

LED Strips for Everyone Everywhere

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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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Patreon: **mitchaltman**

THE BUNNY IS A LIE
EASTERHEGG 2026 | EH23



CORNFIELD ELECTRONICS

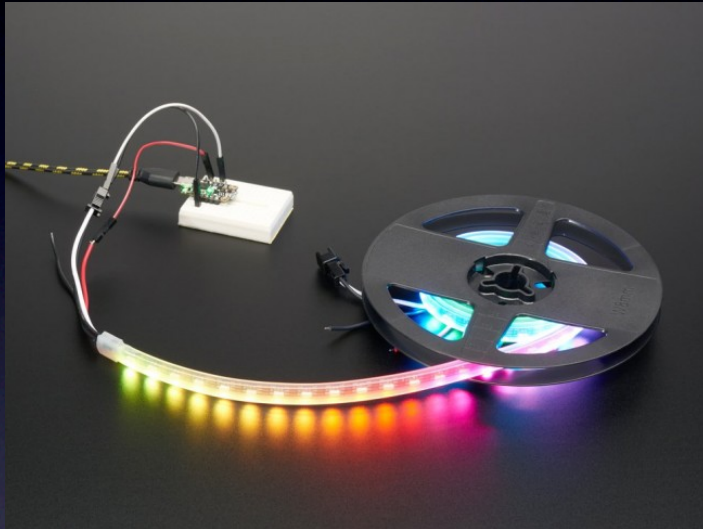
LED Strips for Everyone Everywhere



Syllabus

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

LED Strips for Everyone Everywhere



These slides are available at:

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

Brief Intro to LEDs and Electronics



A Green LED

Brief Intro to LEDs and Electronics



Lots of different colored LEDs!

Brief Intro to LEDs and Electronics

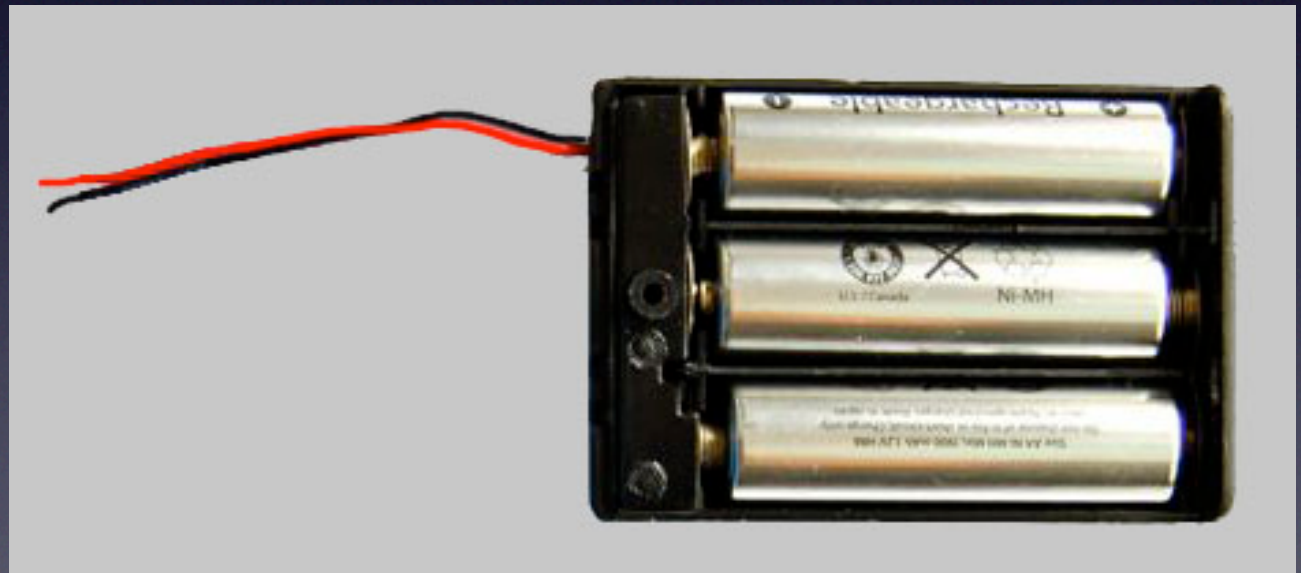


How to make them light up?

