

# *LED Strips for Everyone Everywhere*

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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** (1<sup>st</sup> and biggest hardware accelerator)

Co-founder of **Noisebridge** (San Francisco hackerspace)

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# *LED Strips for Everyone Everywhere*

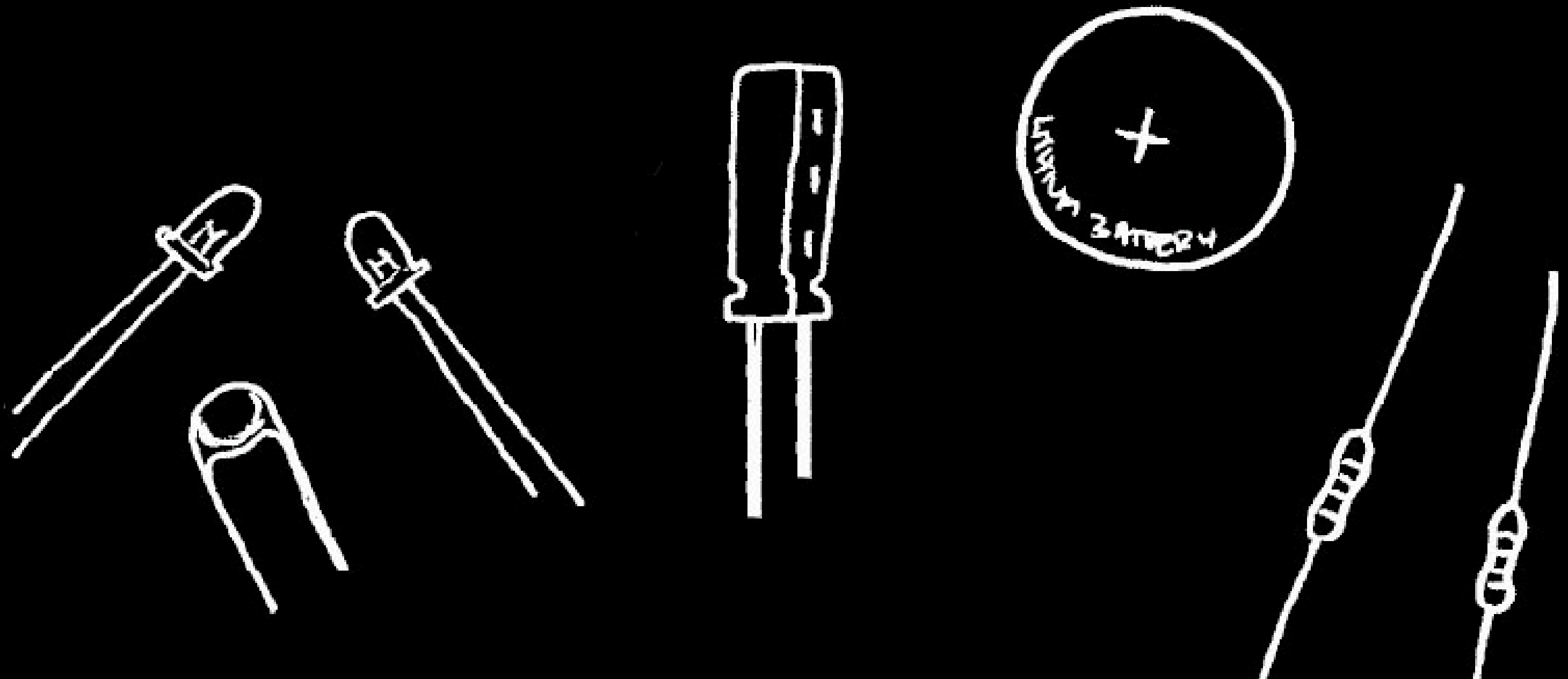


# LEDs

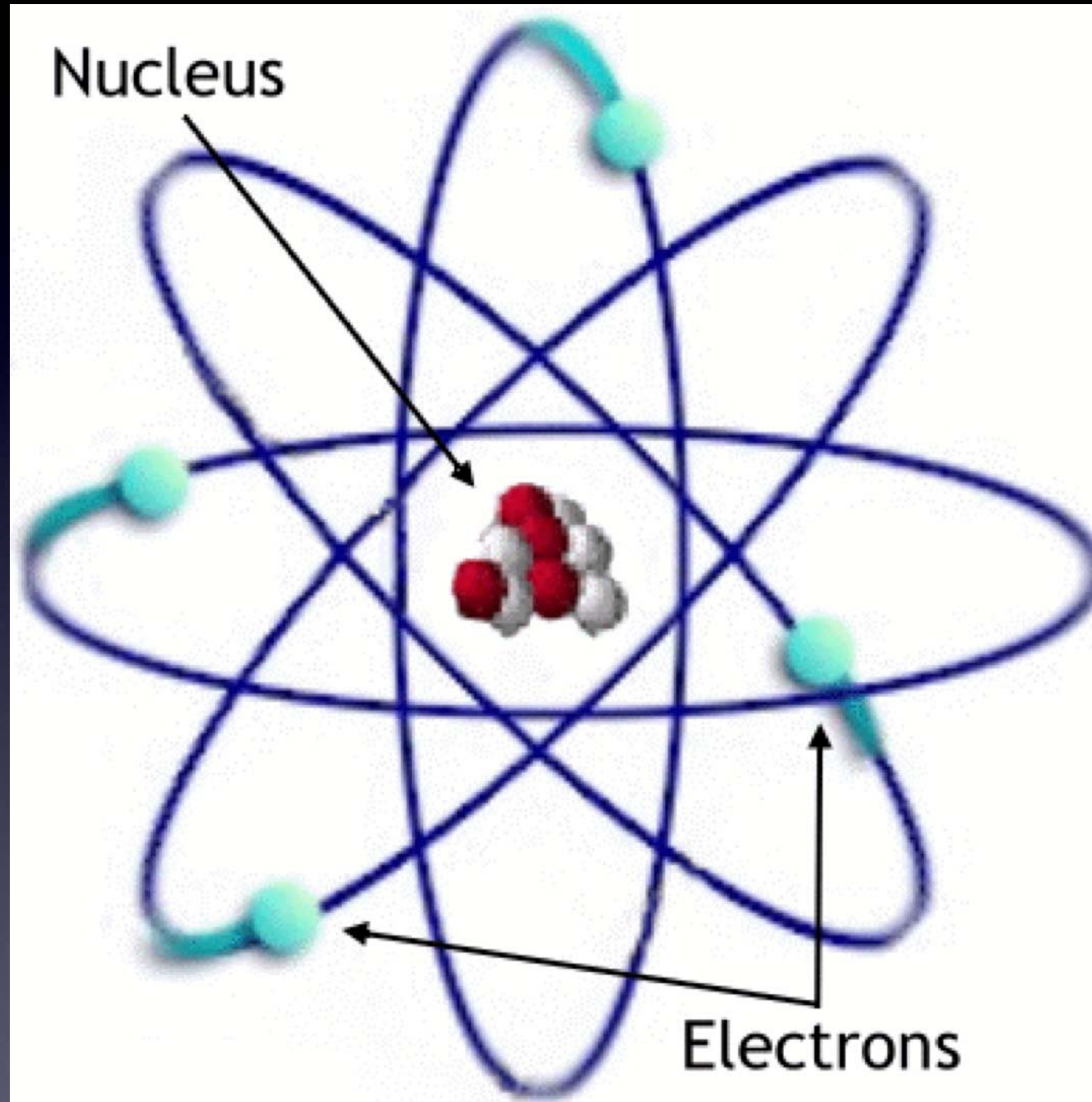


Lots of different colored LEDs!

# *A Little About Electronics*

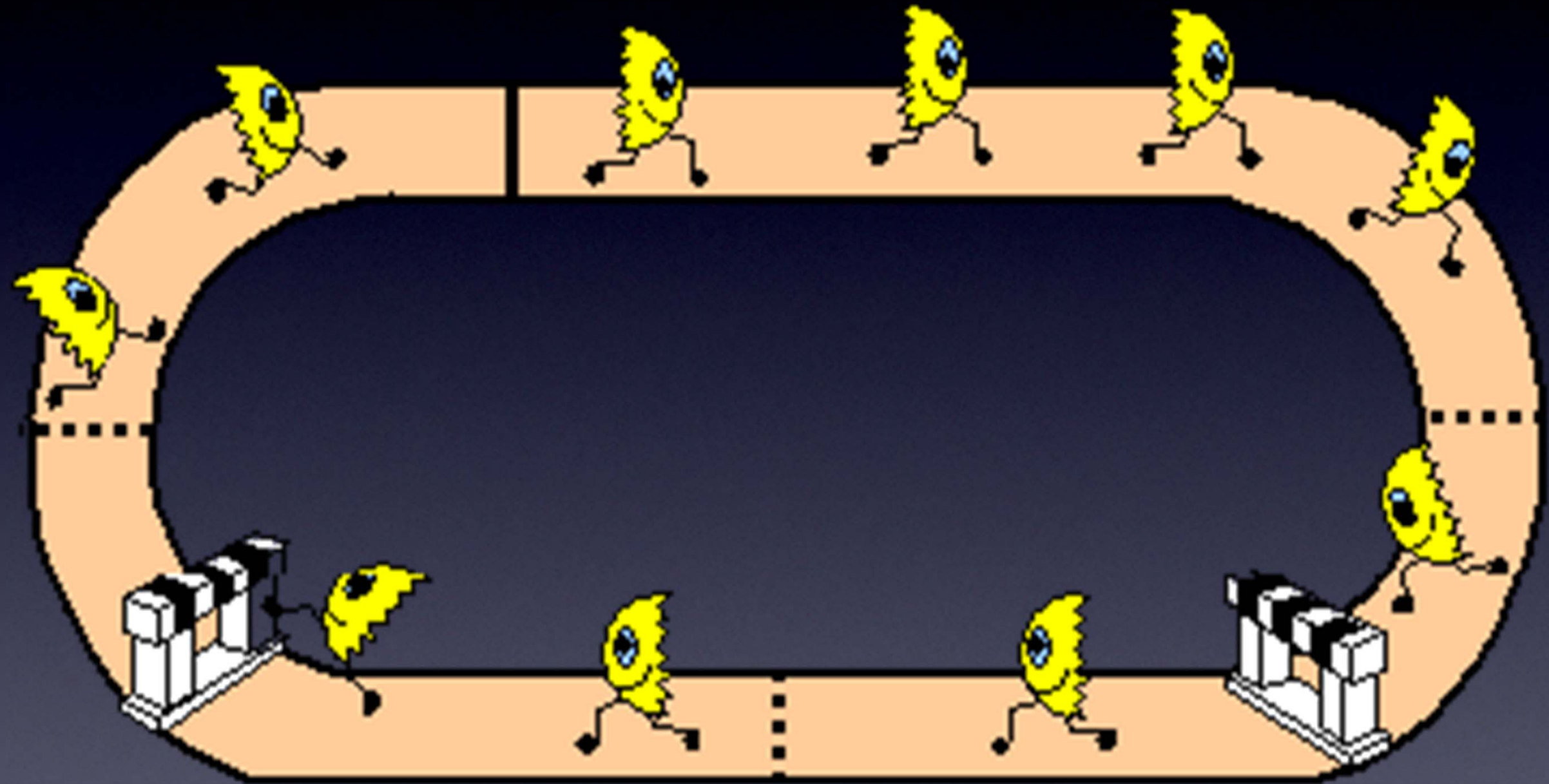


# A Little About Electronics



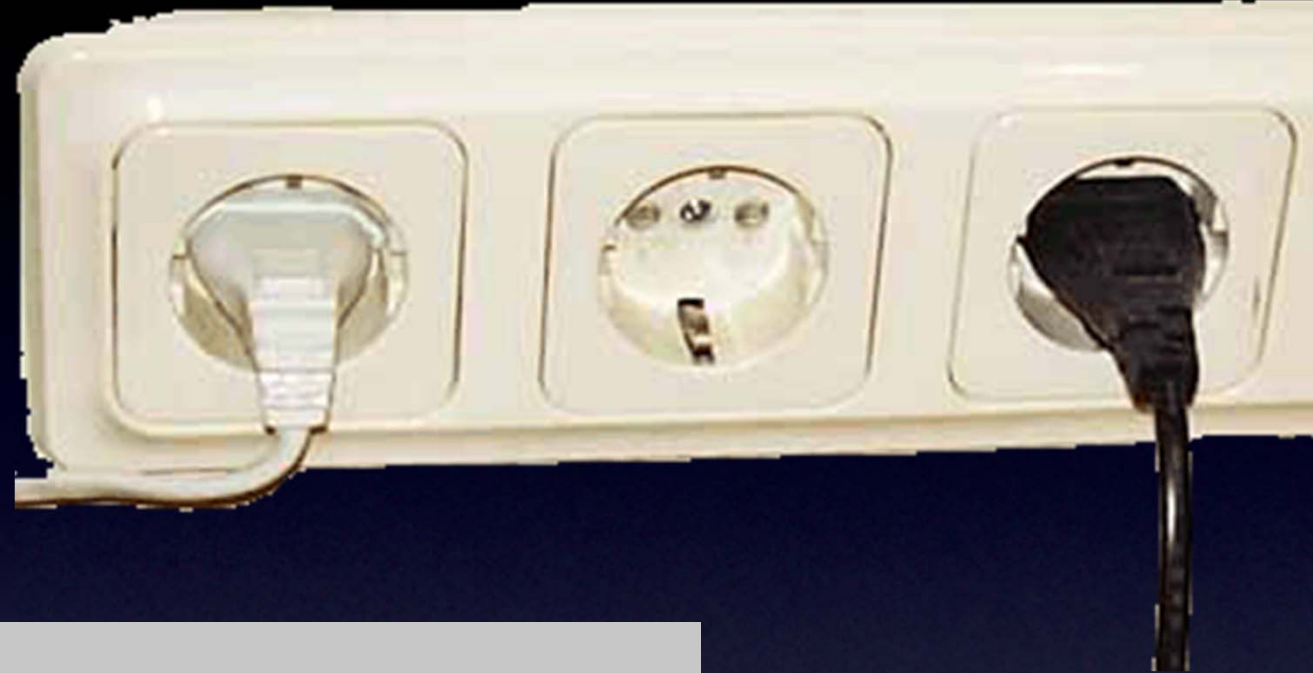
Electrons

# A Little About Electronics



Circuit = Electrons going in complete circle = Magic!

# A Little About Electronics



## Power Supplies

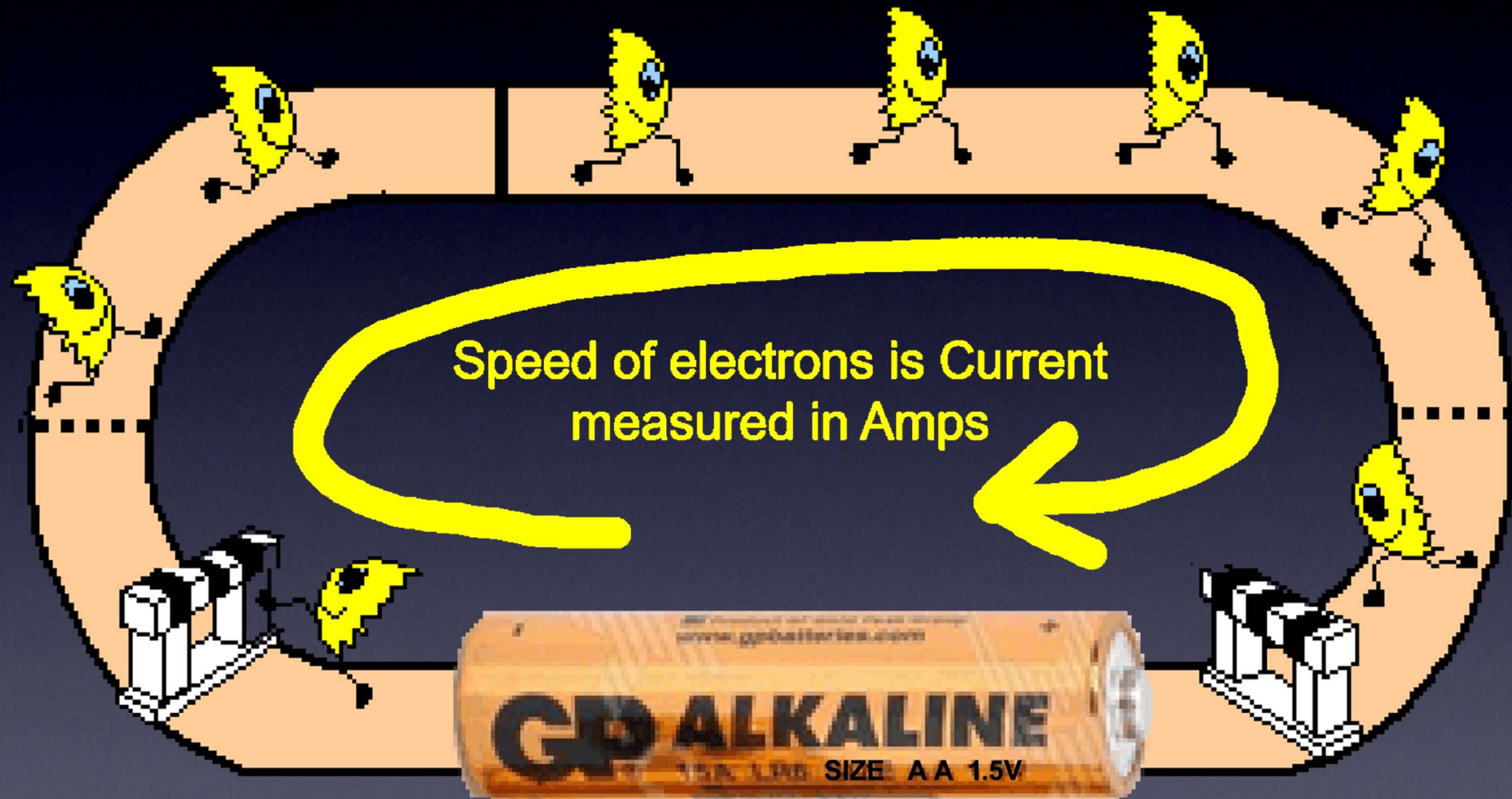
# A Little About Electronics



**Volts** / Voltage



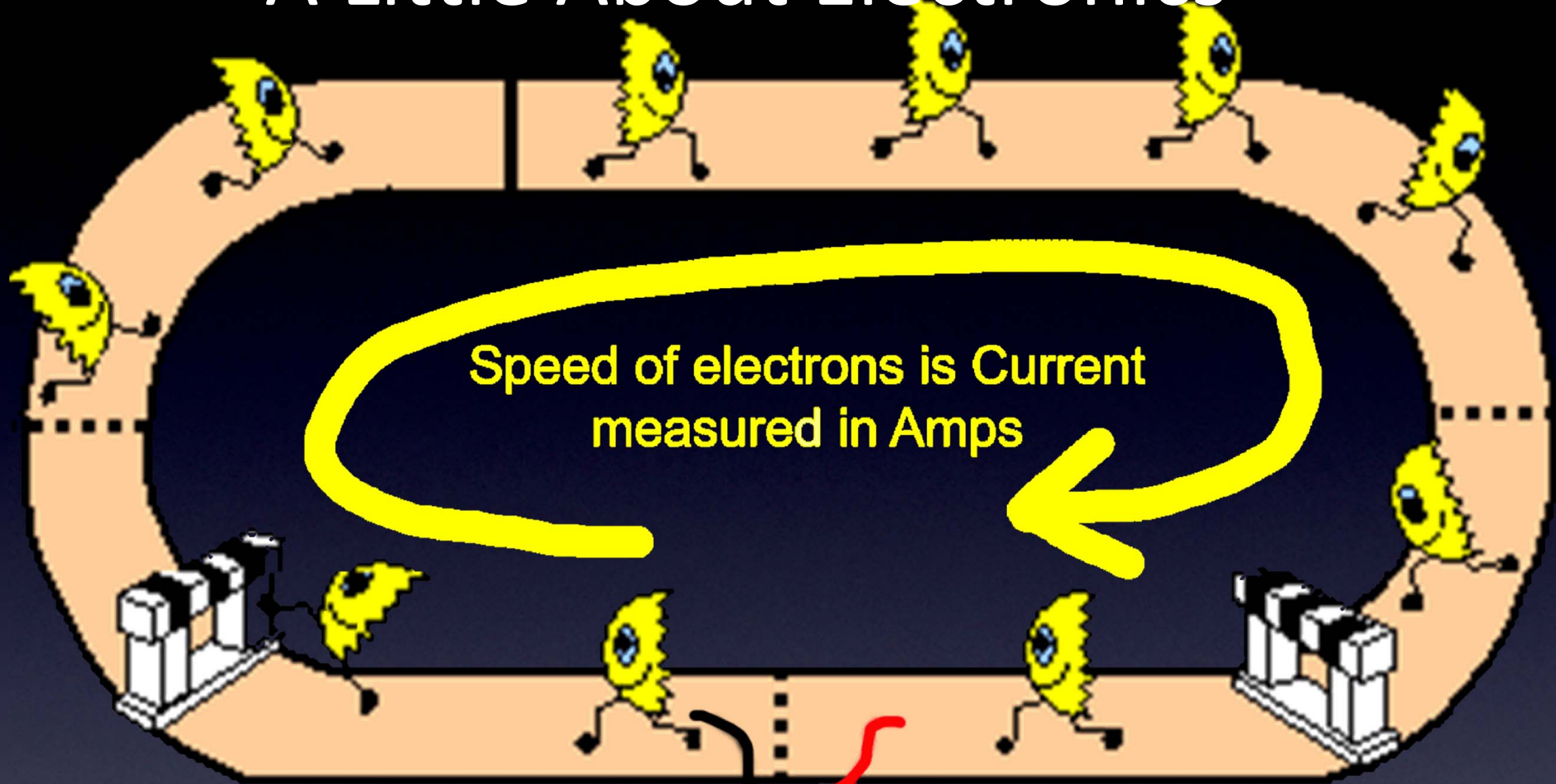
# A Little About Electronics



Electrons pushed with 1.5V.  
So, they move!

