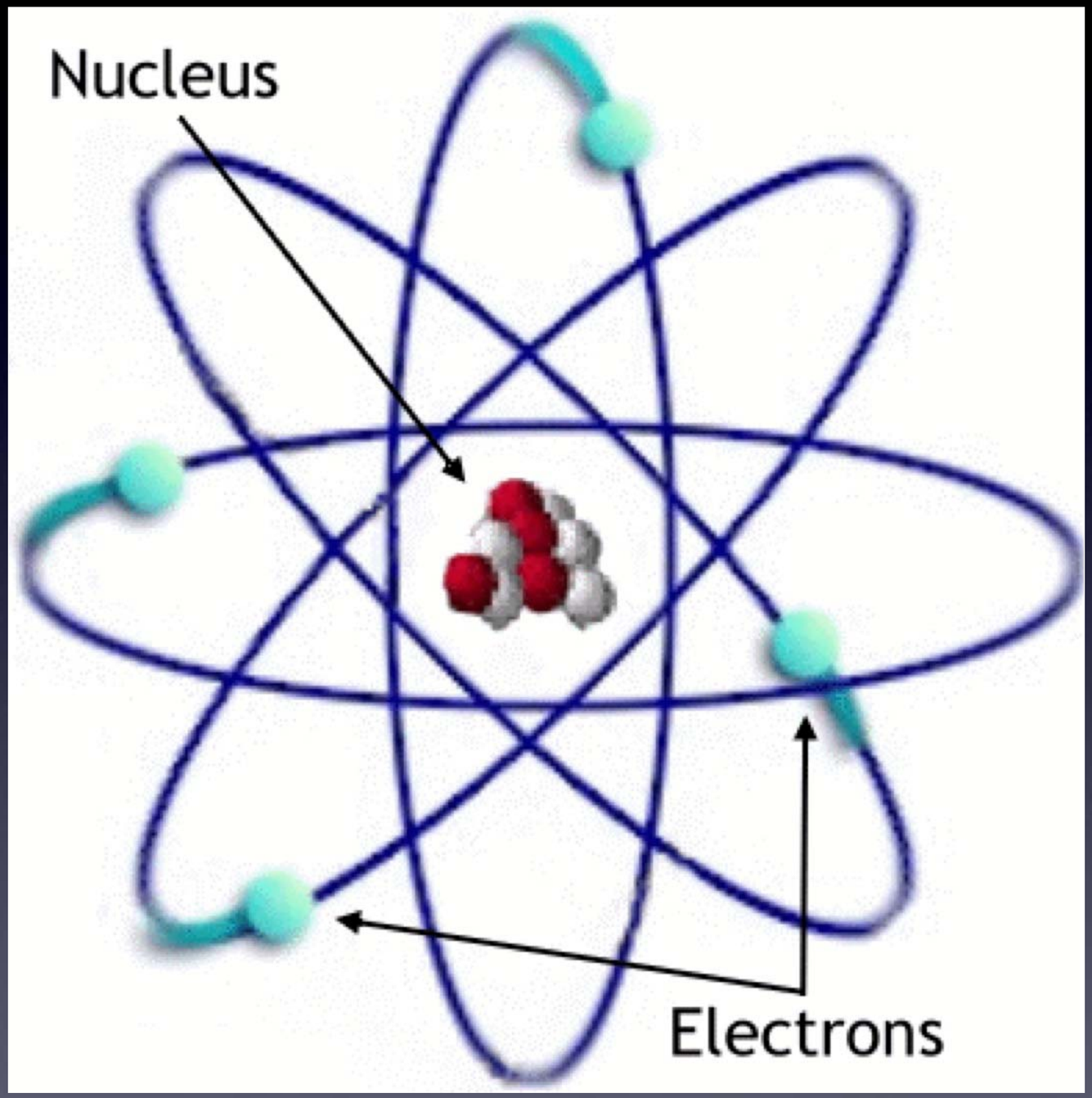
# LEDs

Lots of different colored LEDs!

# *A Little About*
# ***Electronics***

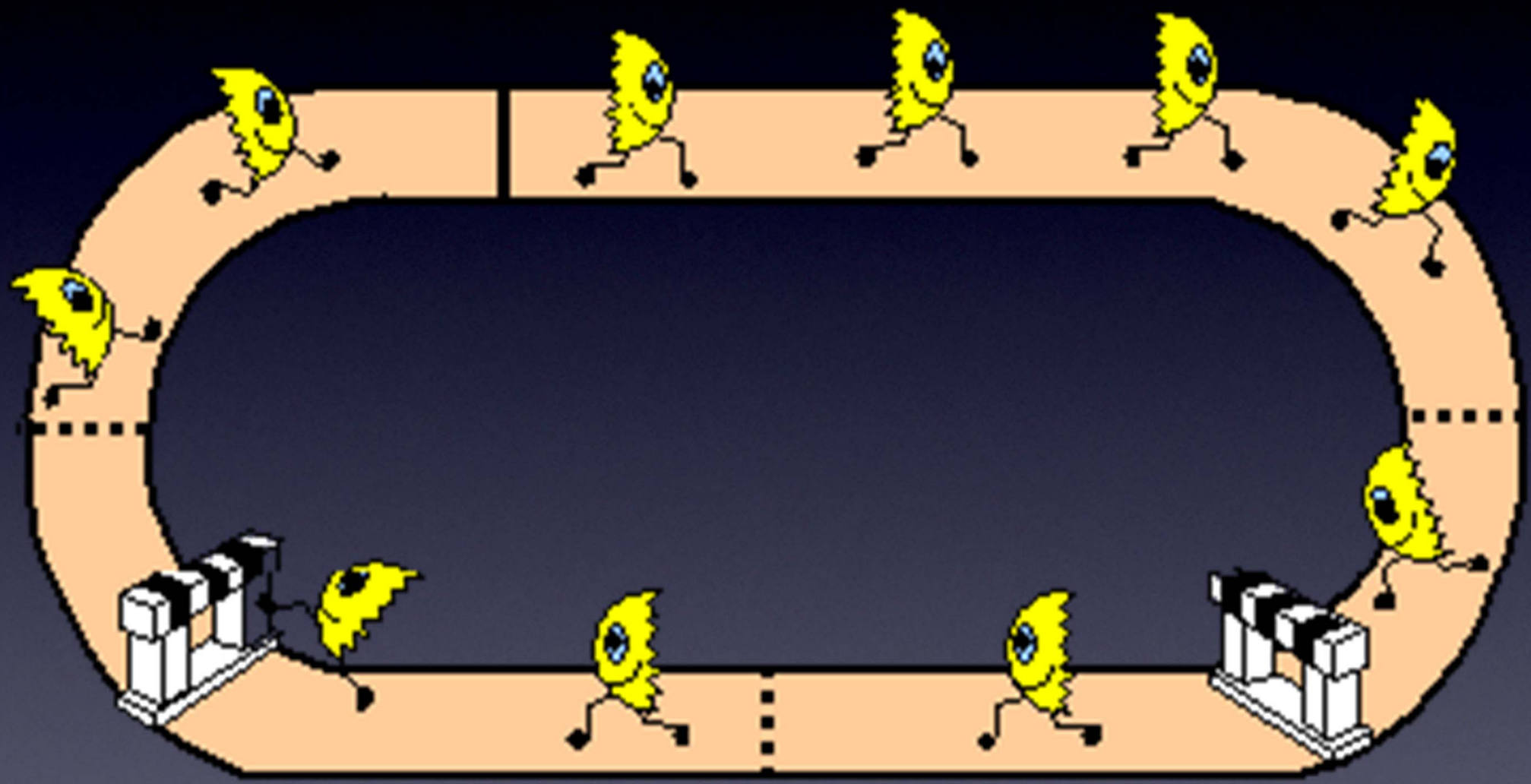


# A Little About Electronics



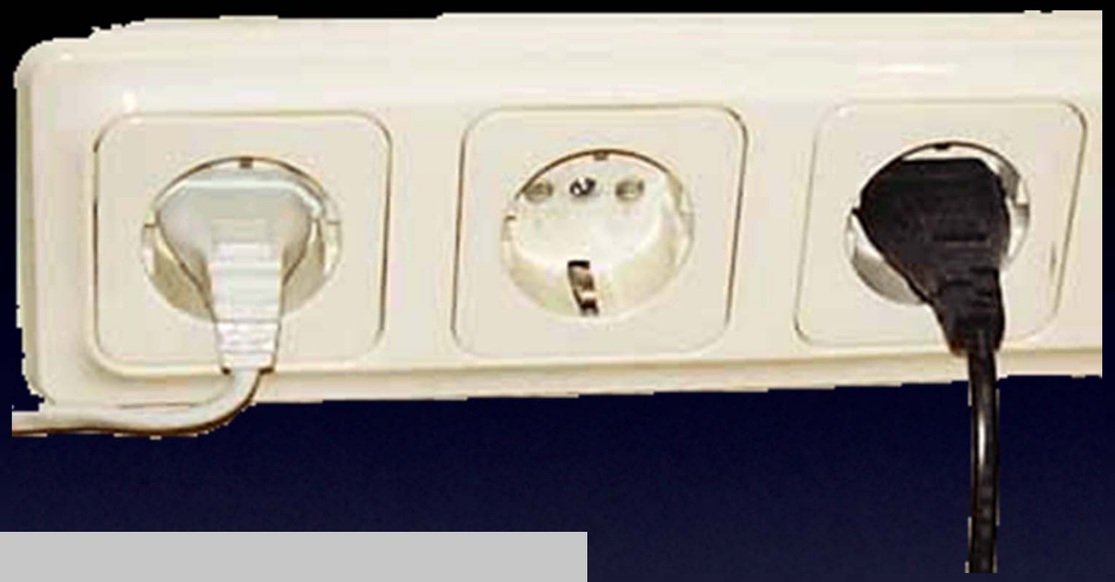

Electrons

# A Little About Electronics



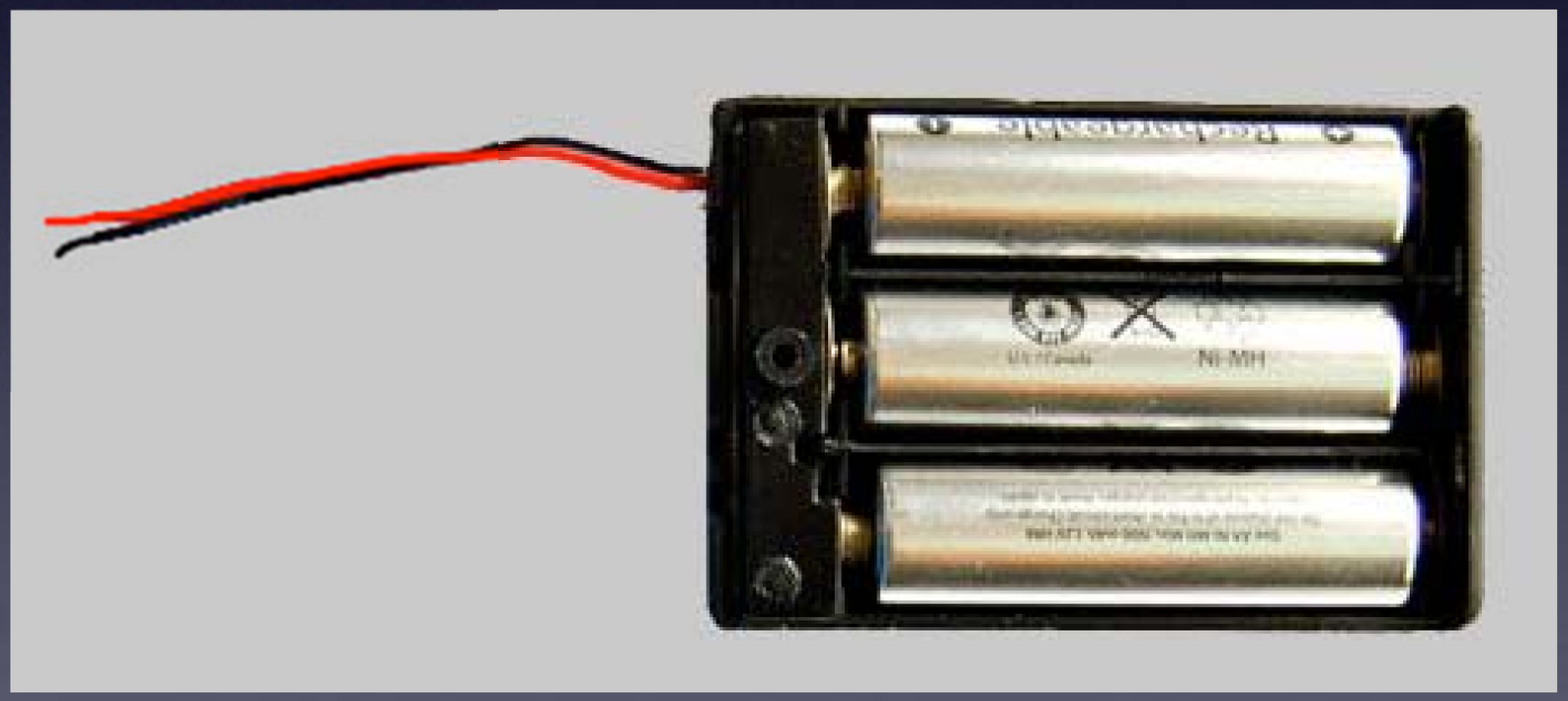
Circuit = Electrons going in complete circle = Magic!

# A Little About Electronics



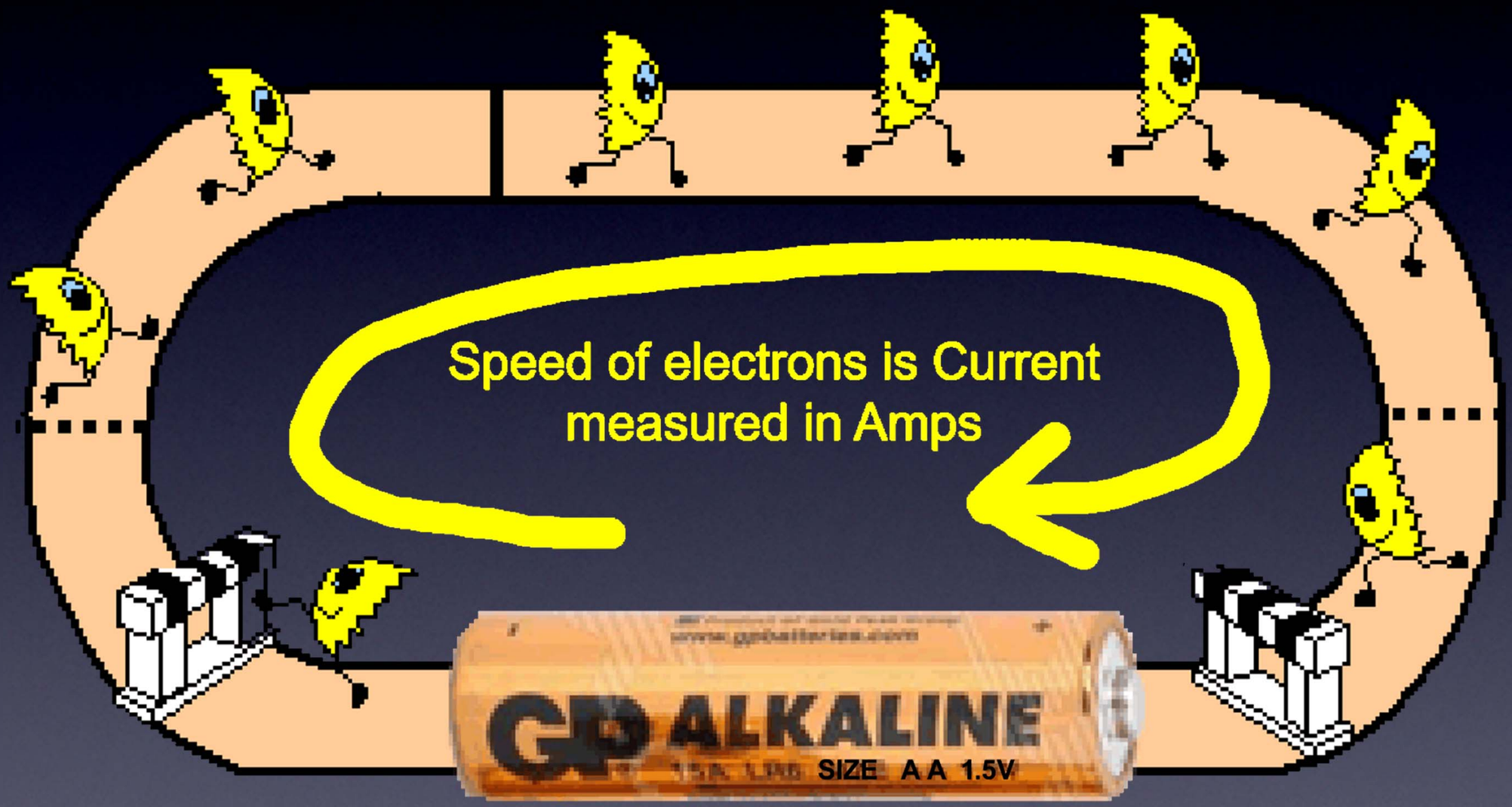
Power Supplies

# Everything You Need to Know About Electronics



Voltage / **Volts**

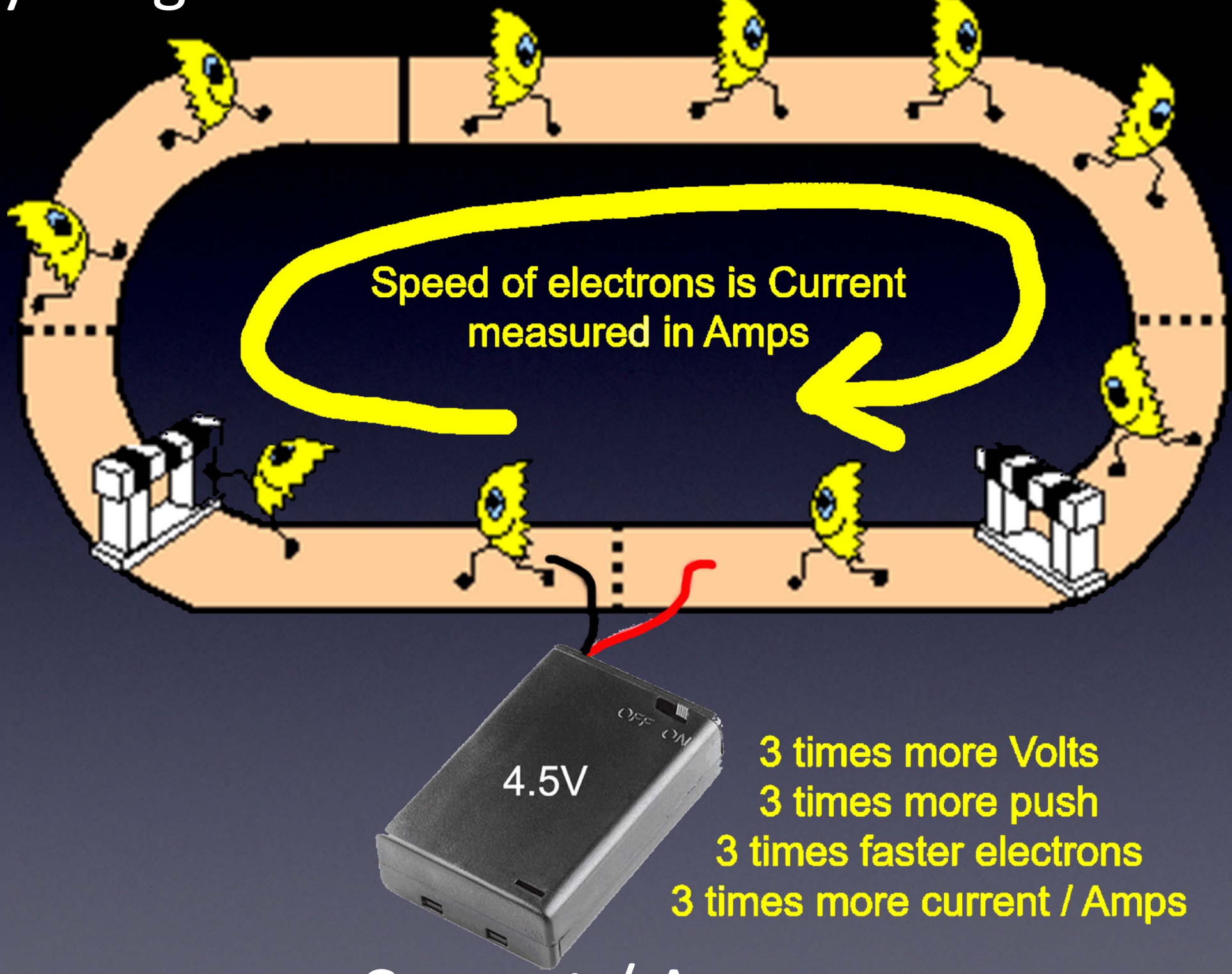
# Everything You Need to Know About Electronics




Electrons pushed with 1.5V.
So, they move!

Current / **Amps**

# Everything You Need to Know About Electronics

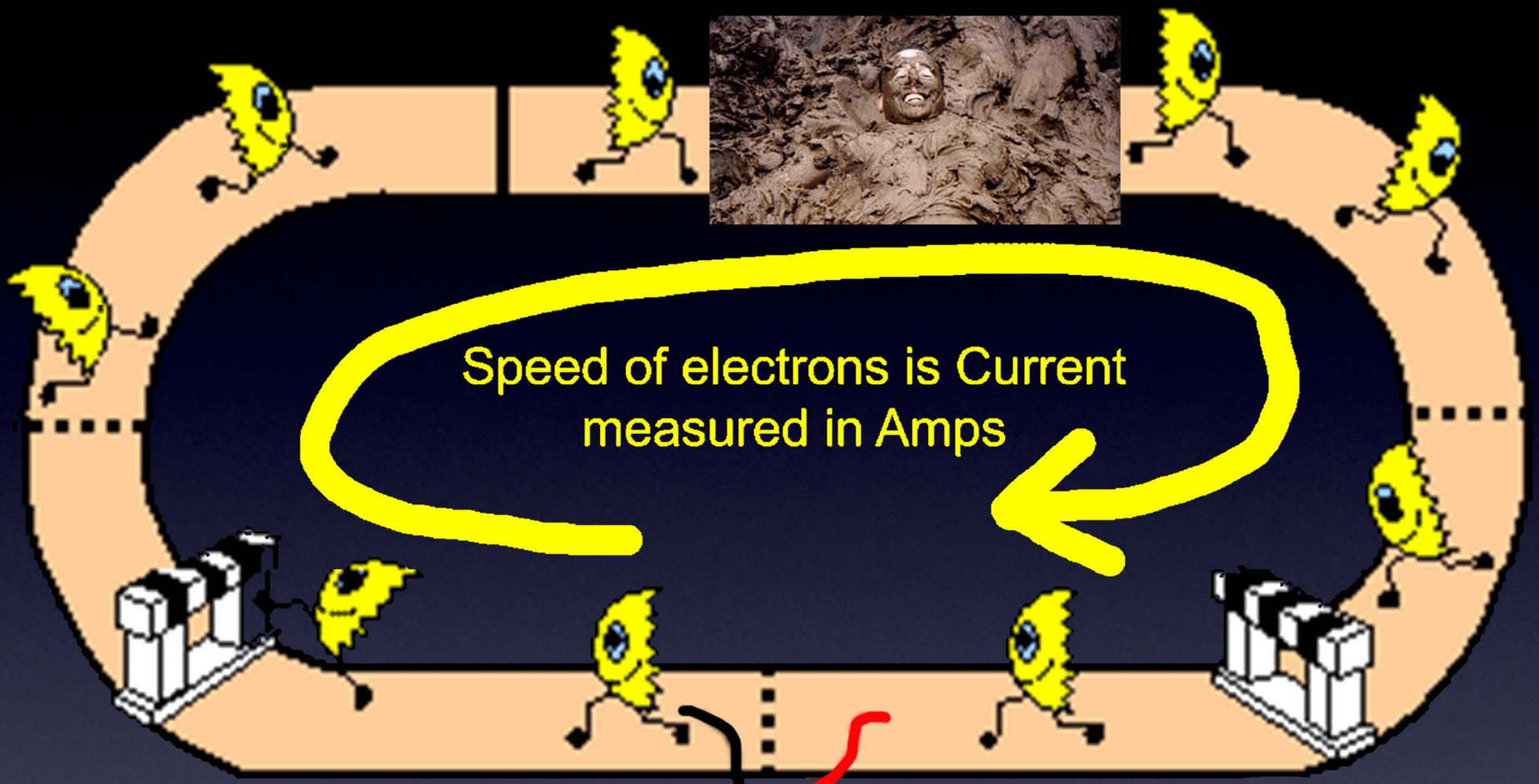



Current / Amps

# Everything You Need to Know About Electronics

Current / Amps

# Everything You Need to Know About Electronics



Resistance in the electrons' path
slows them down,
which means
less current (less Amps).