Brief Intro to LEDs and Electronics

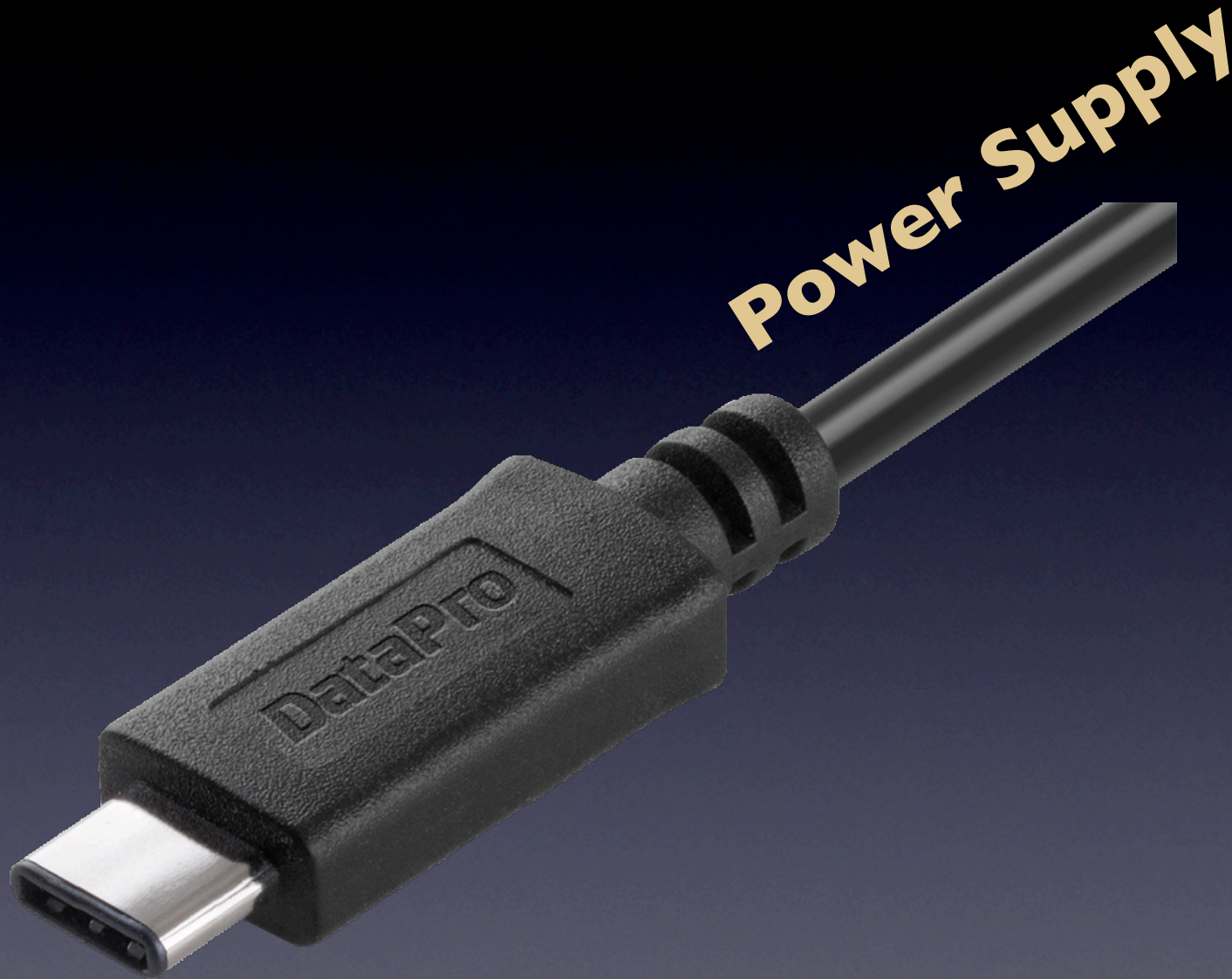


Power Supply



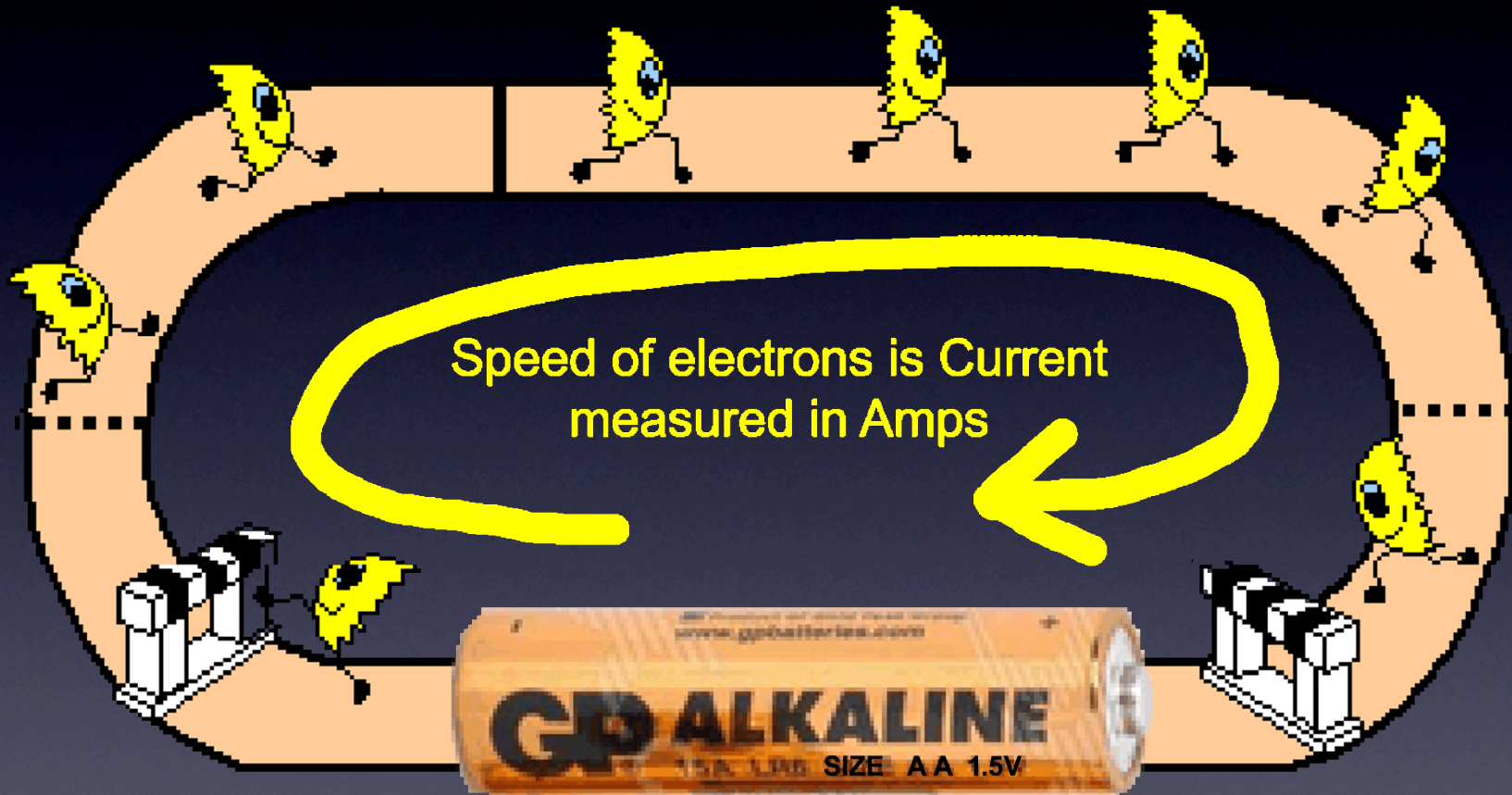
Voltage / **Volts**

Brief Intro to LEDs and Electronics



Voltage / **Volts**

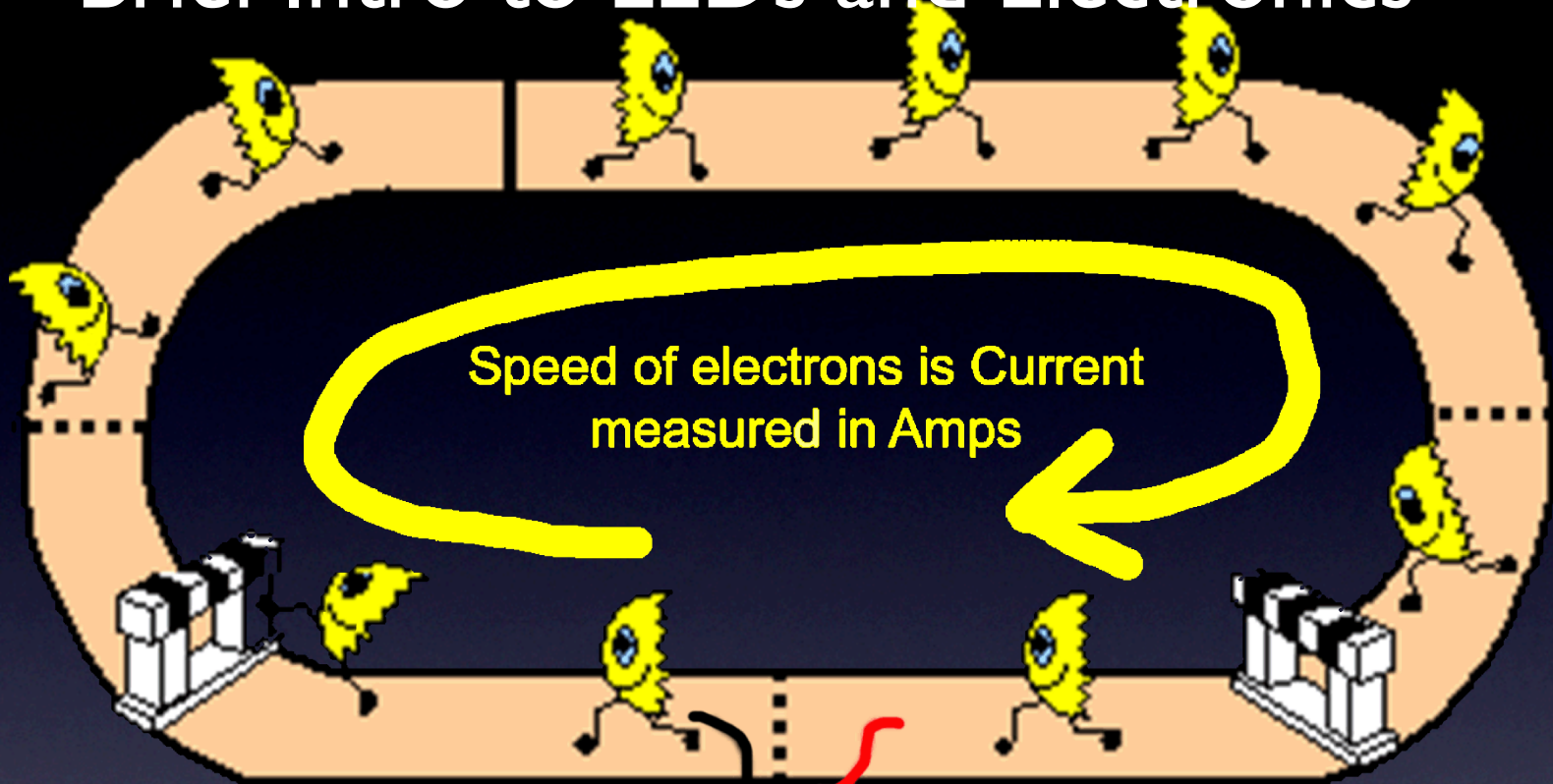
Brief Intro to LEDs and Electronics



Electrons pushed with 1.5V.
So, they move!

Current / **Amps**

Brief Intro to LEDs and Electronics



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

Current / **Amps**

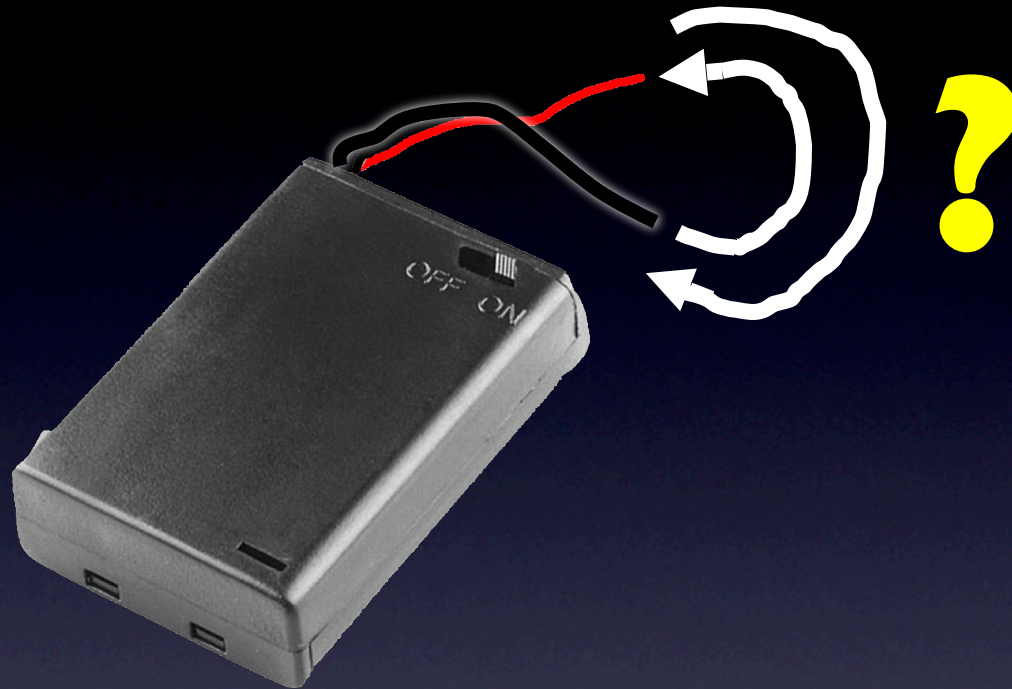
Brief Intro to LEDs and Electronics

Too much energy?

Lots of energy!

Magic smoke goes away...

Brief Intro to LEDs and Electronics

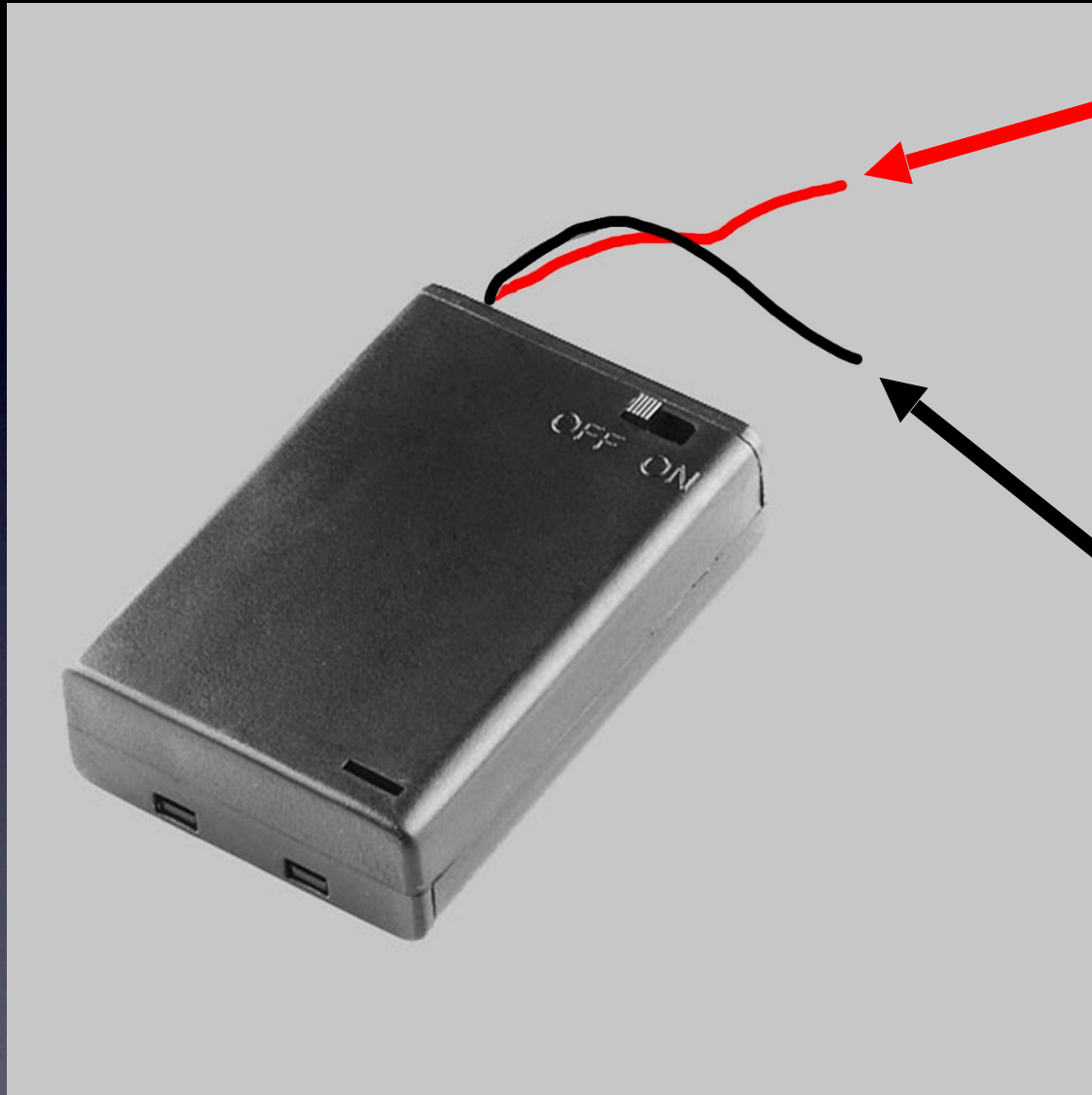


What happens?

Polarity

Power Supply – it matters how you connect it!

Brief Intro to LEDs and Electronics



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

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

Power Supply – it matters how you connect it!