**Amps** / Current

# A Little About Electronics



3 times more Volts  
3 times more push  
3 times faster electrons  
3 times more current / Amps

Amps / Current

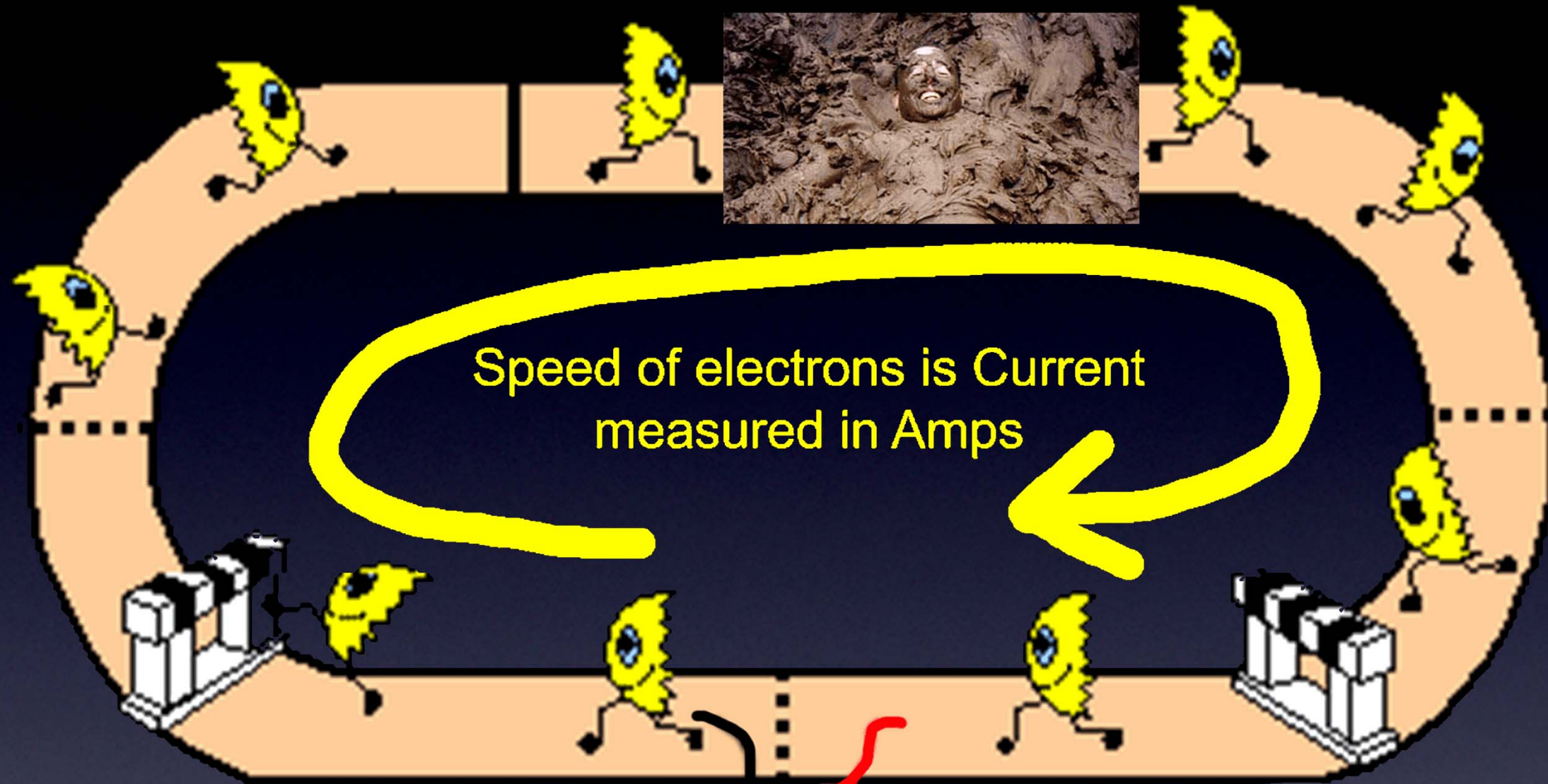
# A Little About Electronics

**Too much energy?**

**Lots of energy!**

Amps / Current

# Everything You Need to Know About Electronics



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



Resistance / **Ohms**

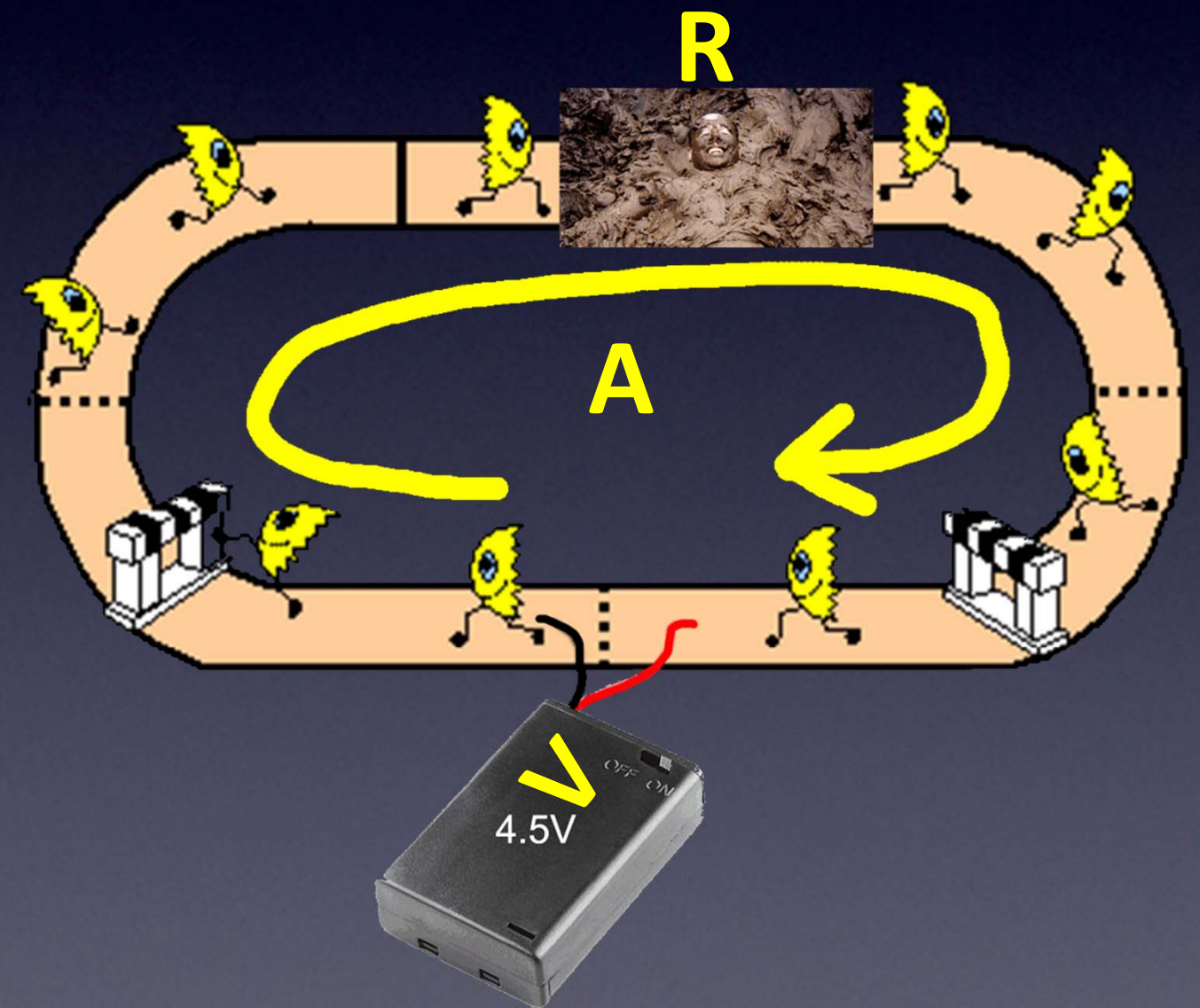
# A Little About Electronics

## Ohm's Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

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



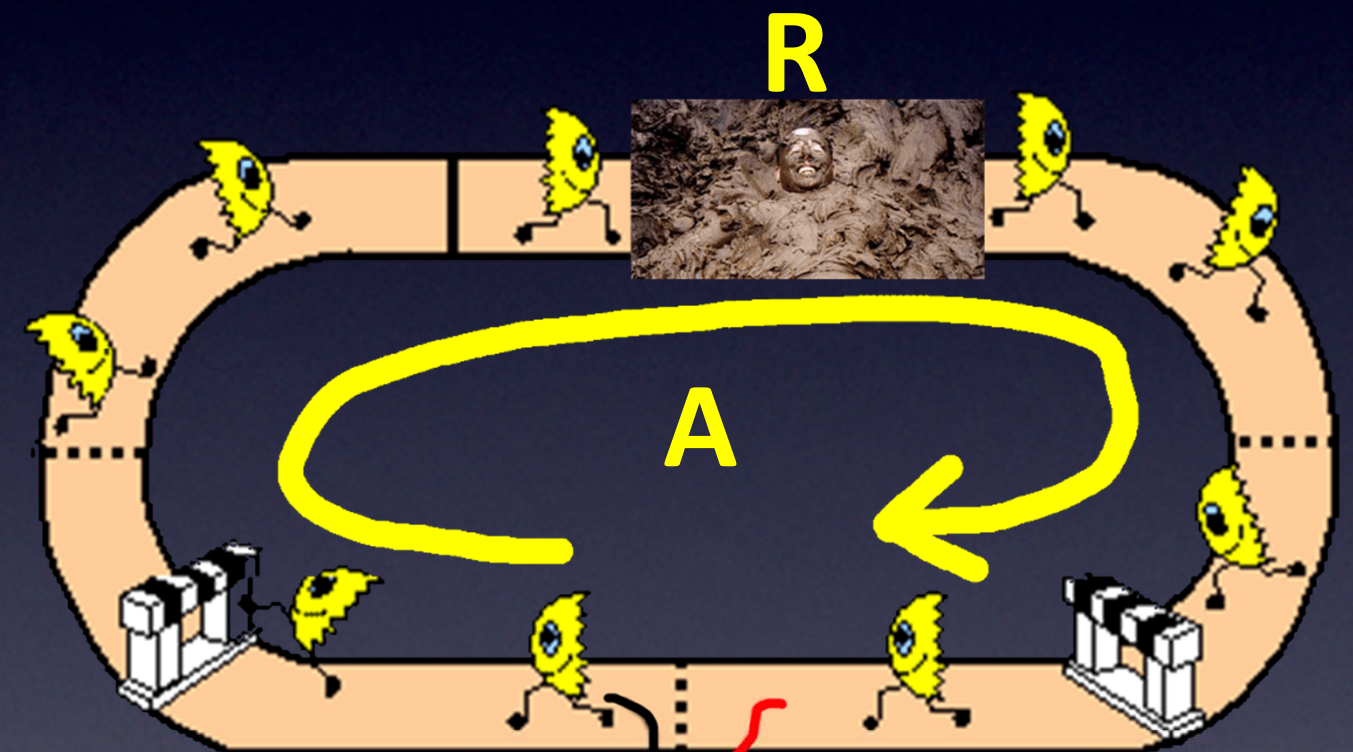
# A Little About Electronics

## Ohm's Law

**Volts** -- *force* pushing electrons

**Amps** -- *speed* of electrons

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



$$\text{Volts} = \text{Amps} \times \text{R}$$

(Ohms)

# A Little About Electronics



# What happens?

*polarity*

Power Supply – it matters how you connect it!

LED

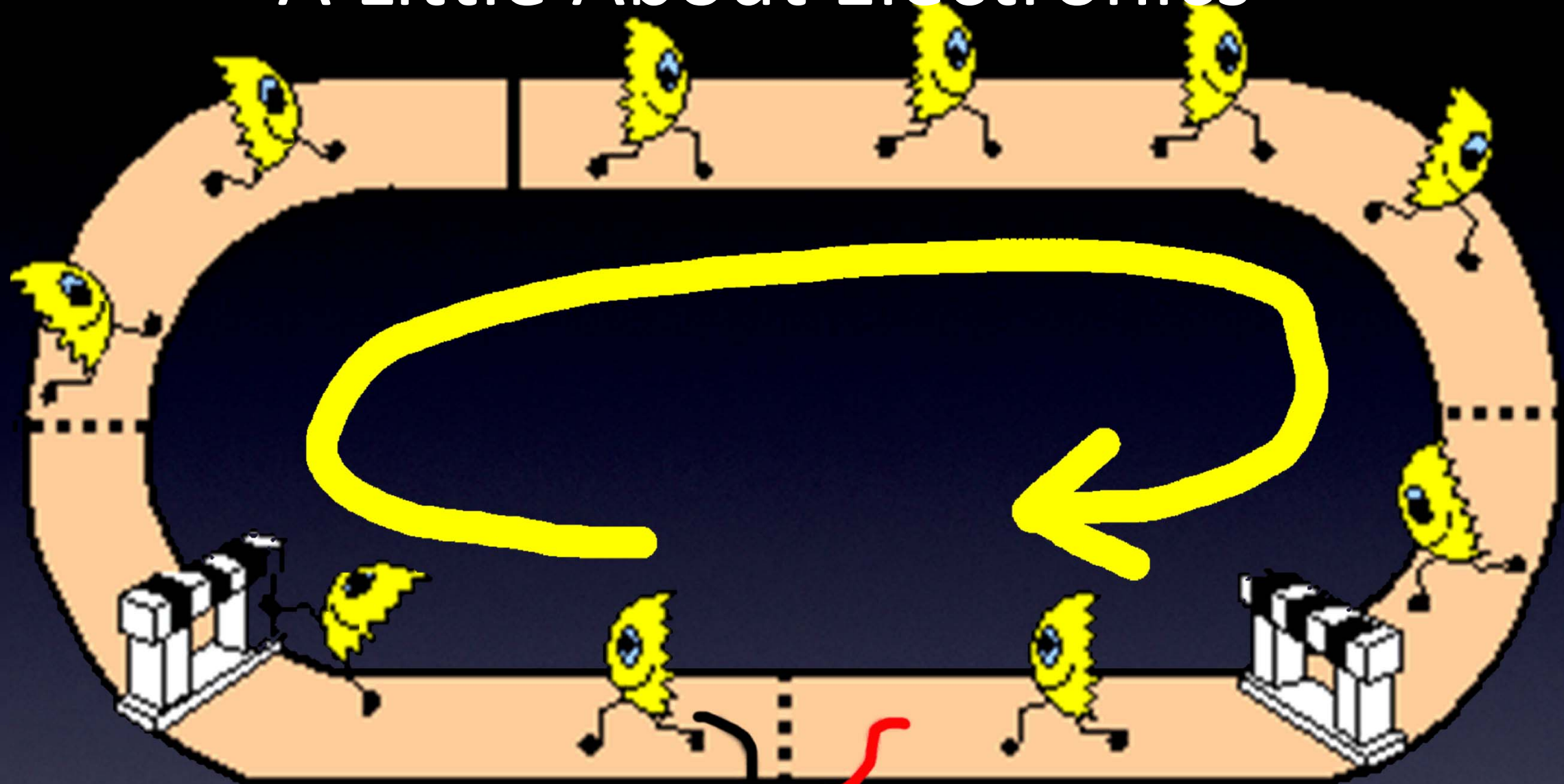


Plus / Positive (+)

Minus / Negative (-)



# A Little About Electronics



**Black Wire = “-”**

**Red Wire = “+”**



**Power Supply – it matters how you connect it!**

# A Little About Electronics



**Red wire:**  
**Power,**  
**Plus, Positive,**  
**4.5V,**  
**Vcc**

**Black wire:**  
**Minus, Negative,**  
**0V,**  
**Ground (GND)**

Power Supply – it matters how you connect it!

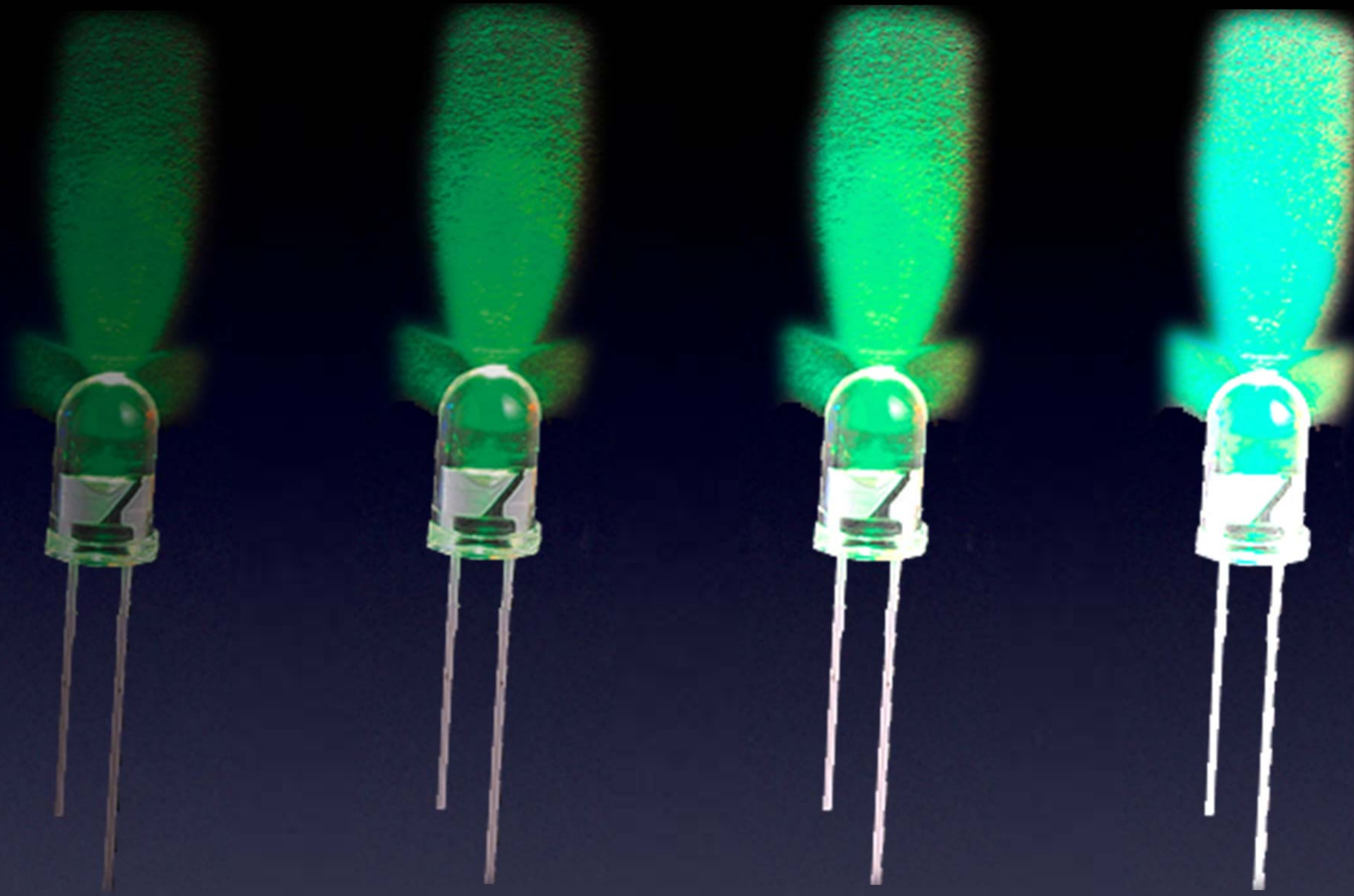
# A Little About Electronics



Lots of different colored LEDs!

LED

# Everything You Need to Know About Electronics



More current  $\rightarrow$  More brightness! (until...)

LED

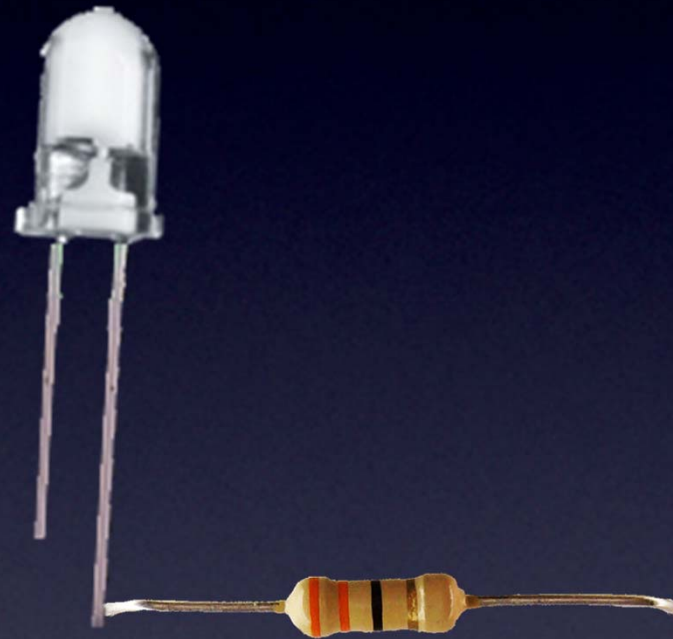
# Everything You Need to Know About Electronics



More current → More brightness! (until...)