Resistance / **Ohms**

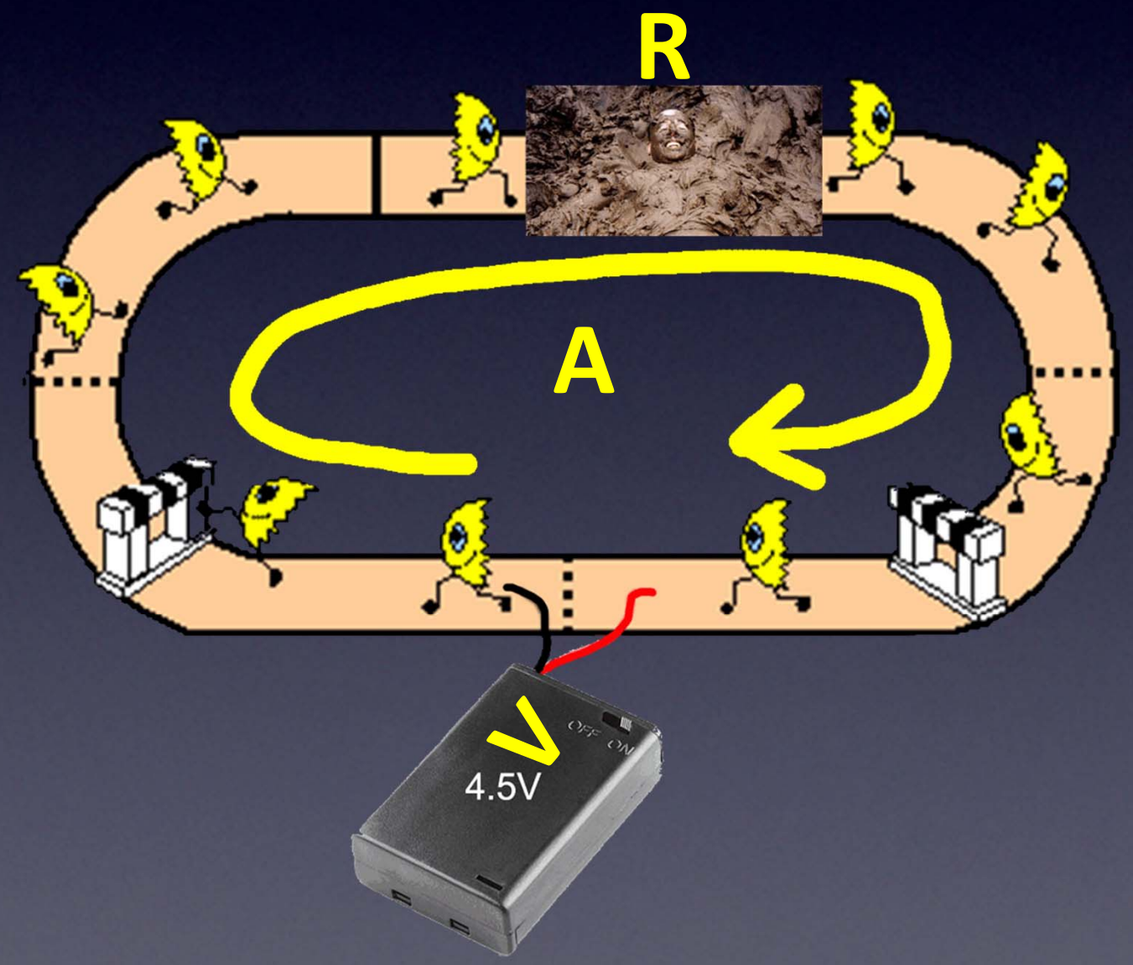
# A Little About Electronics

## Ohm's Law

**V**olts -- ***force*** pushing electrons

**A**mps -- ***speed*** of electrons

Ohms -- ***Resistance*** to flow of electrons



# A Little About Electronics

## Ohm's Law

**V**olts -- ***force*** pushing electrons

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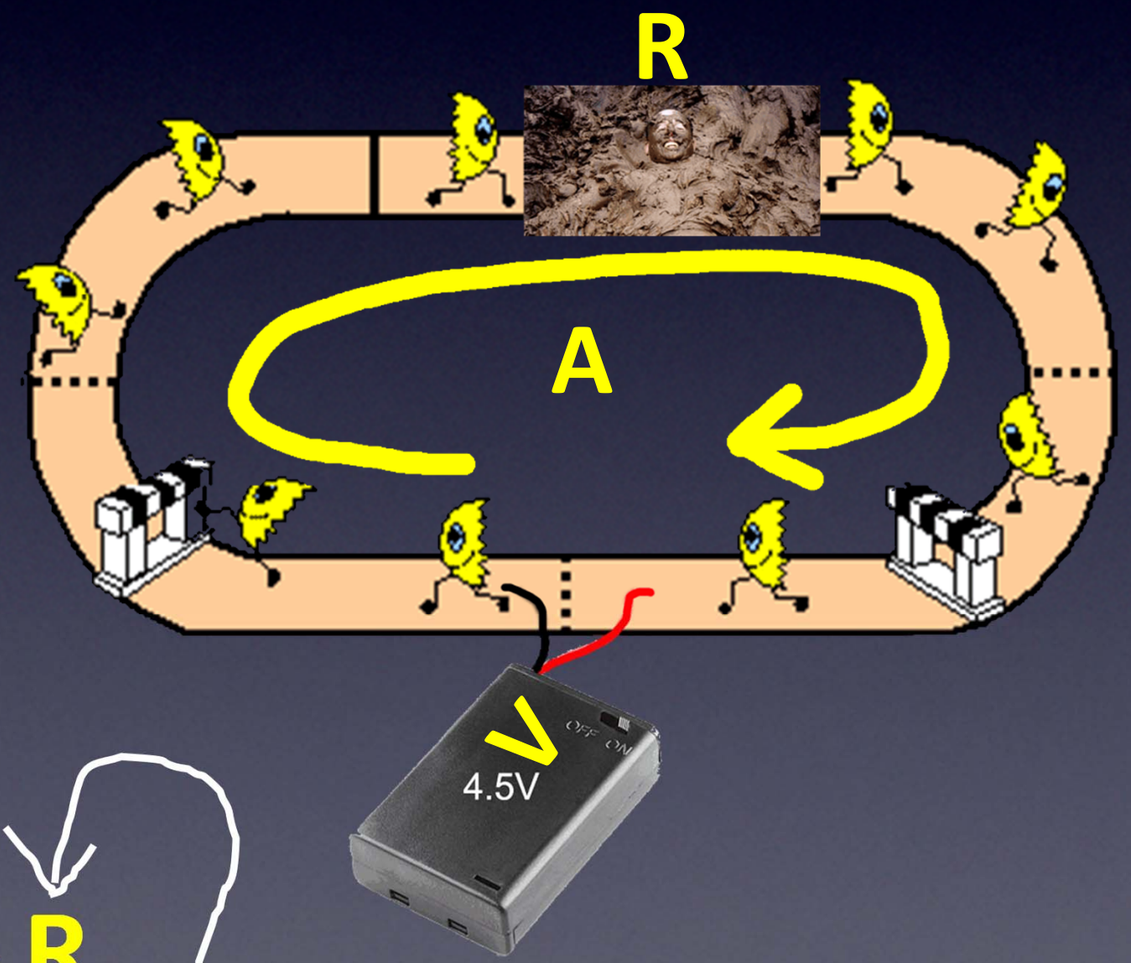
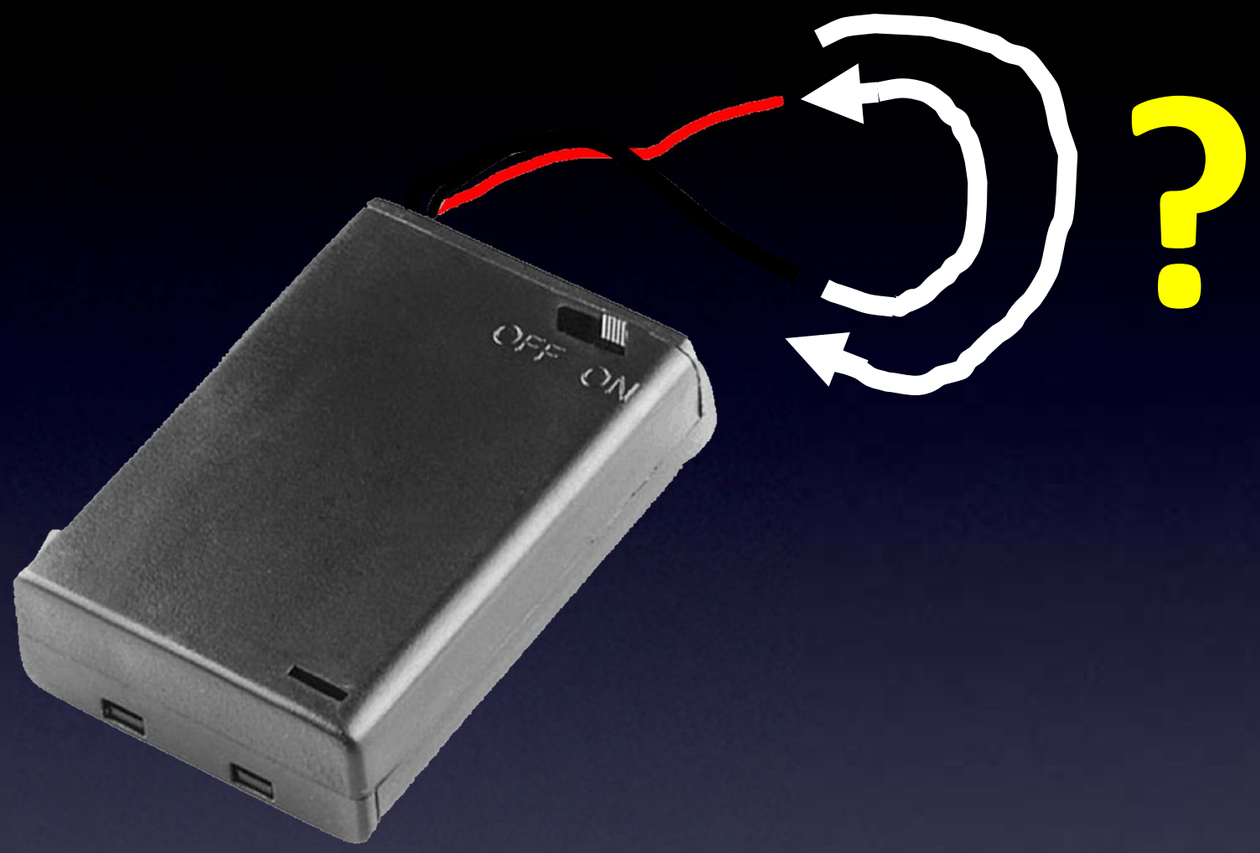
Ohms -- ***Resistance*** to flow of electrons




**V**olts = **A**mps x **R**

(Ohms)

# A Little About Electronics




# What happens?

Polarity

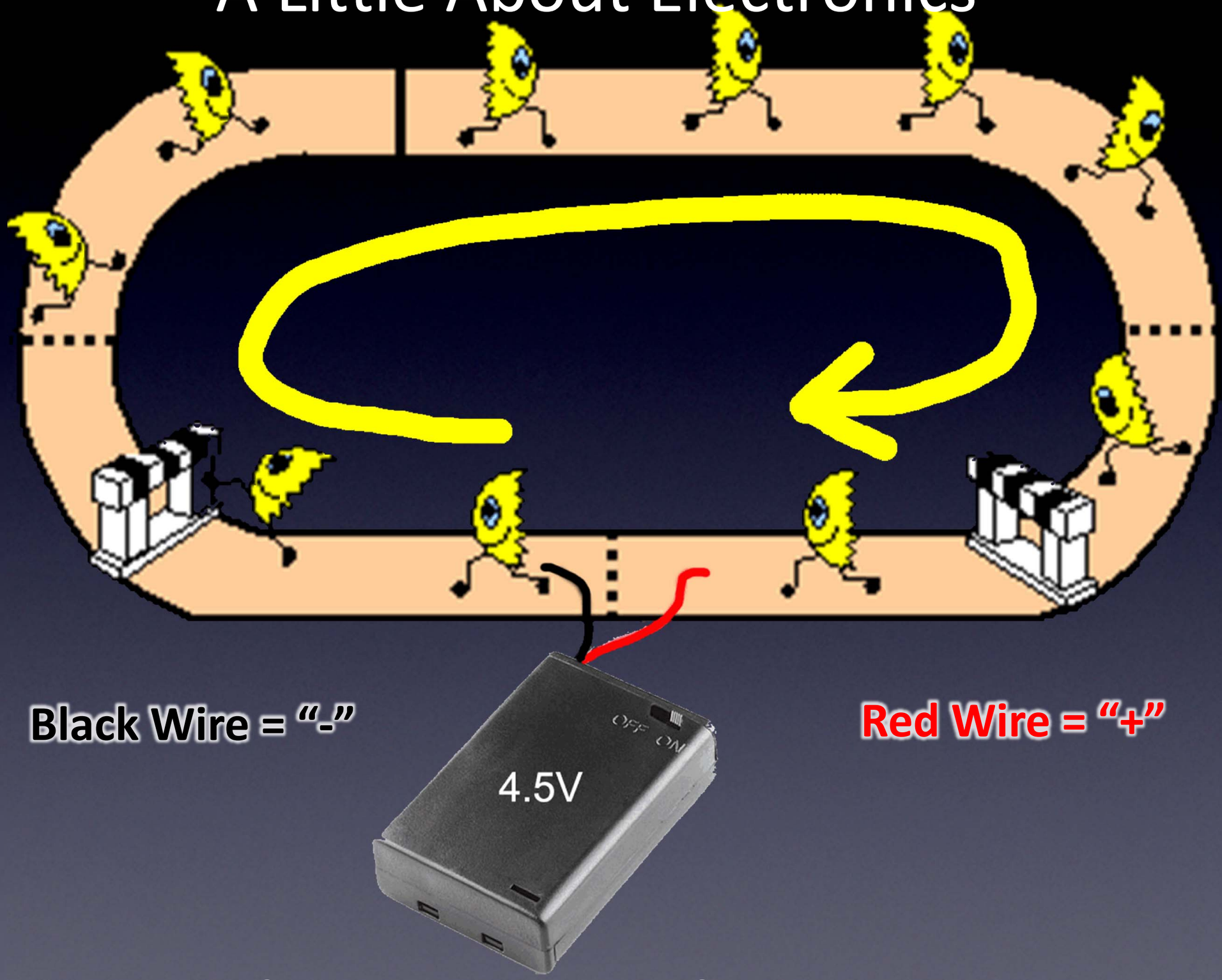
Power Supply – it matters how you connect it!

# LED

Plus / Positive (+)

Minus / Negative (-)

# A Little About Electronics

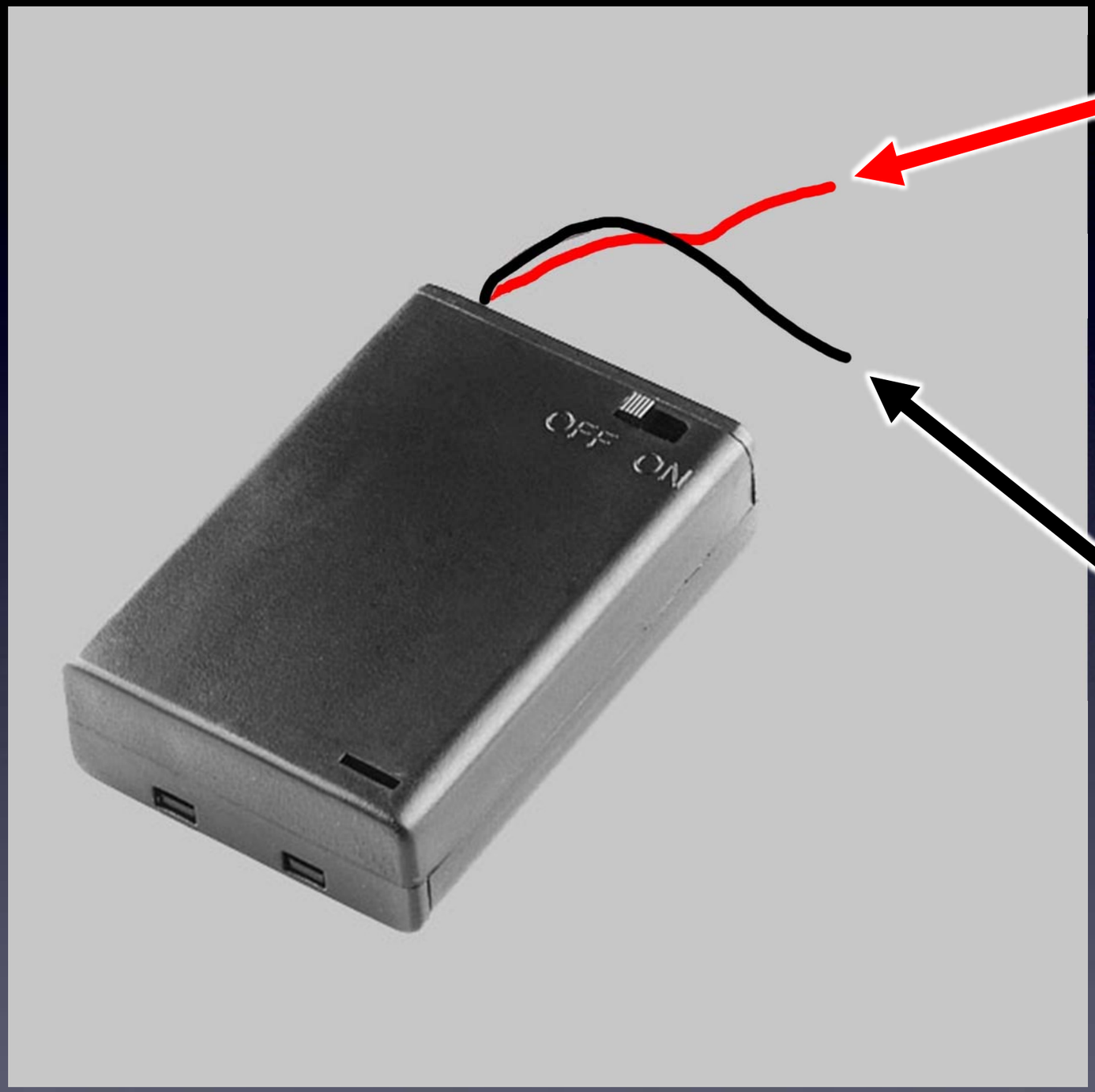



**Black Wire = “-”**

**Red Wire = “+”**

Power Supply – it matters how you connect it!

# A Little About Electronics




**<u>Red wire</u>:**
**Power,**
**Plus, Positive,**
**4.5V,**
**Vcc**

**<u>Black wire</u>:**
**Minus, Negative,**
**0V,**
**Ground (GND)**

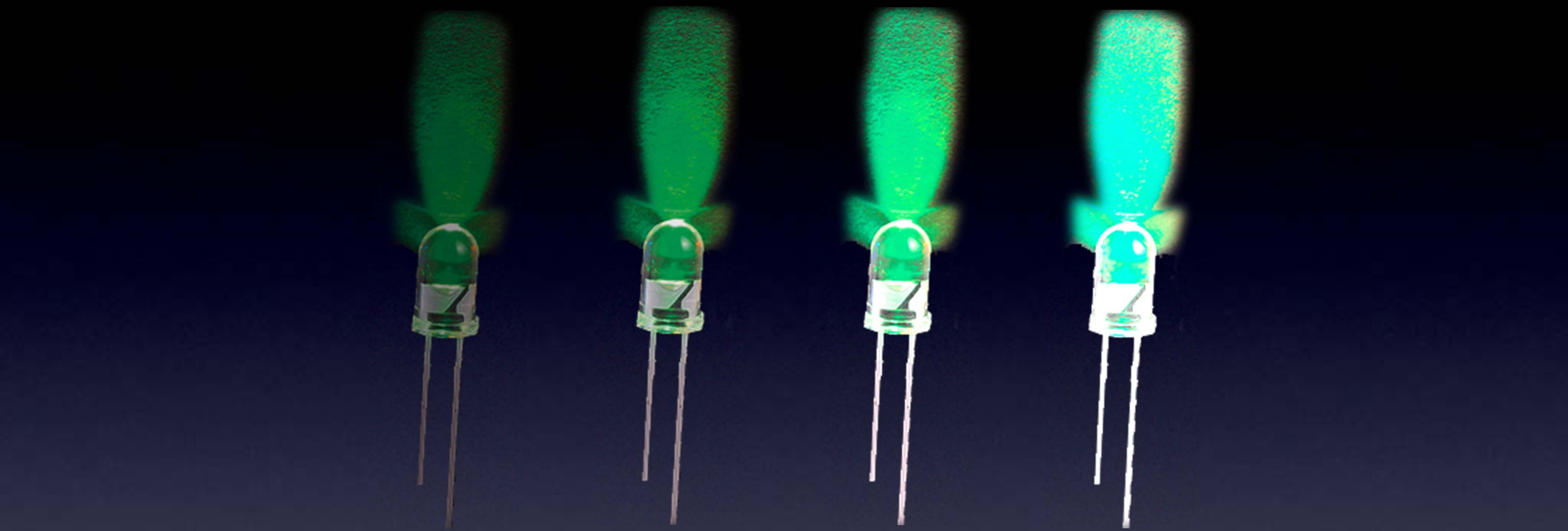
Power Supply – it matters how you connect it!

# A Little About Electronics

Lots of different colored LEDs!

LED

# Everything You Need to Know About Electronics



More current → More brightness!  (until…)

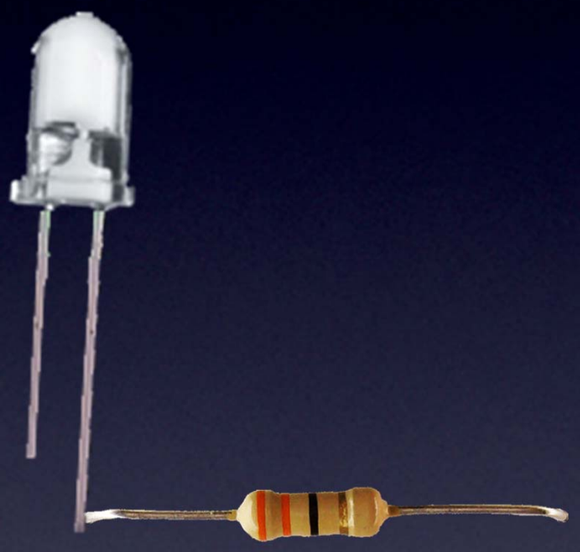
LED

# Everything You Need to Know About Electronics

More current → More brightness!  (until…)