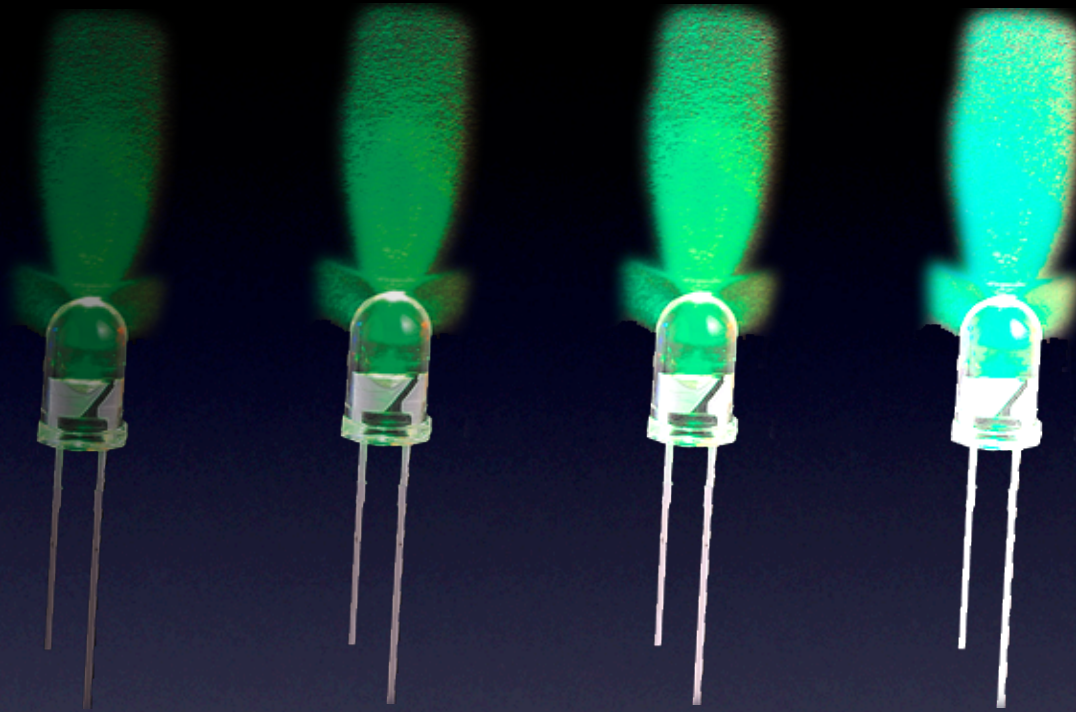
Brief Intro to LEDs and Electronics



Plus / Positive (+)

Minus / Negative (-)

LED Brightness



More current → More brightness!

LED

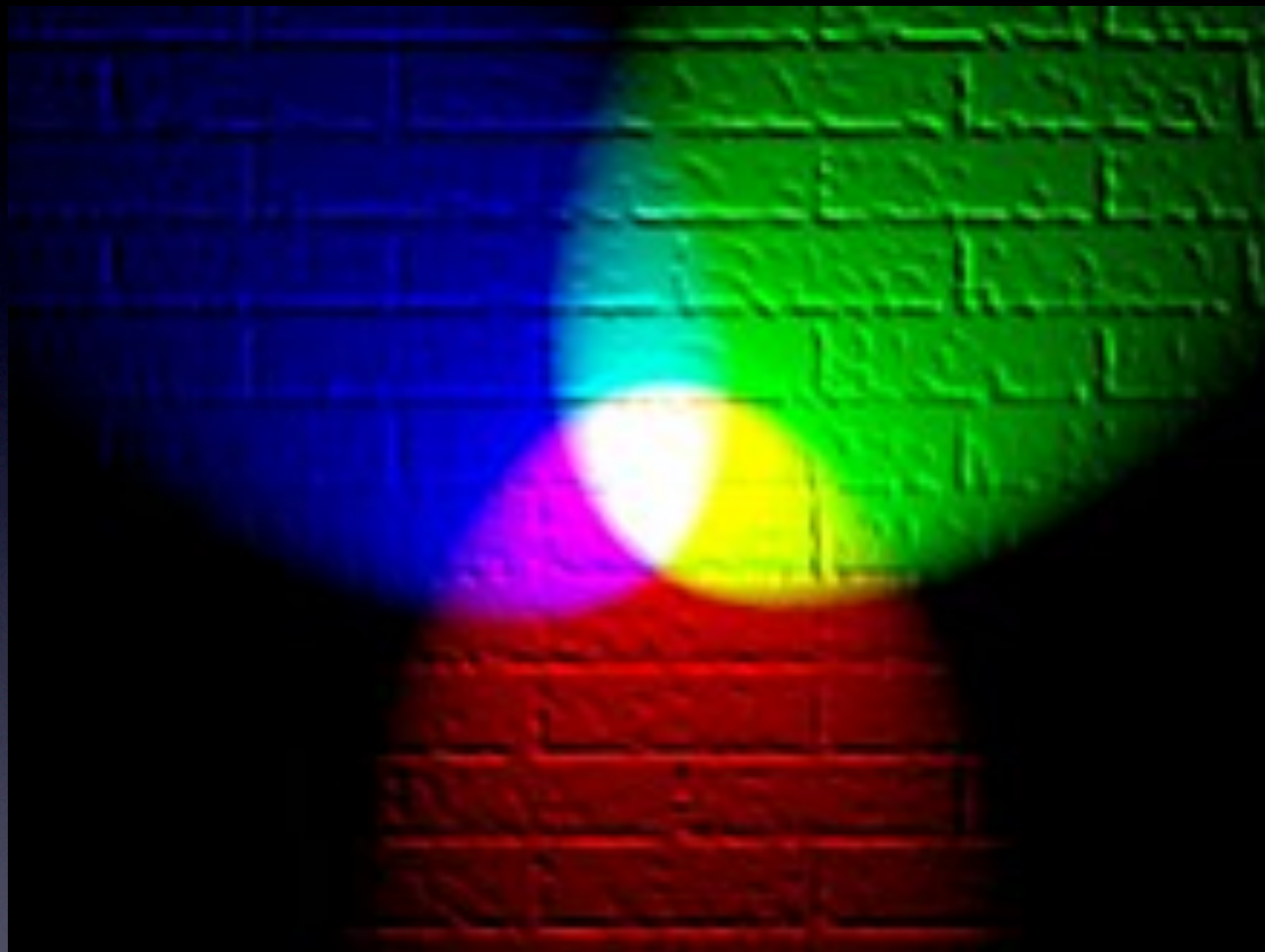
LED Brightness

But, we will use a trick:

PWM

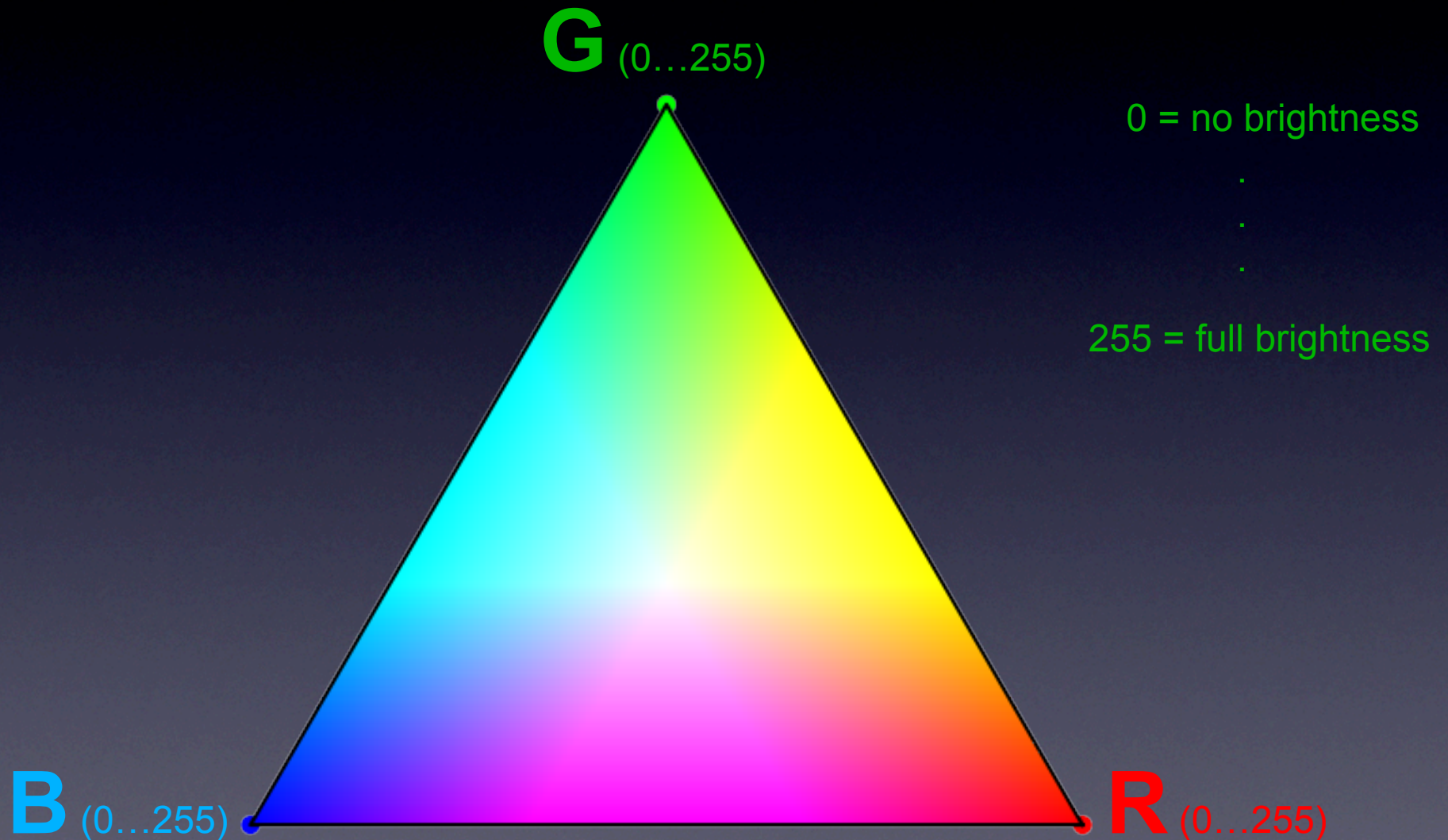
(coming soon...)