LED

# Everything You Need to Know About Electronics

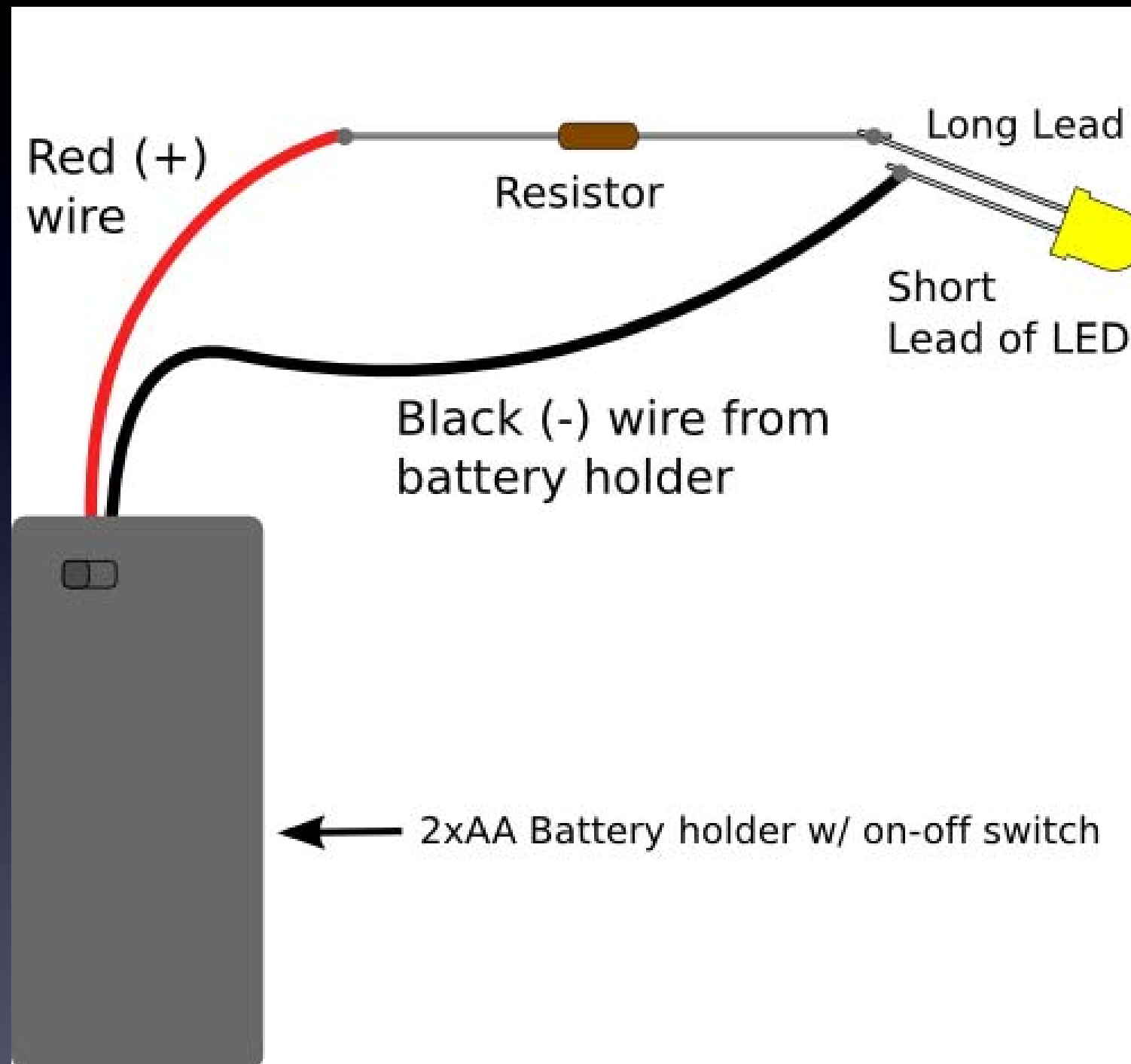


*(with a resistor  
so no magic smoke goes away)*

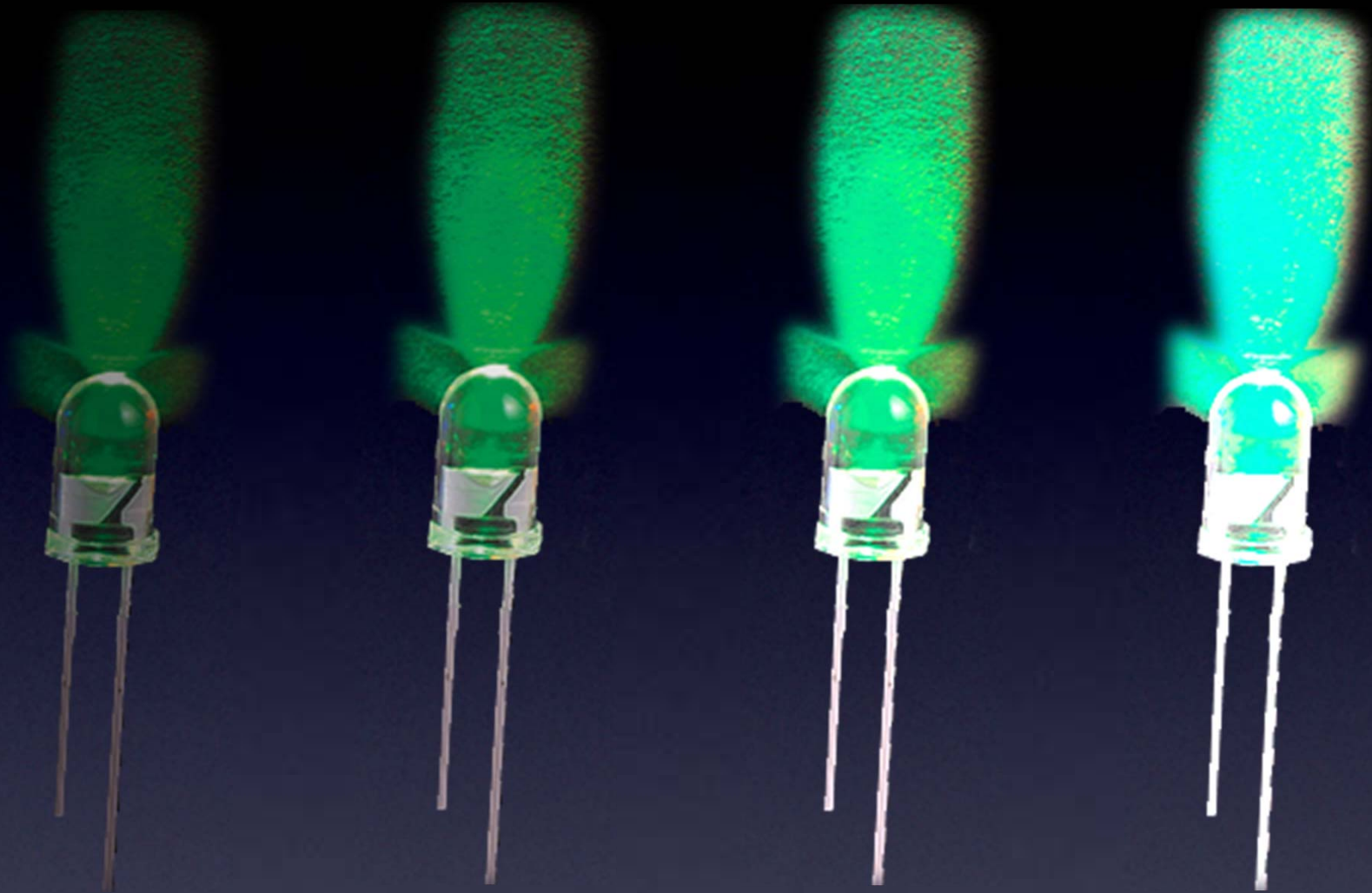
This is why we put a resistor in line with an LED

LED

# LED Brightness



# LED Brightness



Less resistance



# Lighting an LED

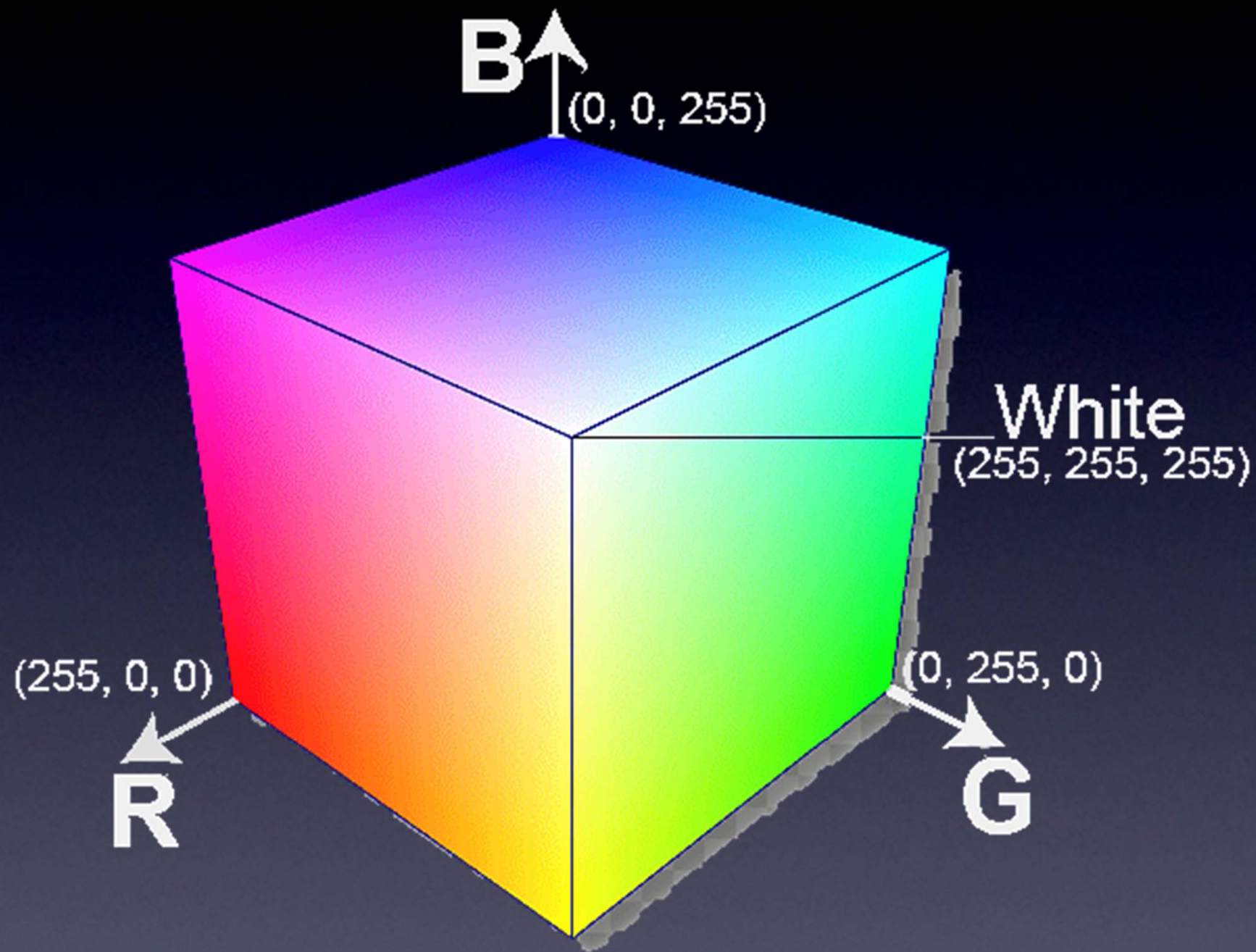


LED & battery

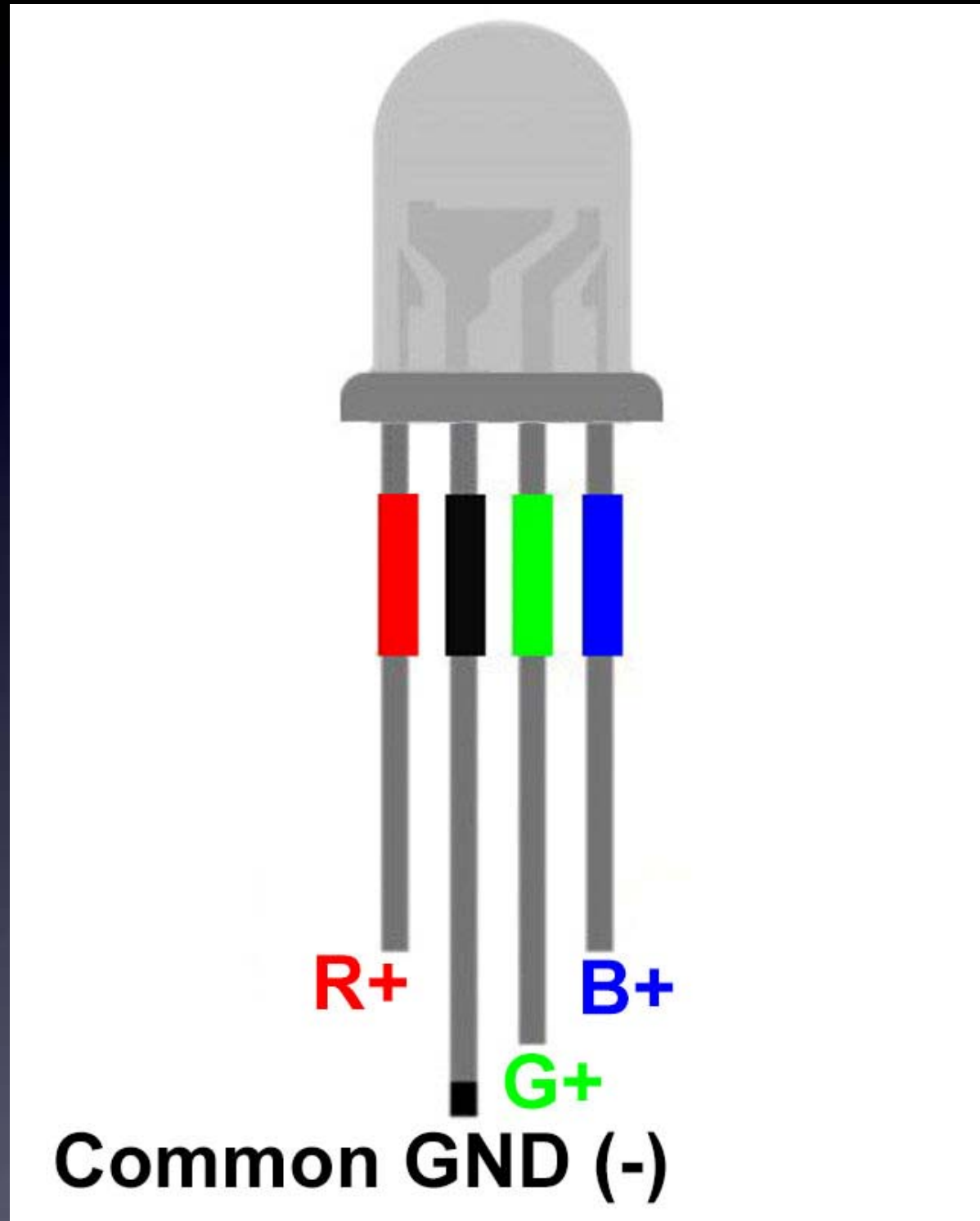
# Light Color Mixing



# Light Color Mixing



# RGB LED



# RGB LED with microcontroller (Example)

Trippy RGB Waves kit

# Intro to Arduino



# Intro to Arduino

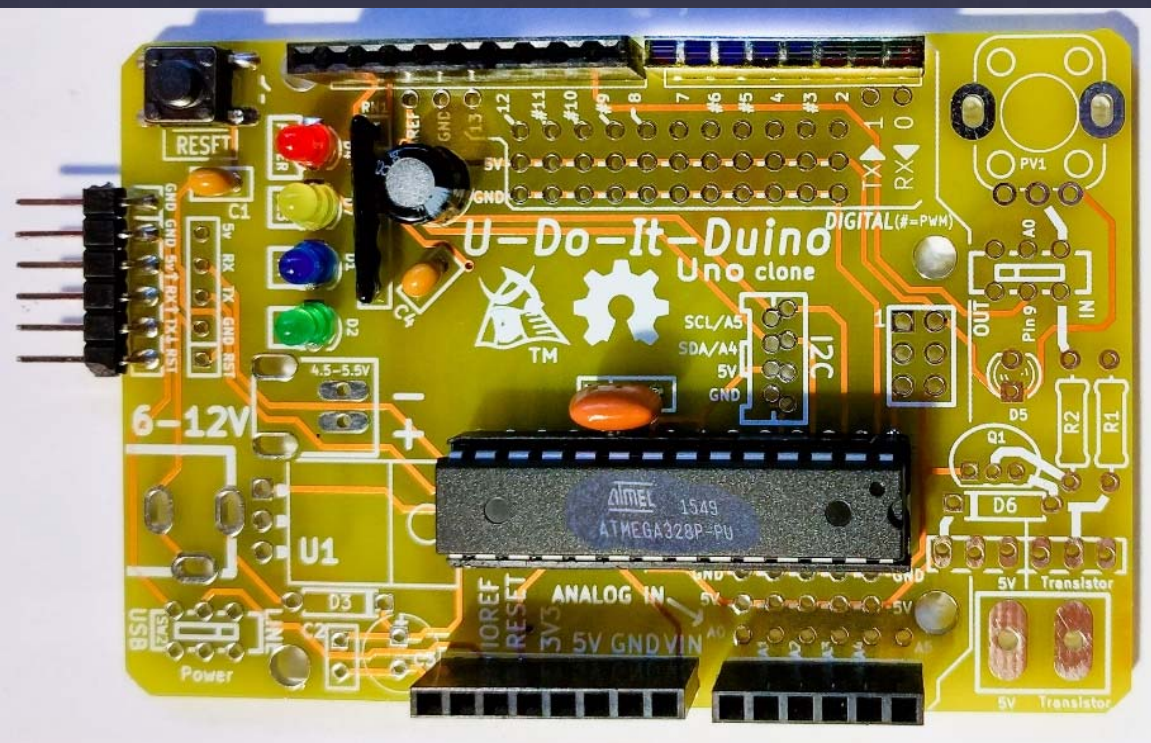
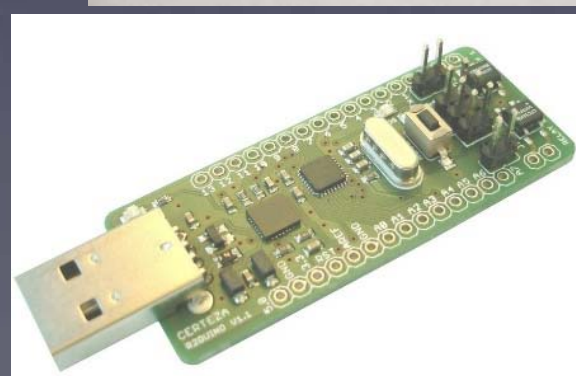
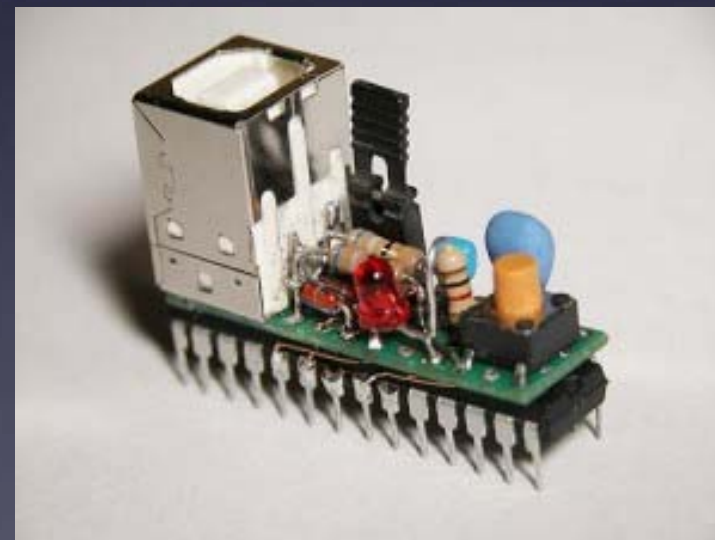
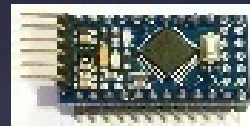
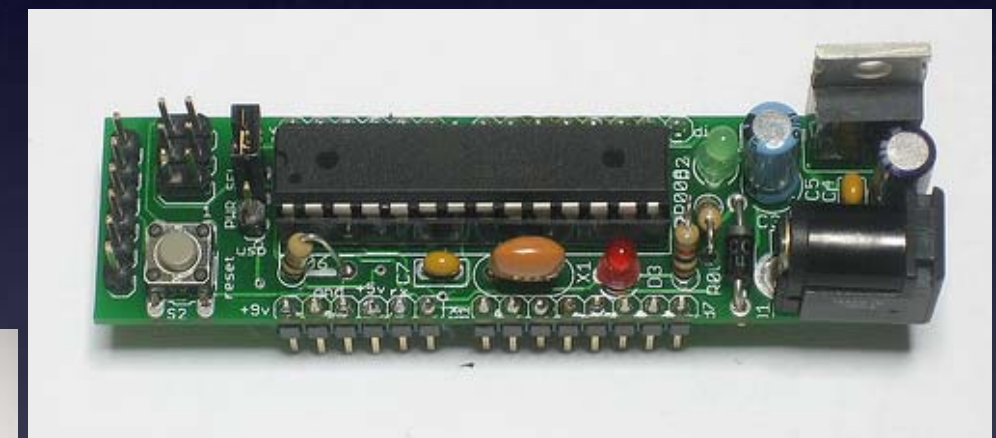
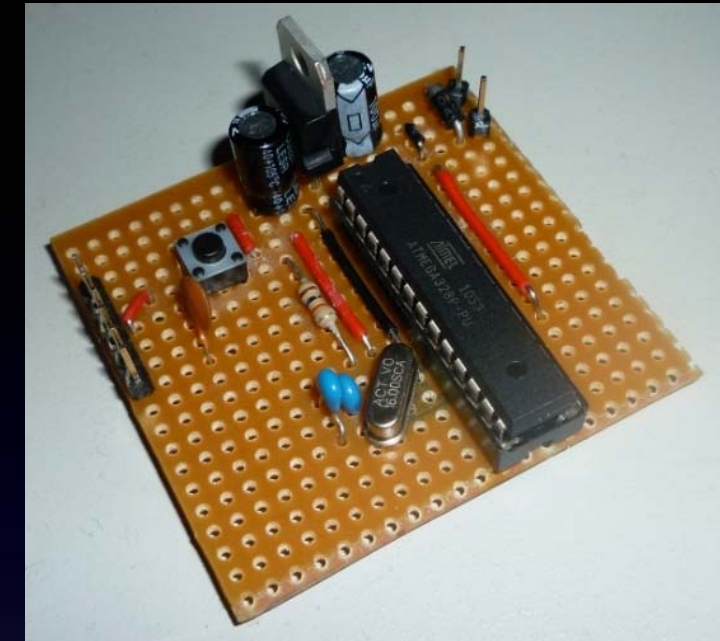
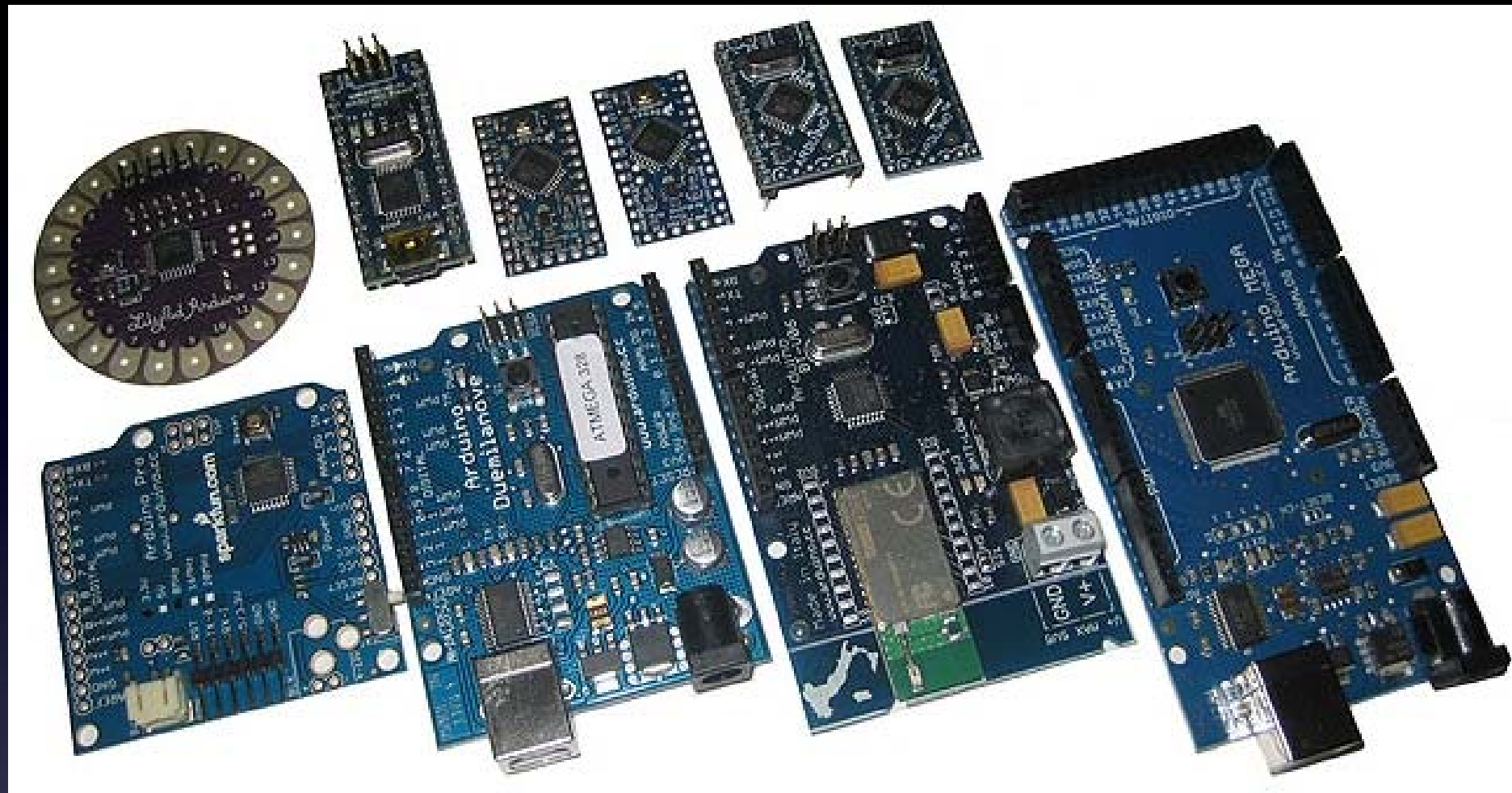