LED

# Everything You Need to Know About Electronics

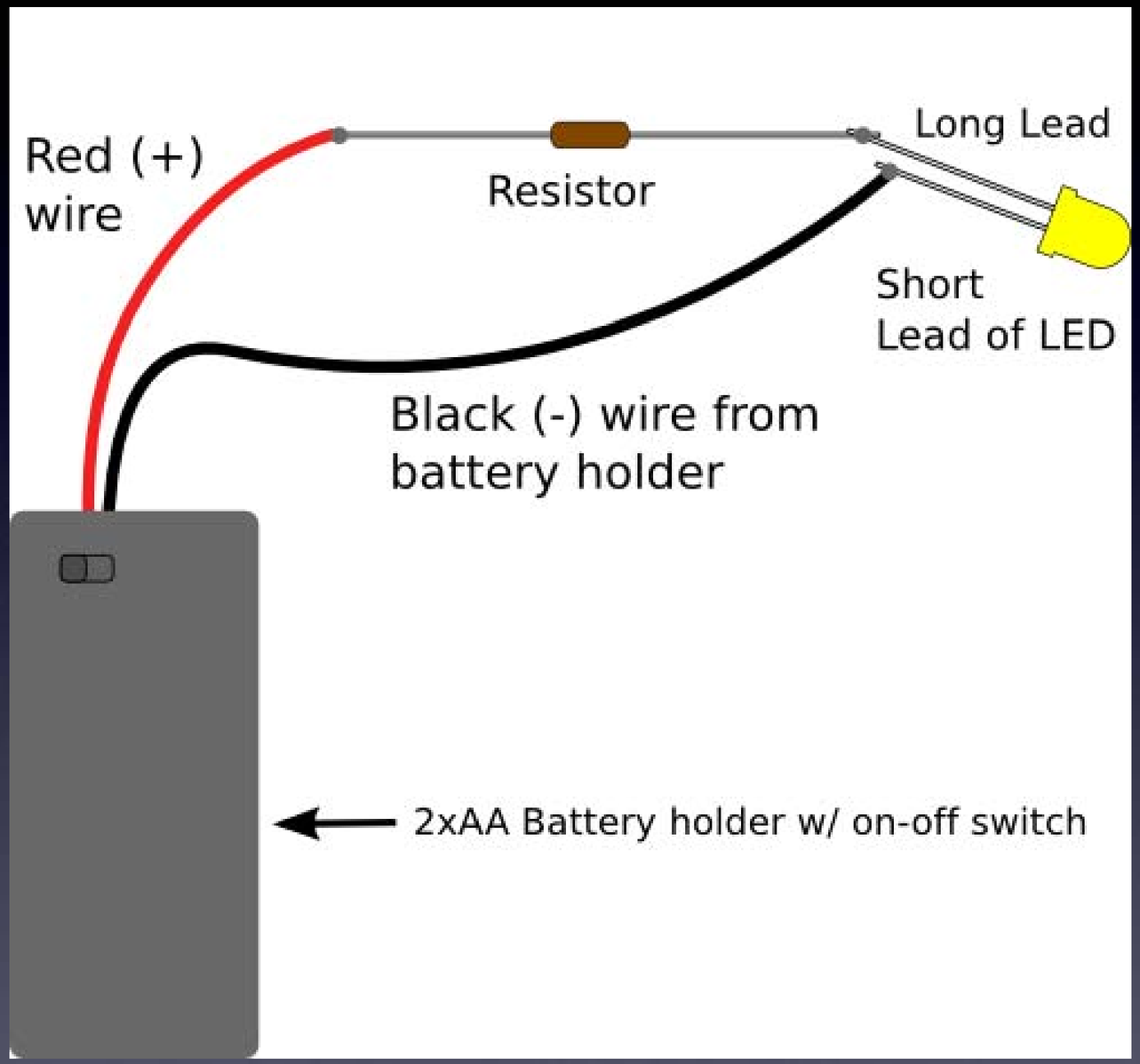


*(with a resistor*
*so no magic smoke goes away)*

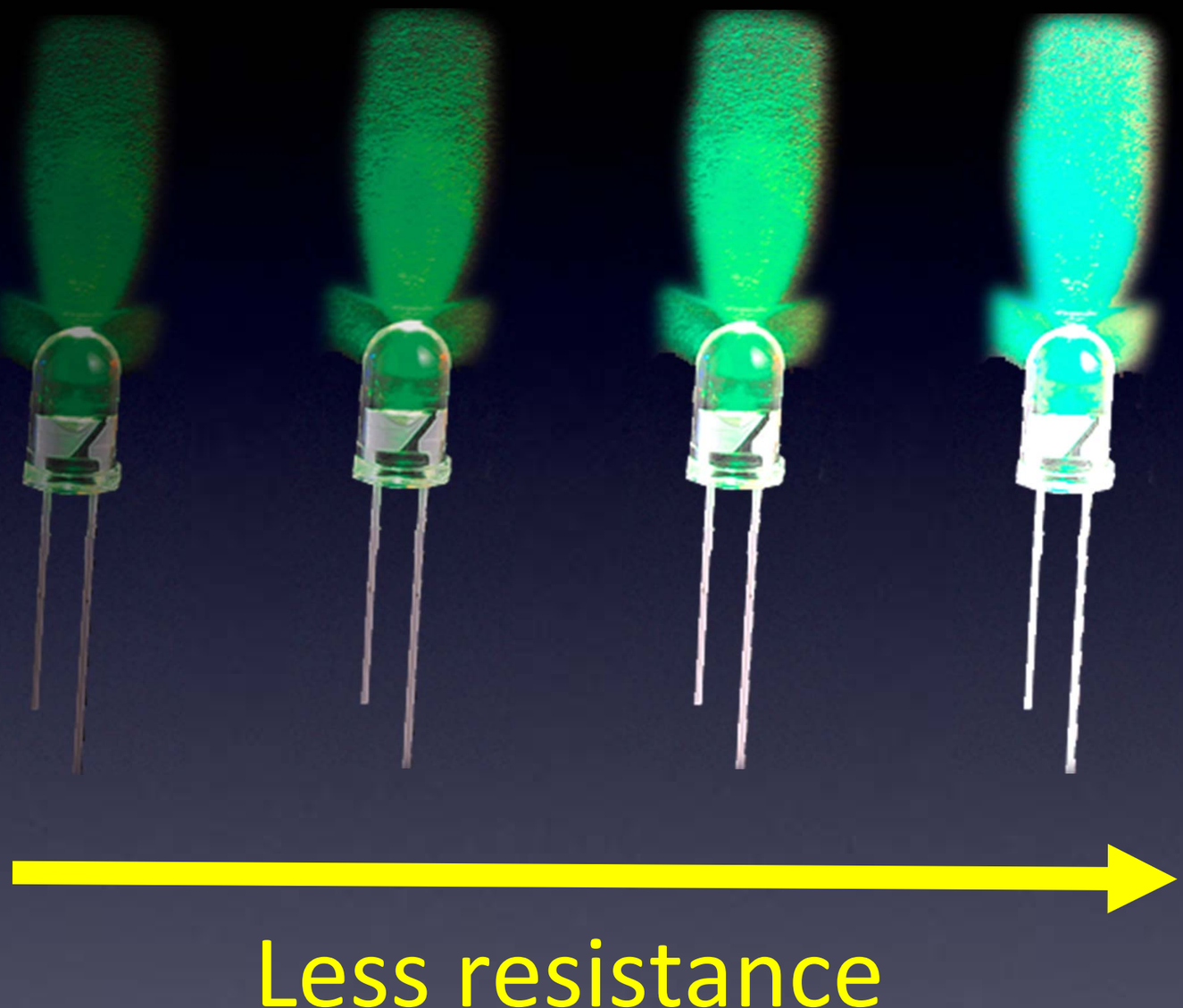
This is why we put a resistor in line with an LED

LED

# LED Brightness



# LED Brightness



Less resistance

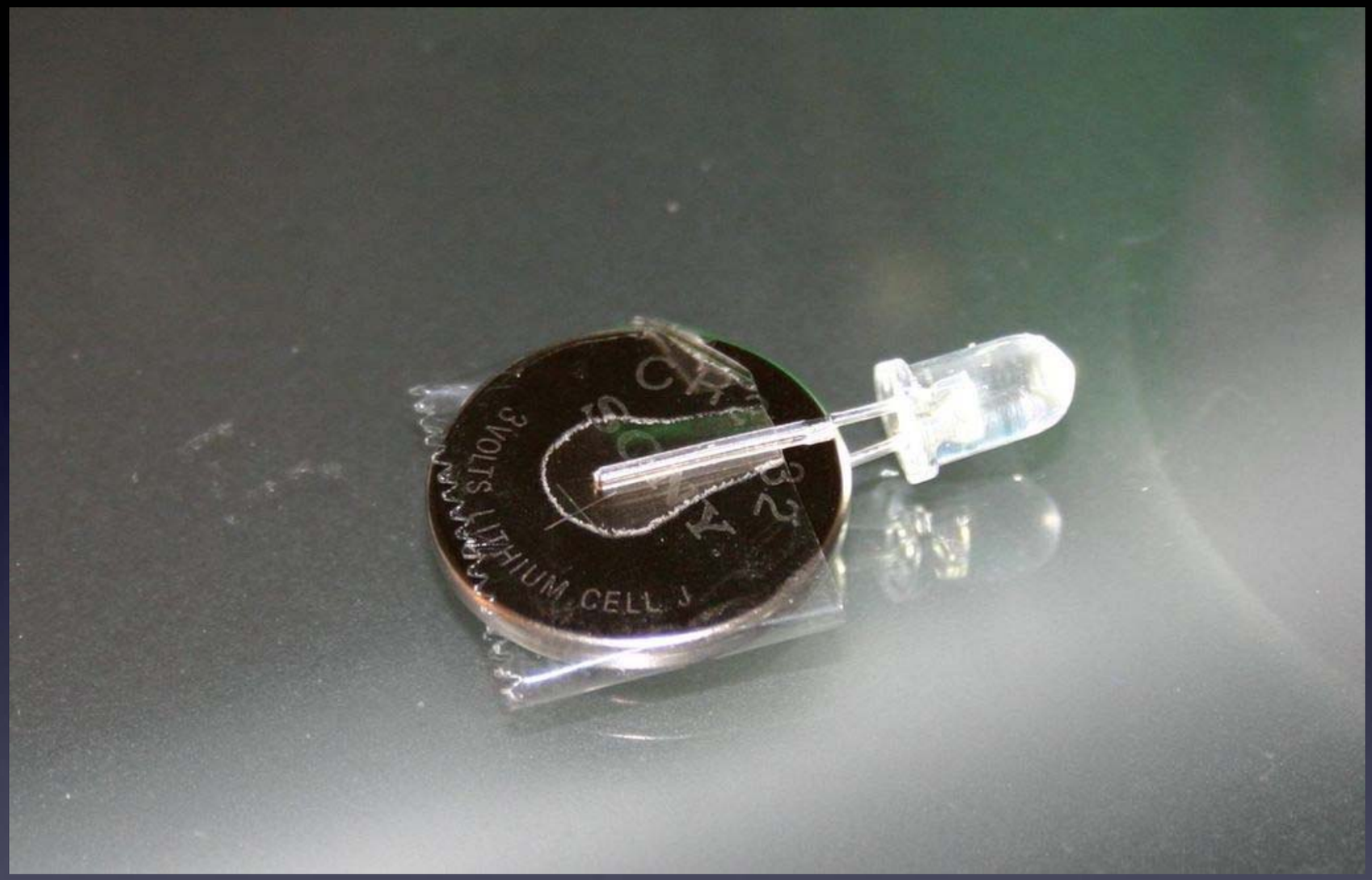
# LED Brightness

But, we will use:

**PWM**

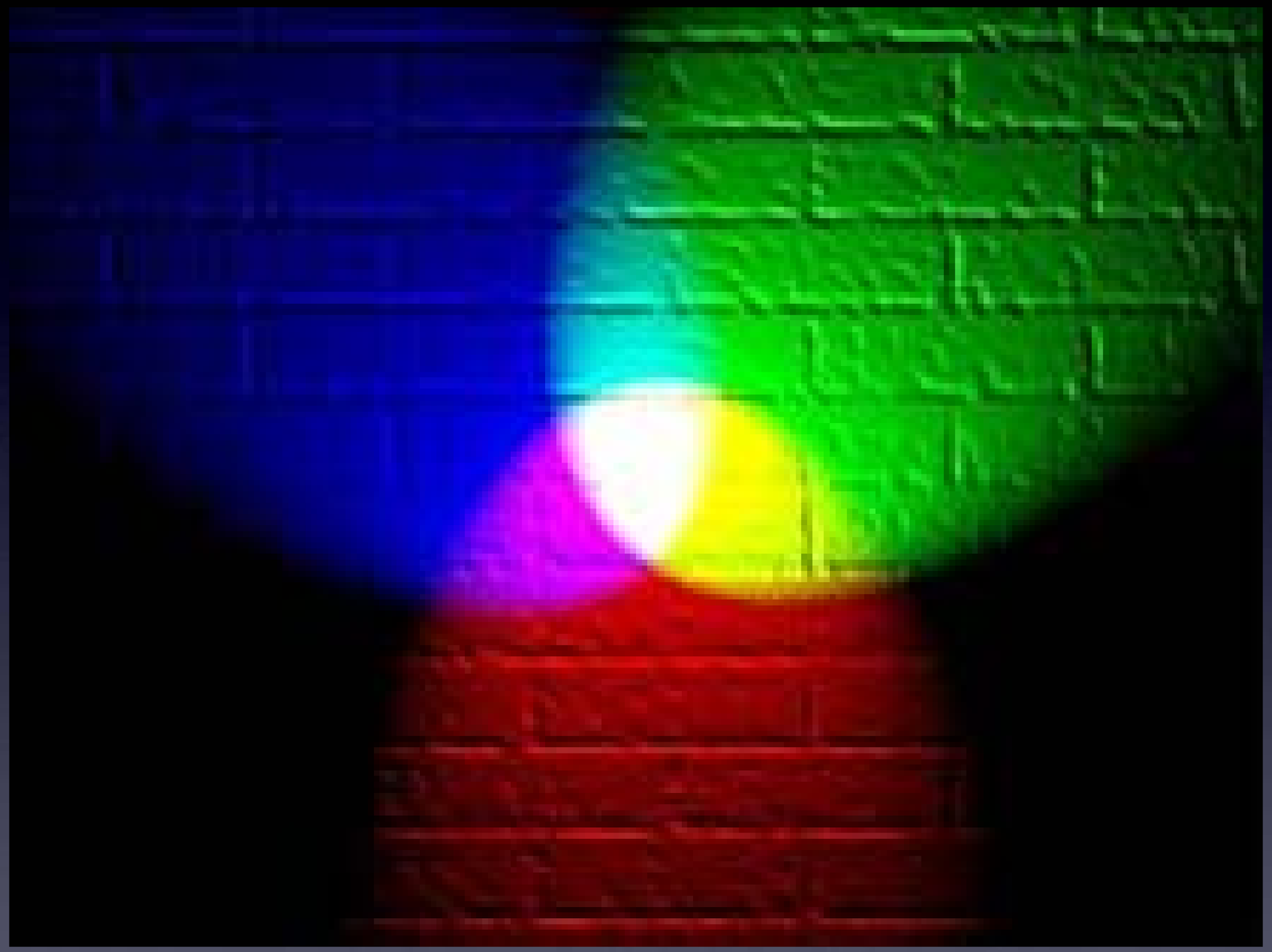
*(coming soon)*

# Lighting an LED

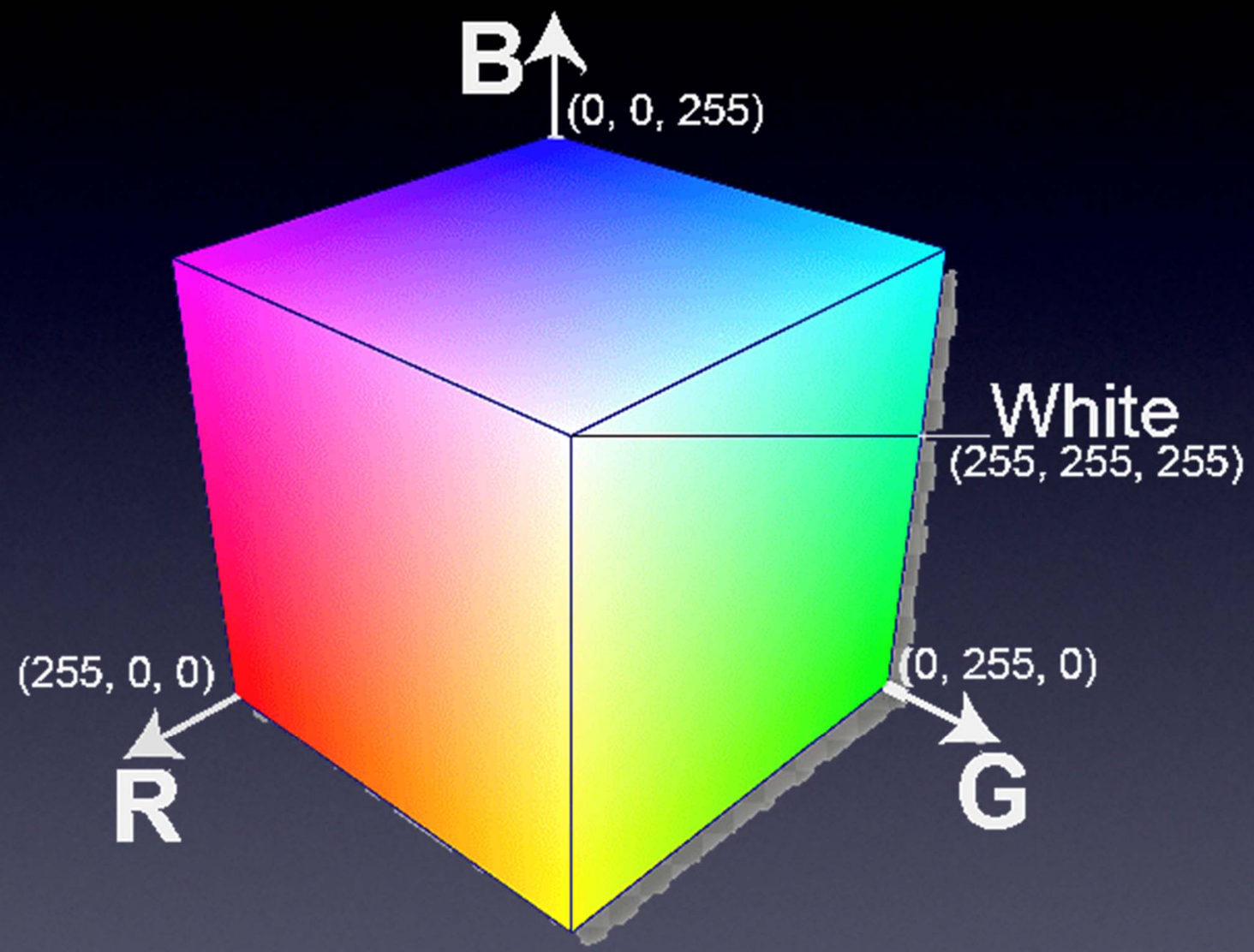



LED & battery

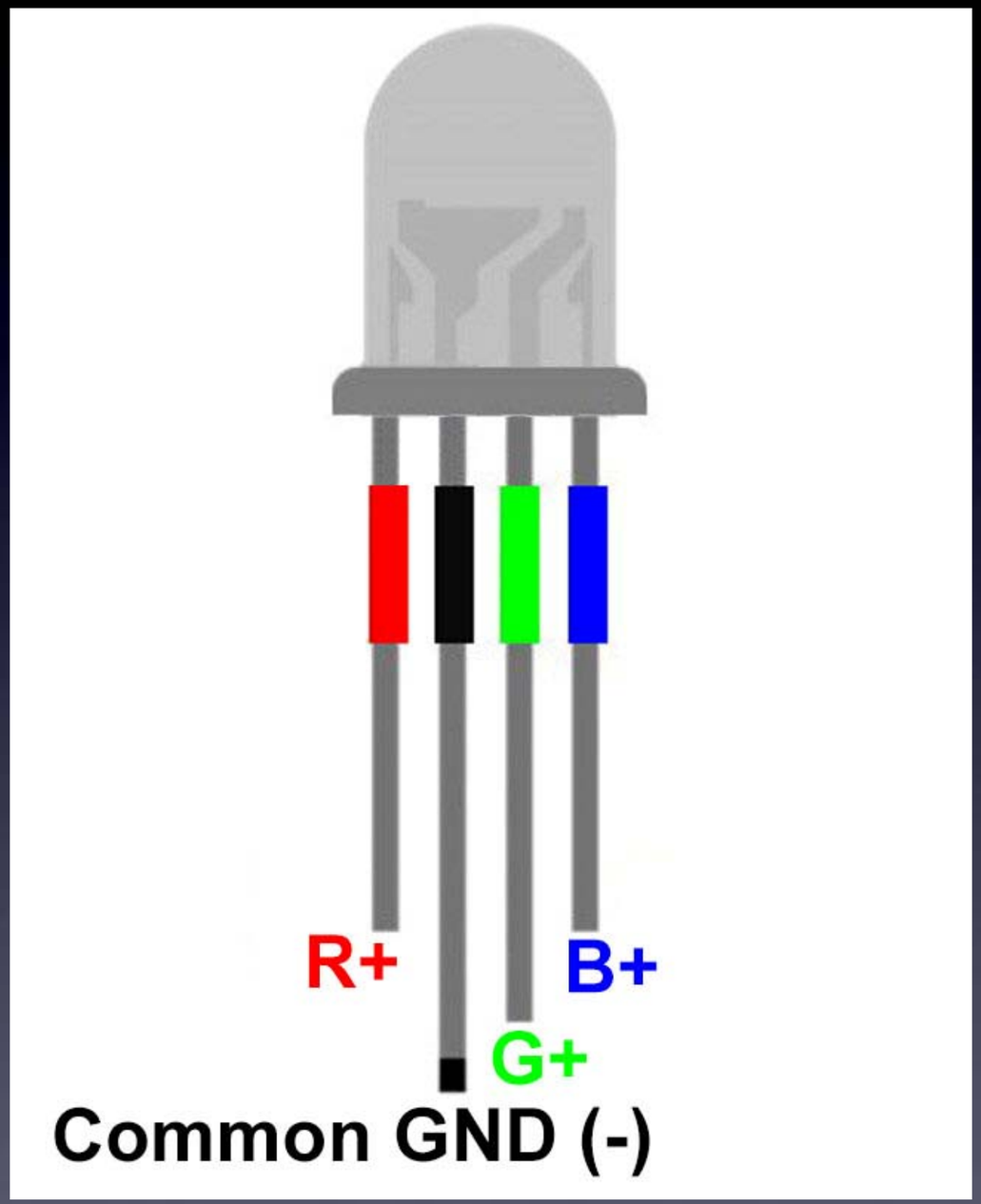
# Light Color Mixing



# Light Color Mixing



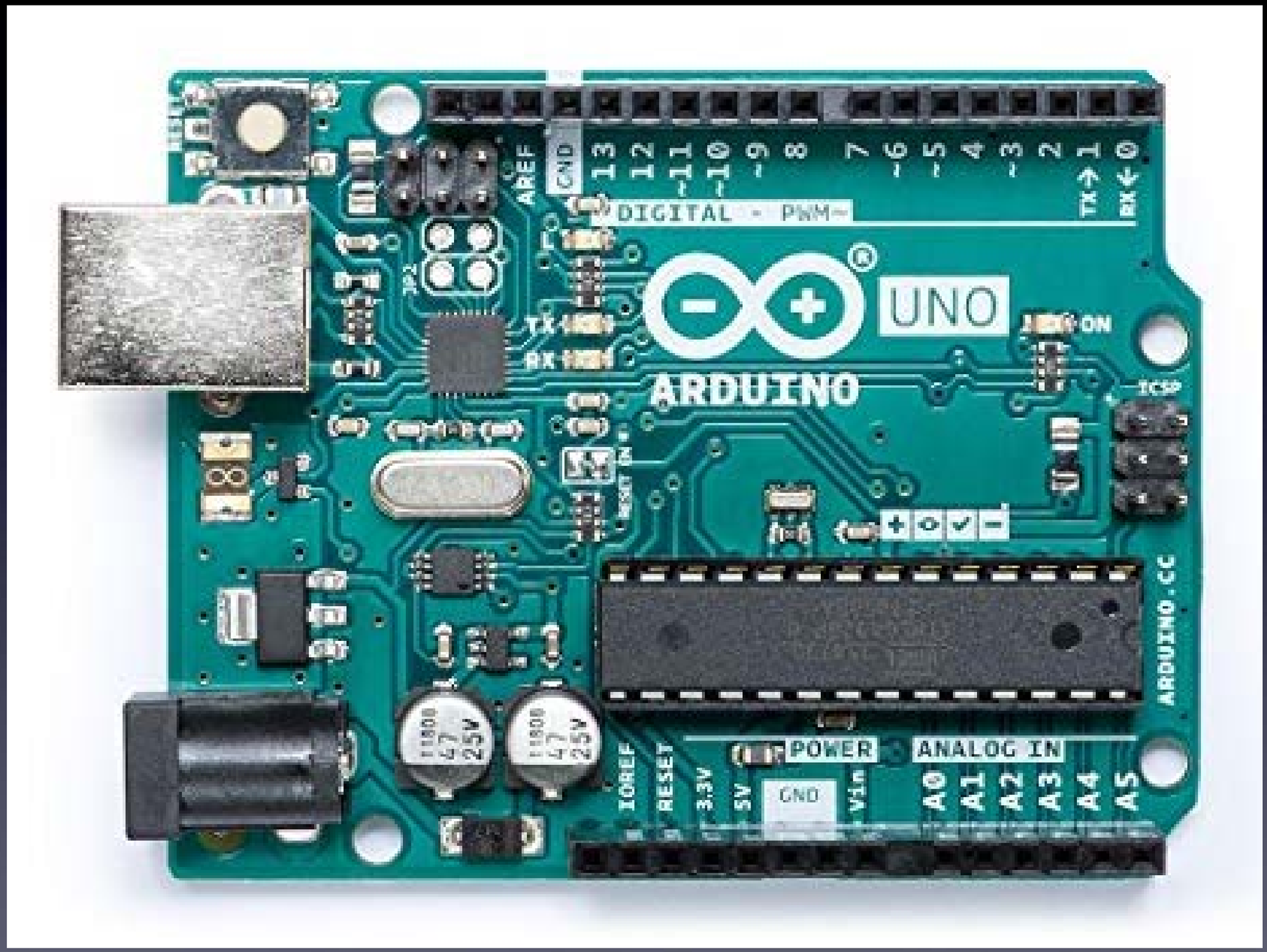
# RGB LED



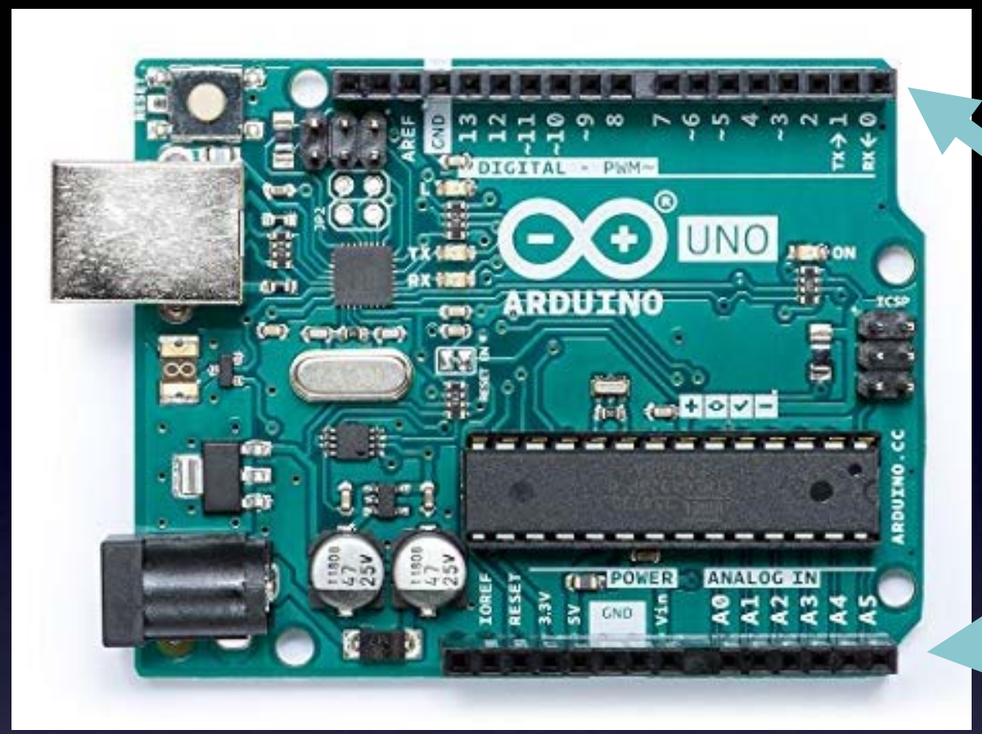
# RGB LED with microcontroller (Example)