Light Color Mixing



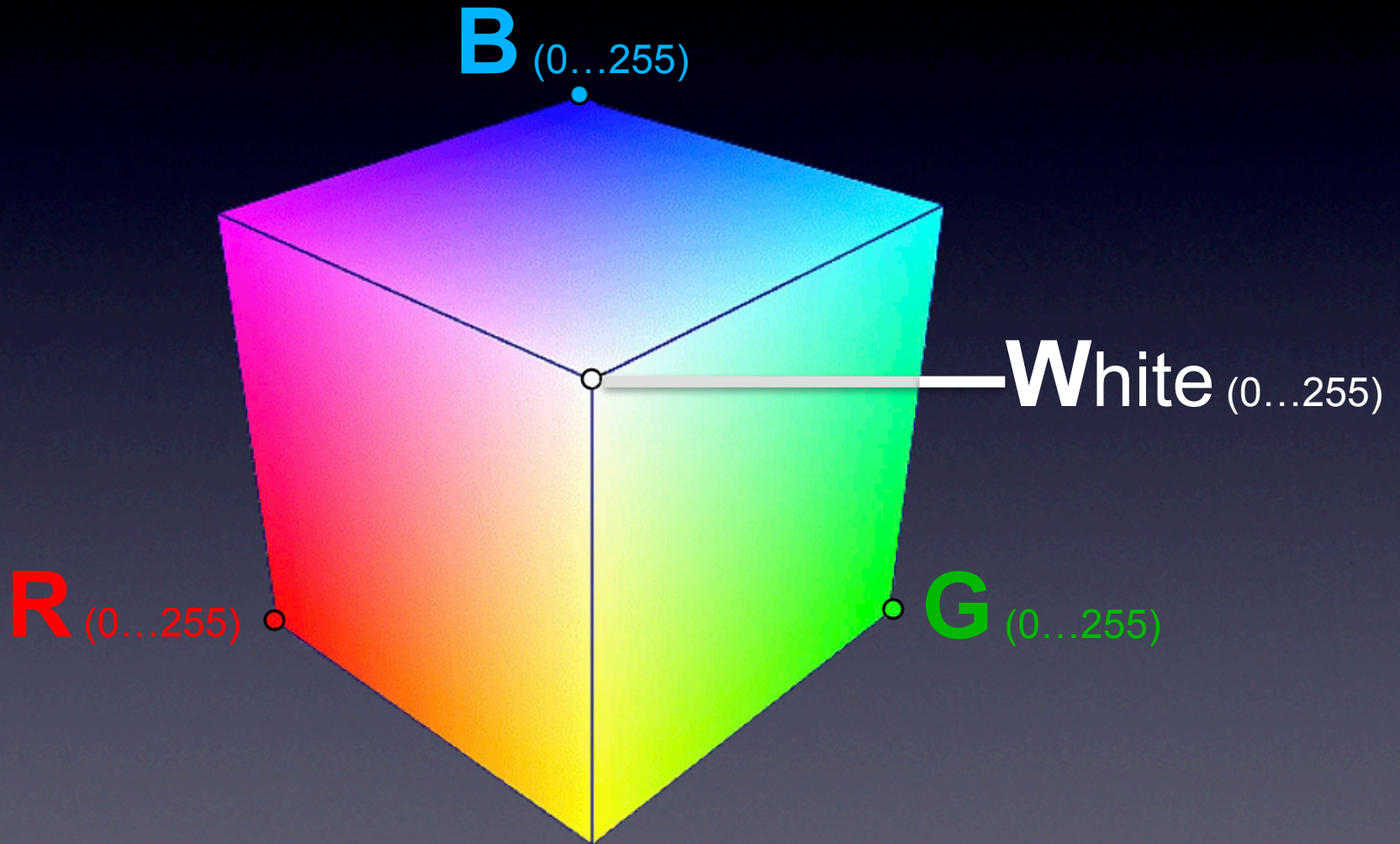
Light Color Mixing

RGB Color Triangle



Light Color Mixing

RGBW Color Cube



LED Brightness

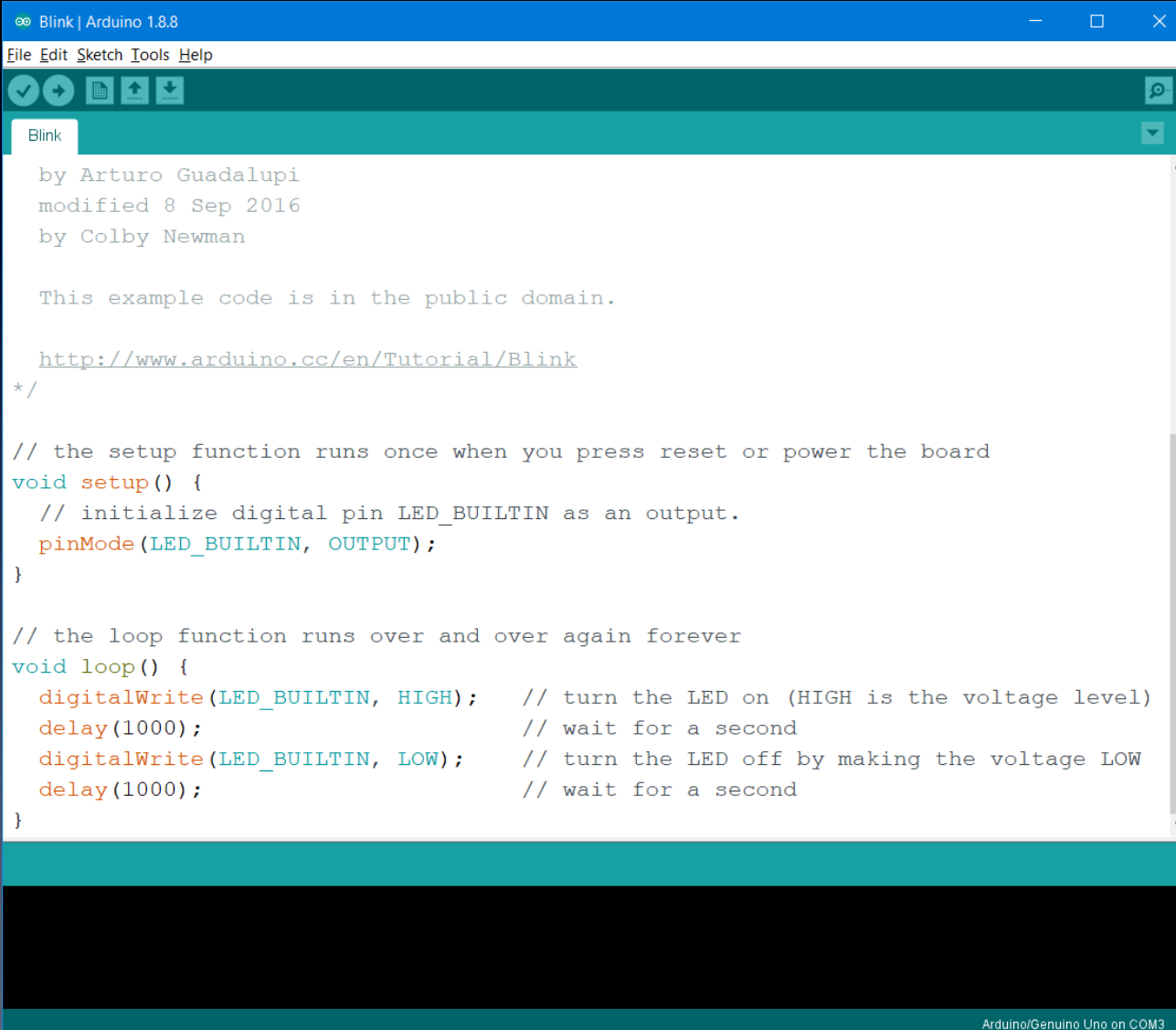
We will use a trick:

PWM

(to control “brightness” with a computer chip)

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". The toolbar contains icons for check, undo, redo, save, and upload. The main editor area shows the "Blink" sketch code. The code includes a header comment with author information and a URL, followed by the setup and loop functions. 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
  */

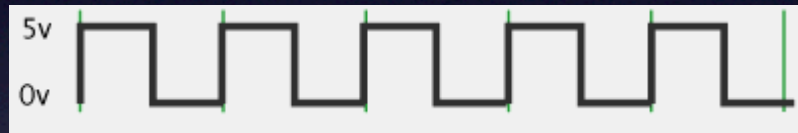
  // the setup function runs once when you press reset or power the board
  void setup() {
    // initialize digital pin LED_BUILTIN as an output.
    pinMode(LED_BUILTIN, OUTPUT);
  }

  // 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



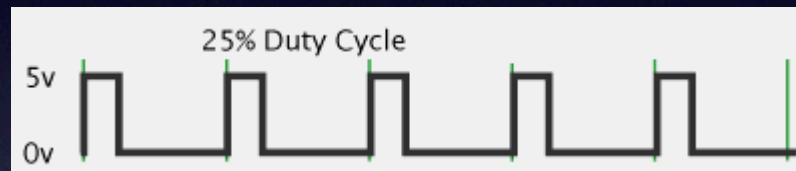
Square Wave:

ON half the time / OFF half of the time

(half the energy of ON all the time)

Digital Signal Processing

PWM



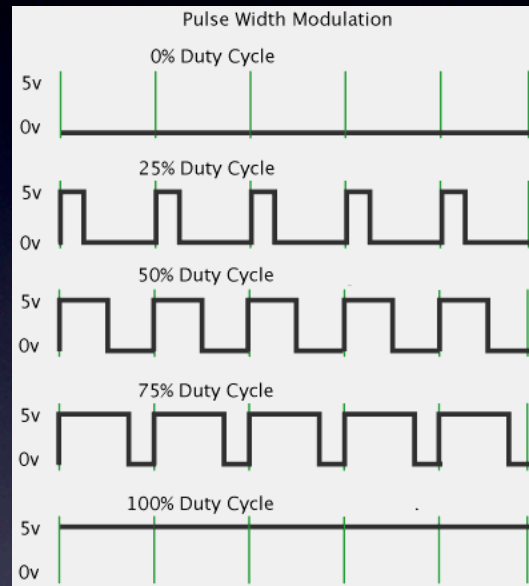
Pulse Wave (different Pulse Widths):

ON and OFF at any ratio you like

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

LED Brightness

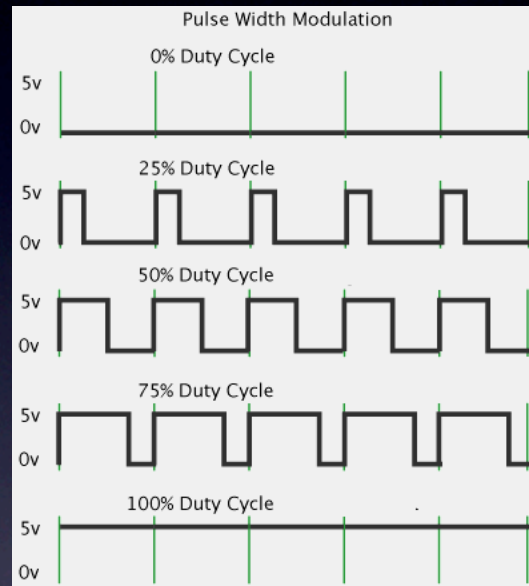
PWM



Pulse Wave (different Pulse Widths):

ON and OFF at any ratio you like

LED Brightness



PWM

Pulse Width Modulation

“Modulation” — anything that changes over time

Arduino

Example “sketch”: Fade



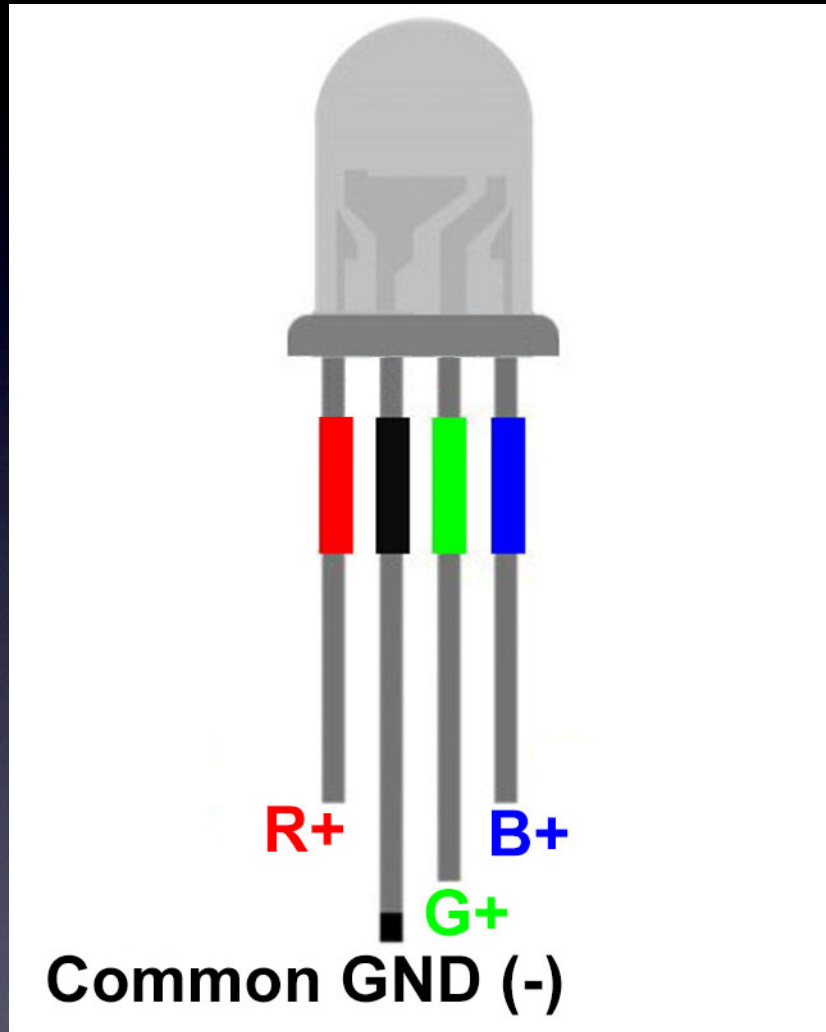
The screenshot shows the Arduino IDE interface. The title bar reads "Fade | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for check, run, save, upload, and download. The main editor area shows the following code:

```
/*  
 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);  
}
```