*Use an Arduino board*

Super easy to connect parts to its microcontroller's pins

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

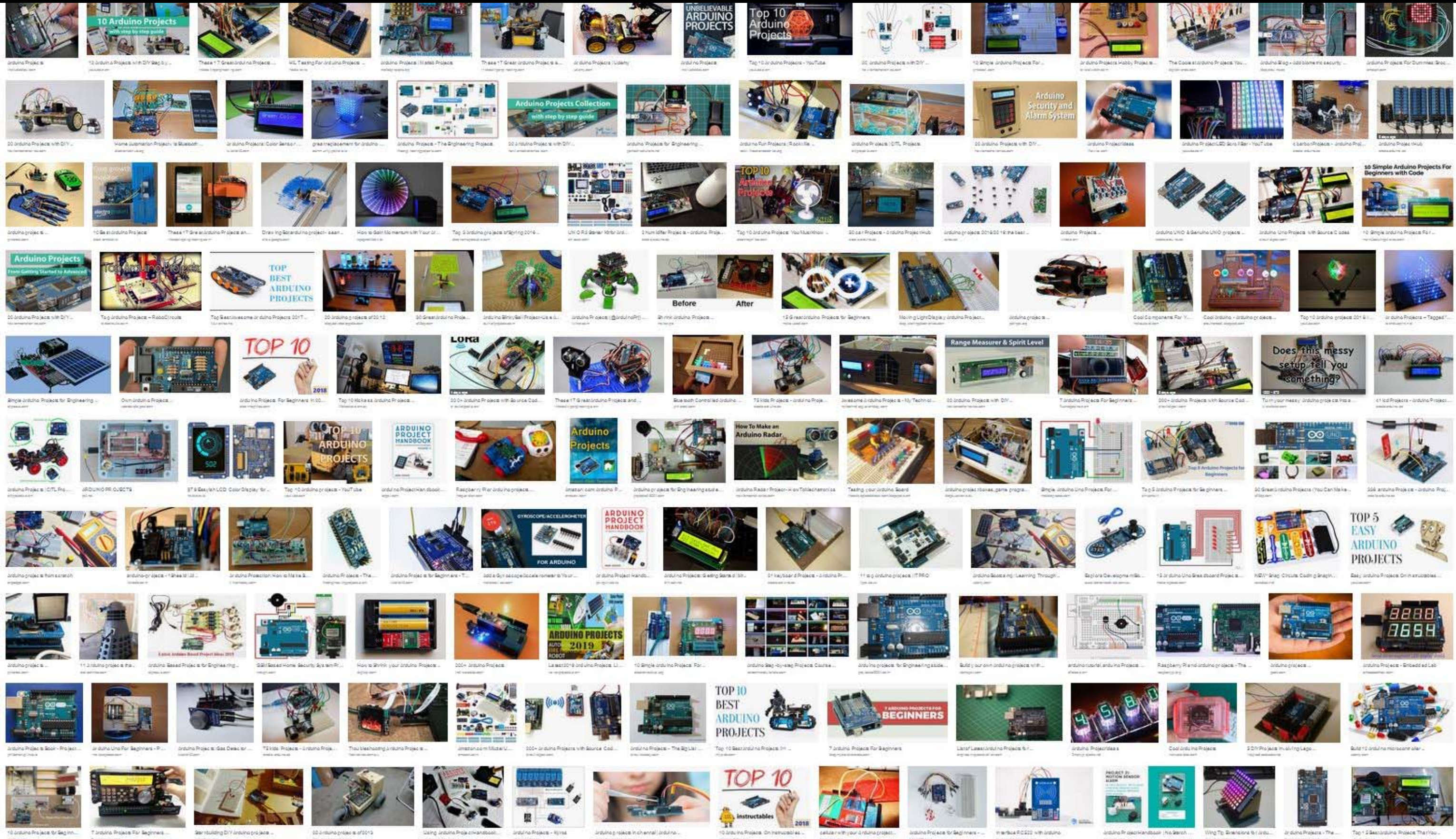
# Intro to Arduino



Open Source



# Intro to Arduino



*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 window*  
[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:

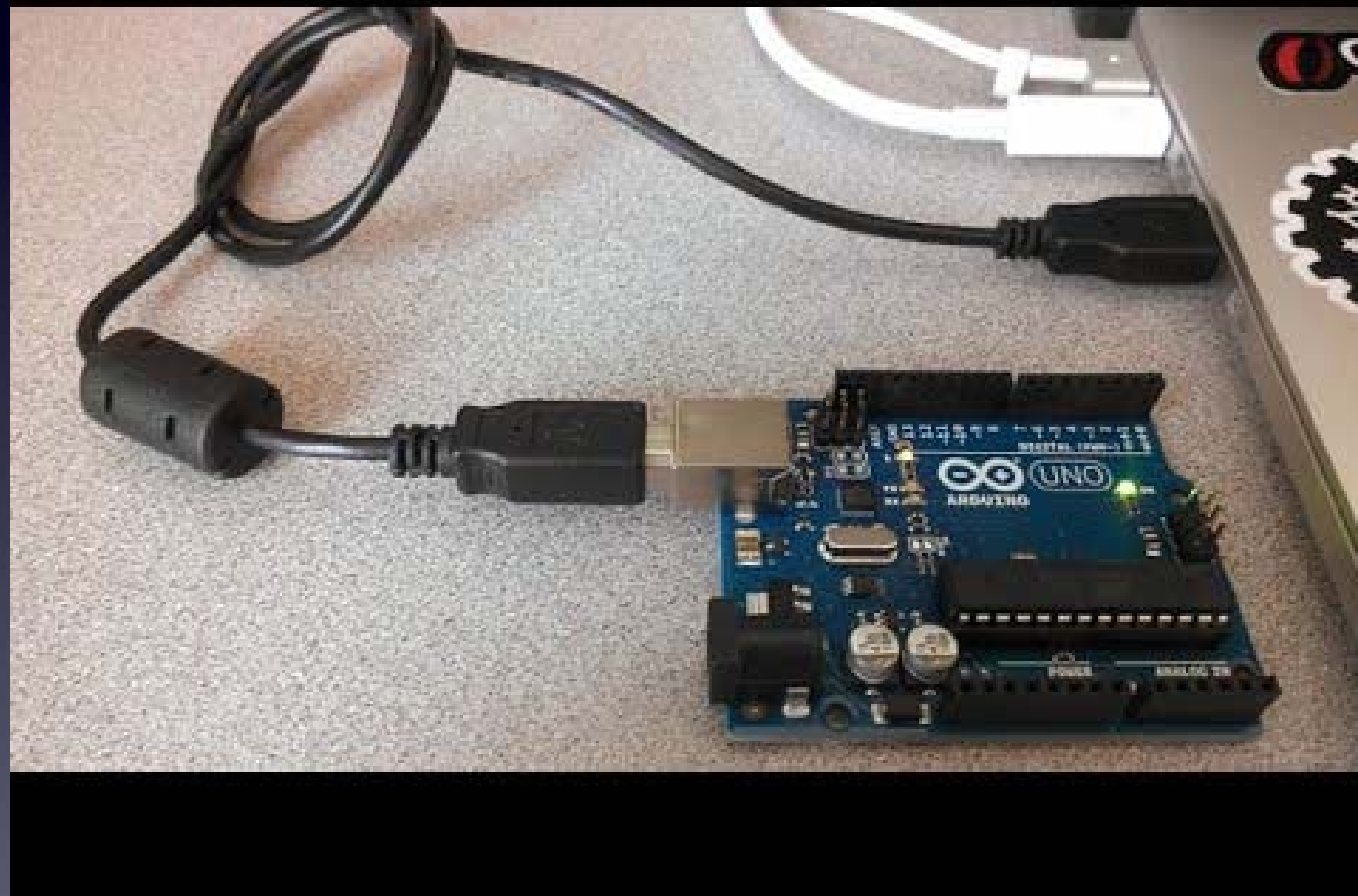
Download Arduino sketches

Search for: *“RGB LED Strip Sketches”*

Store them on your computer anywhere you like.



# Connect your Arduino to your computer



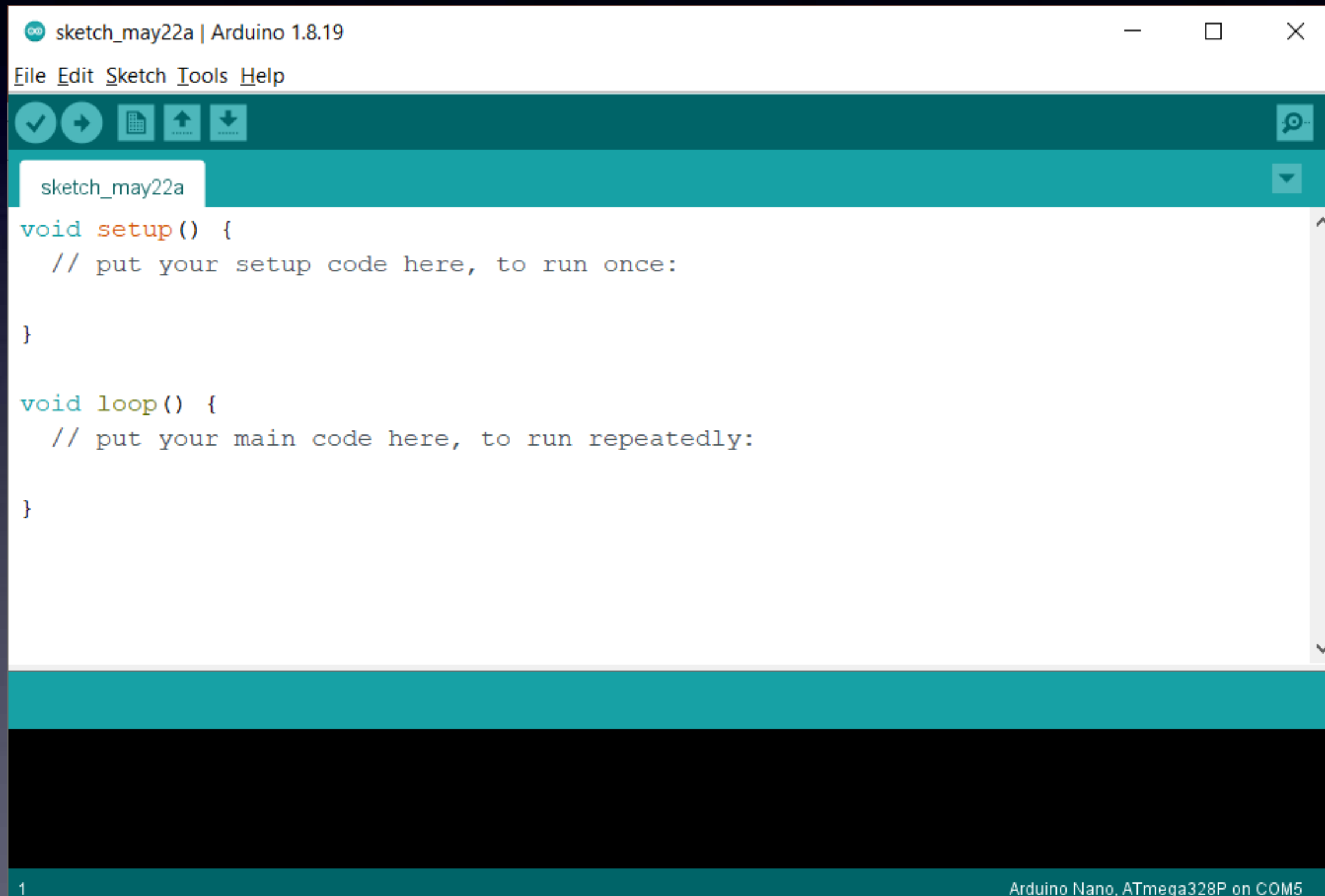
# Serial Port Driver



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:**



The screenshot shows the Arduino IDE interface. The window title is "sketch\_may22a | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for "Check", "Run", "New", "Open", and "Save". The sketch editor shows a blank sketch named "sketch\_may22a" with the following code:

```
void setup() {  
  // put your setup code here, to run once:  
  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  
}
```

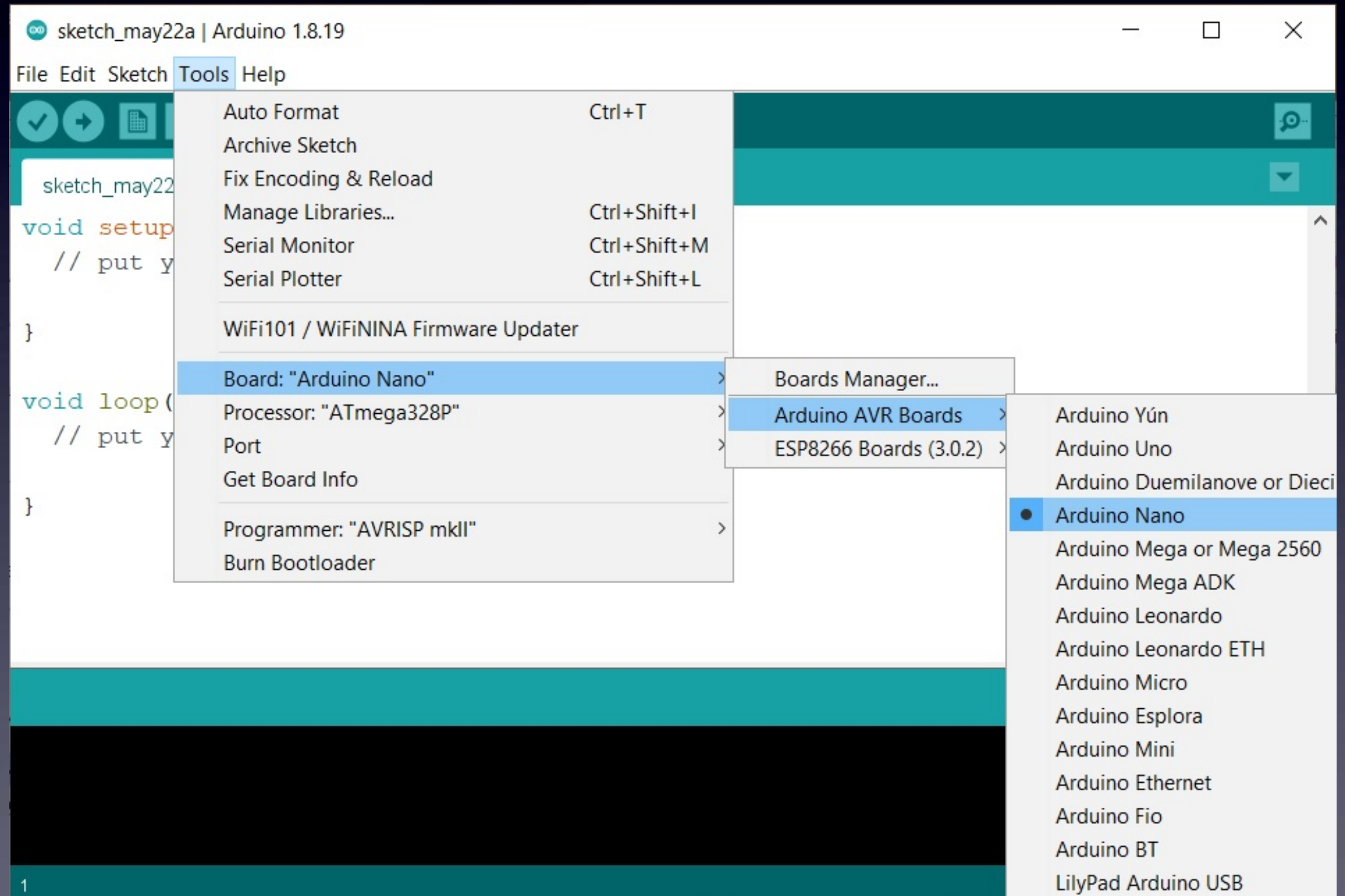
The status bar at the bottom left shows "1" and the bottom right shows "Arduino Nano, ATmega328P on COM5".