Trippy RGB Waves kit

# Intro to Arduino



# Intro to Arduino




Super easy to
connect parts
to its microcontroller's pins

*Use an Arduino board*

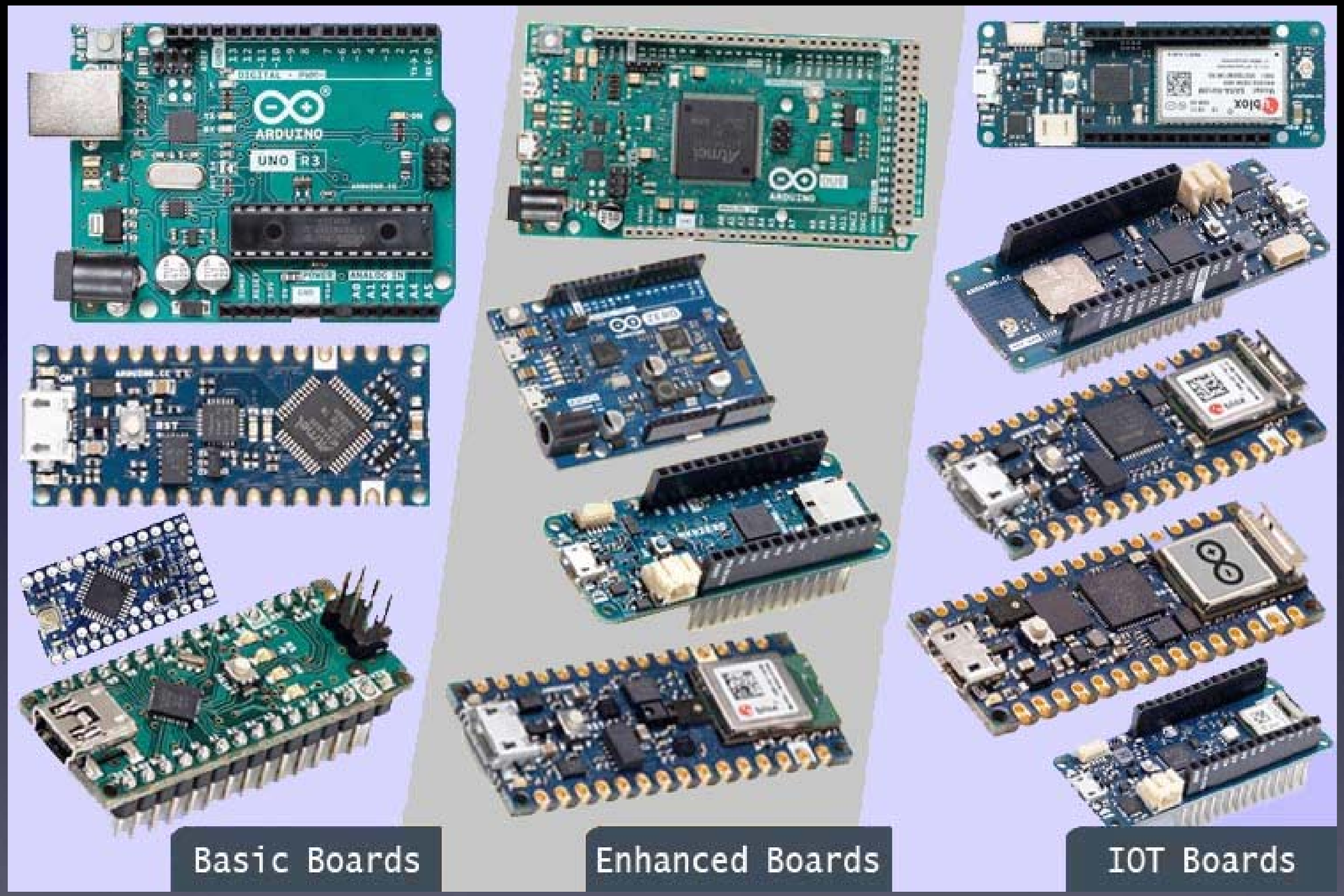
# Intro to Arduino

*Use an Arduino board*

Super easy to
connect parts
to its microcontroller's pins

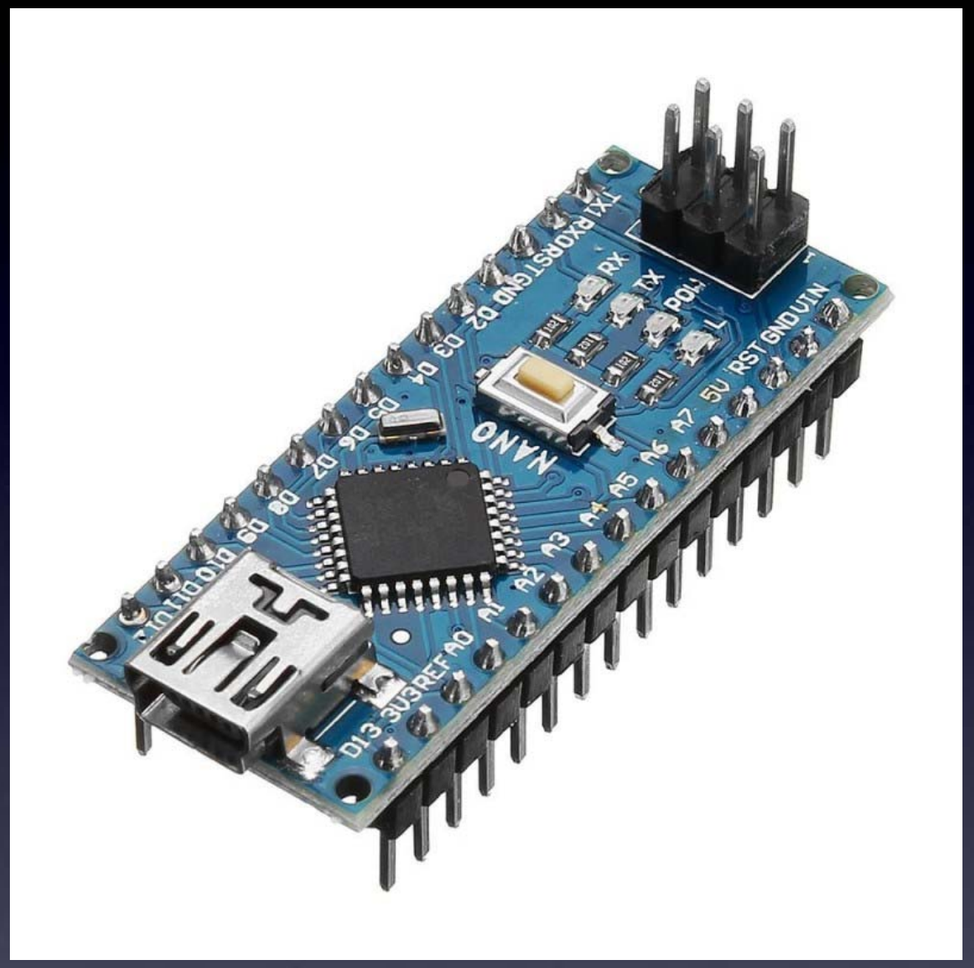
Super easy to
create and upload a program
to control the parts

# Intro to Arduino



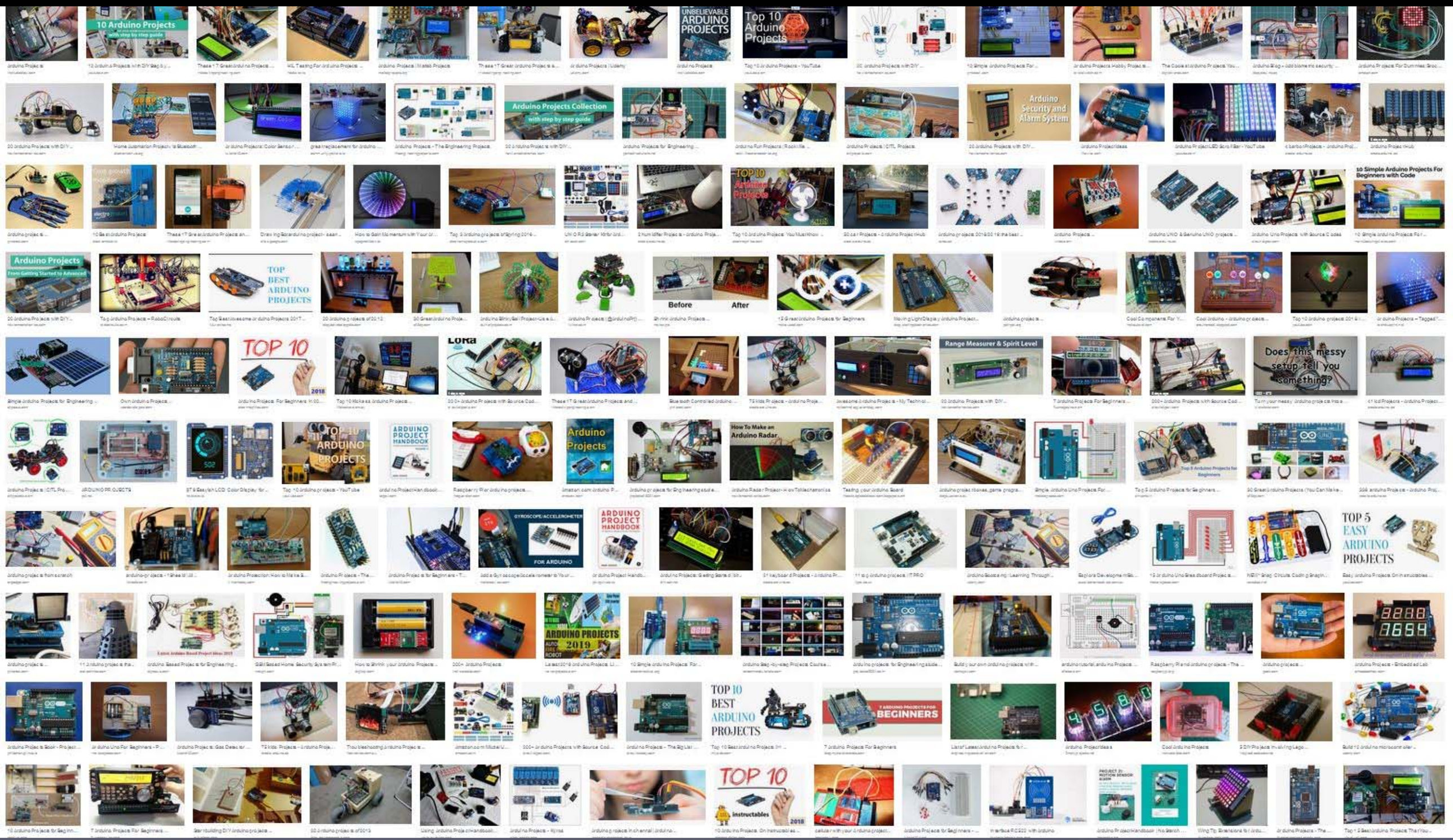

Open Source

# Intro to Arduino




Arduino Nano “clone”

# Intro to Arduino




*hundreds of thousands of projects online!*

# Intro to Arduino

## Arduino For Total Newbies workshop

Day 3 Tuesday 29-December, 13:00 to 16:30

→ → ***Right-click on this link, and open in a new windo***
Arduino For Total Newbies workshop room on Big Blue

**NOTE: You do NOT need to register to take this works**
Just show up before the start time at the Big Blue Button room, given above.

---

***Learn Arduino***
***using TV-B-Gone***
***as an example project***
***(no materials required)***

*Arduino For Total Newbies workshops*

# Arduino

**For more info, there are many good Arduino tutorials online.**
**A good place to start is:**
**<https://www.arduino.cc/en/Tutorial/HomePage>**

# Arduino

**First:**
Download and install the Arduino software
< http://arduino.cc >

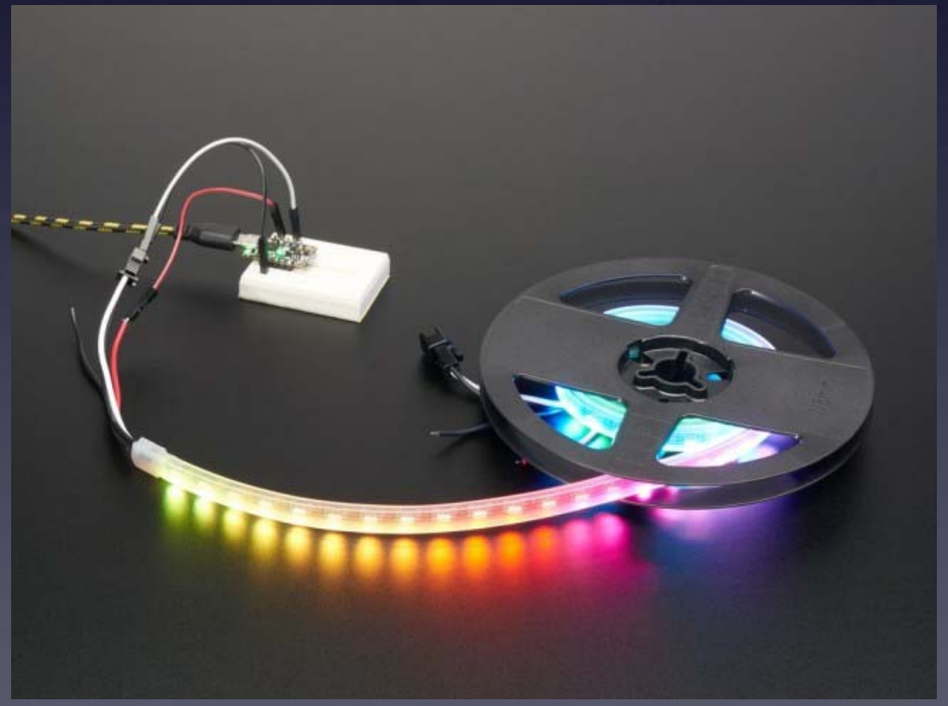
# Arduino

**Second:**

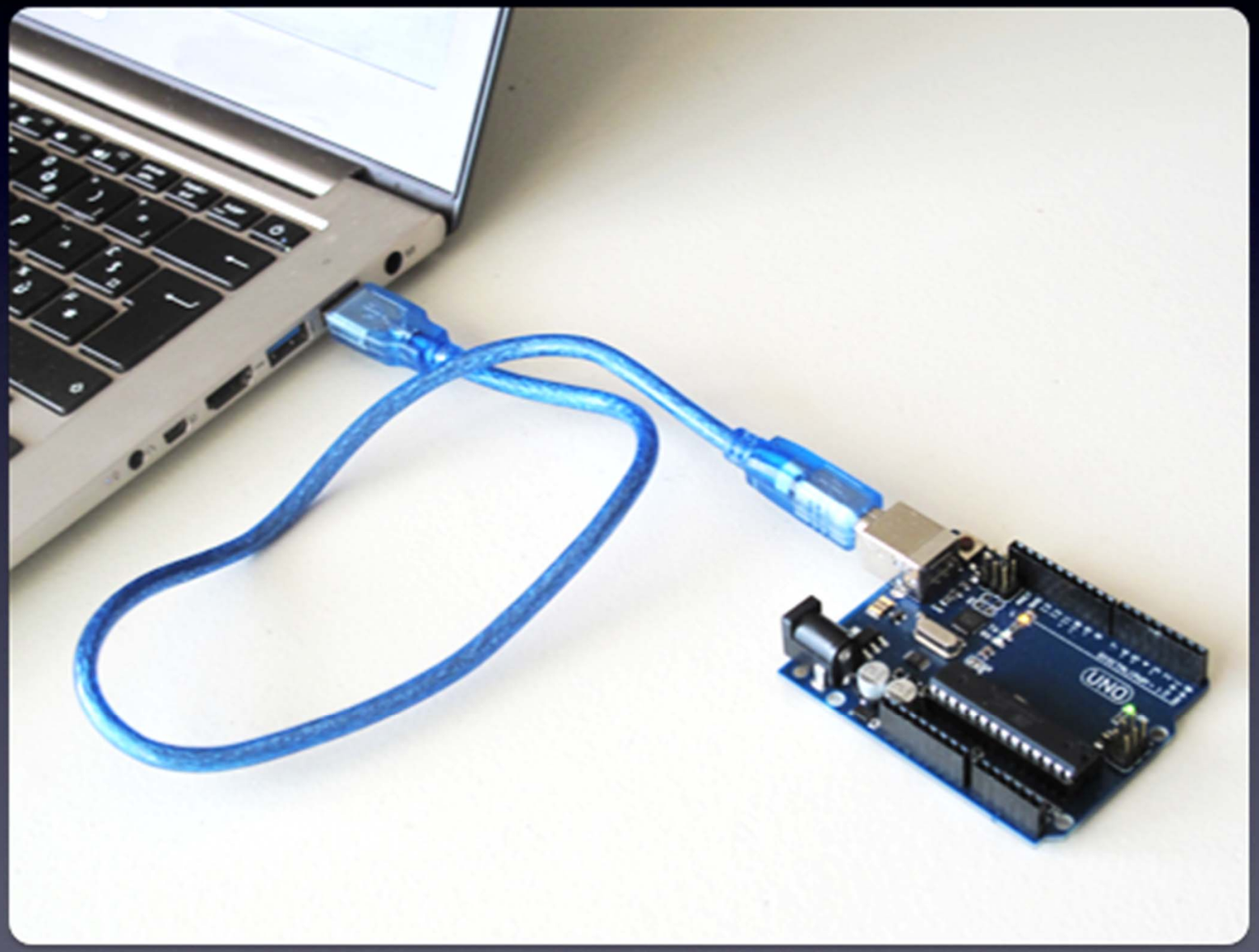
Download Arduino sketches

**Search for:** *“RGB LED Strip Sketches”*

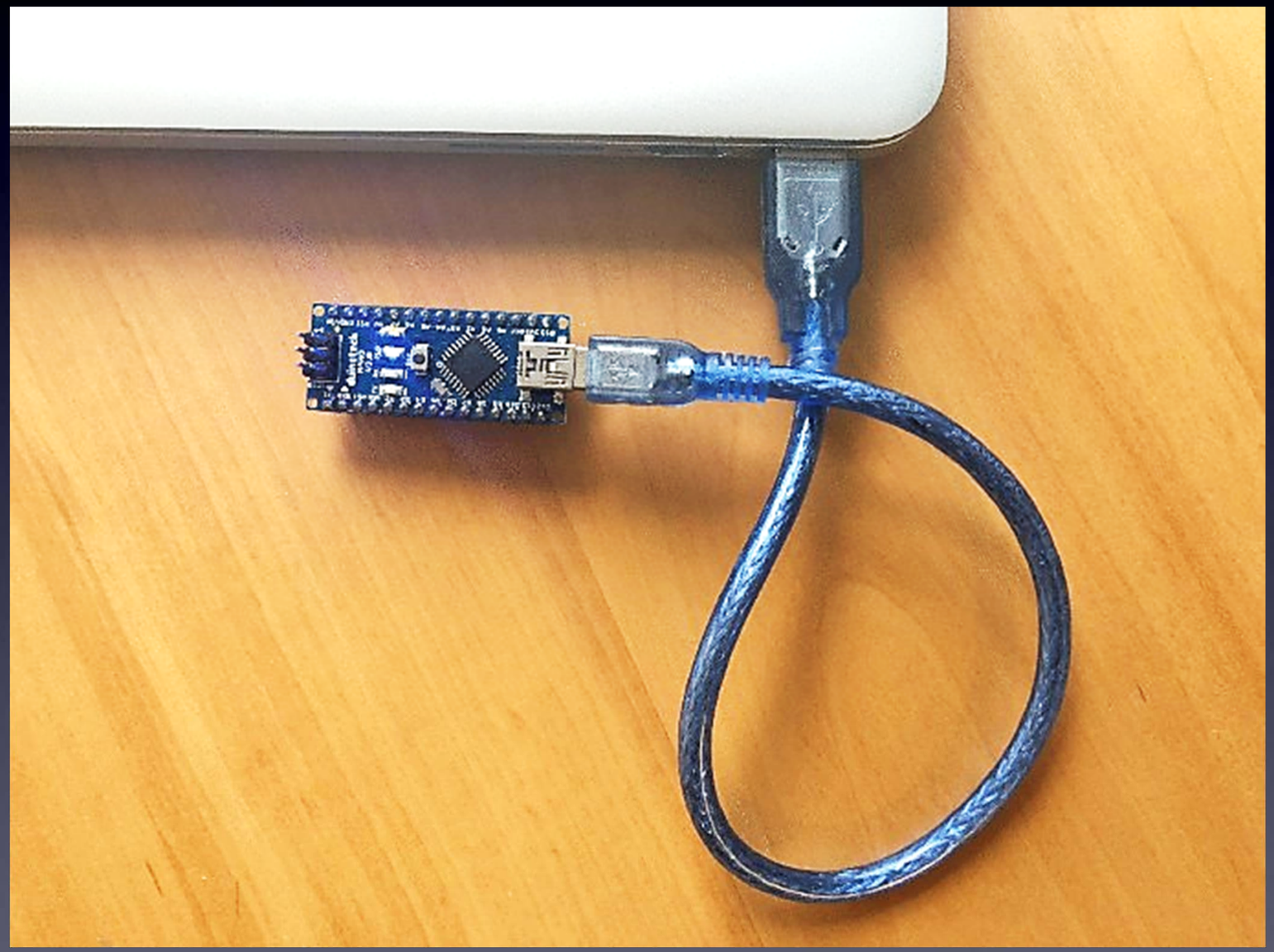
Store them on your computer anywhere you like.