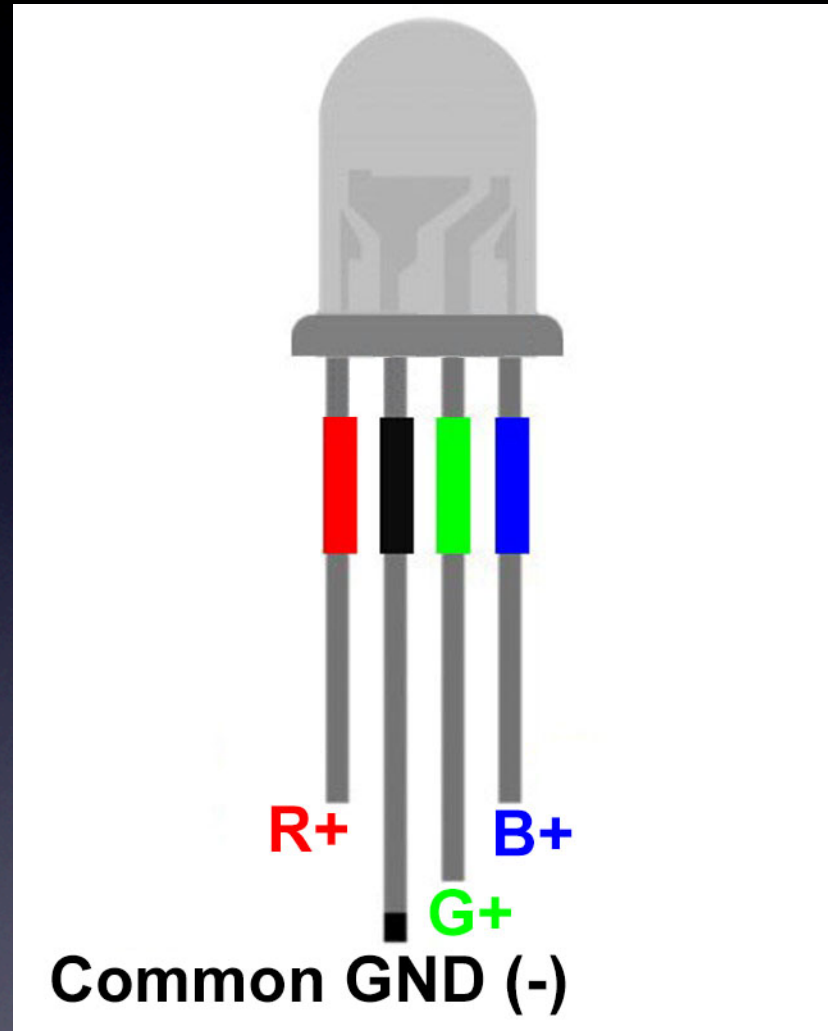
Below the code, a status bar indicates "Done uploading." and a message box shows: "Sketch uses 1144 bytes (3%) of program storage space. Maximum is 32256 bytes. Global variables use 13 bytes (0%) of dynamic memory, leaving 2035 bytes for local variables." The bottom status bar shows "1" and "Arduino Nano, ATmega168 on COM5".

Uses PWM to fade an LED on and off

RGB LED

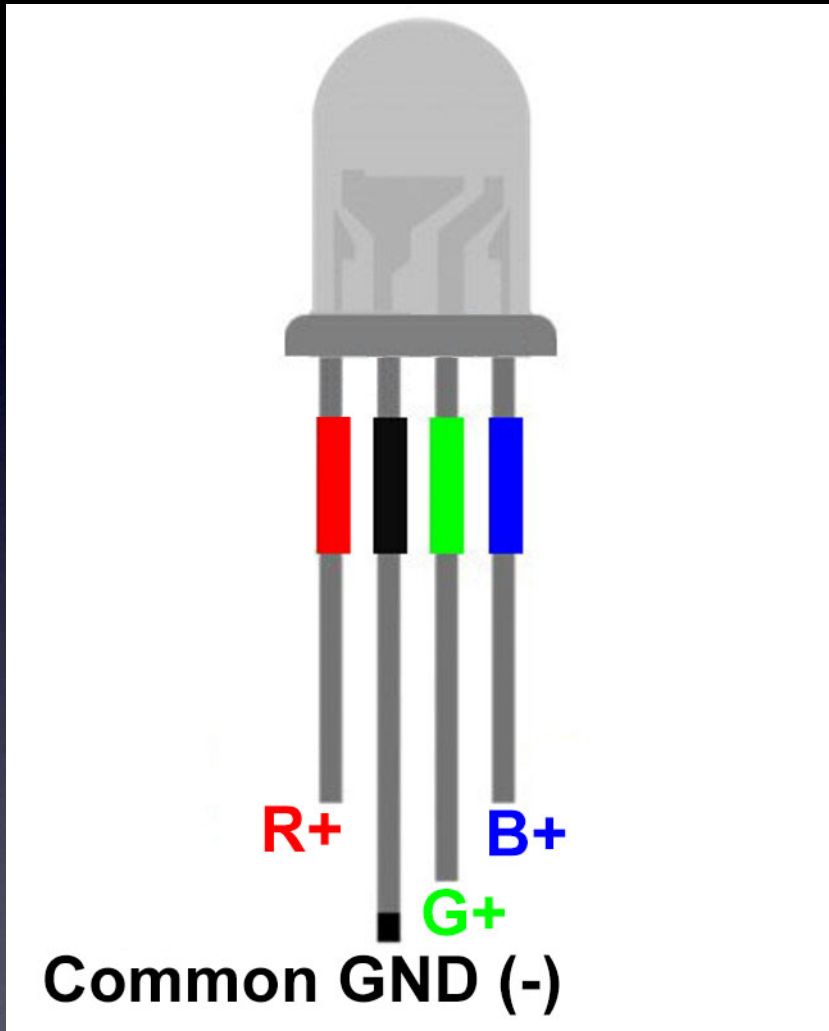


RGB LED



*Can use PWM with a microcontroller to control brightness of **R** and **G** and **B***

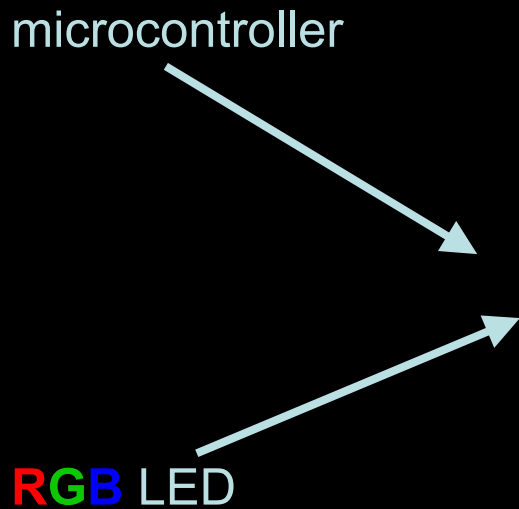
RGB LED



We can create
any color in the **RGB**
triangle!

Can use PWM with a microcontroller
to control brightness of **R** and **G** and **B**

RGB LED with microcontroller (Example)



Trippy RGB Waves kit

RGB LED



Contains:

* *microcontroller*

* **RGB** LED

WS2812B

RGB LED



Contains:

* *microcontroller*

* **RGB** LED

WS2812B

“Neopixel”

RGB LED Strips

Each pixel contains:

** microcontroller*

** RGB LED*



WS2812B strip

“Neopixel” RGB LED strip

RGB LED Strips

Each pixel contains:

** microcontroller*

** **RGB** LED*



To control all pixels, we only need:

* +5V and GND

* control data from a microcontroller data

WS2812B strip

“Neopixel” RGB LED strip

Intro to Arduino



Intro to Arduino



Created for non-geeky artists

Intro to Arduino



Super easy to connect parts to its microcontroller's pins

Use an Arduino board

Intro to Arduino

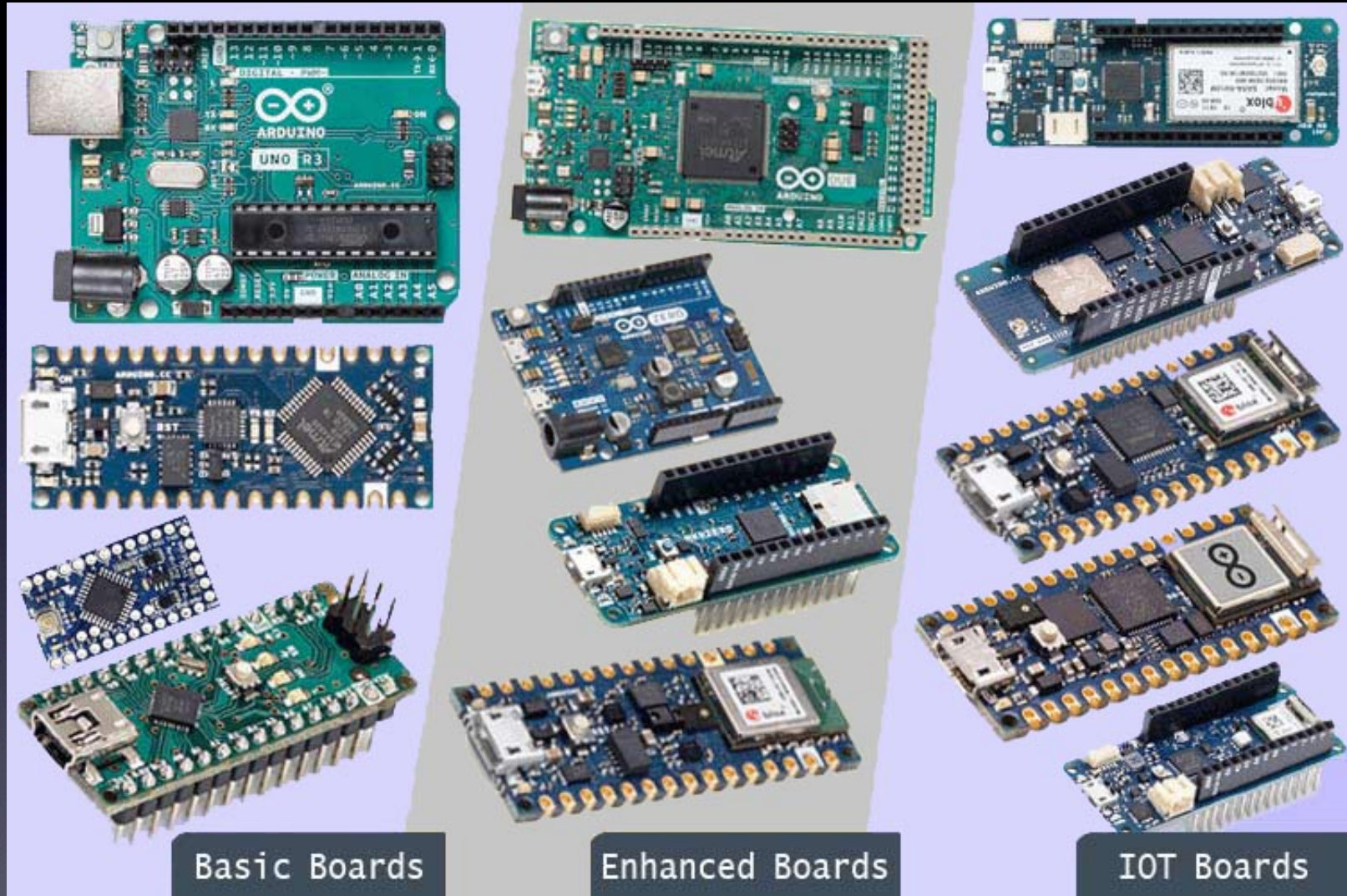


Use an Arduino board

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 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 workshop
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