# Arduino

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

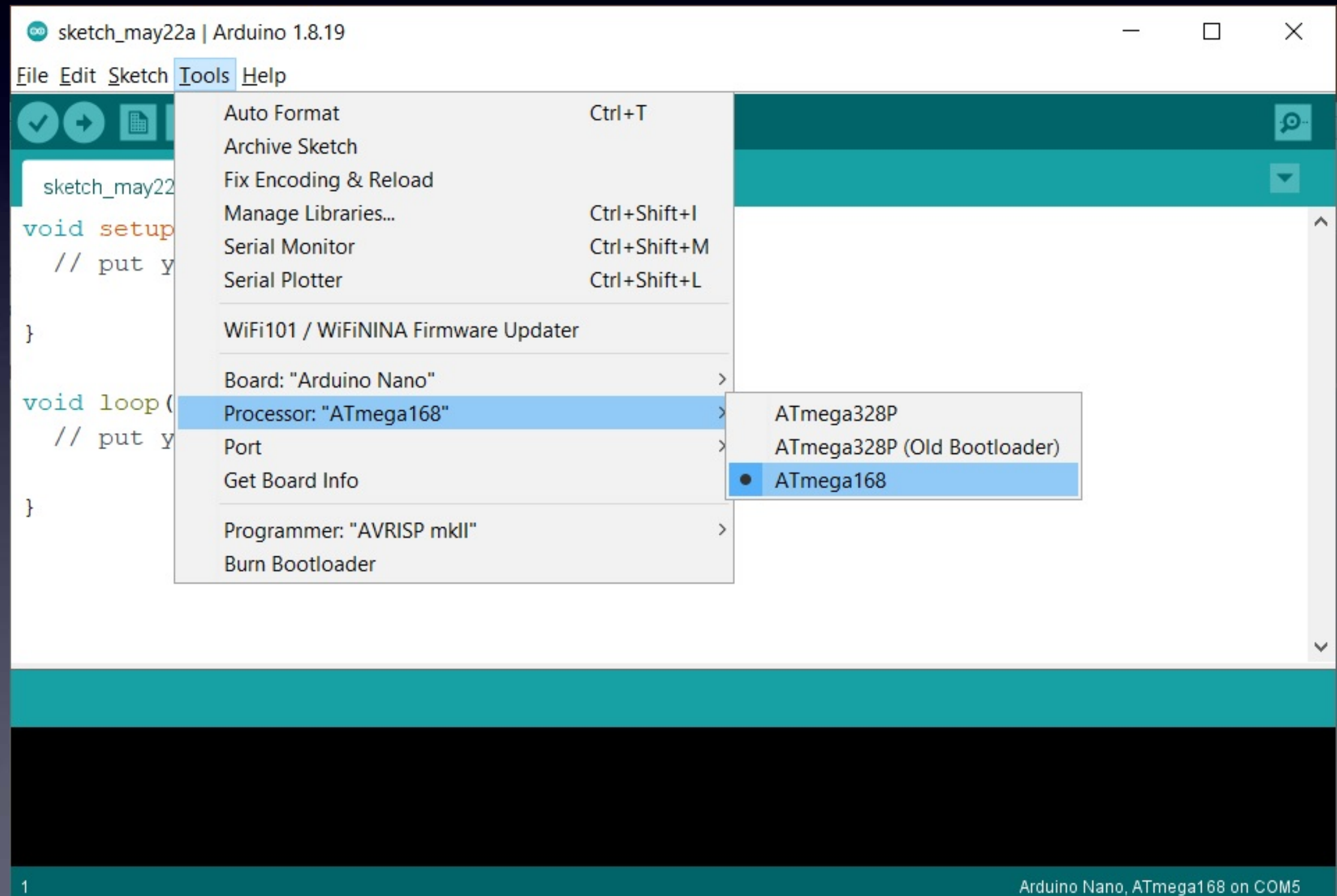
(1)  
Choose  
"Arduino Nano"  
as the Board



# Arduino

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

(2)  
Choose  
your Processor  
as the Board

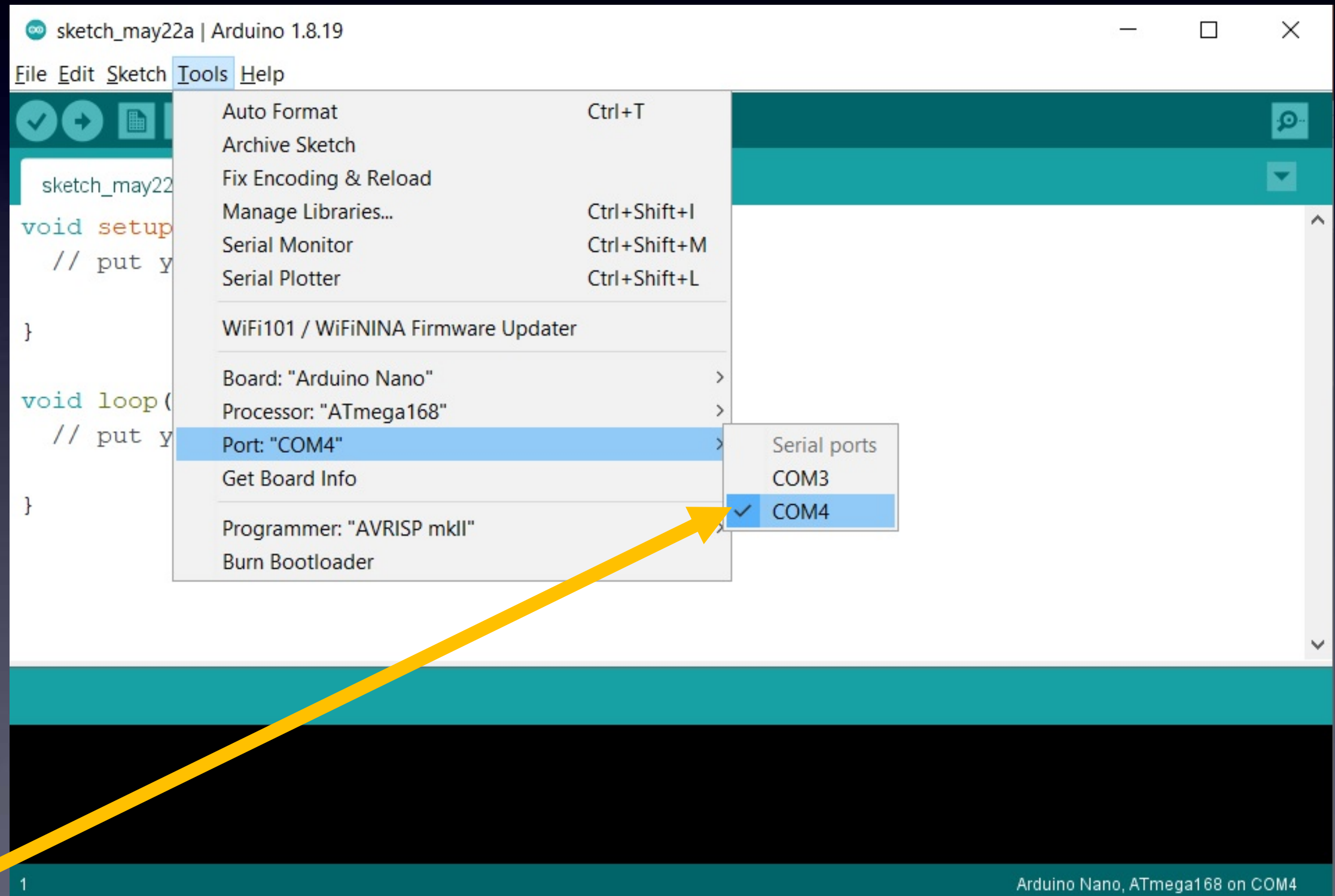


# Arduino

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)

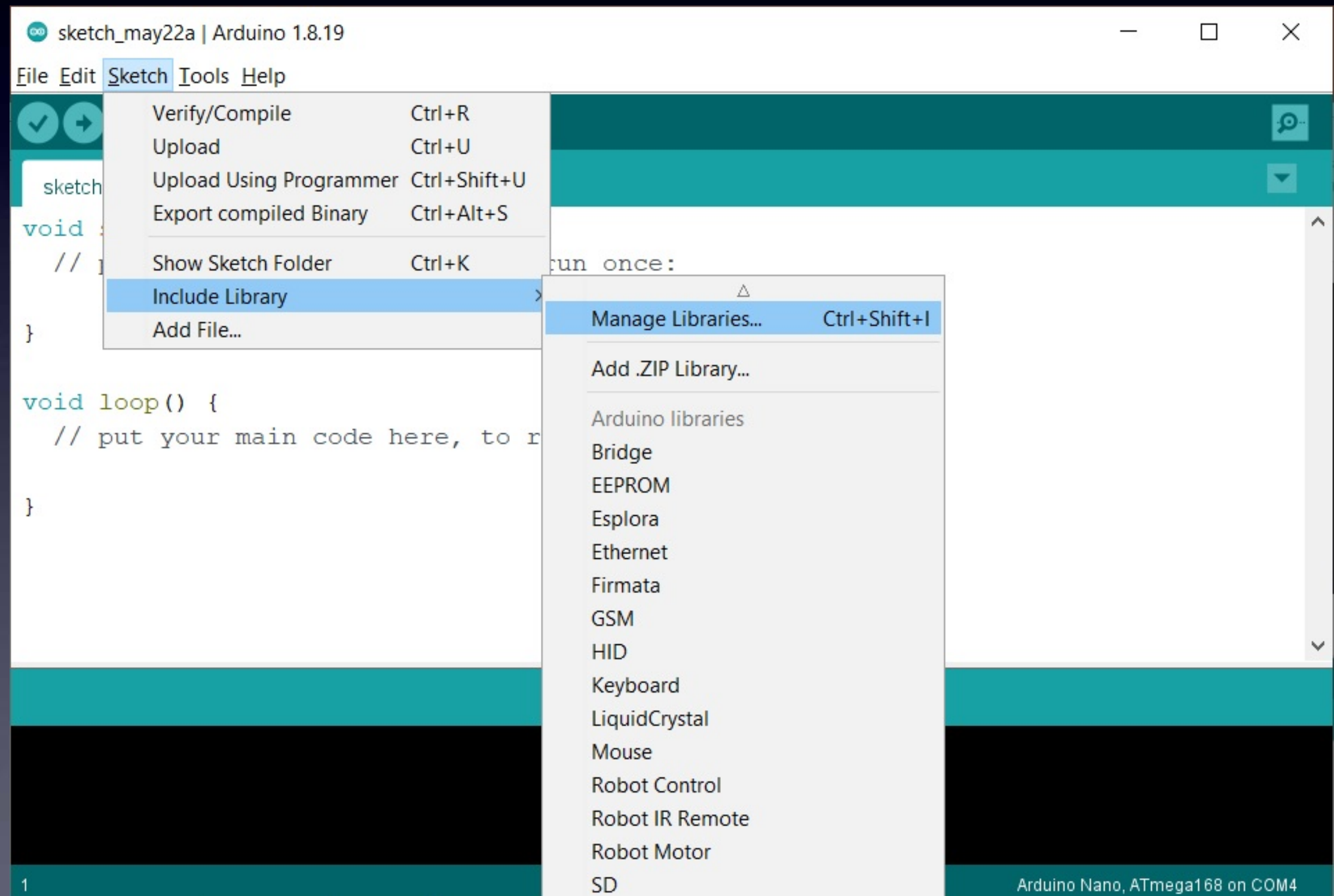
(After installing the driver for your Arduino (USB-Serial adapter), with your Arduino plugged in, your operating system will see a serial port and it appears here.)



# Arduino

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

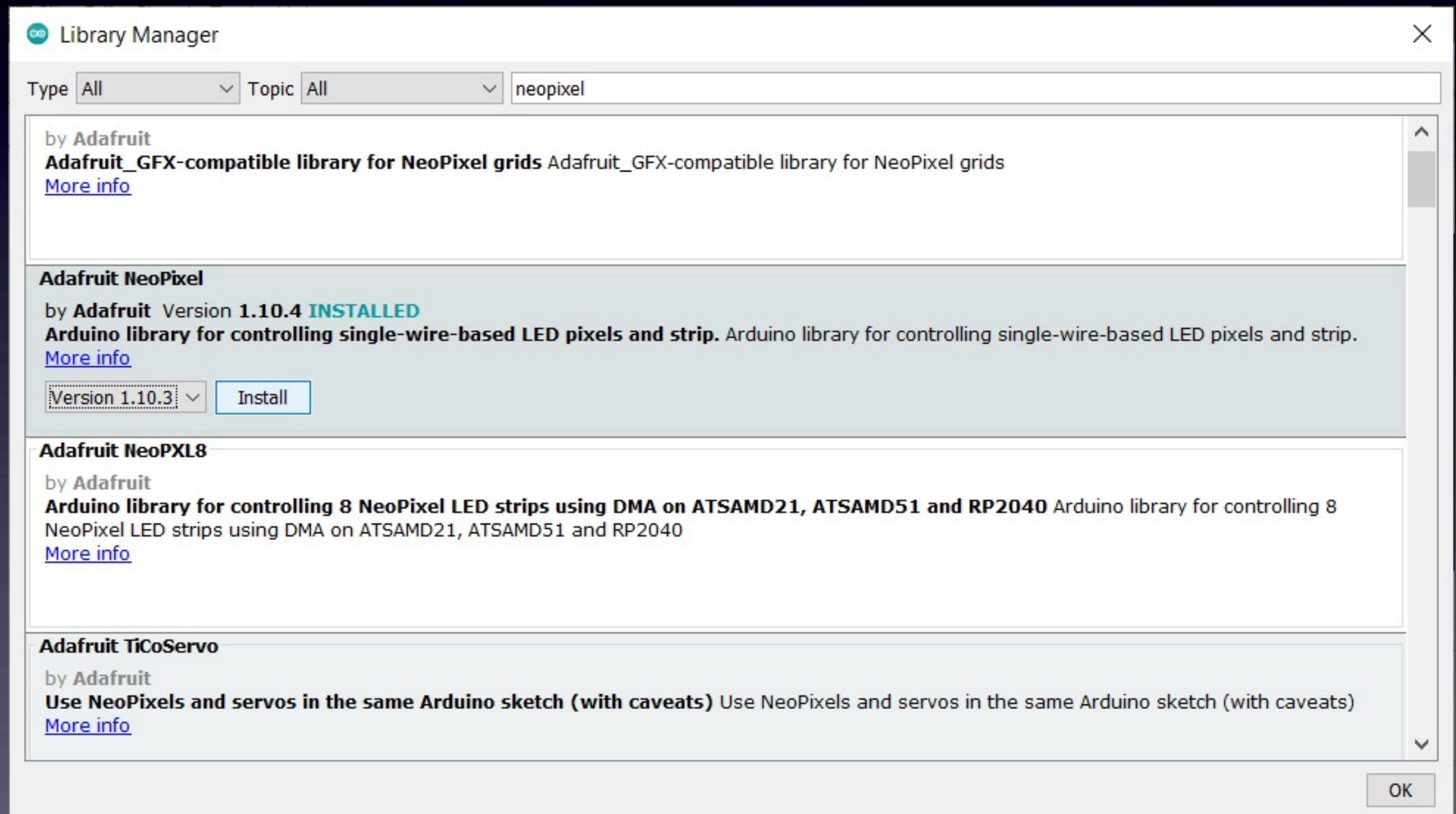
(4a)  
Install  
the  
Neopixel  
library



# Arduino

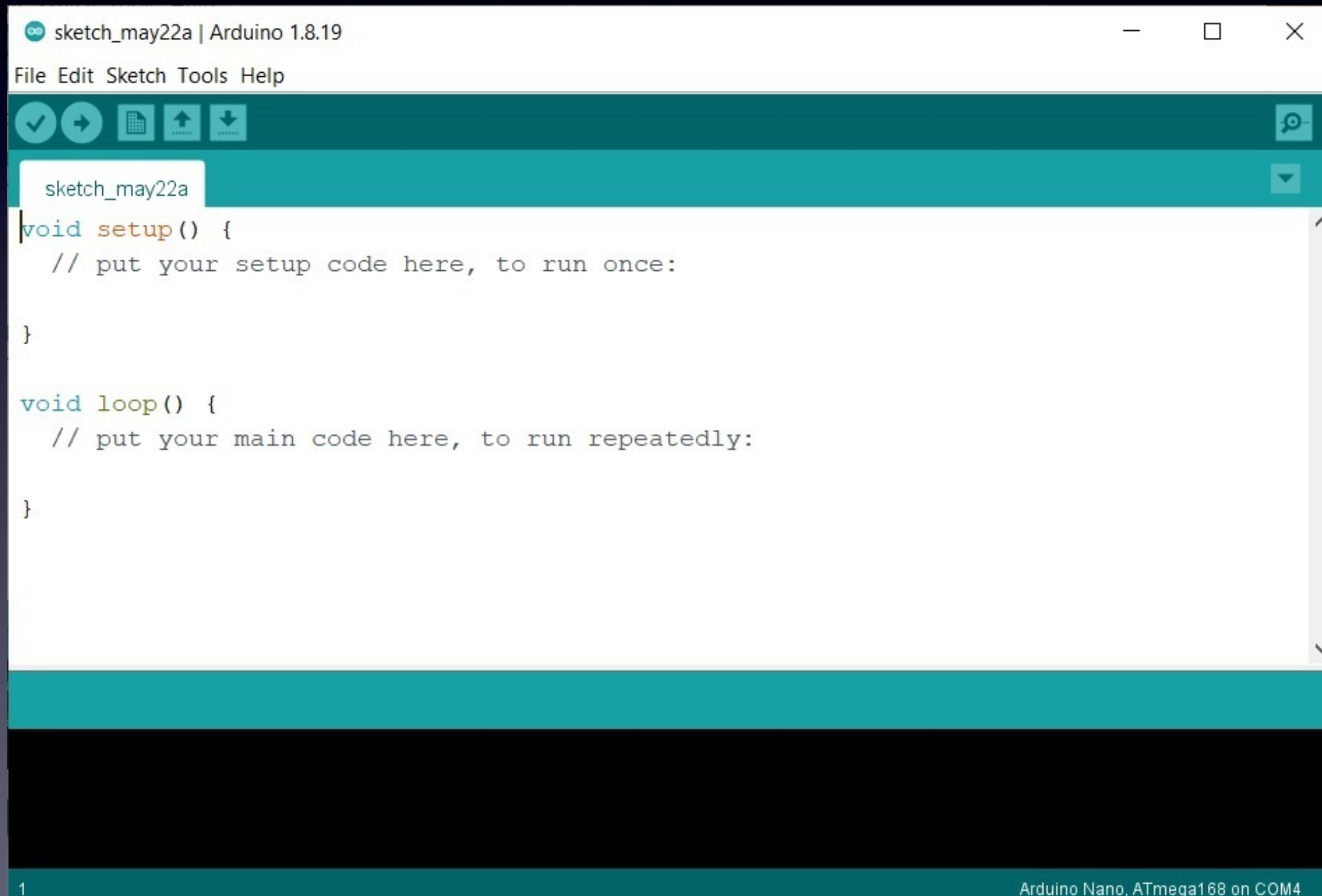
The first time you start your Arduino software you need to set things up

(4b)  
Install  
the  
Neopixel  
library



# Arduino

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



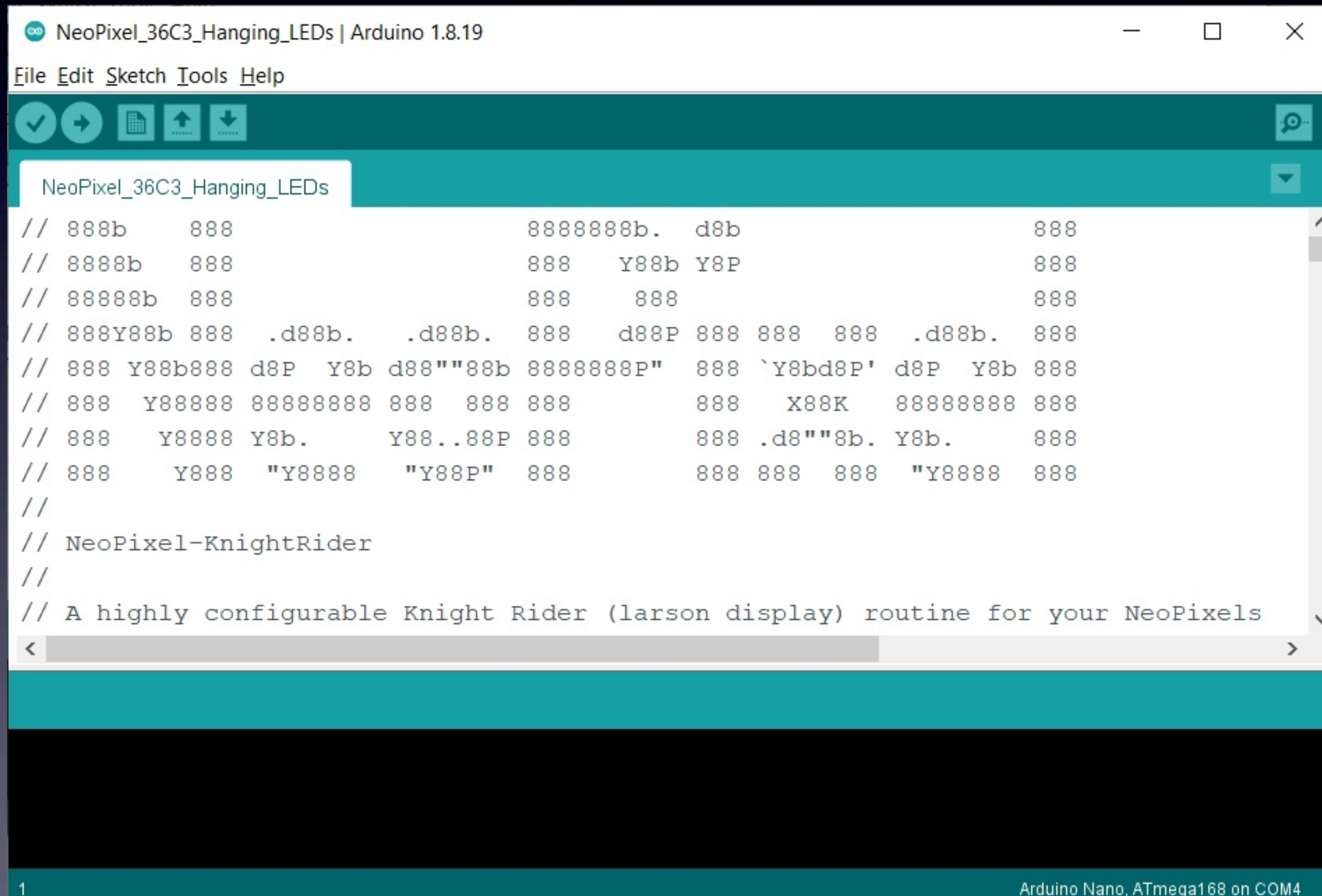
```
sketch_may22a | Arduino 1.8.19
File Edit Sketch Tools Help
sketch_may22a
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}

1 Arduino Nano, ATmega168 on COM4
```