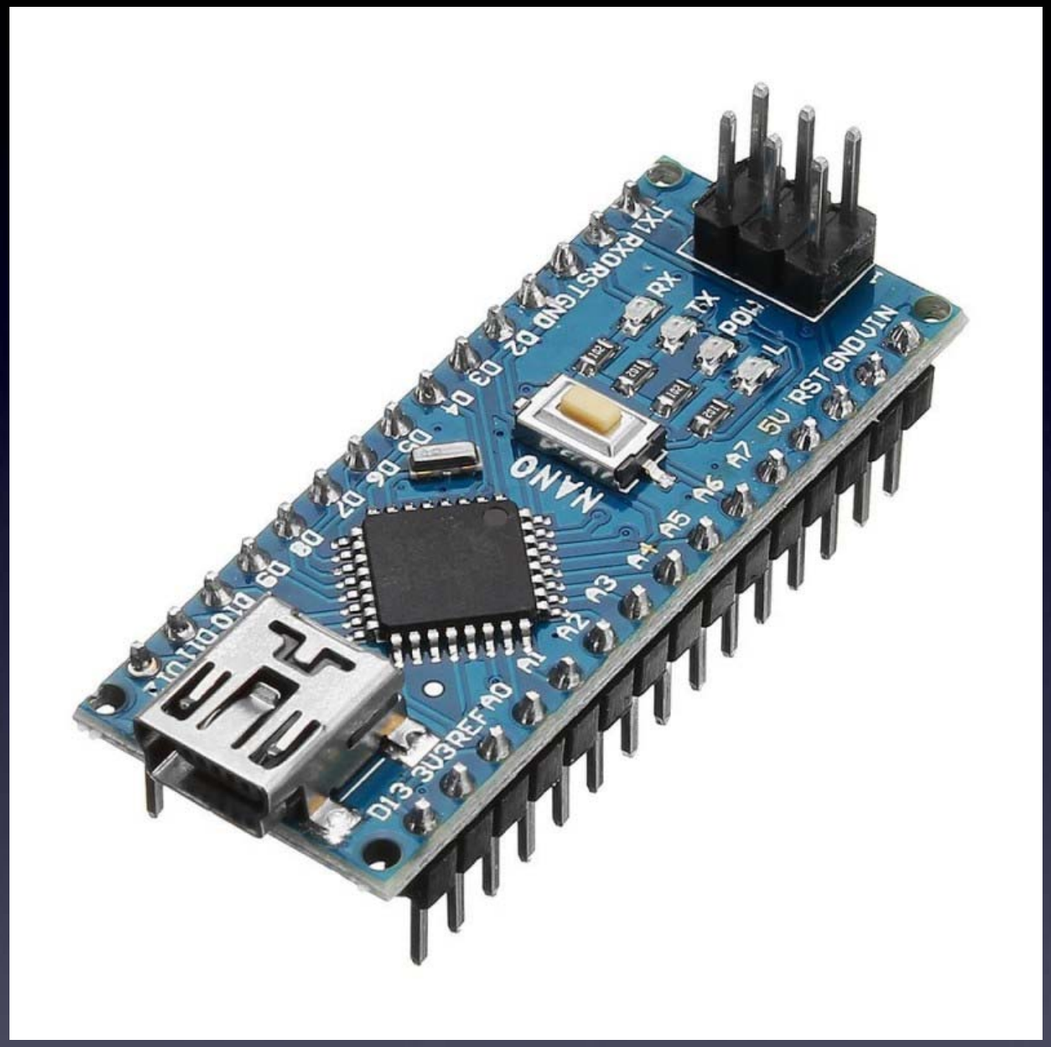
# Connect your Arduino to your computer



# Connect your Arduino to your computer



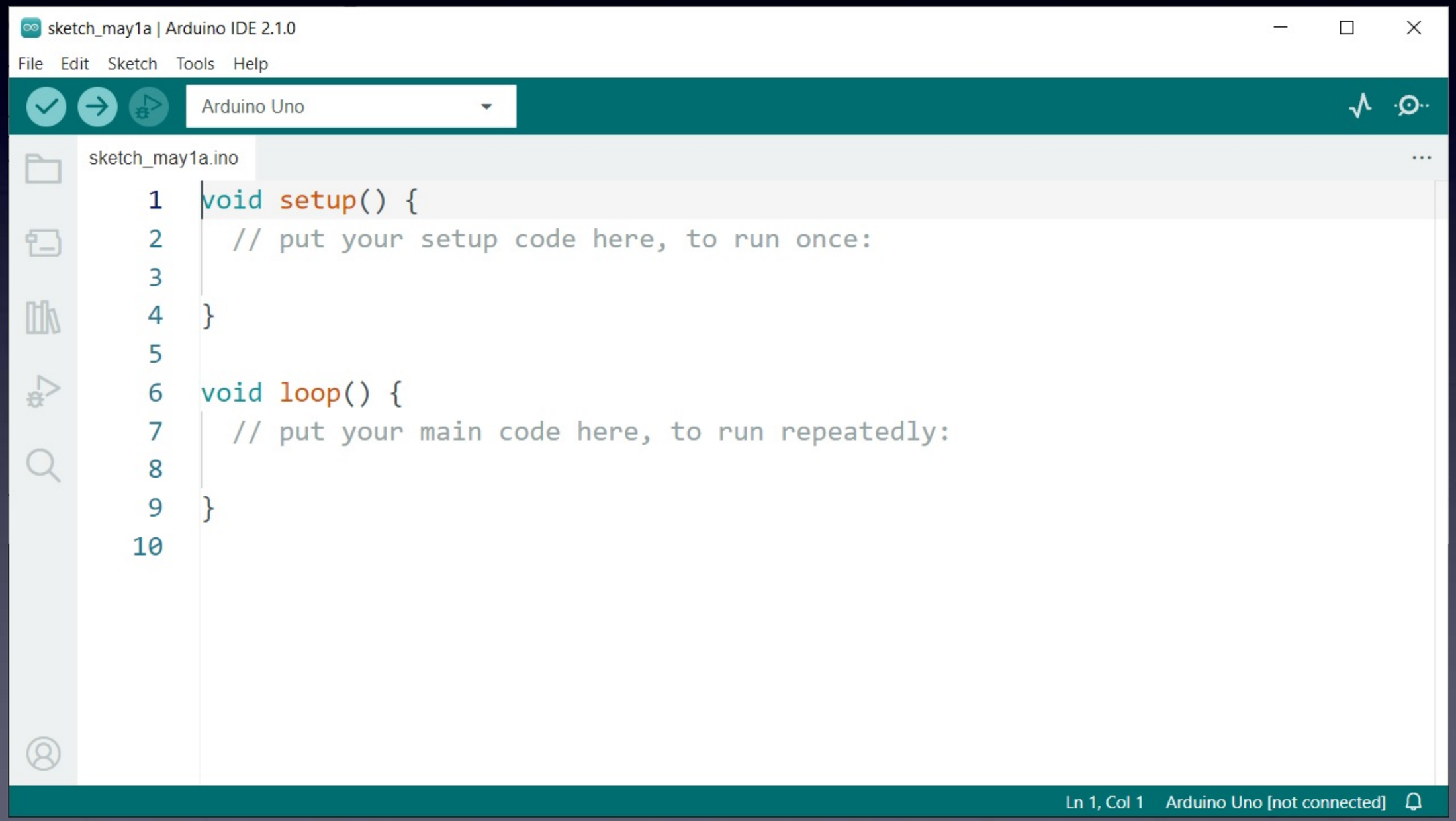
# Serial Port Driver




**You may need to download and install a driver for your Operating System (Windows, MacOS, or Linux):**

# Arduino

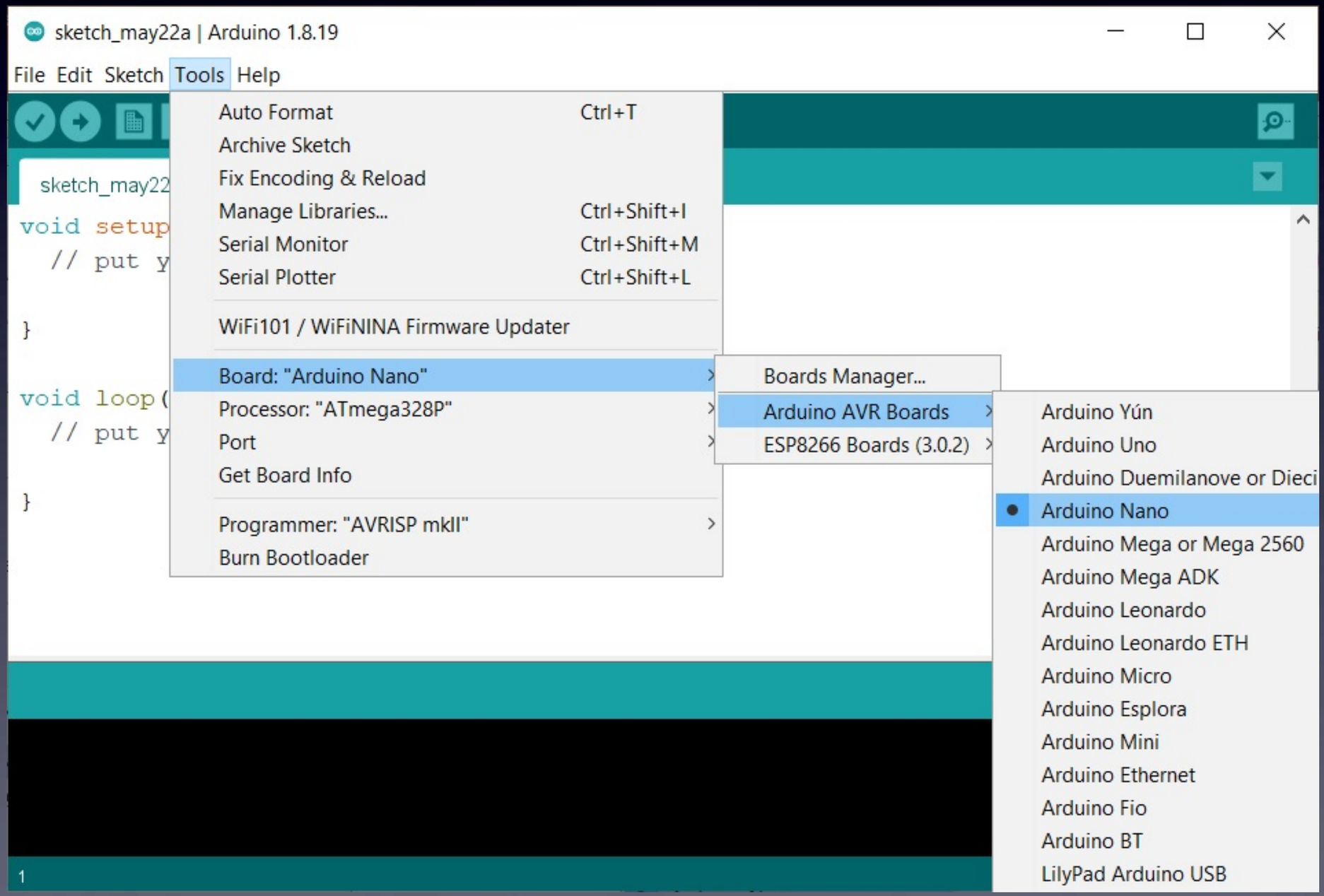
**After you download and install the Arduino software start it, and you will see a screen that looks like this:**



# Arduino

## The first time you start your Arduino software you need to set things up

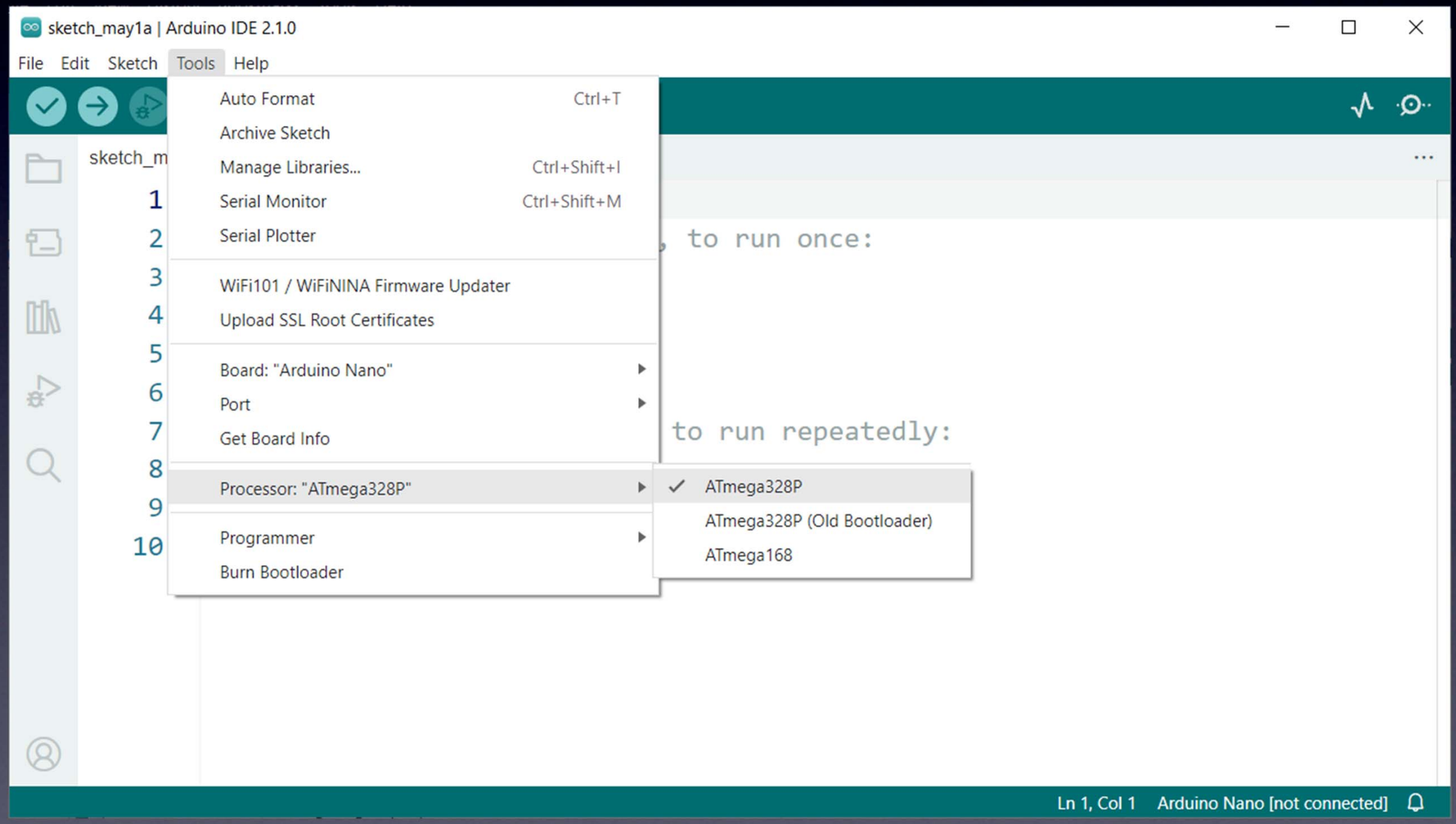
**(1) Choose “Arduino Nano” as the Board**



# Arduino

## The first time you start your Arduino software you need to set things up

**(2)**
**Choose your Processor as the Board**

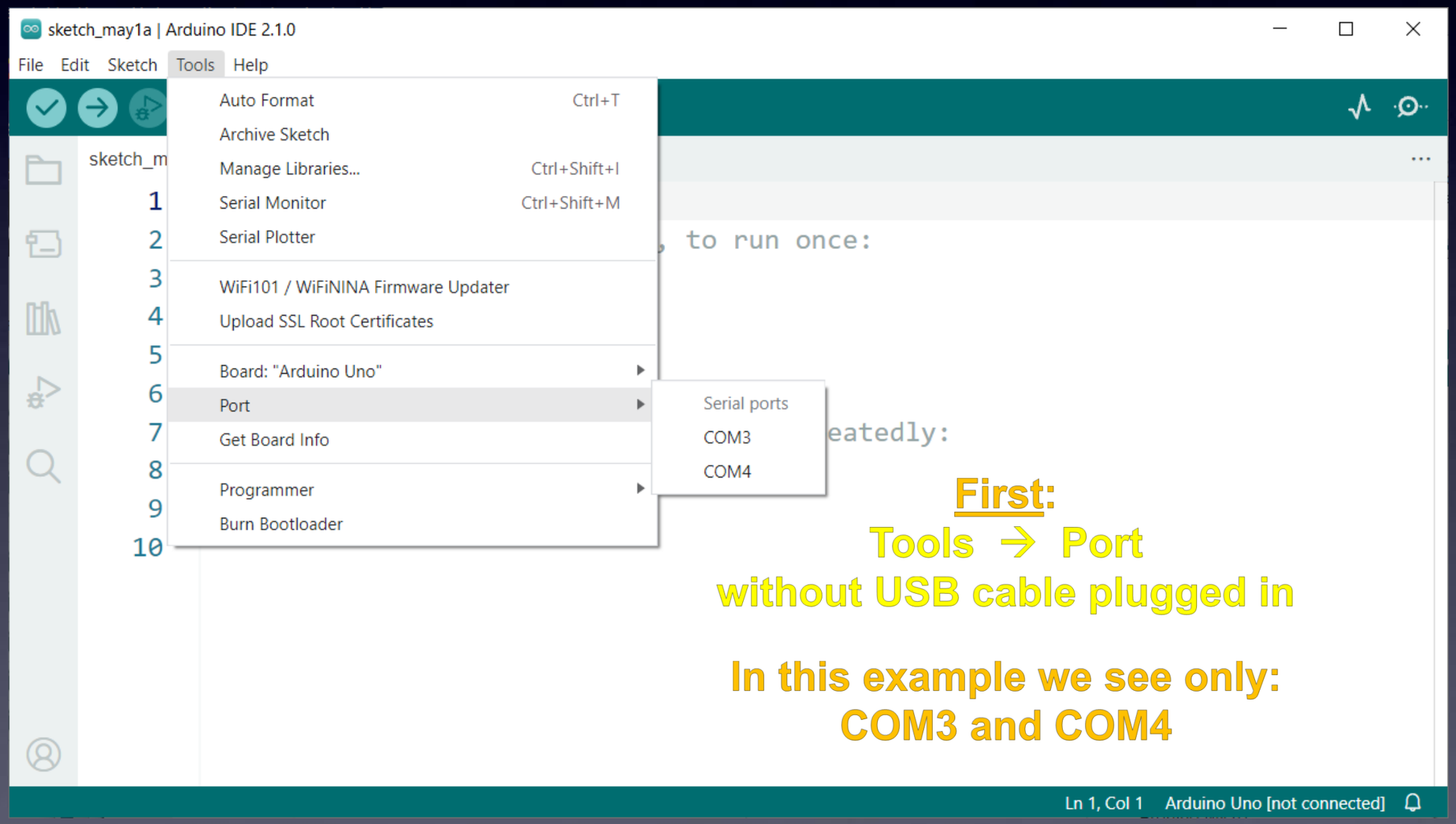



**If this one doesn't work, then choose "ATmega328P (Old Bootloader)"**

# Arduino

## The first time you start your Arduino software you need to set things up

**(3) Choose the Port (this will be different depending on your Operating System)**

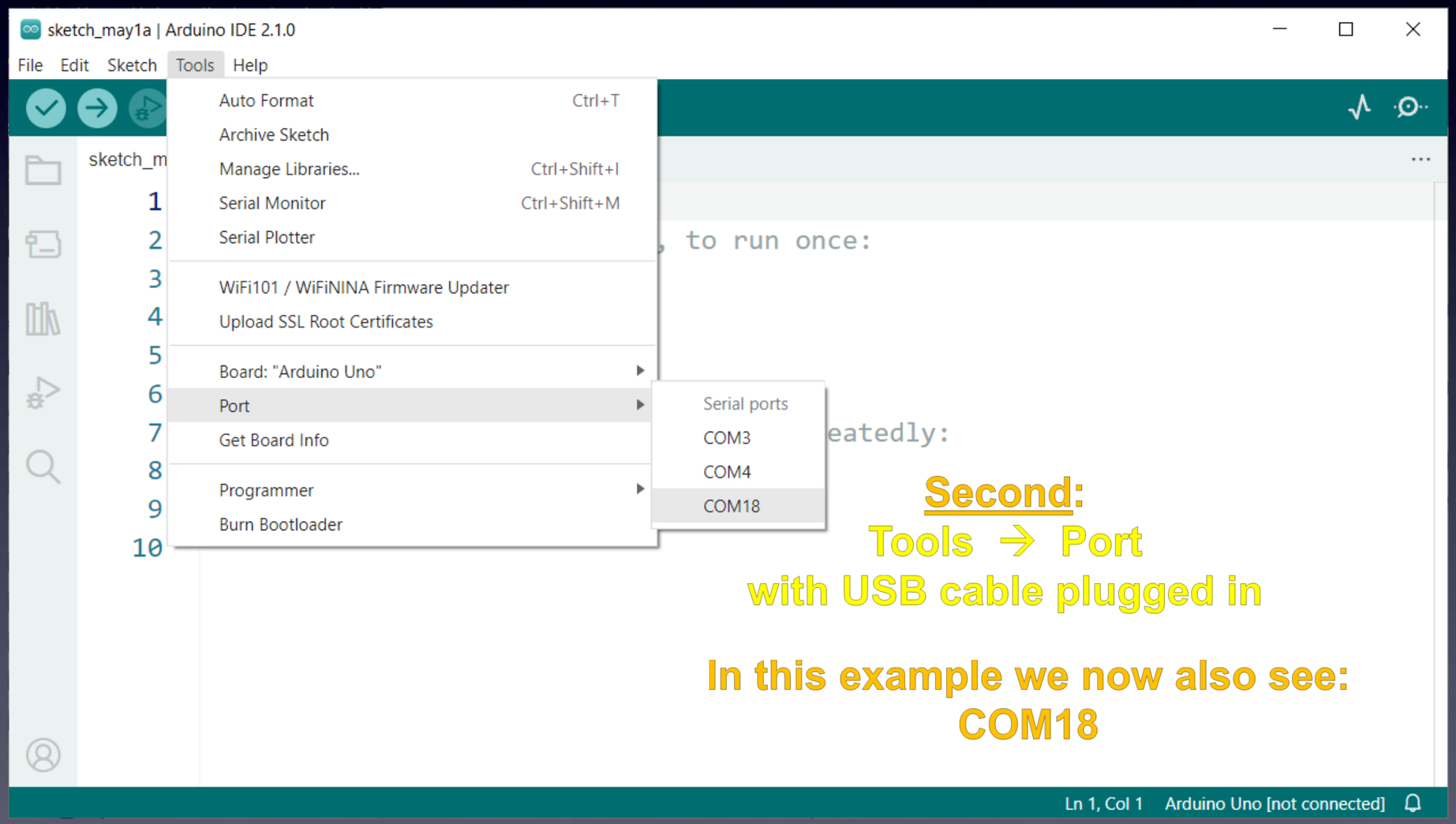


# Arduino

## The first time you start your Arduino software you need to set things up

**(3) Choose the Port (this will be different depending on your Operating System)**

**(After installing the driver for your Arduino (USB-Serial adapter), with your Arduino plugged in, your operating system will see a serial port and it appears here.)**