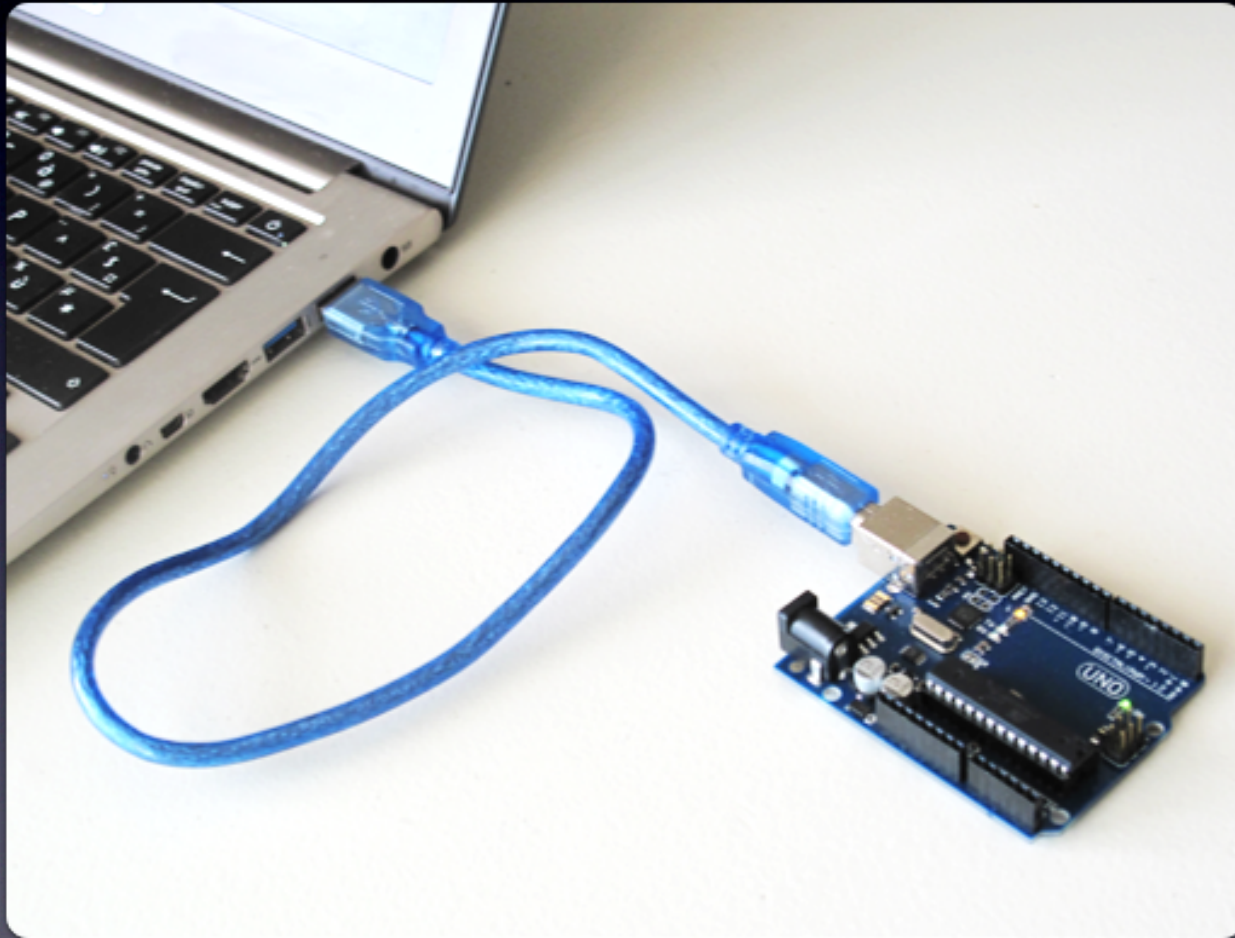
For more info, there are many good Arduino tutorials online.
A good place to start is:

<<https://www.arduino.cc/en/Tutorial/HomePage>>

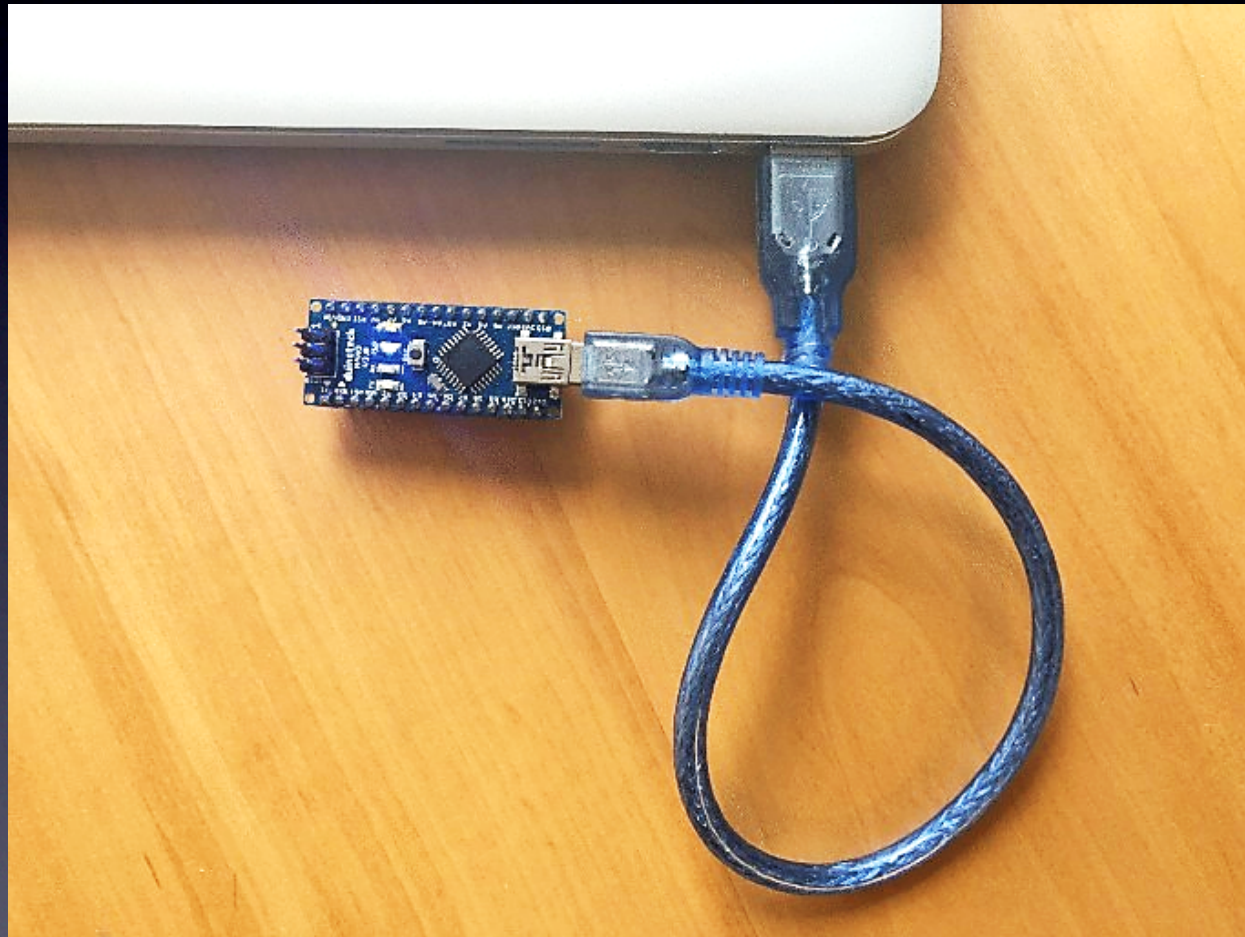


Windows, MacOS, or Linux

Connect your Arduino to your computer



Connect your Arduino to your computer



Arduino

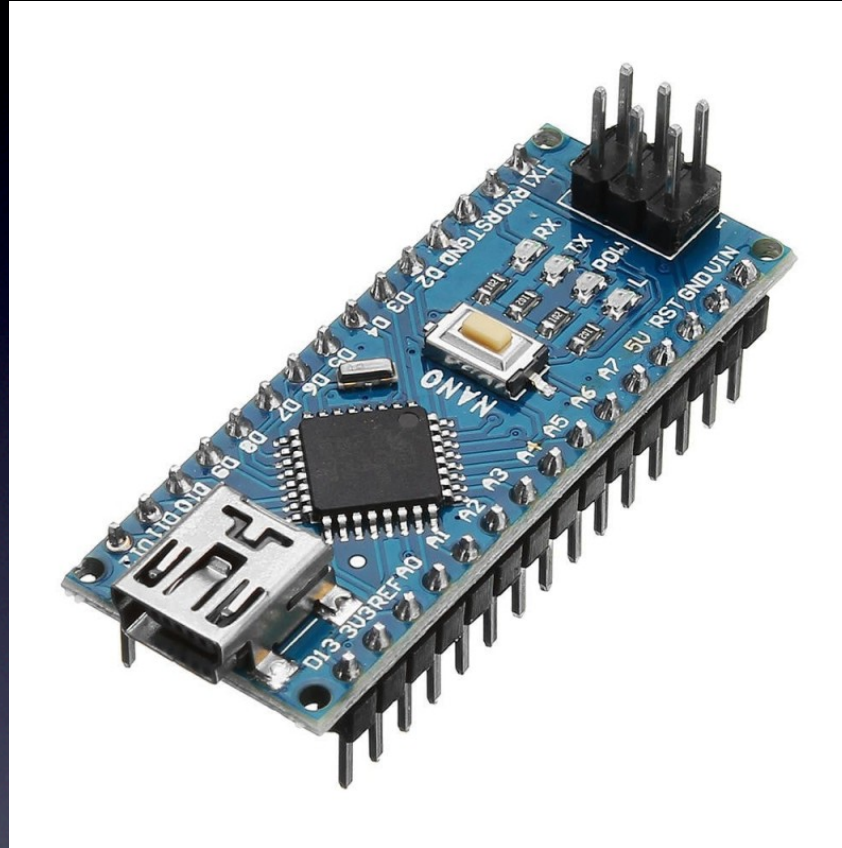
Download and install the Arduino software
< <http://arduino.cc> >

Any version is fine!



Windows, MacOS, or Linux

Serial Port Driver




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

search for: "CH340 Driver"