# Arduino

Open the “sketch” you want to program



The screenshot shows the Arduino IDE interface. The title bar reads "NeoPixel\_36C3\_Hanging\_LEDs | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for saving, running, uploading, and downloading. The sketch editor shows the following code:

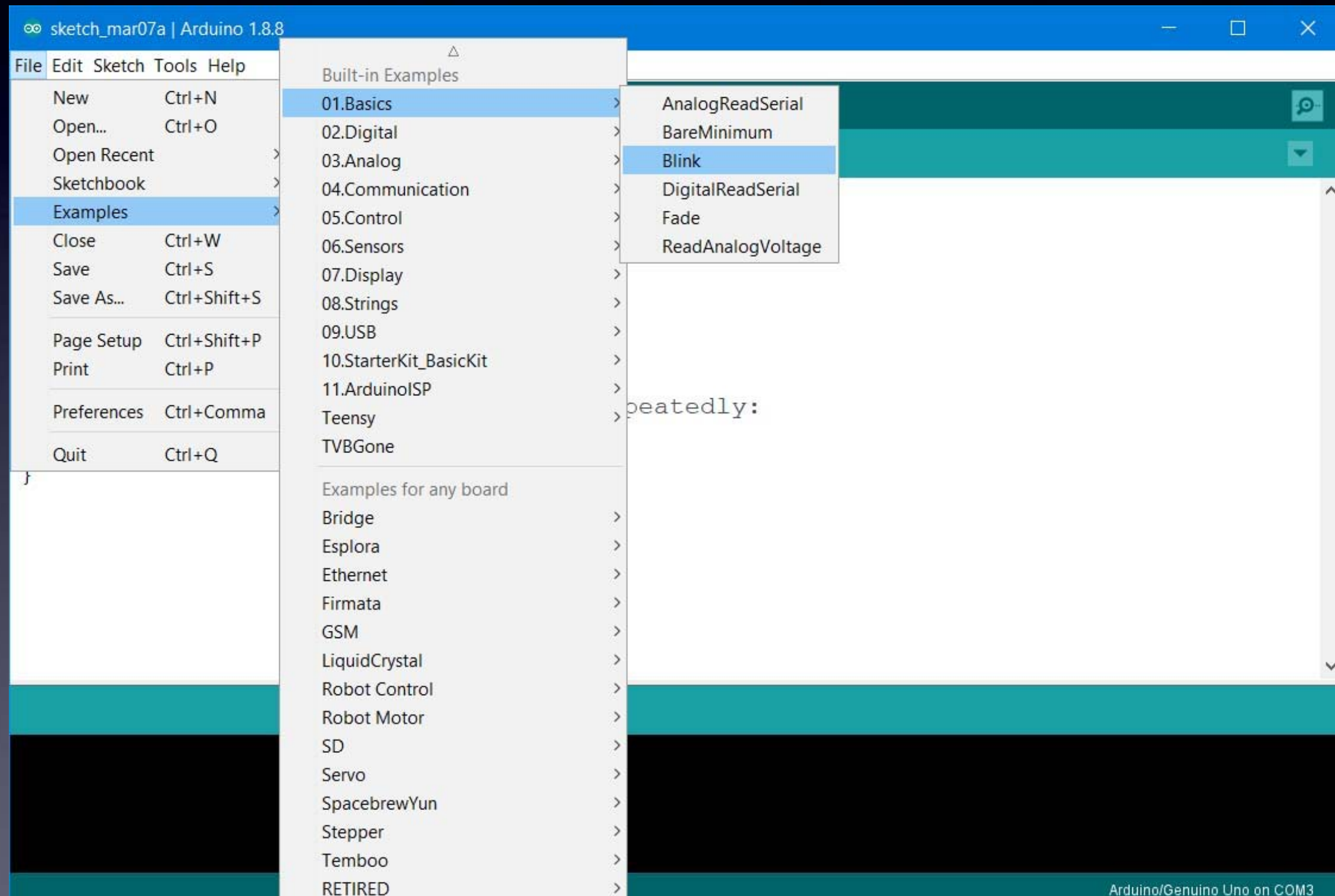
```
// 888b      888      88888888b.  d8b      888
// 8888b      888      888      Y88b Y8P      888
// 88888b      888      888      888      888      888
// 888Y88b 888      .d88b.      .d88b. 888      d88P 888 888 888      .d88b. 888
// 888 Y88b888 d8P  Y8b d88""88b 88888888P" 888 `Y8bd8P' d8P  Y8b 888
// 888  Y88888 888888888 888 888 888      888  X88K 888888888 888
// 888  Y8888 Y8b.      Y88..88P 888      888 .d8""8b. Y8b.      888
// 888  Y888  "Y8888  "Y88P" 888      888 888 888  "Y8888 888
//
// NeoPixel-KnightRider
//
// A highly configurable Knight Rider (larson display) routine for your NeoPixels
```

The bottom status bar indicates "1" on the left and "Arduino Nano, ATmega168 on COM4" on the right.

# Arduino

Let's start simple!

Let's all make an LED blink!





# Arduino

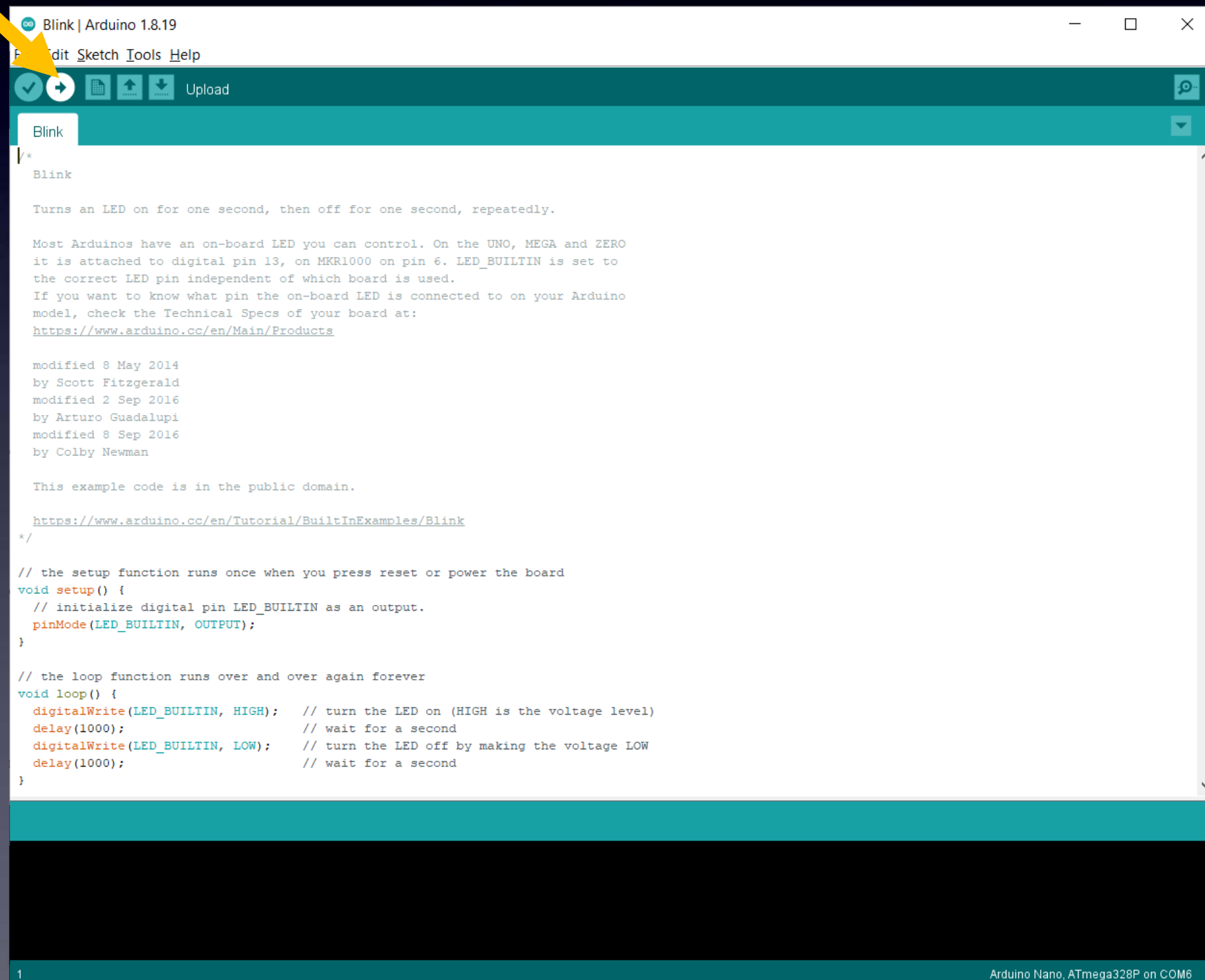
## Example “sketch”: Blink

The image shows a screenshot of the Arduino IDE interface. The window title is "Blink | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for checkmark, undo, redo, upload, and download. The main editor area shows the "Blink" sketch with the following content:

```
/*  
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  
}
```

# Arduino

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



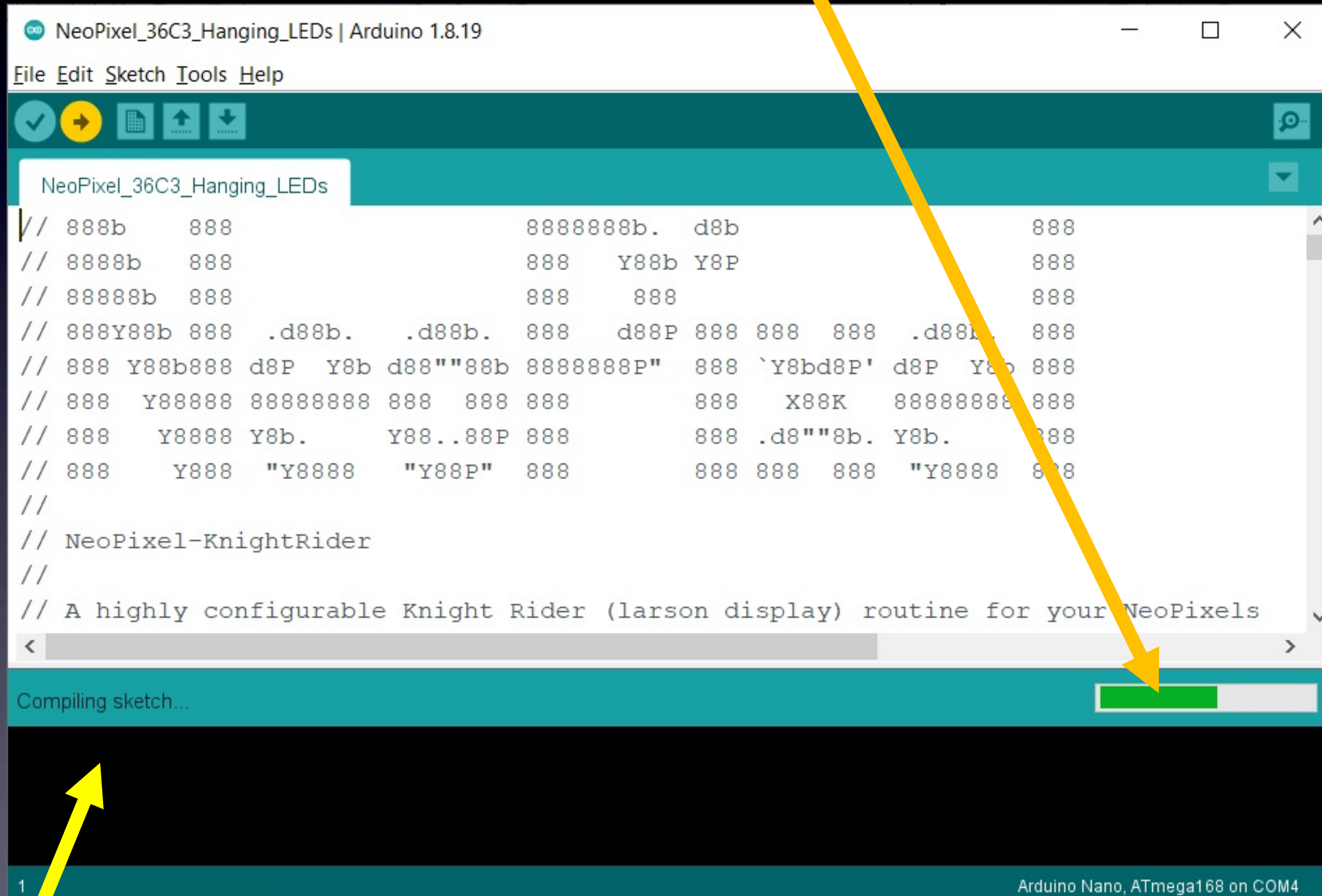
```
Blink | Arduino 1.8.19
File Edit Sketch Tools Help
Upload
Blink
/*
 * Blink
 *
 * Turns an LED on for one second, then off for one second, repeatedly.
 *
 * Most Arduinos have an on-board LED you can control. On the UNO, MEGA and ZERO
 * it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILTIN 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:
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 * modified 8 May 2014
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 *
 * 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, ATmega328P on COM6
```

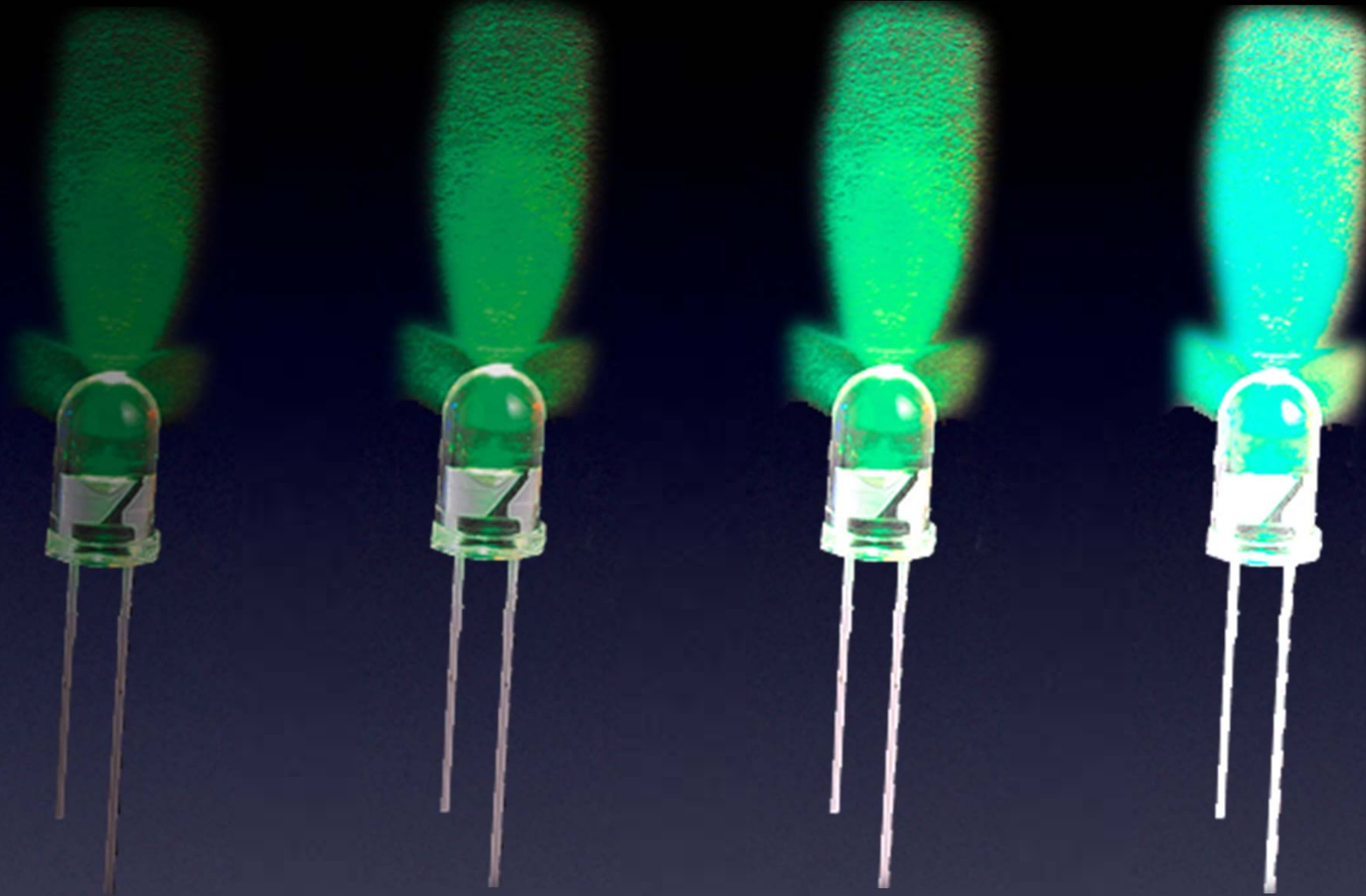
# Arduino

While uploading, you will see a progress bar...



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

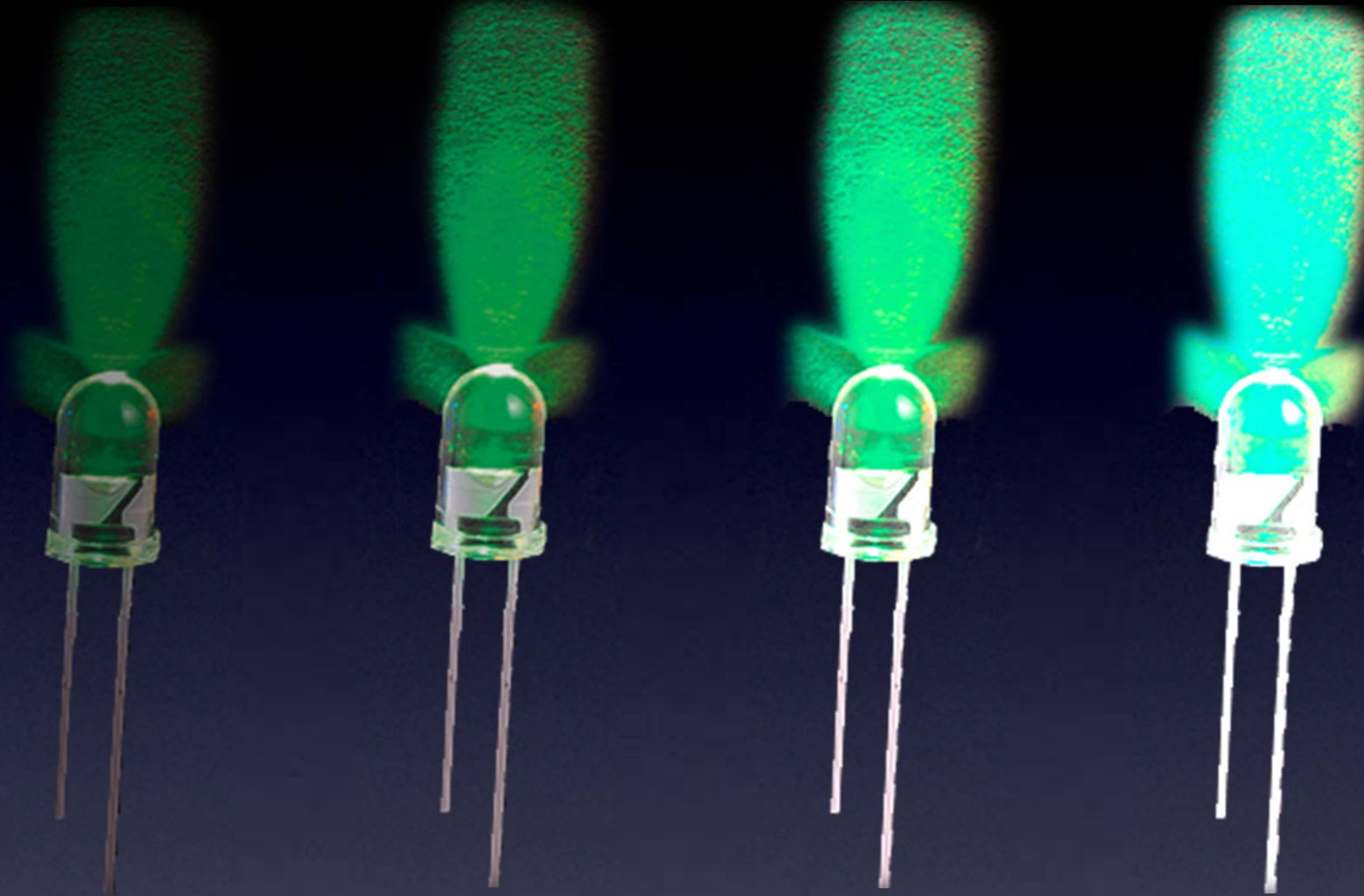
# LED Brightness



More resistance (less current)

(one way to change brightness)