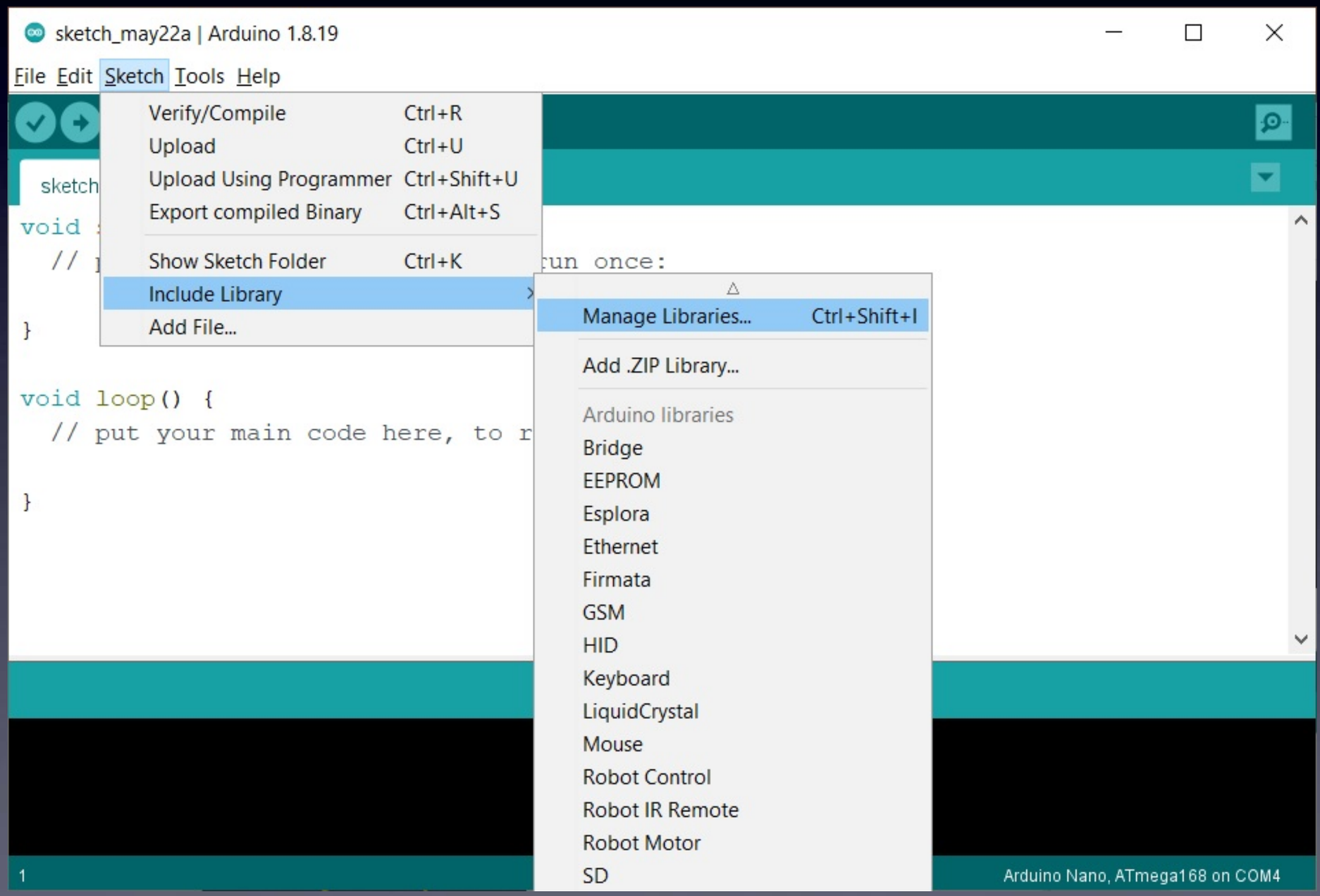

**Second:**
**Tools → Port**
**with USB cable plugged in**

**In this example we now also see: COM18**

# Arduino

## The first time you start your Arduino software you need to set things up

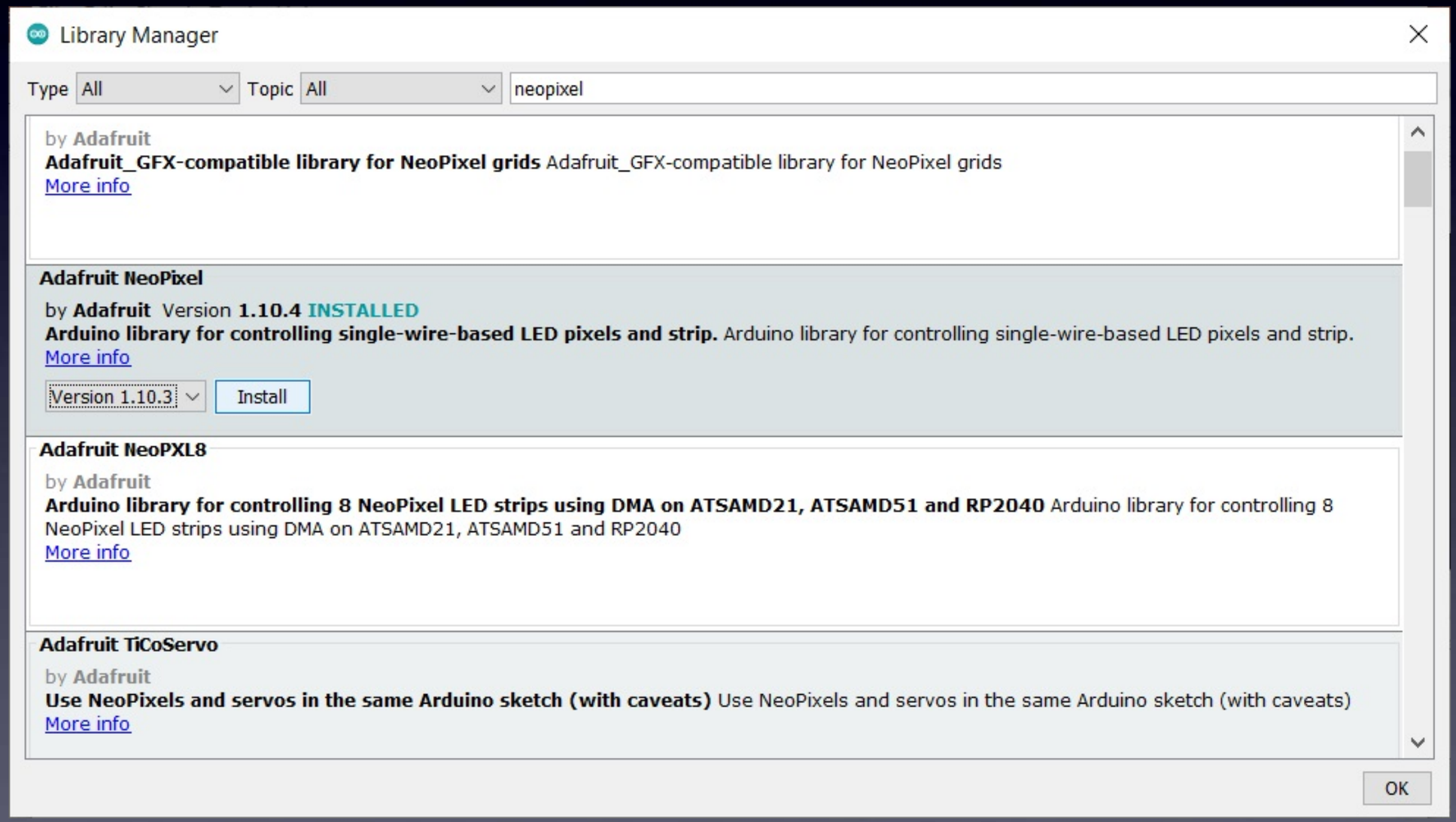
**(4a) Install the Neopixel library**



# Arduino

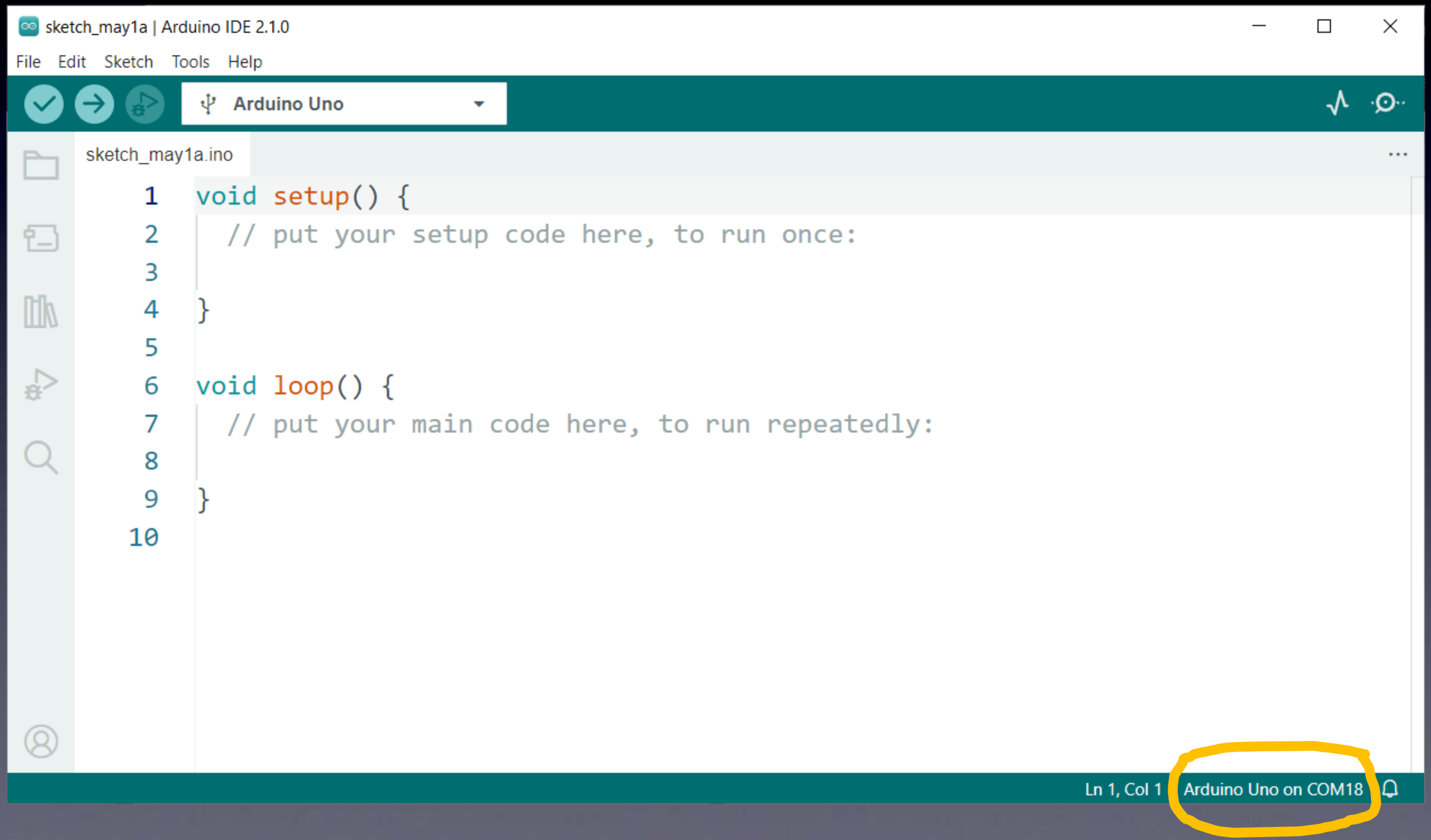
## The first time you start your Arduino software you need to set things up

## (4b) Install the Neopixel library



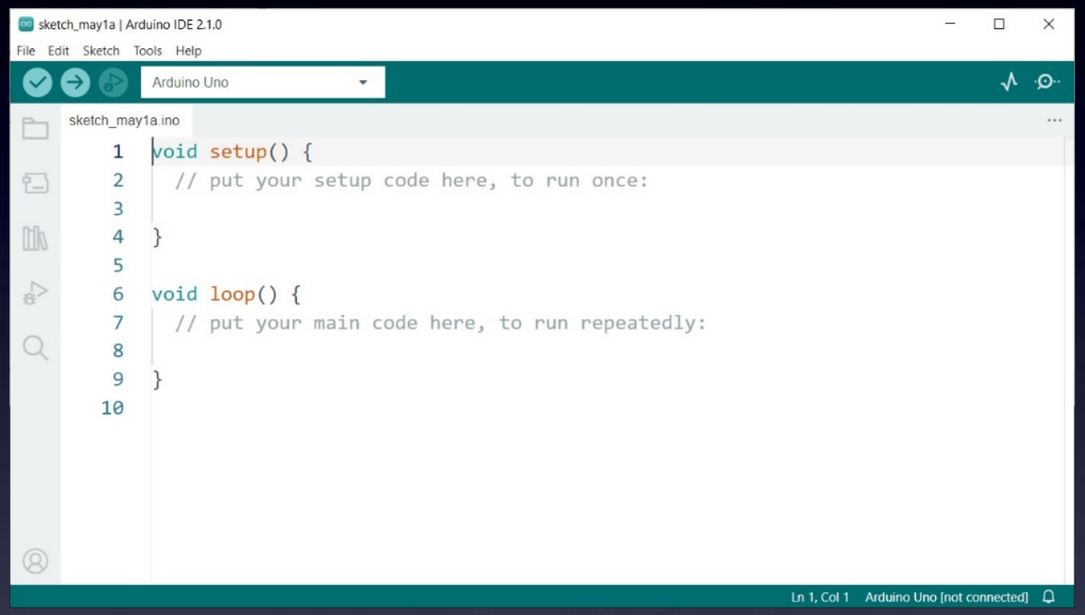
# Arduino

## Your Arduino software is now ready to program your Arduino board!



# Arduino

## Designed for non-geeky artists



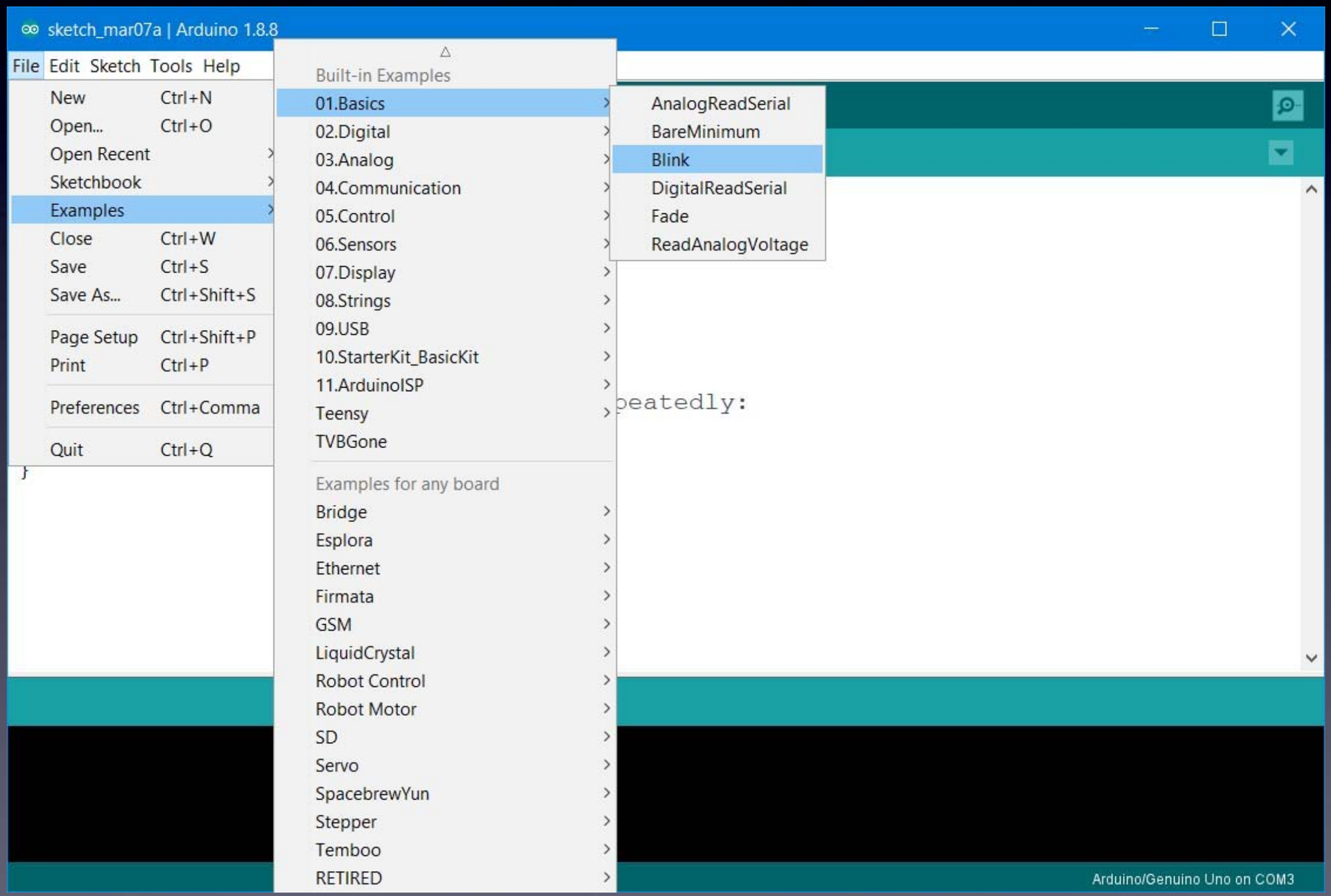

**“Sketch” :**

**an Arduino program**

# Arduino

## Let’s start simple!

## Let’s all make an LED blink!



# Arduino

## Example “sketch”:  Blink

Blink | Arduino 1.8.19

File Edit Sketch Tools Help

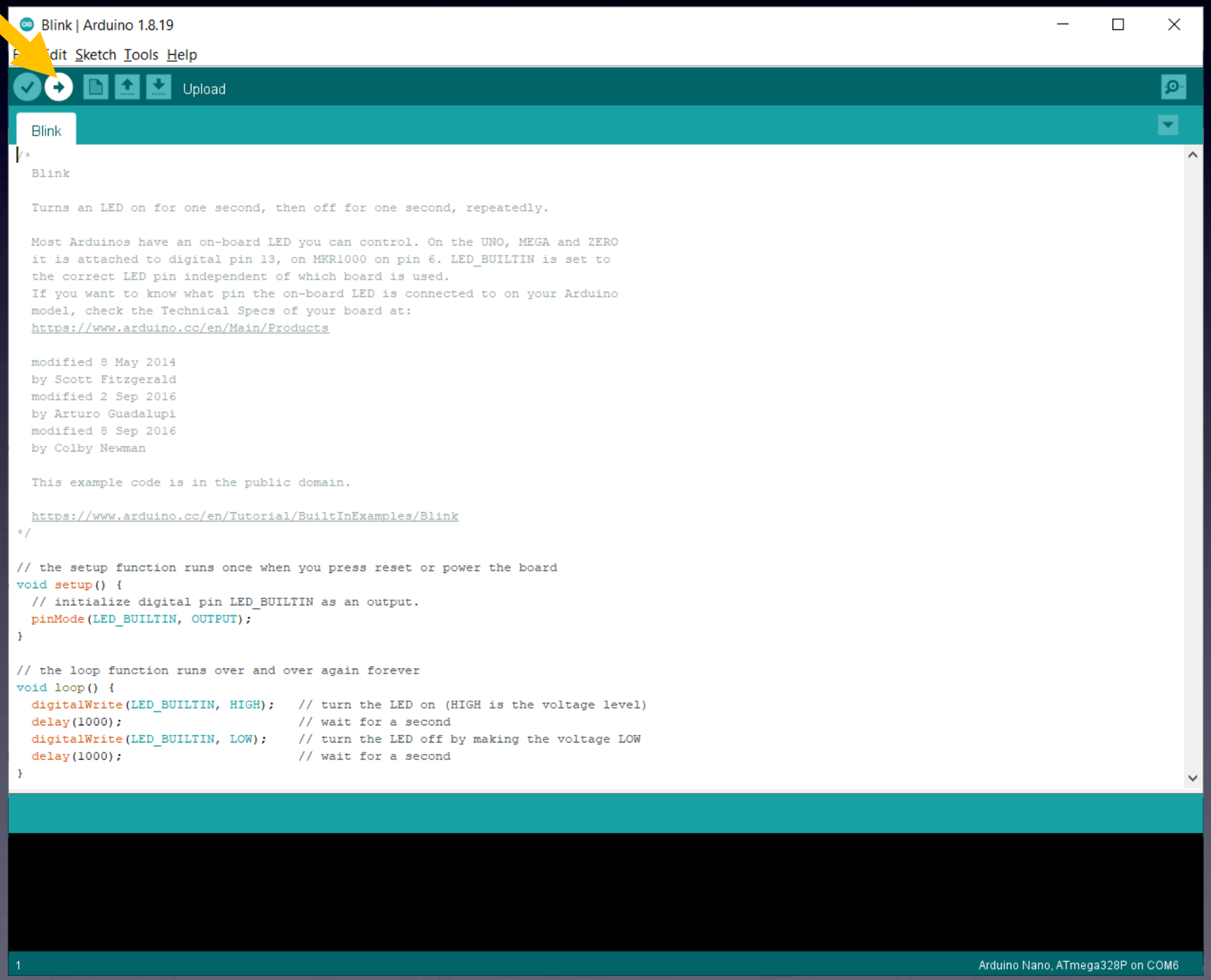
Blink

```
/*
  Blink

  Turns an LED on for one second, then off for one second, repeatedly.

  Most Arduinos have an on-board LED you can control. On the UNO, MEGA and ZERO
  it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILTIN is set to
  the correct LED pin independent of which board is used.
  If you want to know what pin the on-board LED is connected to on your Arduino
  model, check the Technical Specs of your board at:
  https://www.arduino.cc/en/Main/Products

  modified 8 May 2014
  by Scott Fitzgerald
  modified 2 Sep 2016
  by Arturo Guadalupi
  modified 8 Sep 2016
  by Colby Newman

  This example code is in the public domain.

  https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink
*/

// the 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() {
  digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);                       // wait for a second
  digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);                       // wait for a second
}
```

1 Arduino Nano, ATmega168 on COM4

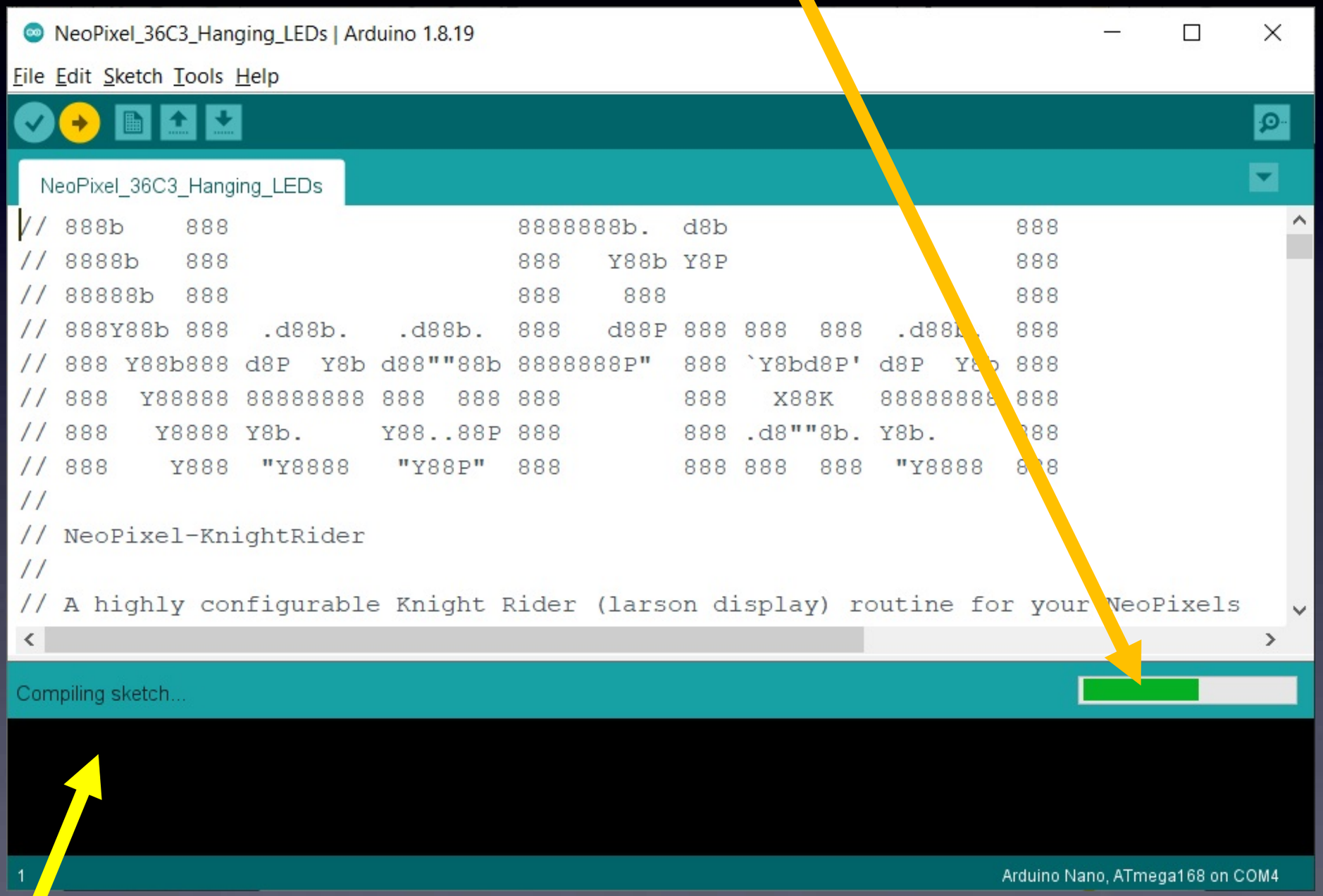
# Arduino

**With the USB cable connected to your Arduino board press the Upload button**



# Arduino

**While uploading, you will see a progress bar…**



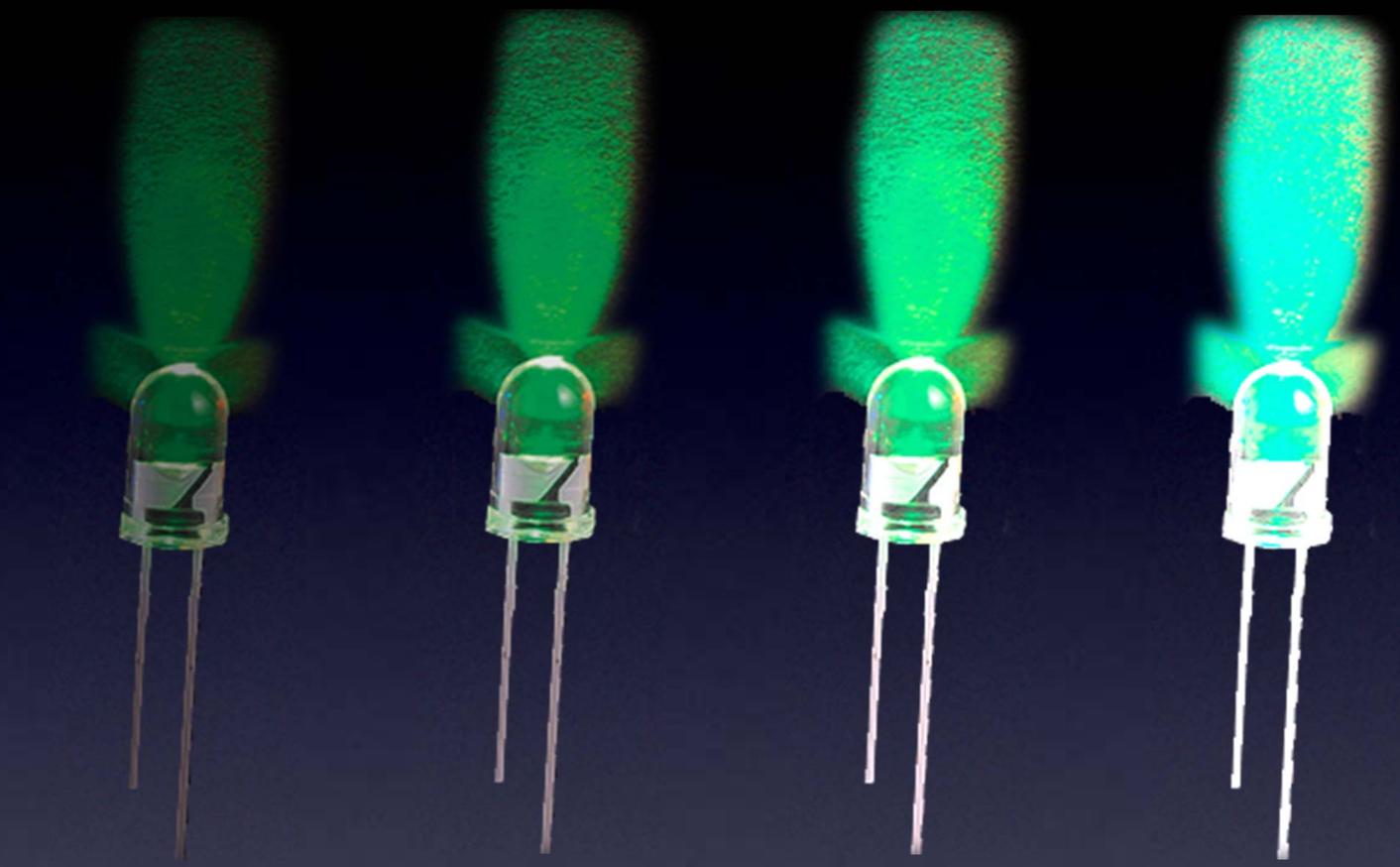

**…and when it's completed successfully, it says: "Upload done"**

# LED Brightness

More resistance (less current)