Arduino

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

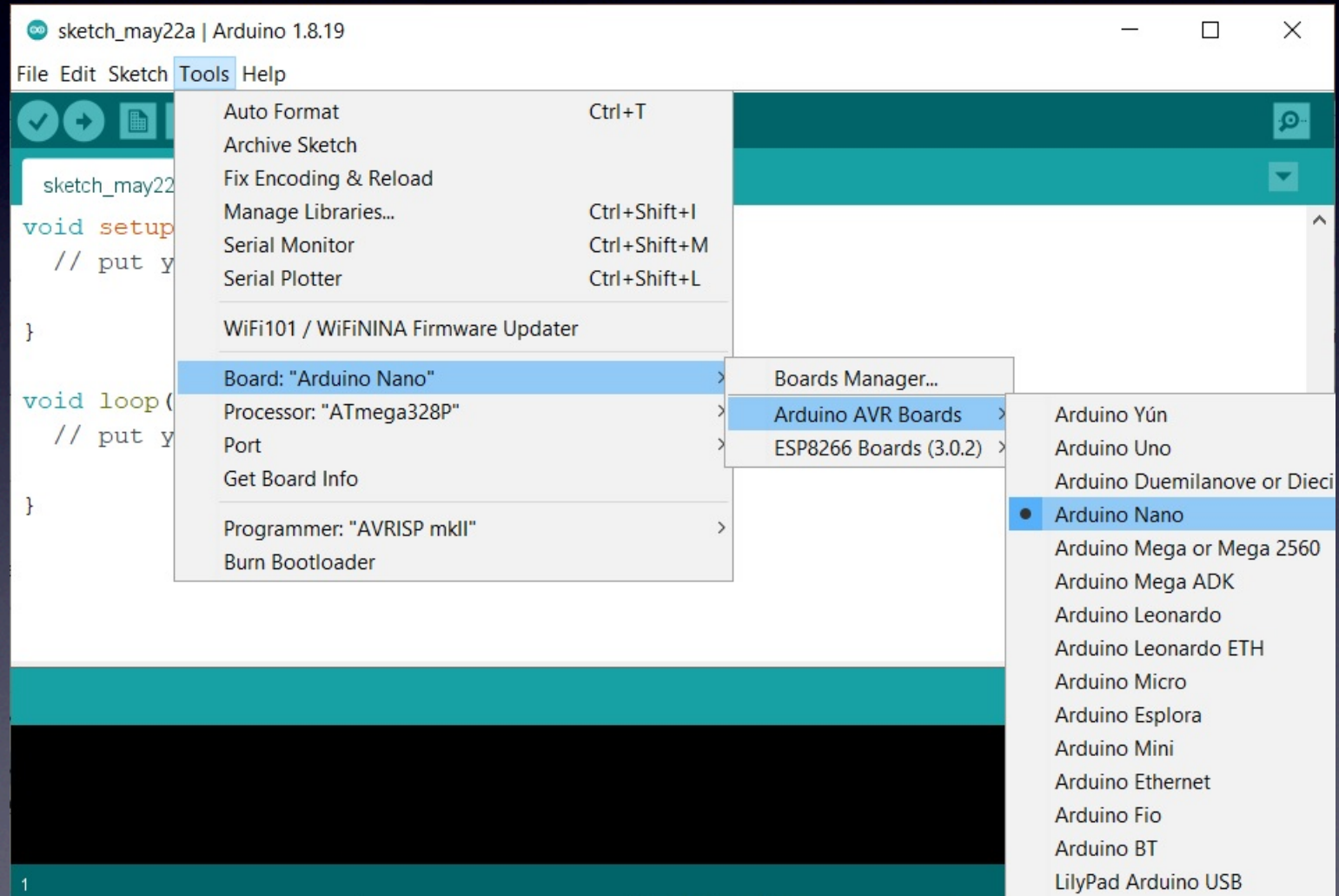


```
sketch_may1a | Arduino IDE 2.1.0
File Edit Sketch Tools Help
Arduino Uno
sketch_may1a.ino
1 void setup() {
2   // put your setup code here, to run once:
3
4 }
5
6 void loop() {
7   // put your main code here, to run repeatedly:
8
9 }
10
Ln 1, Col 1  Arduino Uno [not connected]
```

Arduino

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

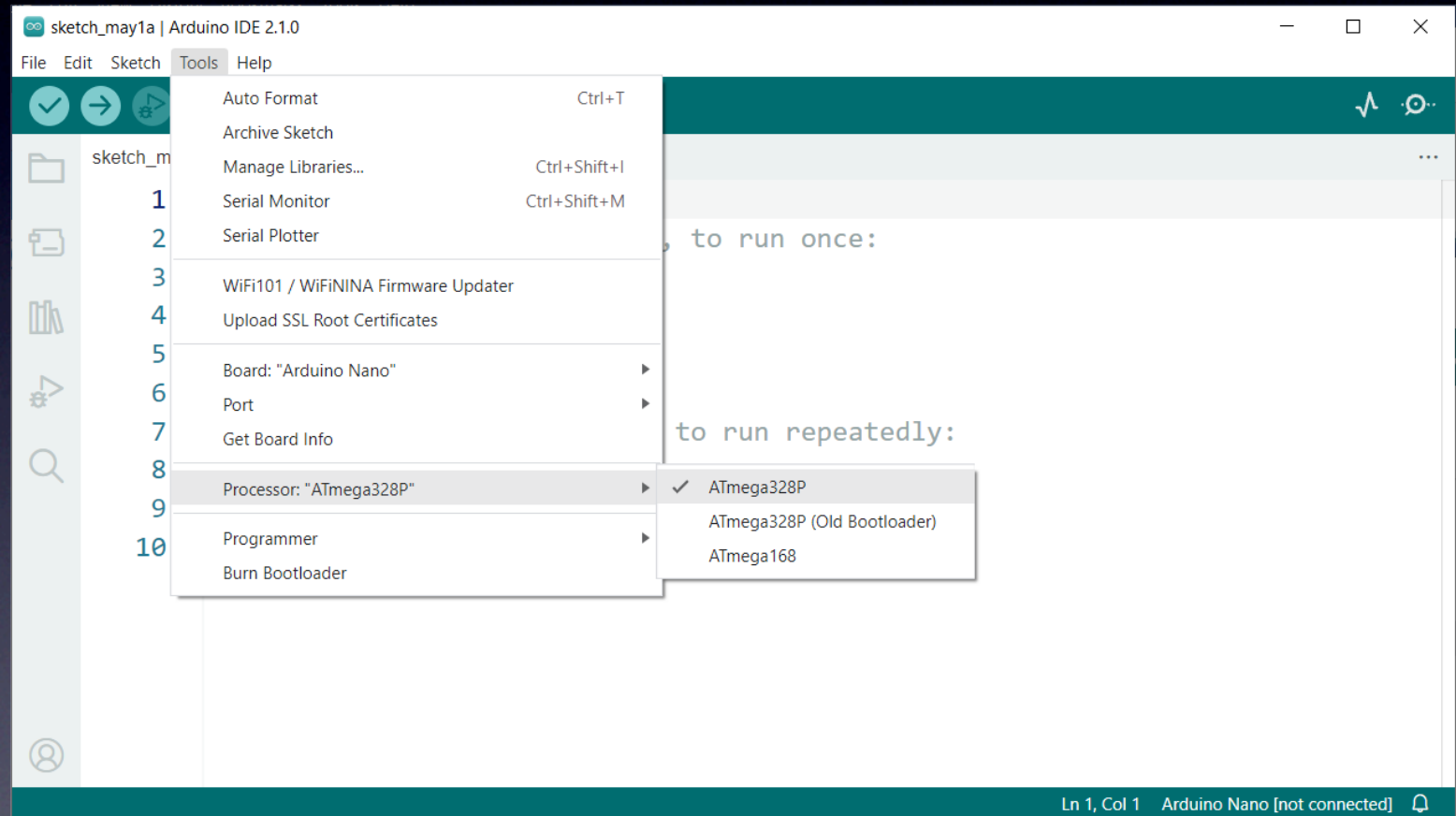
(1)
Choose
"Arduino Nano"
as the Board



Arduino

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

(2)
Choose
your Processor
as the Board

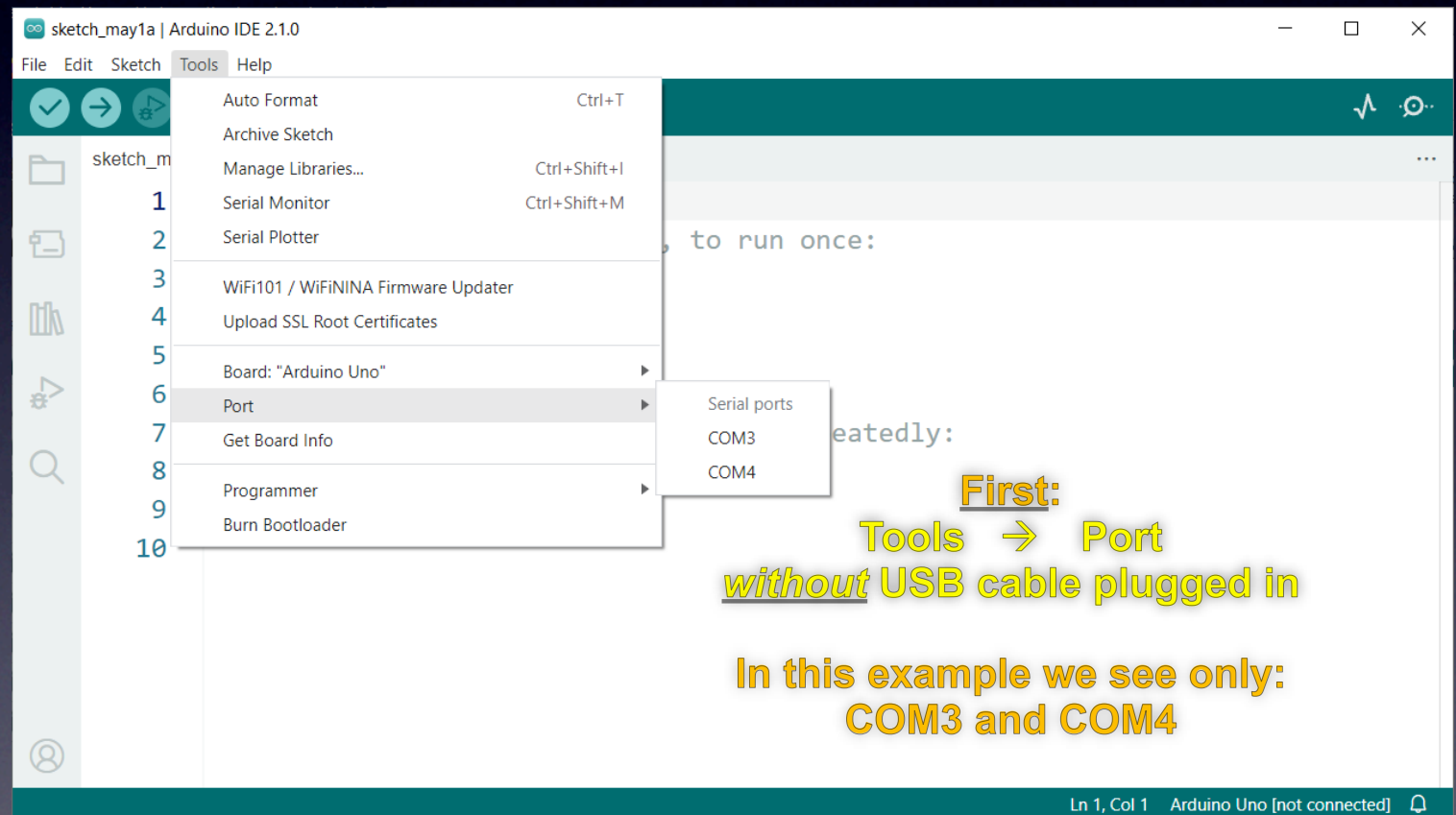


If this one doesn't work,
then
choose
"ATmega328P (Old Bootloader)"

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)