# LED Brightness



Less average current

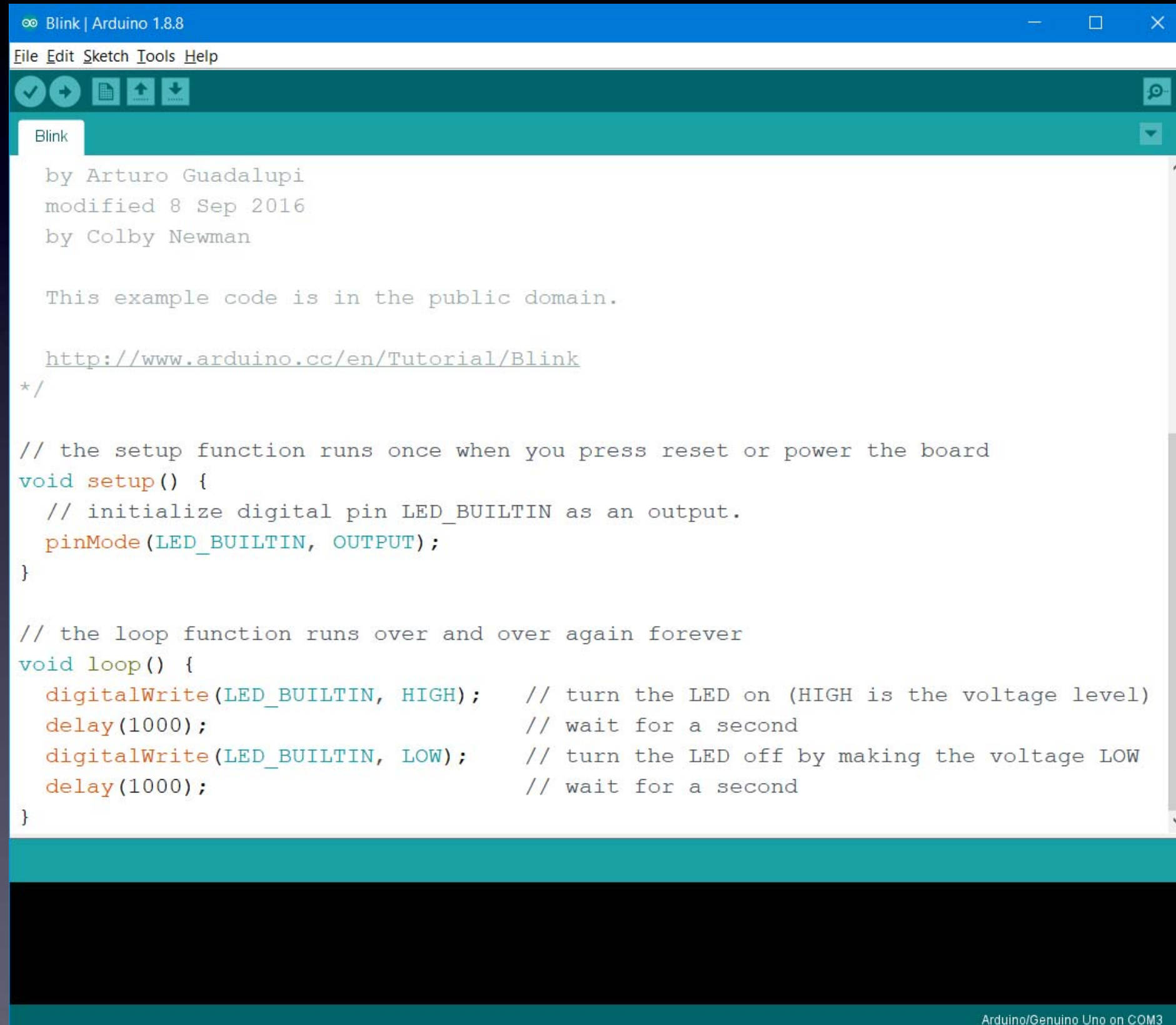
This is how we do it with a microcontroller

LED Brightness

**PWM**

# Arduino

## Hacking the Blink sketch

A screenshot of the Arduino IDE interface. The window title is "Blink | Arduino 1.8.8". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for checkmark, undo, redo, save, and upload. The main editor area shows the code for the Blink sketch. The code includes comments about the author (Arturo Guadalupi), modification date (8 Sep 2016), and author (Colby Newman). It also includes a URL: <http://www.arduino.cc/en/Tutorial/Blink>. The code defines a setup function to initialize the LED\_BUILTIN pin as an output and a loop function that turns the LED on for 1000ms and off for 1000ms. The status bar at the bottom right indicates "Arduino/Genuino Uno on COM3".

```
Blink | Arduino 1.8.8
File Edit Sketch Tools Help
[Icons]
Blink
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/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
}

Arduino/Genuino Uno on COM3
```

# 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 ?



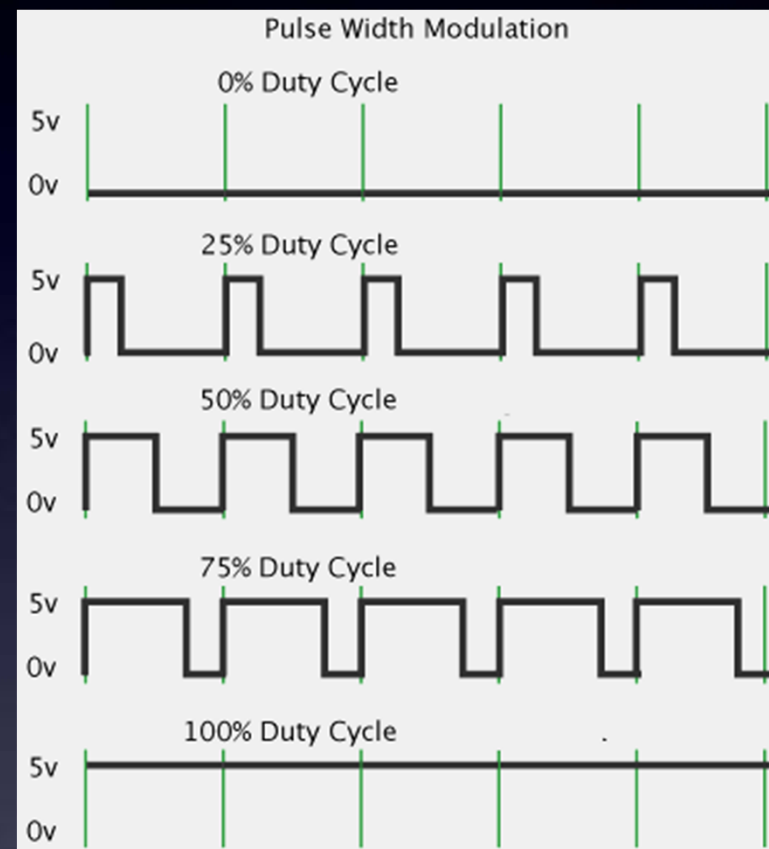
**Pulse Wave:**

ON and OFF at any ratio you like

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

# LED Brightness

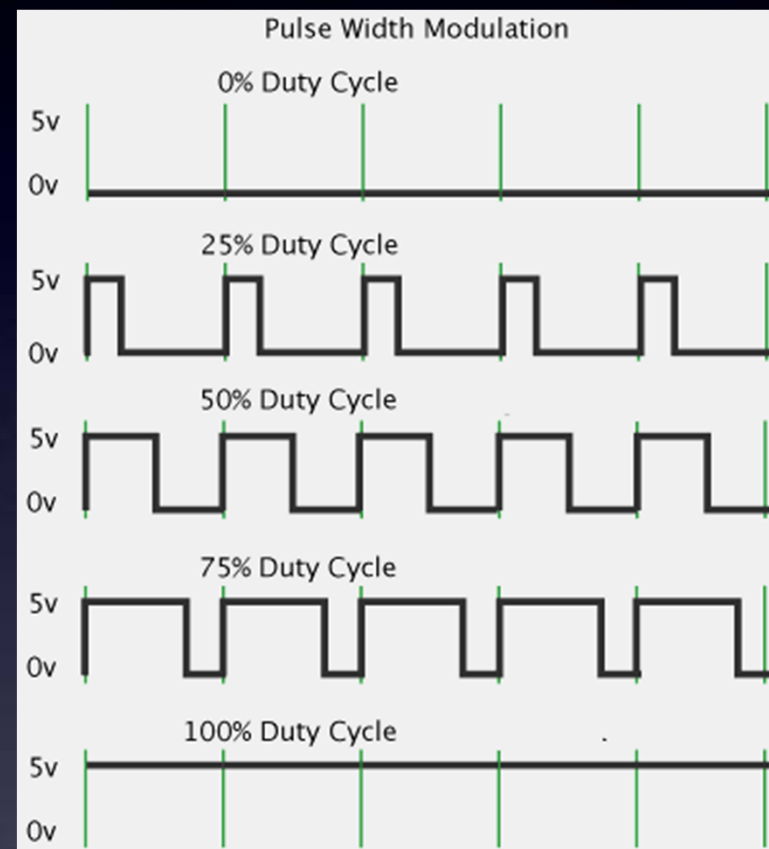
PWM



**Pulse Wave:**

ON and OFF at any ratio you like

# LED Brightness

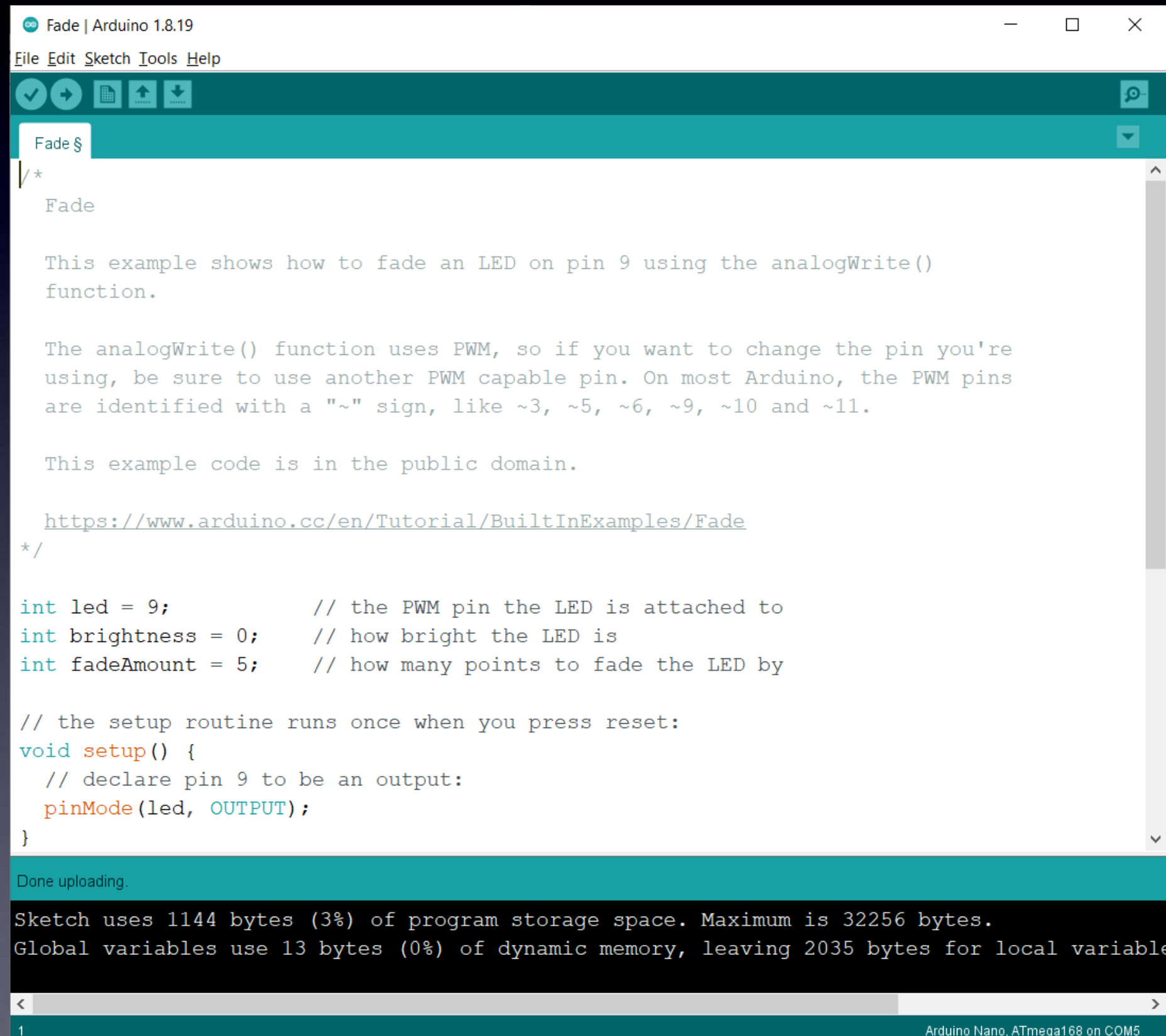


**PWM**

**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.

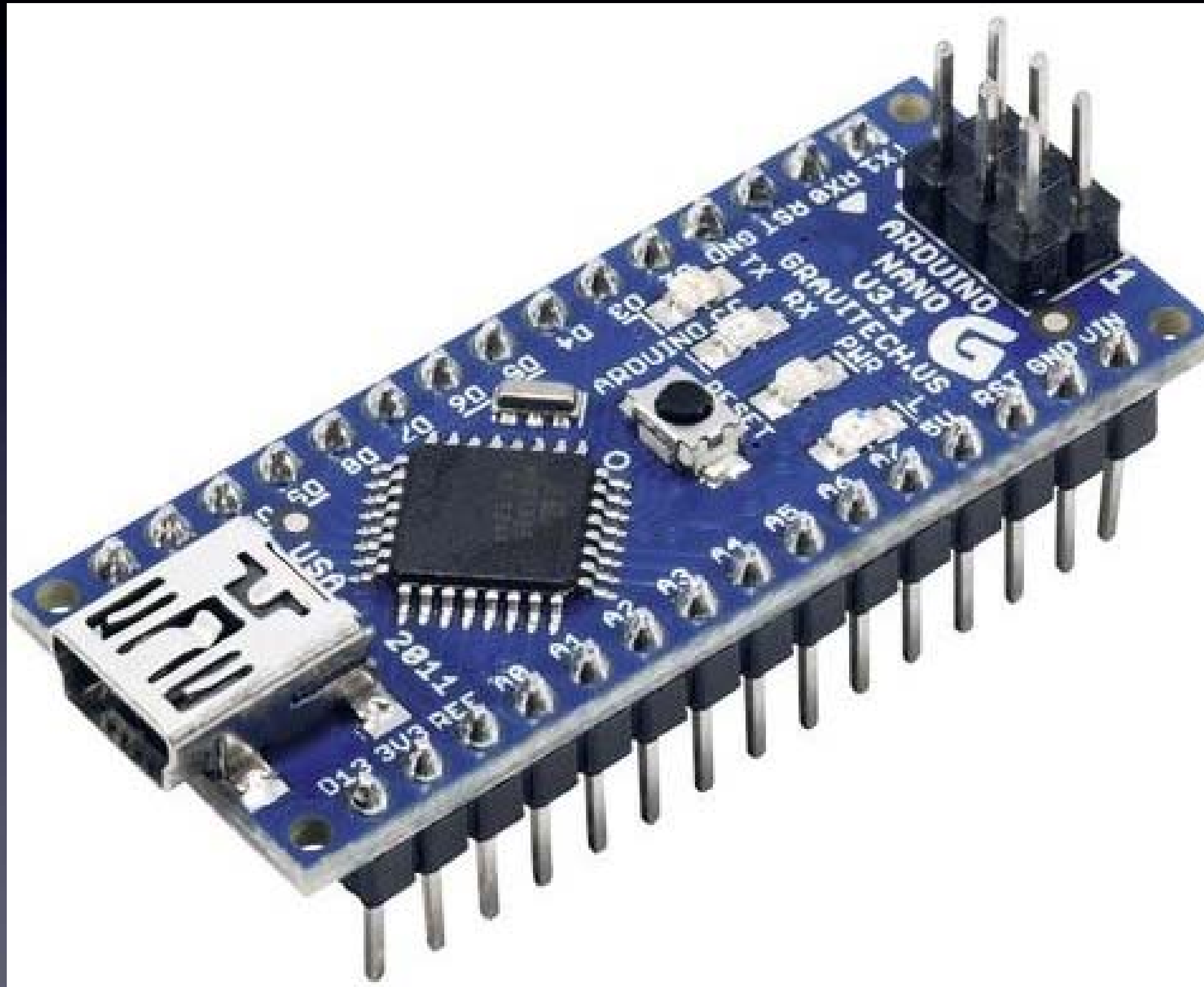
Sketch uses 1144 bytes (3%) of program storage space. Maximum is 32256 bytes.
Global variables use 13 bytes (0%) of dynamic memory, leaving 2035 bytes for local variables.