**(one way to change brightness)**

# LED Brightness



Less *average* current

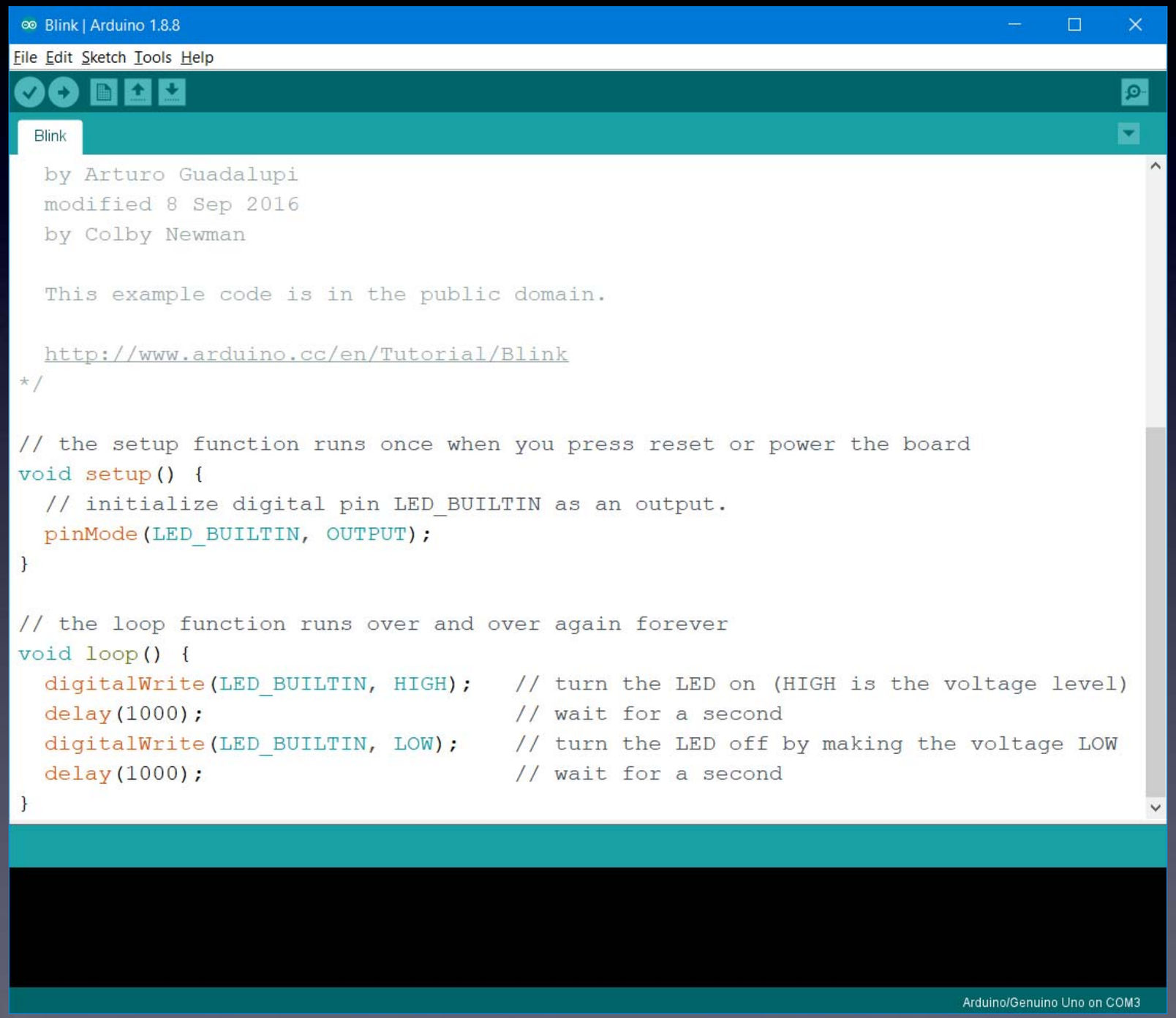
**This is how we do it with a microcontroller**

# LED Brightness

**PWM**

# Arduino

## Hacking the Blink sketch



# LED Brightness

PWM

**Square Wave:**

ON half the time / OFF half of the time

# LED Brightness

PWM

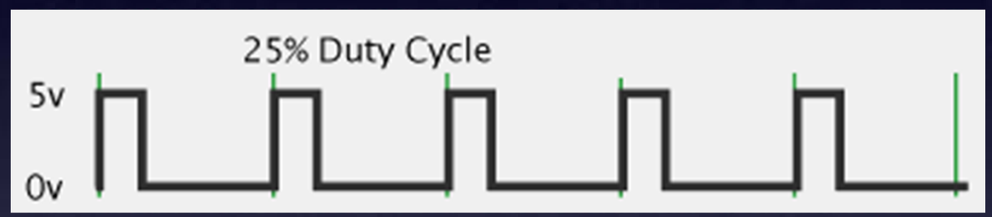
**Square Wave:**

ON half the time / OFF half of the time

*(half the energy of ON all the time)*

# Digital Signal Processing

PWM ?



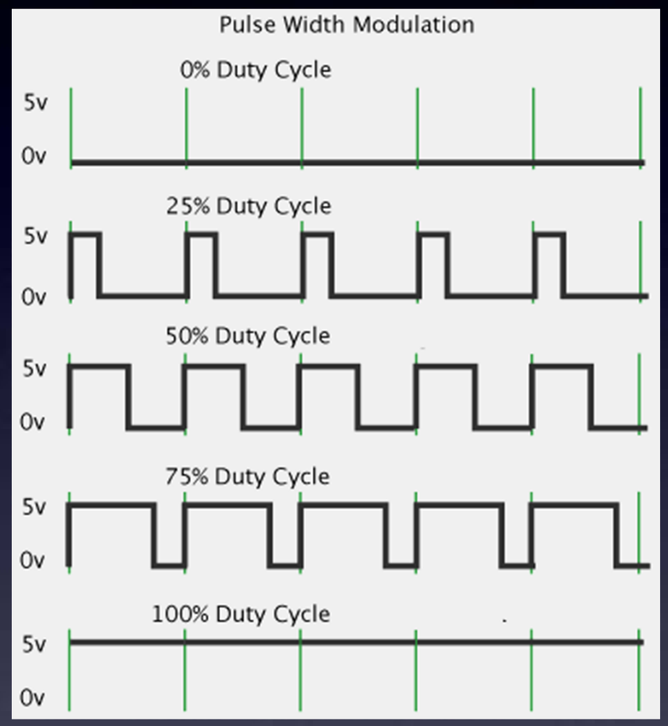

**Pulse Wave:**

ON and OFF at any ratio you like

**This waveform:  ON for 25% of the time / OFF for 75% of the time**

# LED Brightness

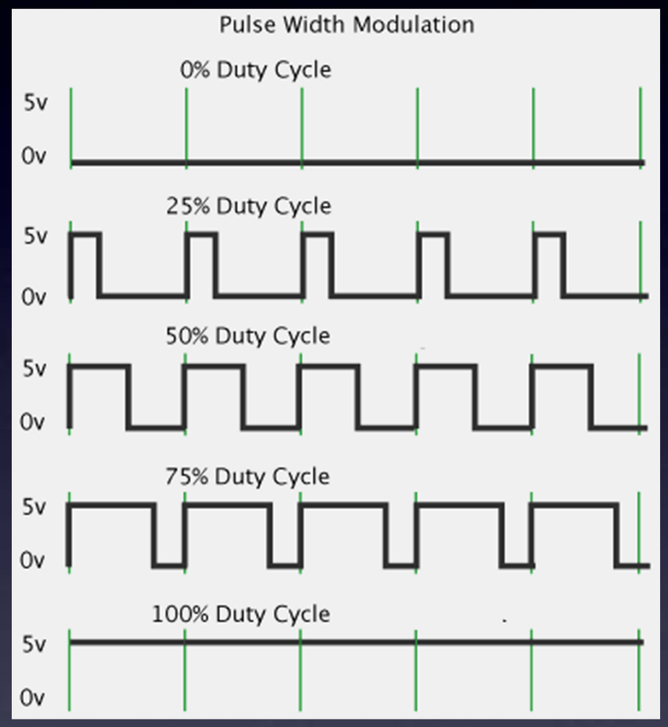
PWM




**Pulse Wave:**

ON and OFF at any ratio you like

# LED Brightness




**PWM**
**Pulse Width Modulation**

# Arduino

## Example “sketch”:  Fade

Fade | Arduino 1.8.19

File Edit Sketch Tools Help

Fade §

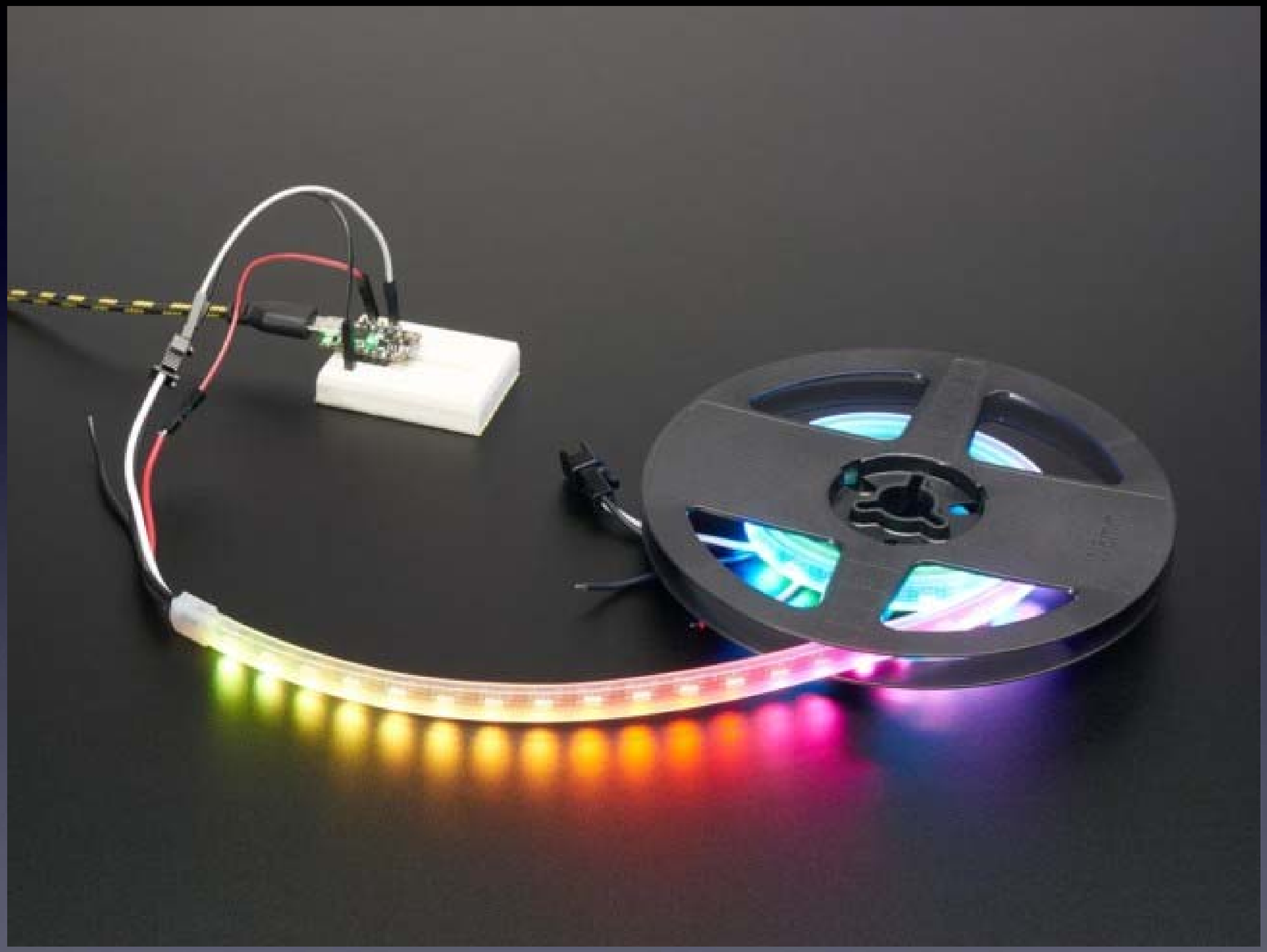
```
/*
  Fade

  This example shows how to fade an LED on pin 9 using the analogWrite()
  function.

  The analogWrite() function uses PWM, so if you want to change the pin you're
  using, be sure to use another PWM capable pin. On most Arduino, the PWM pins
  are identified with a "~" sign, like ~3, ~5, ~6, ~9, ~10 and ~11.

  This example code is in the public domain.

  https://www.arduino.cc/en/Tutorial/BuiltInExamples/Fade
*/

int led = 9;           // the PWM pin the LED is attached to
int brightness = 0;    // how bright the LED is
int fadeAmount = 5;    // how many points to fade the LED by

// the setup routine runs once when you press reset:
void setup() {
  // declare pin 9 to be an output:
  pinMode(led, OUTPUT);
}
```

Done uploading.

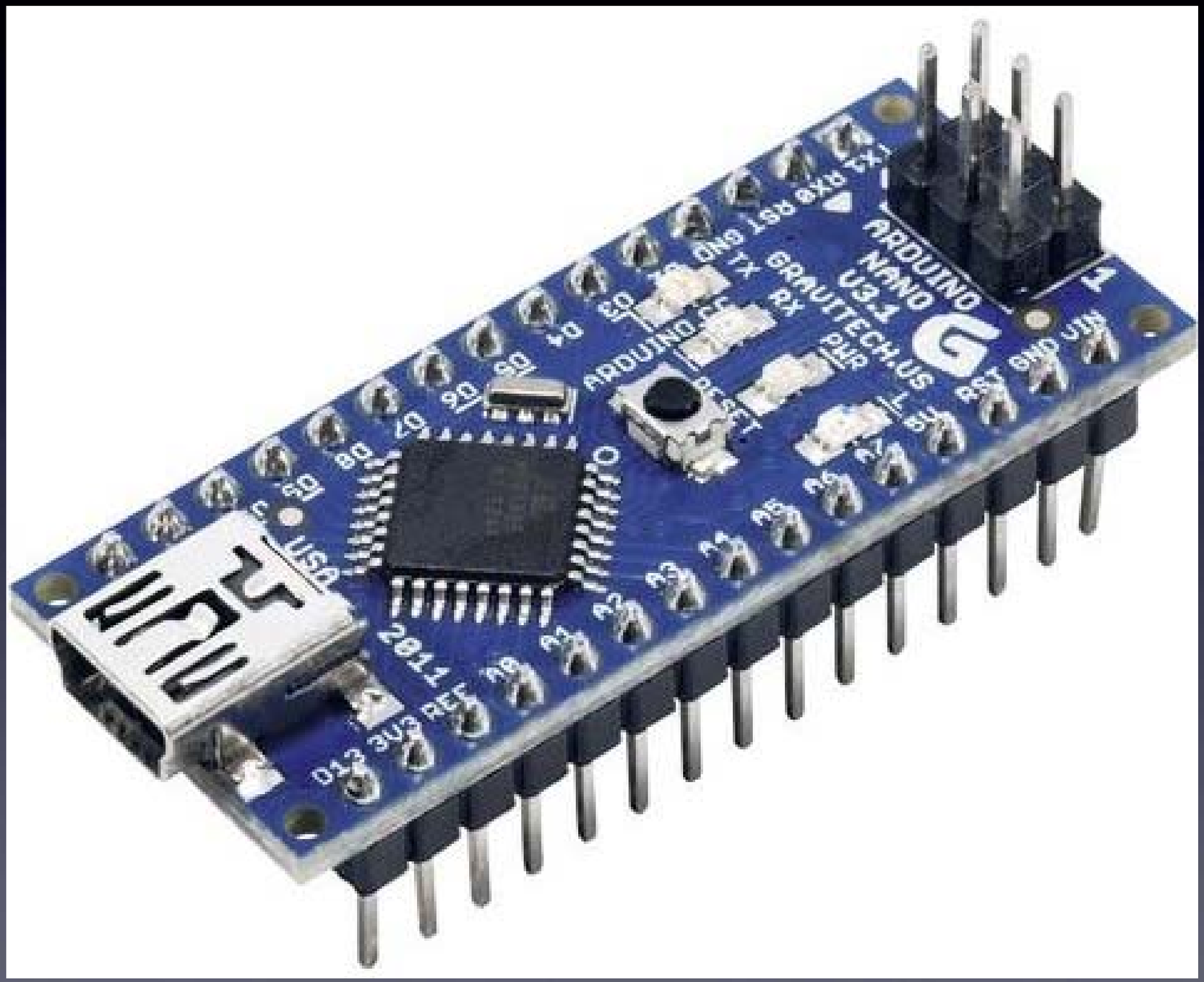
```
Sketch uses 1144 bytes (3%) of program storage space. Maximum is 32256 bytes.
Global variables use 13 bytes (0%) of dynamic memory, leaving 2035 bytes for local variable
```

1 Arduino Nano, ATmega168 on COM5

# Let’s Program Some LED Strips!

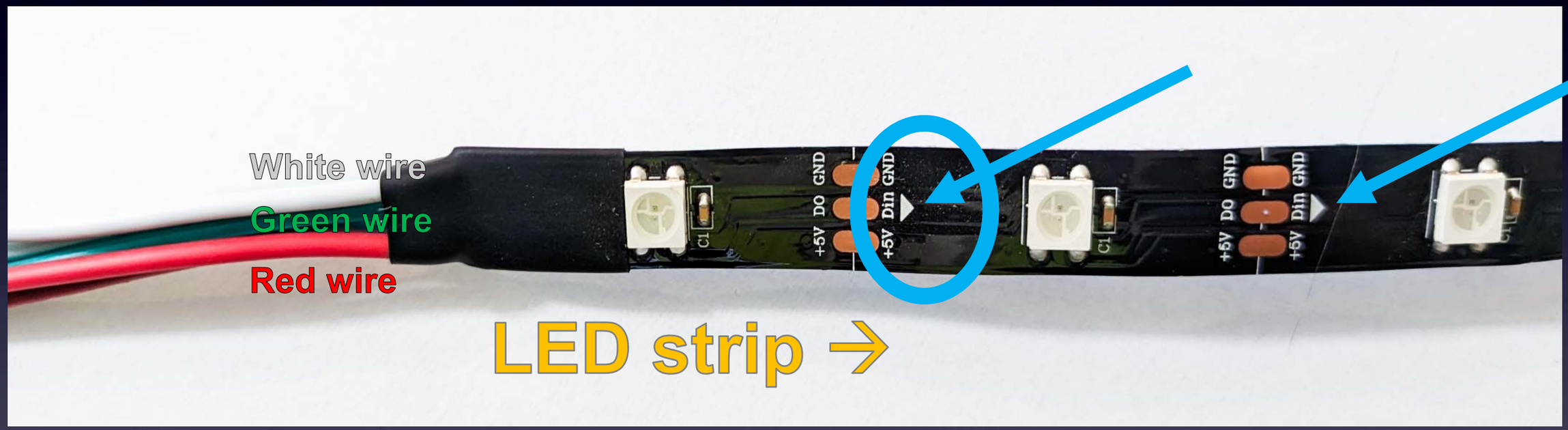


# Arduino Nano



# Arduino Uno

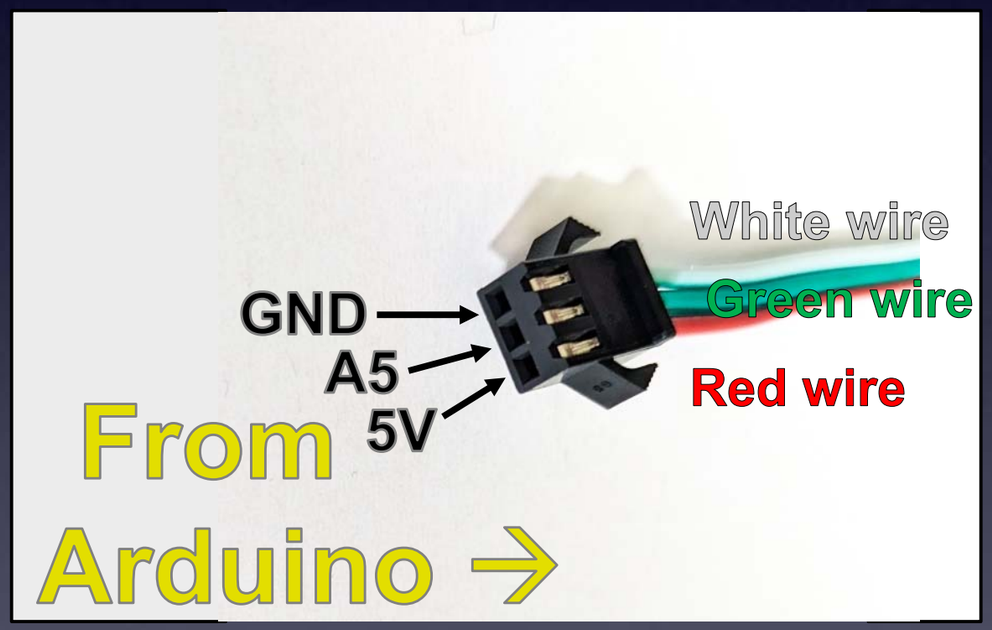
# Let’s Program Some LED Strips!




**The Input side of the LED Strip**
**has arrows at each LED pointing into the strip**

# Let’s Program Some LED Strips!

## The Input side of the LED Strip:

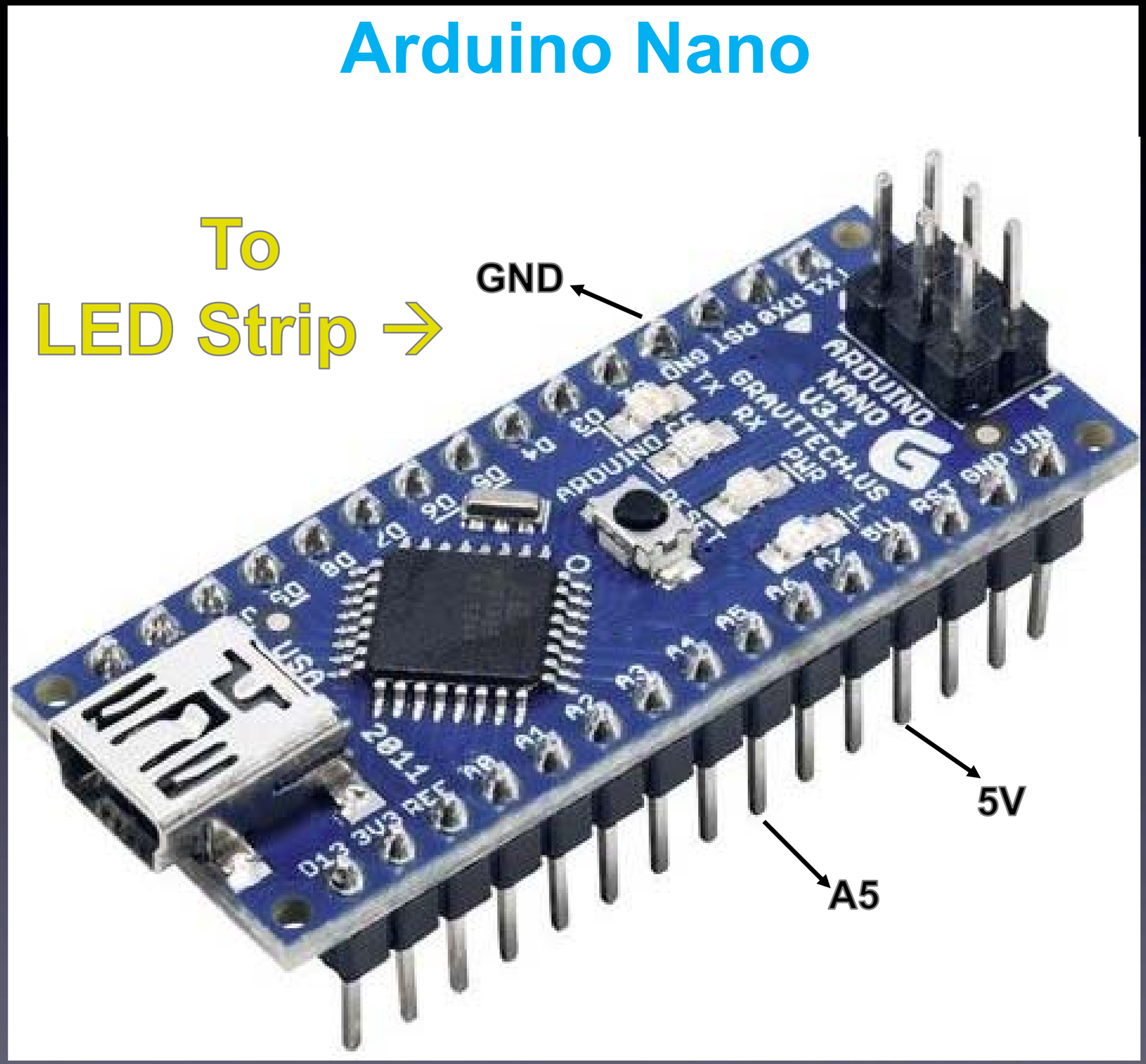



The Input connector of the LED Strip

The Input side of the LED Strip

# Let’s Program Some LED Strips!

## Arduino Nano



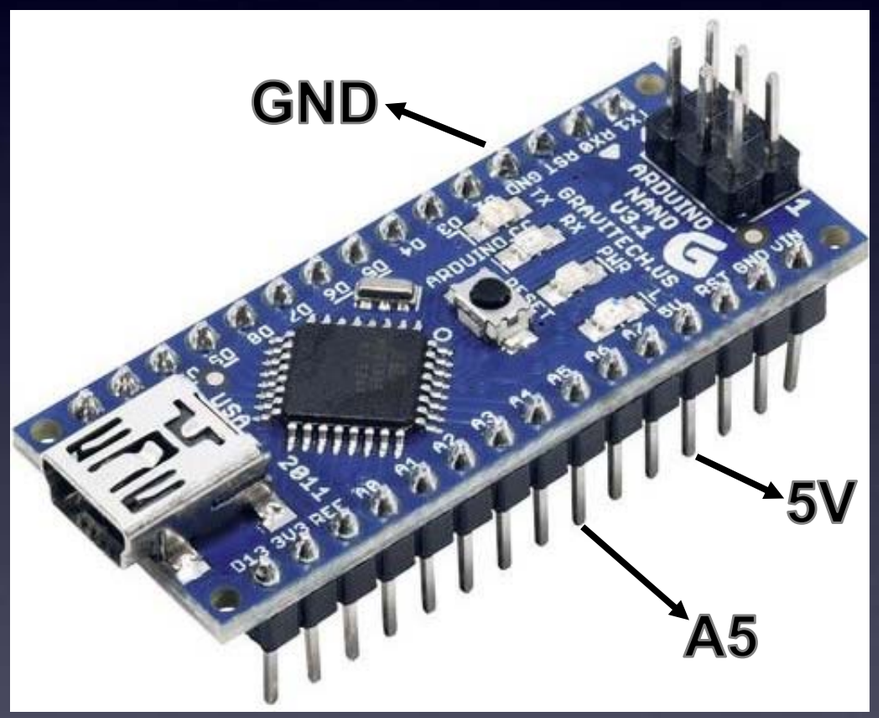
# Let’s Program Some LED Strips!

## Arduino Uno

To LED Strip →

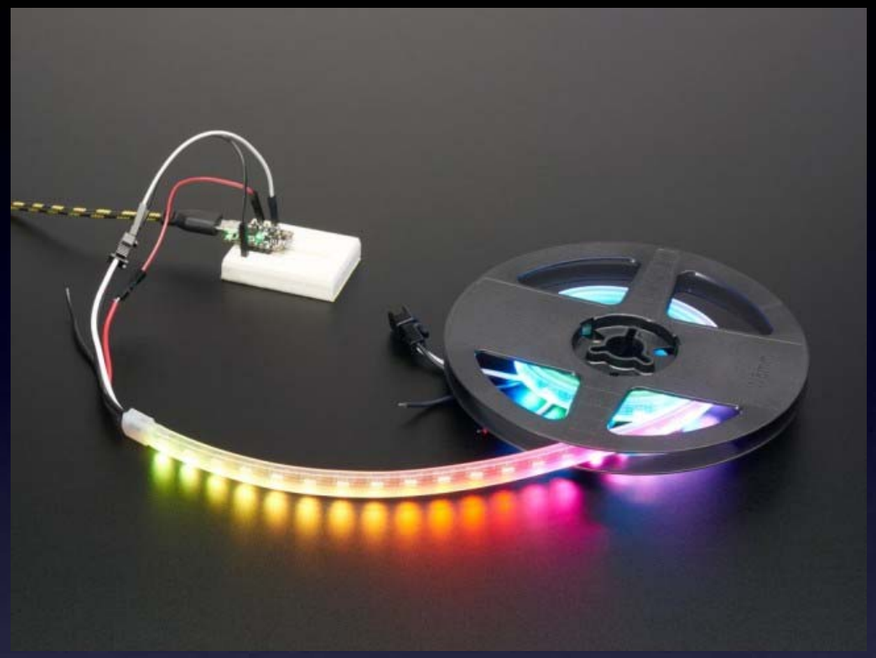
# Let’s Program Some LED Strips!

## Arduino Nano



The Input connector of the LED Strip

# Let’s Program Some LED Strips!

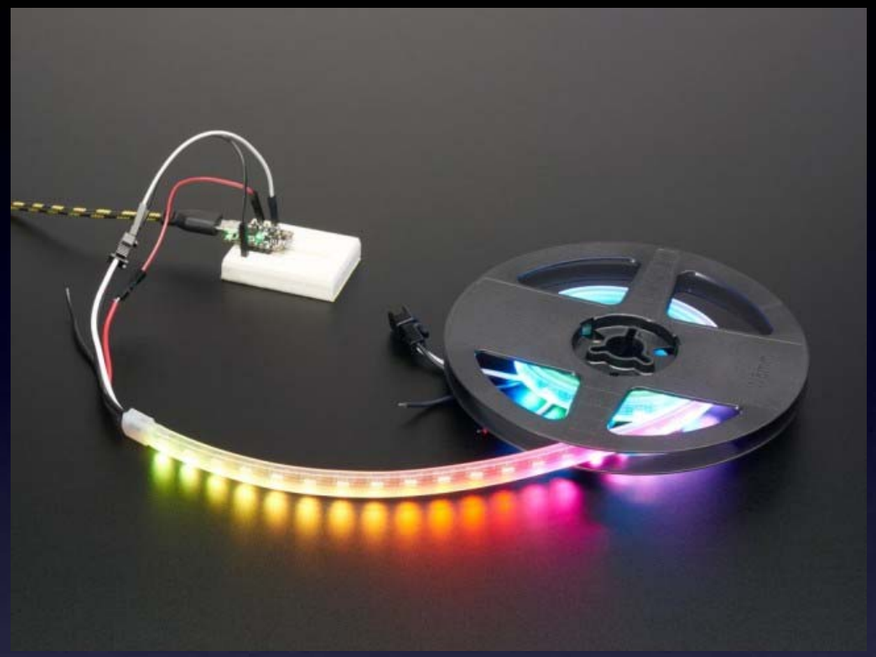


## Download some Arduino “sketches”:

**Search for:** *“RGB LED Strip Sketches”*

Store them on your computer anywhere you like.

# Let’s Program Some LED Strips!

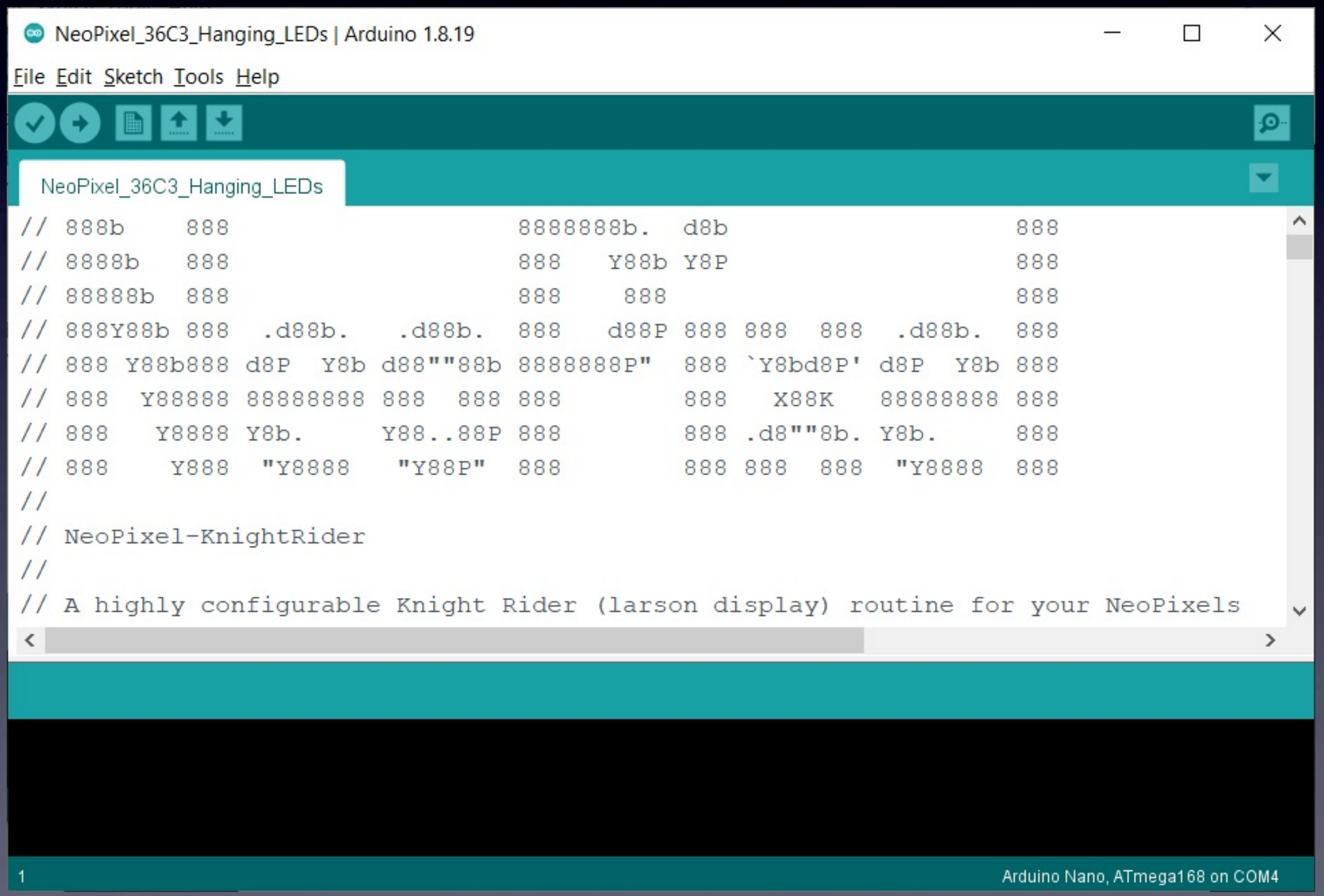


# Download some Arduino “sketches”:

https://CornfieldElectronics.com/cfe/projects.php#ledstrips

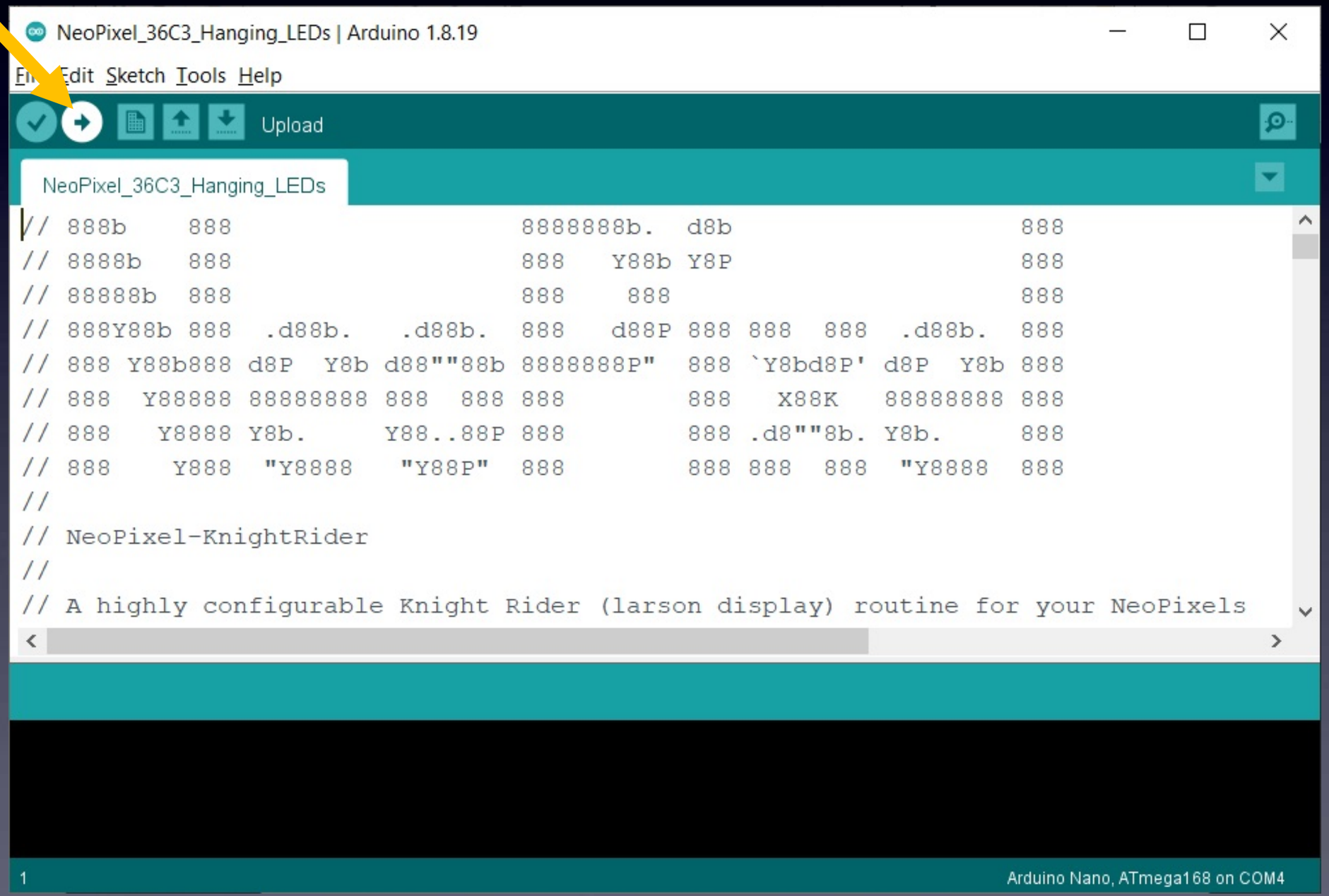
# Let’s Program Some LED Strips!

## Open the “sketch” you want to program



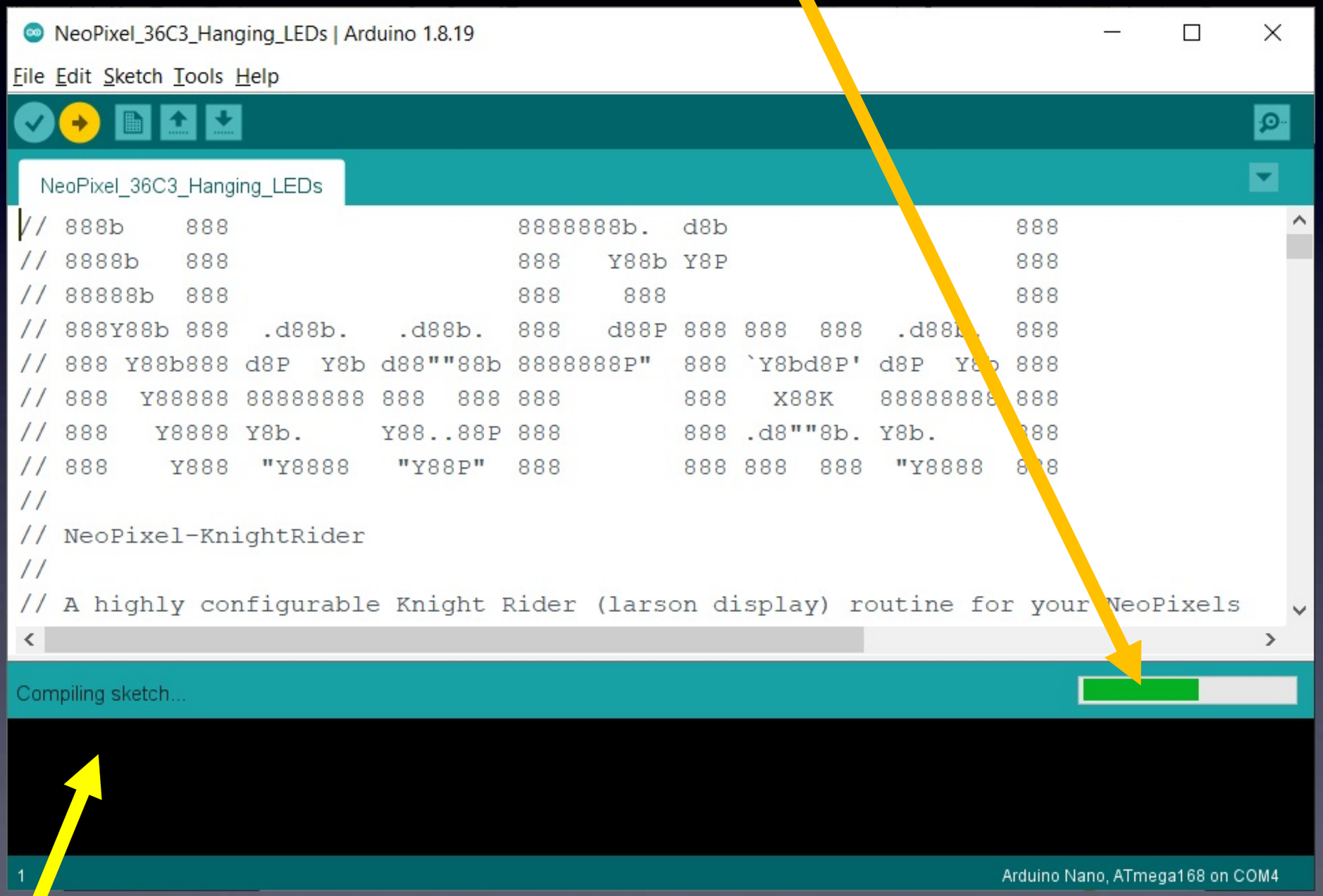
# Let’s Program Some LED Strips!

**With the USB cable connected to your Arduino board**
**press the Upload button**



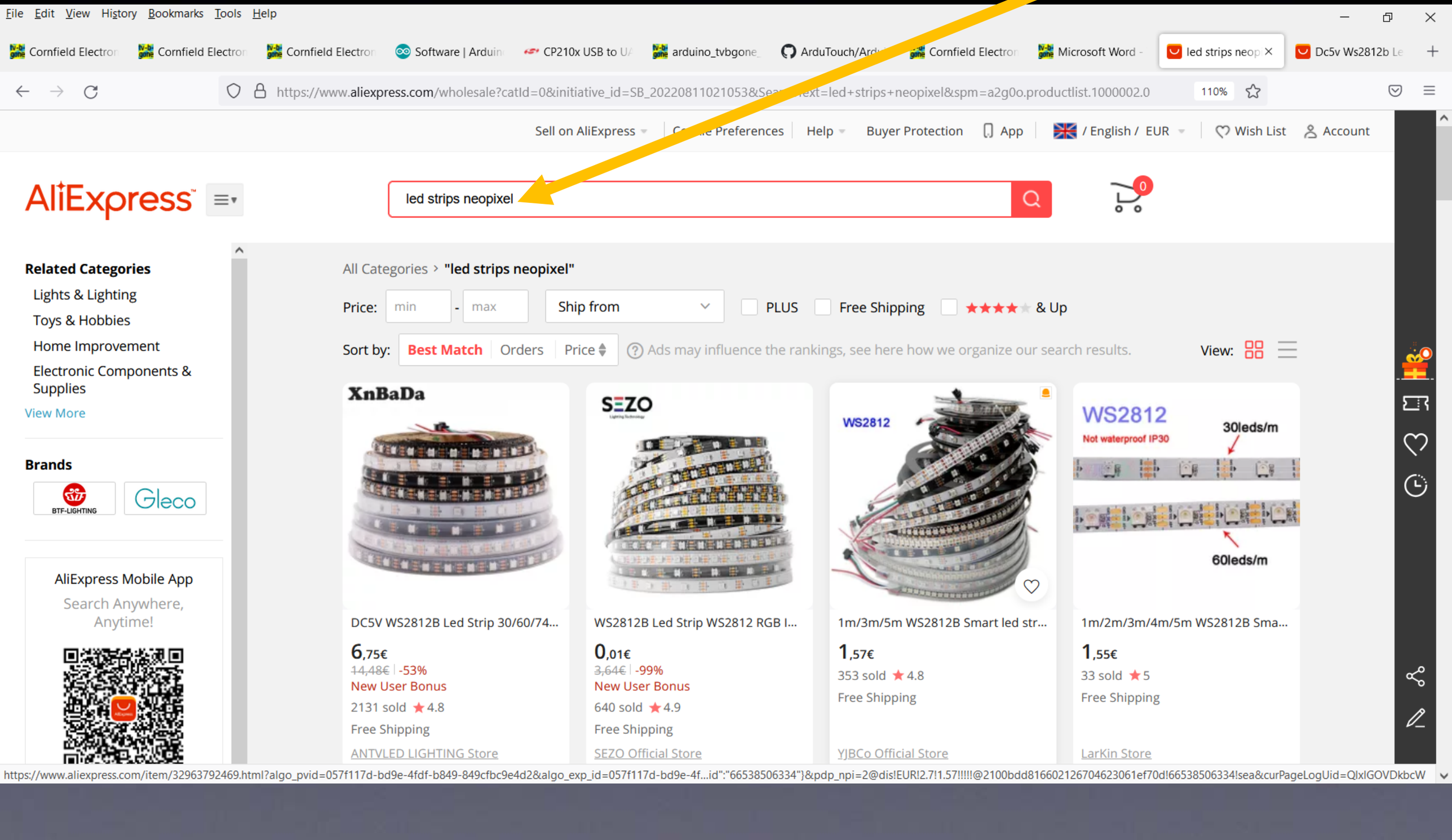
# Let’s Program Some LED Strips!

**While uploading, you will see a progress bar…**




**…and when it’s completed successfully, it says: “Upload done”**

# Ordering LED Strips



# Ordering LED Strips

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Emitting Color: Black PCB

Black PCB | White PCB

Wattage: 1M 30 IP30

| | | | | |
|---|---|---|---|---|
| 1M 30 IP30 | 2M 30 IP30 | 3M 30 IP30 | 4M 30 IP30 | 5M 30 IP30 |
| 1M 30 IP65 | 2M 30 IP65 | 3M 30 IP65 | 4M 30 IP65 | 5M 30 IP65 |
| 1M 30 IP67 | 2M 30 IP67 | 3M 30 IP67 | 4M 30 IP67 | 5M 30 IP67 |
| 1M 60 IP30 | 2M 60 IP30 | 3M 60 IP30 | 4M 60 IP30 | 5M 60 IP30 |
| 1M 60 IP65 | 2M 60 IP65 | 3M 60 IP65 | 4M 60 IP65 | 5M 60 IP65 |
| 1M 60 IP67 | 2M 60 IP67 | 3M 60 IP67 | 4M 60 IP67 | 5M 60 IP67 |
| 1M 74 IP30 | 1M 74 IP65 | 1M 74 IP67 | 1M 96 IP30 | 1M 96 IP65 |
| 1M 96 IP67 | 1M 144 IP30 | 1M 144 IP65 | 1M 144 IP67 | |

Quantity:

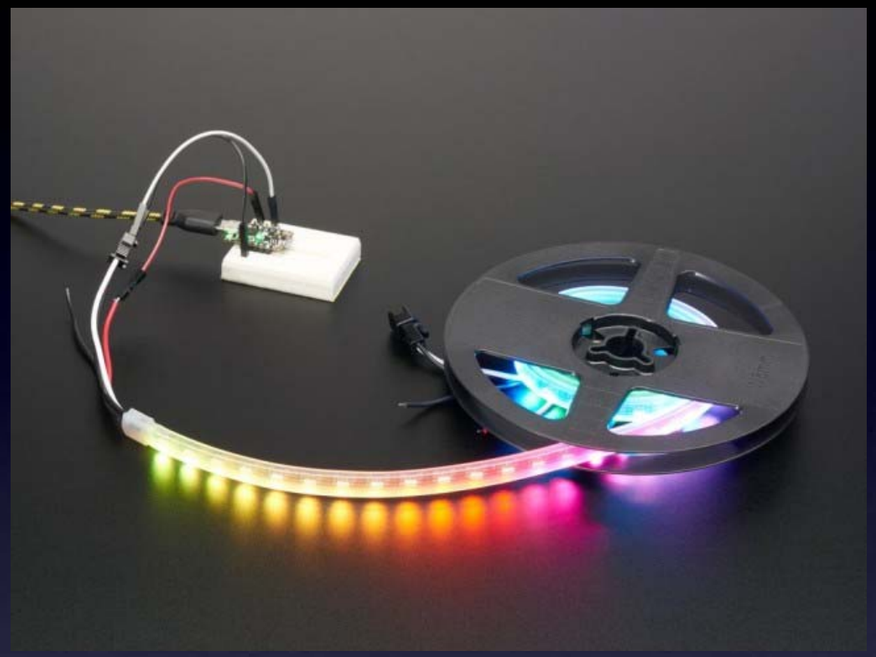
Recommended For You

€ 3,24

€ 4,95

€ 5,02

# *LED Strips for Everyone Everywhere*



**These slides are also available at:**

**https://CornfieldElectronics.com/cfe/projects.php#ledstrips**

Rev4: 23-Dec-2023

# *LED Strips for Everyone Everywhere*


## Mitch Altman

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Inventor of **TV-B-Gone** universal remote controls
Co-founder of **3Ware** (successful Silicon Valley startup)
Pioneer of **VR** (in the mid-1980s)
Founding mentor at **HAX** (1st and biggest hardware accelerator)
Co-founder of **Noisebridge** (San Francisco hackerspace)

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flickr: **maltman23**
WeChat: **mitchaltman**


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