1 Arduino Nano, ATmega168 on COM5
```

# Let's Program Some LED Strips!



# Arduino



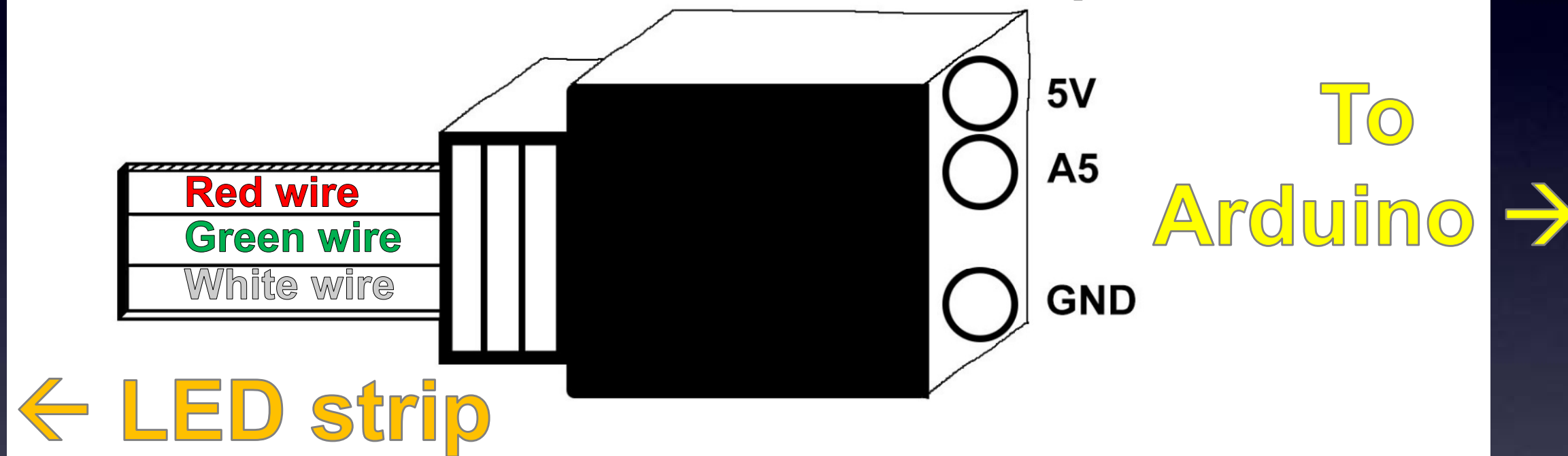
# Arduino



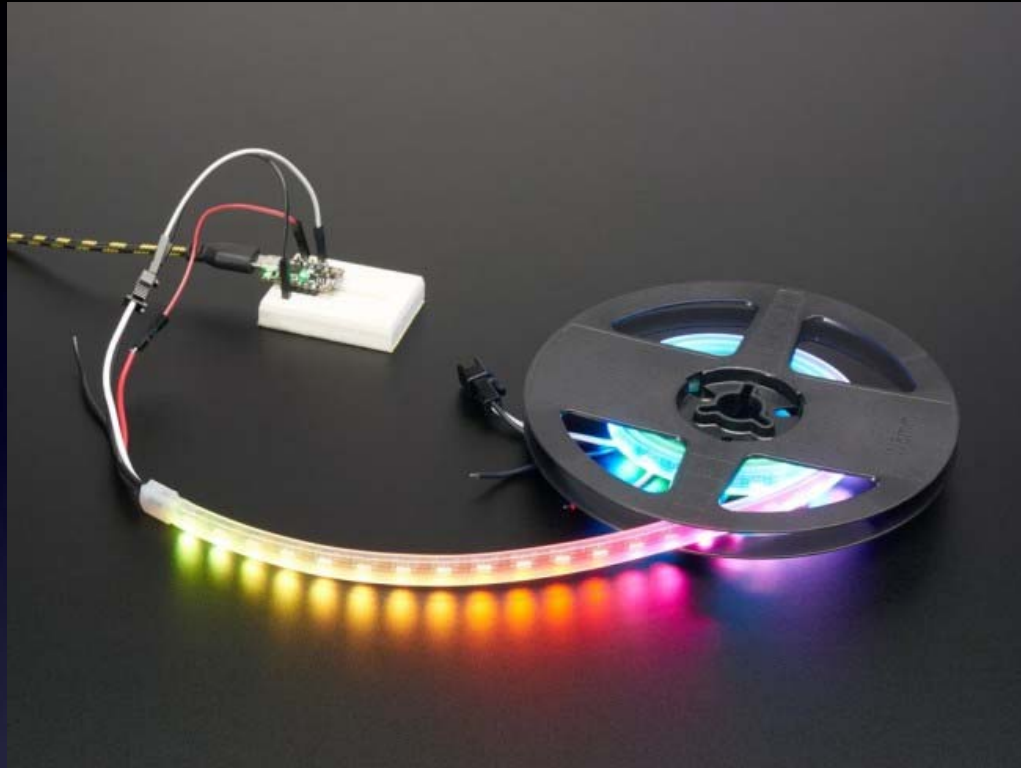


# Let's Program Some LED Strips!

Connector at end of Cable from LED strip



# Let's Program Some LED Strips!

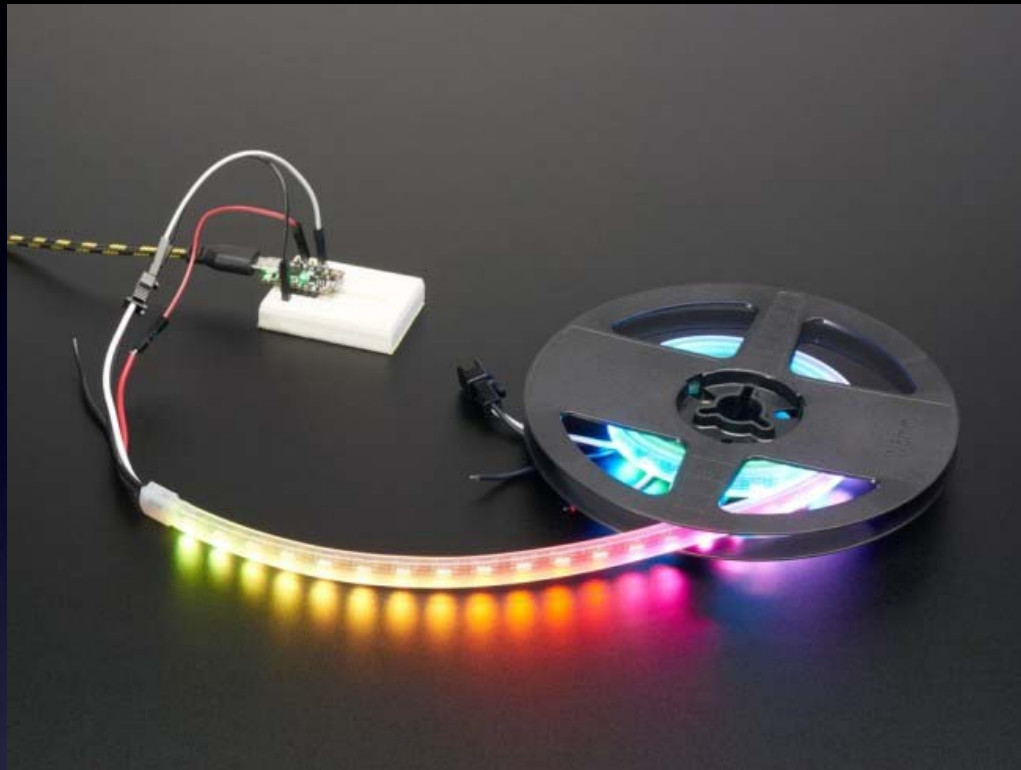


**Download some Arduino “sketches”:**

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

**Store them on your computer anywhere you like.**

# Let's Program Some LED Strips!

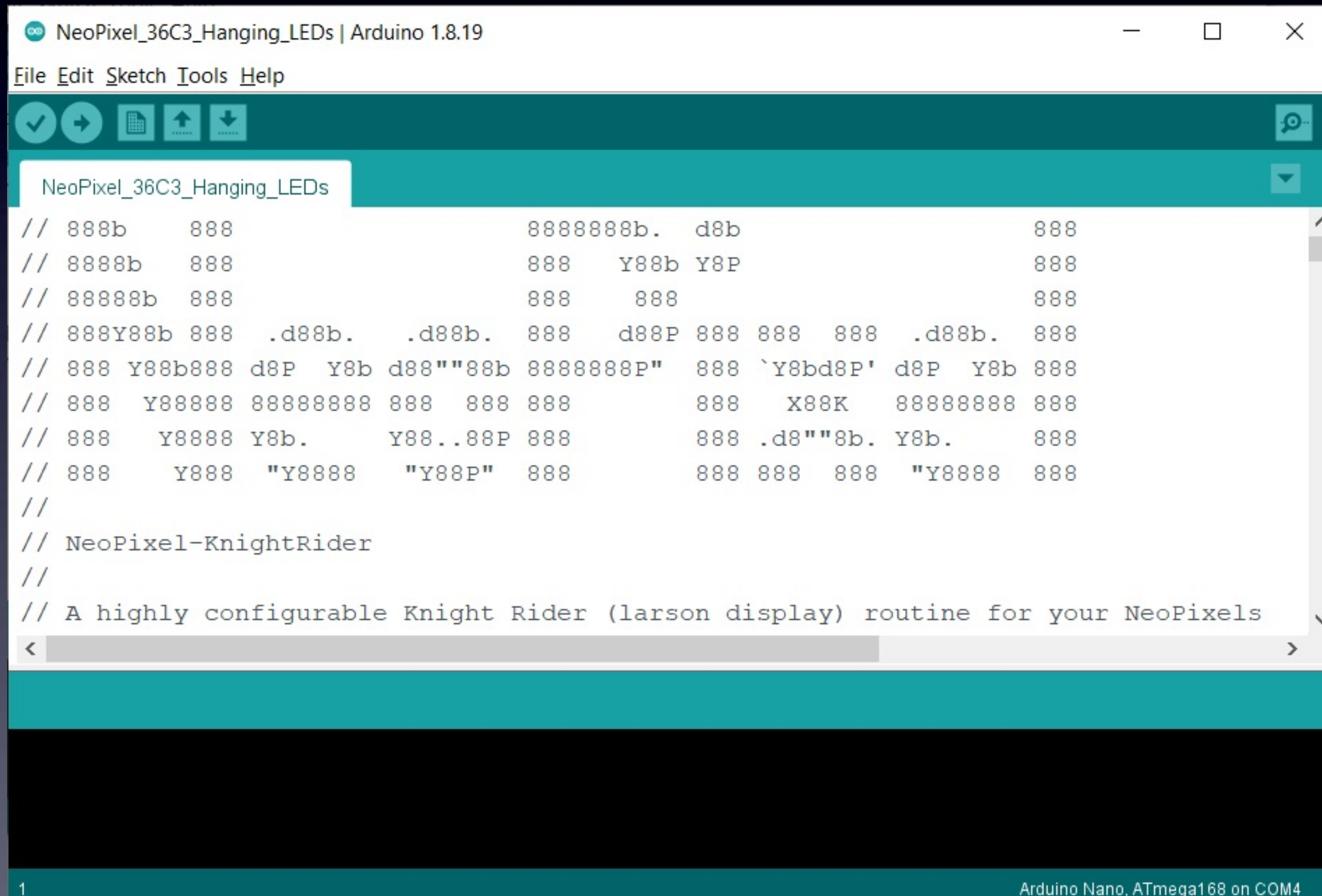


Download some Arduino “sketches”:

<http://tiny.cc/LEDstrips>

# Let's Program Some LED Strips!

Open the "sketch" you want to program



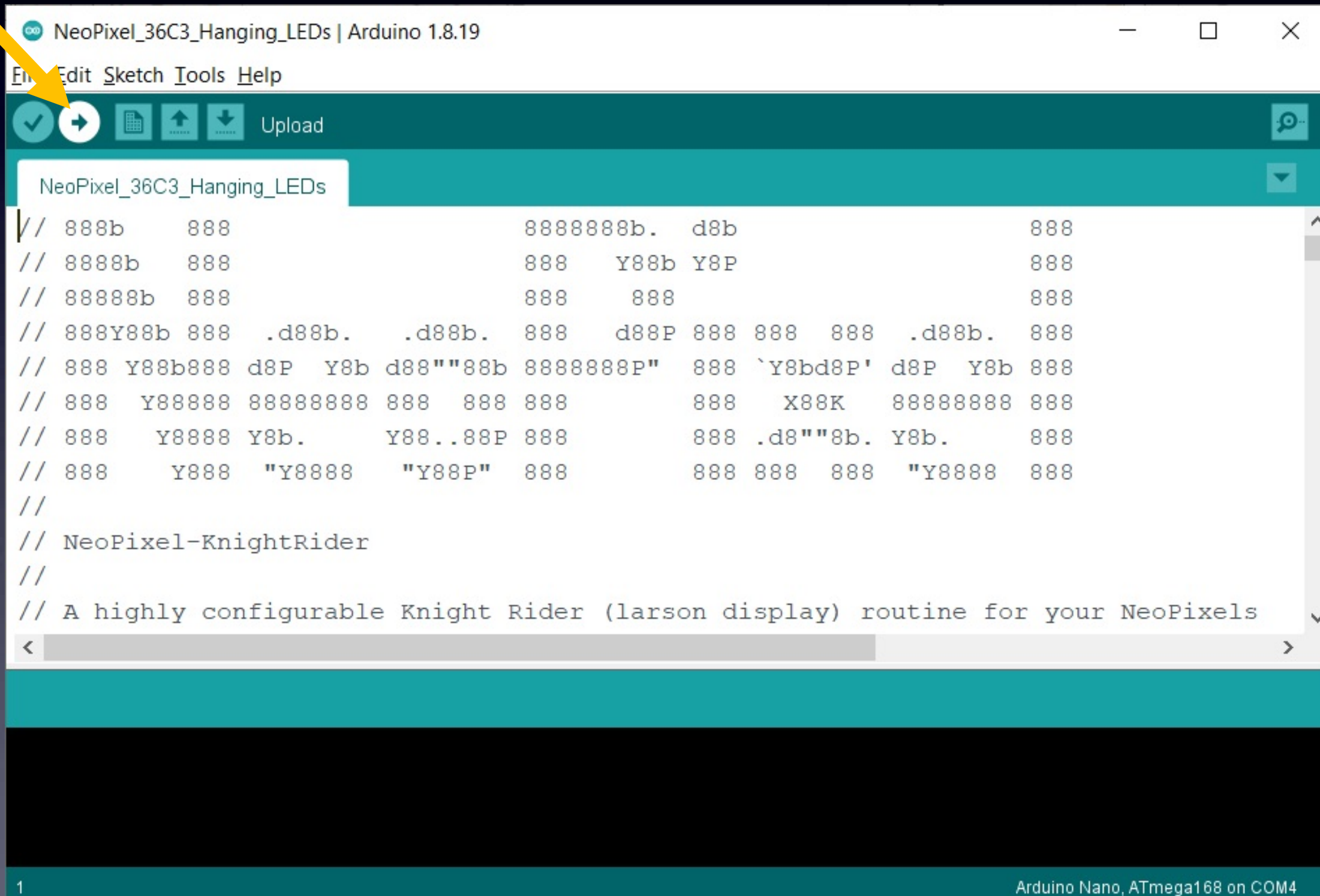
The screenshot shows the Arduino IDE interface. The title bar reads "NeoPixel\_36C3\_Hanging\_LEDs | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for saving, running, and uploading. The sketch editor shows the following code:

```
// 888b      888      88888888b.  d8b      888
// 8888b      888      888      Y88b Y8P      888
// 88888b      888      888      888      888      888
// 888Y88b 888      .d88b.      .d88b. 888      d88P 888 888 888      .d88b. 888
// 888 Y88b888 d8P  Y8b d88""88b 88888888P" 888 `Y8bd8P' d8P  Y8b 888
// 888  Y88888 888888888 888 888 888      888  X88K 888888888 888
// 888  Y8888 Y8b.      Y88..88P 888      888 .d8""8b. Y8b.      888
// 888  Y888  "Y8888  "Y88P" 888      888 888 888  "Y8888 888
//
// NeoPixel-KnightRider
//
// A highly configurable Knight Rider (larson display) routine for your NeoPixels
```

The status bar at the bottom indicates "1" on the left and "Arduino Nano, ATmega168 on COM4" on the right.

# Let's Program Some LED Strips!

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



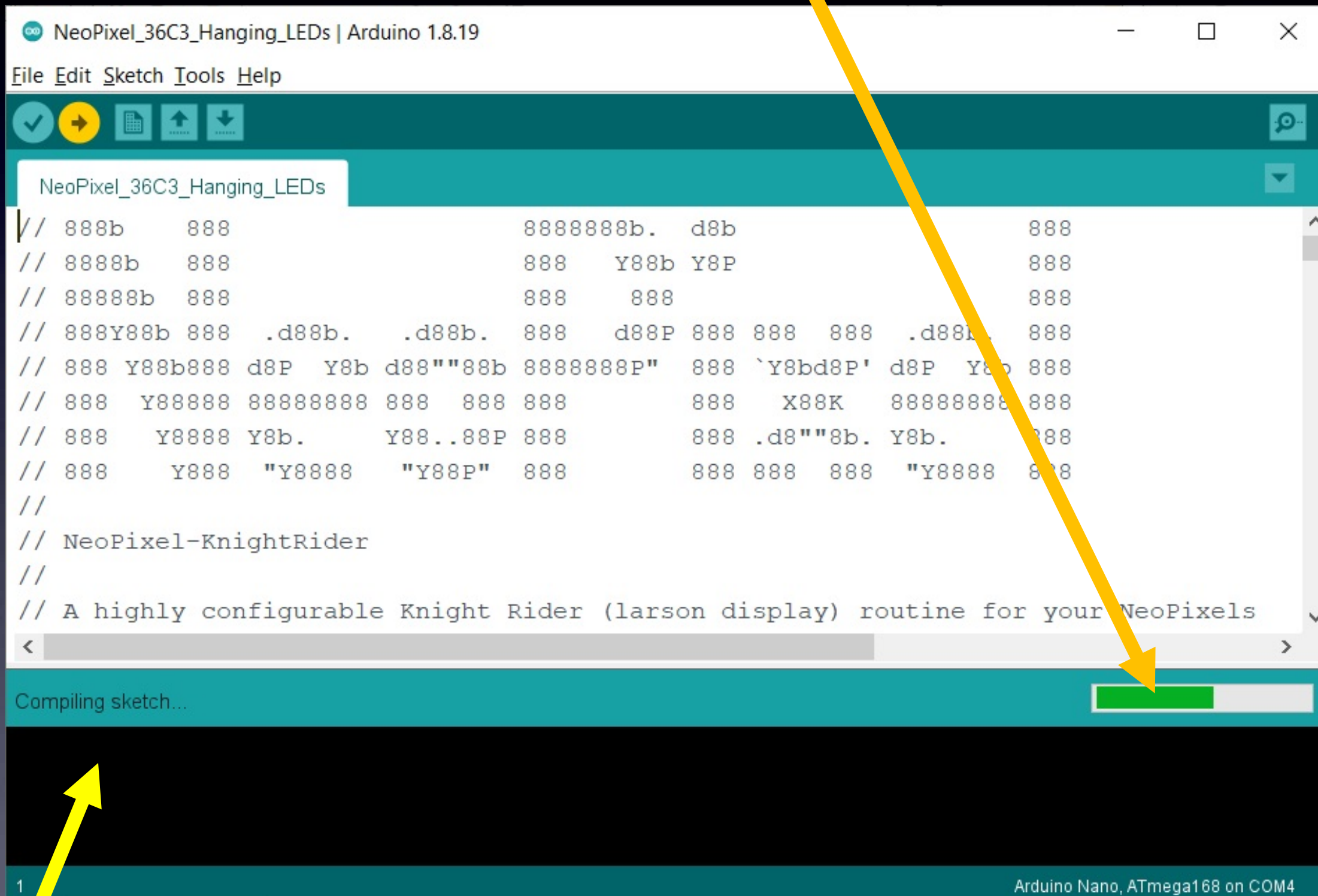
The screenshot shows the Arduino IDE interface for a sketch named "NeoPixel\_36C3\_Hanging\_LEDs". The "Upload" button is highlighted with a yellow arrow. The sketch content is as follows:

```
// 888b 888 8888888b. d8b 888
// 8888b 888 888 Y88b Y8P 888
// 88888b 888 888 888 888
// 888Y88b 888 .d88b. .d88b. 888 d88P 888 888 888 .d88b. 888
// 888 Y88b888 d8P Y8b d88""88b 8888888P" 888 `Y8bd8P' d8P Y8b 888
// 888 Y88888 888888888 888 888 888 888 X88K 888888888 888
// 888 Y8888 Y8b. Y88..88P 888 888 .d8""8b. Y8b. 888
// 888 Y888 "Y8888 "Y88P" 888 888 888 888 "Y8888 888
//
// NeoPixel-KnightRider
//
// A highly configurable Knight Rider (larson display) routine for your NeoPixels
```

At the bottom of the IDE, the hardware configuration is shown as "Arduino Nano, ATmega168 on COM4".

# 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

AliExpress

led strips neopixel

### Related Categories

- Lights & Lighting
- Toys & Hobbies
- Home Improvement
- Electronic Components & Supplies

[View More](#)

### Brands



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Search Anywhere, Anytime!



All Categories > "led strips neopixel"

Price: min - max Ship from PLUS Free Shipping ★★★★★ & Up

Sort by: **Best Match** Orders Price Ads may influence the rankings, see here how we organize our search results.

View:



DC5V WS2812B Led Strip 30/60/74...

**6,75€**  
~~14,48€~~ | -53%  
New User Bonus  
2131 sold ★ 4.8  
Free Shipping

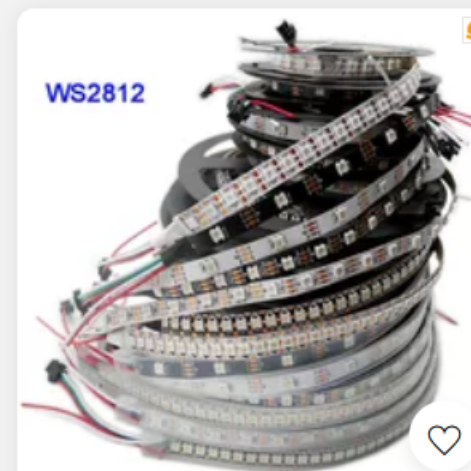
ANTVLED LIGHTING Store



WS2812B Led Strip WS2812 RGB I...

**0,01€**  
~~3,64€~~ | -99%  
New User Bonus  
640 sold ★ 4.9  
Free Shipping

SEZO Official Store



1m/3m/5m WS2812B Smart led str...

**1,57€**  
353 sold ★ 4.8  
Free Shipping

YJBCo Official Store



1m/2m/3m/4m/5m WS2812B Sma...

**1,55€**  
33 sold ★ 5  
Free Shipping

LarKin Store

# Ordering LED Strips

AliExpress

ANTVLED LIGHTING Store  
98.1% Positive feedback

+ Follow  
2108 Followers

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Store Home Products Sale Items Top Selling Feedback

## XnBaDa



DC5V WS2812B Led Strip 30/60/74/96/144 leds/m WS2812 Black/White PCB IP30/65/67 Smart RGB Led Light 1M 4M 5M

★★★★★ 4.8 566 Reviews 2131 orders

€ 0,01

€ 3,84 -99%

New User Bonus

Enjoy special discounts!

€ 19,90 Off Store Coupon Get coupons

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

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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

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5M 60 IP67

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1M 74 IP65

1M 74 IP67

1M 96 IP30

1M 96 IP65

1M 96 IP67

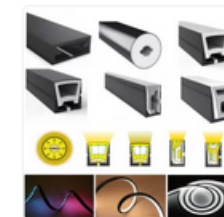
1M 144 IP30

1M 144 IP65

1M 144 IP67

Quantity:

Recommended For You



€ 3,24



€ 4,95

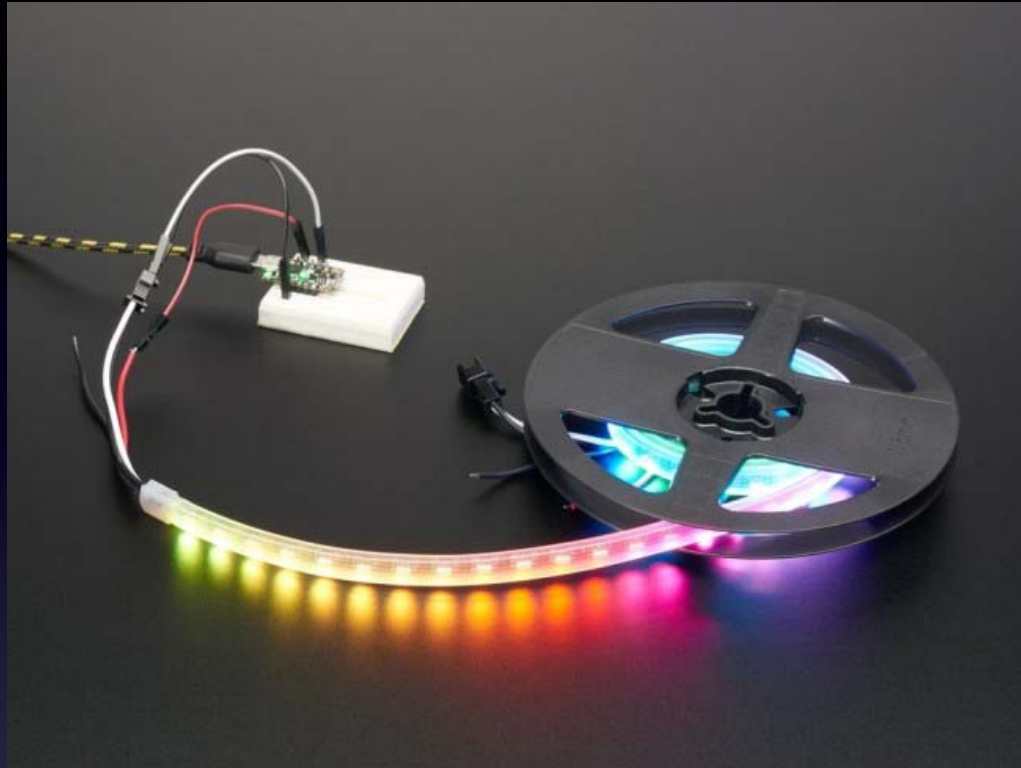


€ 5,02





# *LED Strips for Everyone Everywhere*



**These slides are also available at:**

**<http://tiny.cc/LEDstrips>**

# *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** (1<sup>st</sup> and biggest hardware accelerator)

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