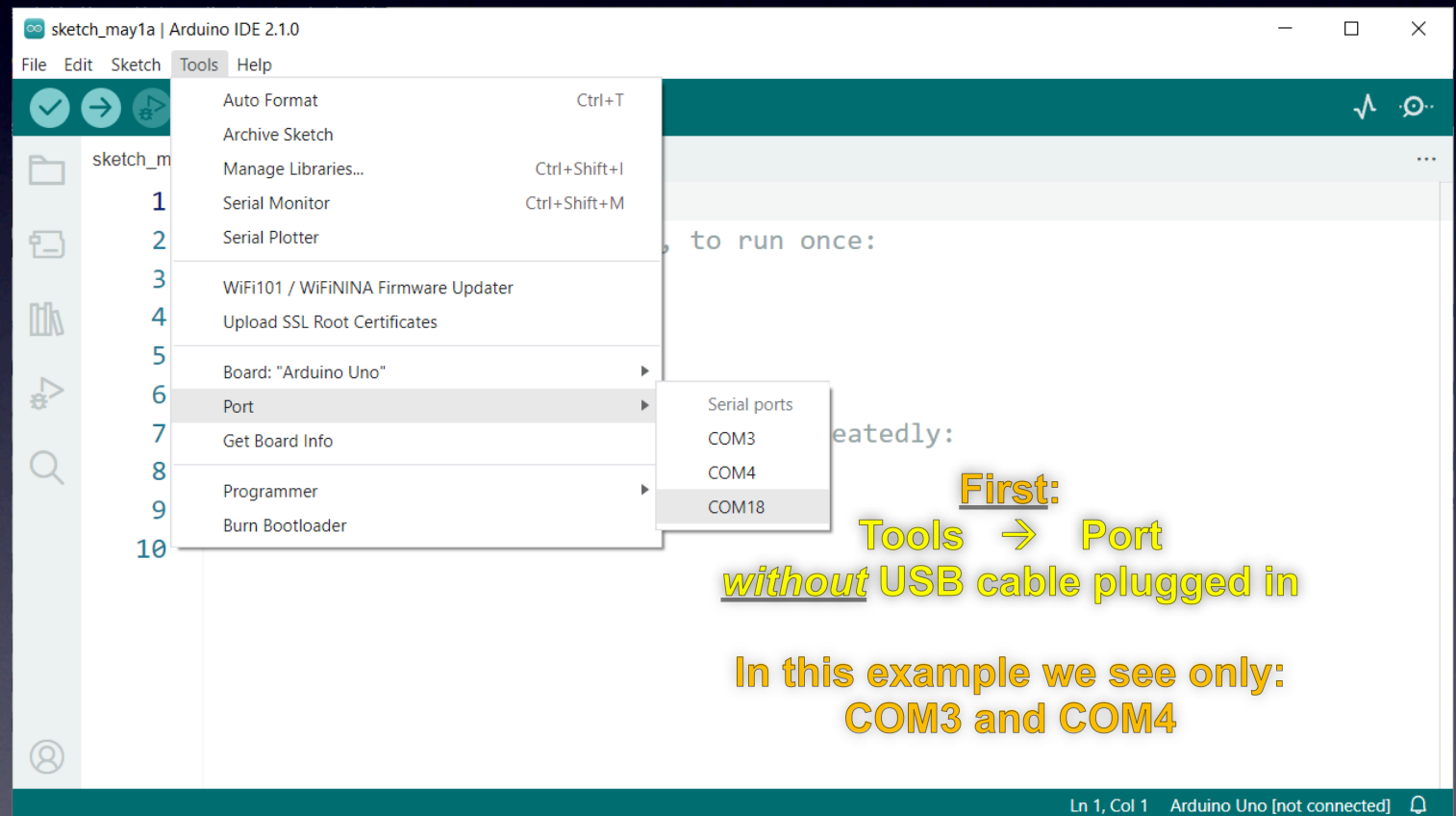


Arduino

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.)

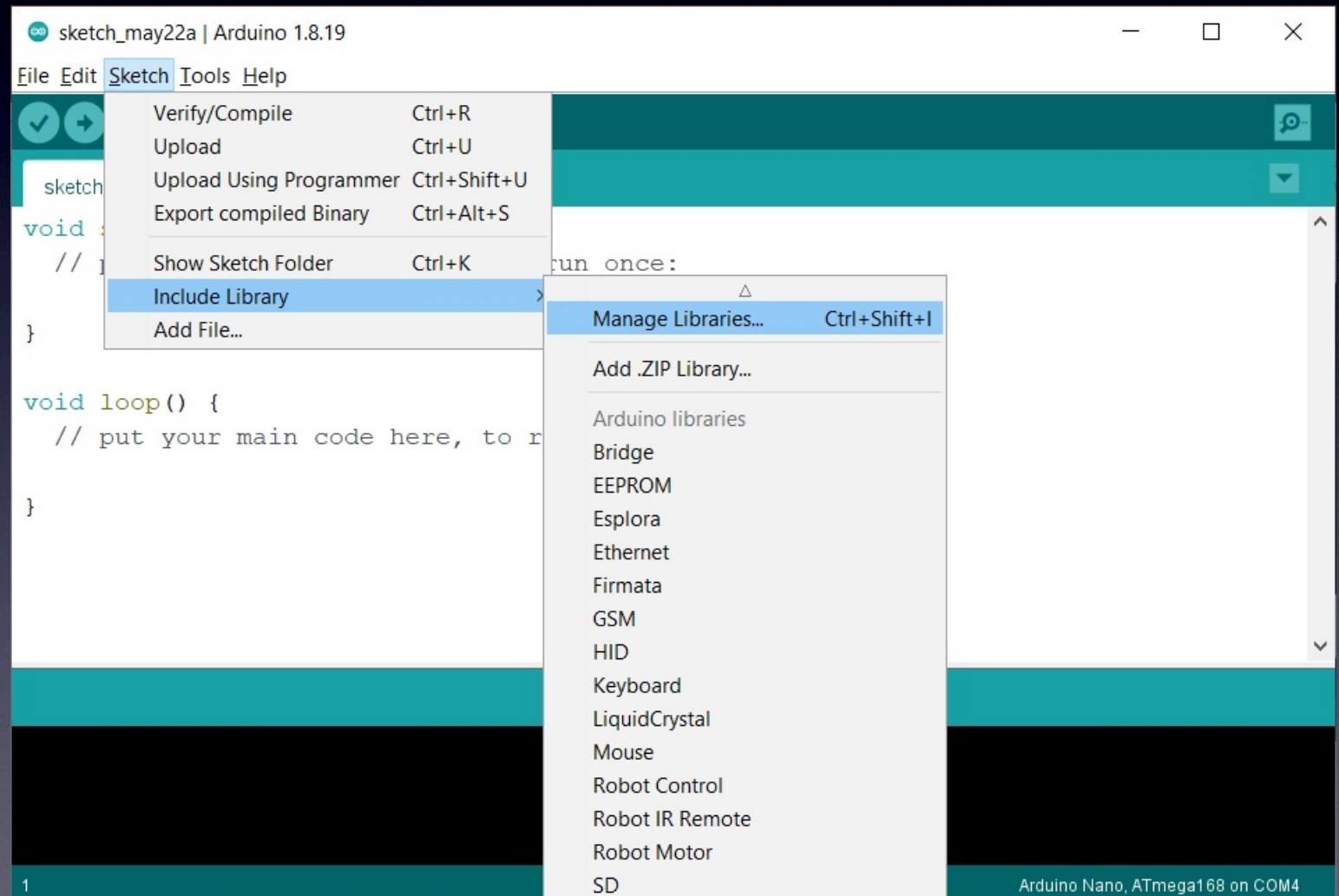


(Driver: search for: "CH340 Driver")

Arduino

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

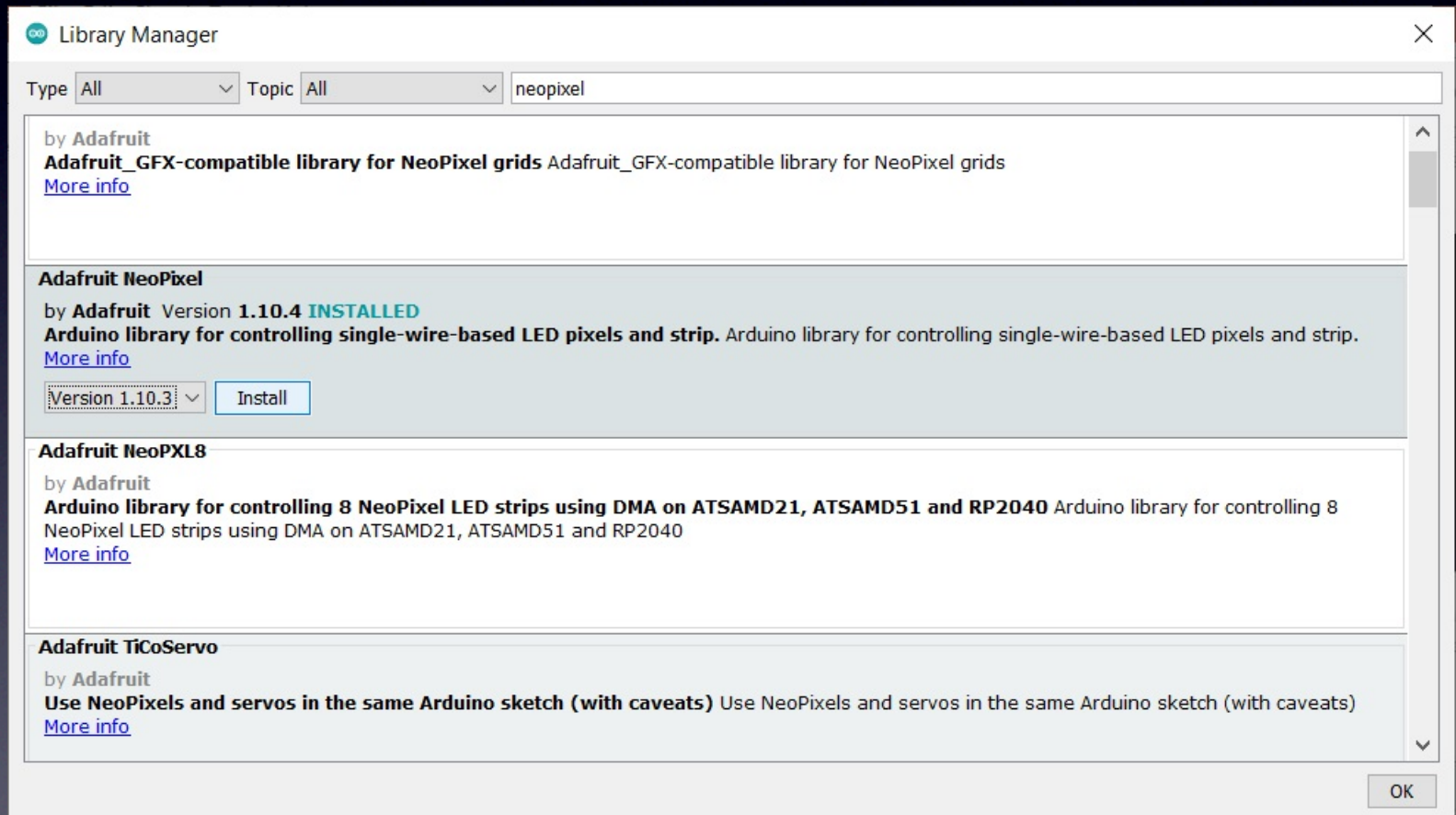
(4a)
Install
the
Neopixel
library



Arduino

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

(4b)
Install
the
Neopixel
library



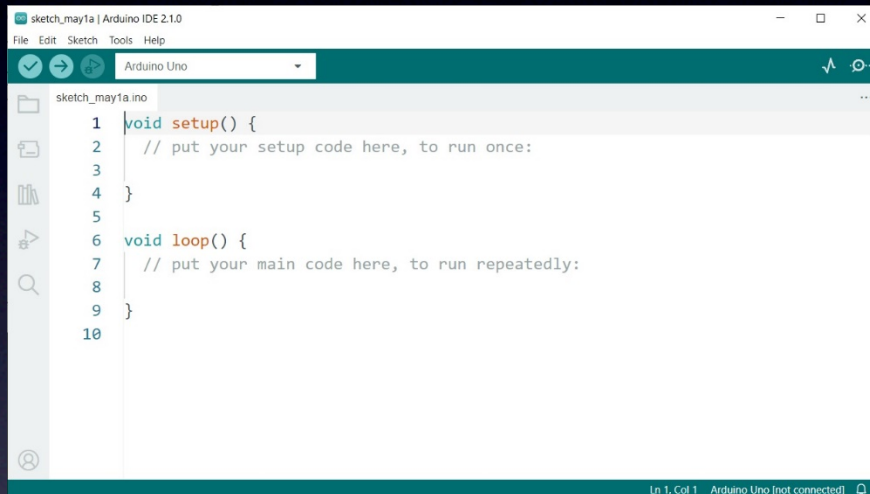
Arduino

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

```
sketch_may1a | Arduino IDE 2.1.0
File Edit Sketch Tools Help
Arduino Uno
sketch_may1a.ino
1 void setup() {
2   // put your setup code here, to run once:
3
4 }
5
6 void loop() {
7   // put your main code here, to run repeatedly:
8
9 }
10
Ln 1, Col 1 Arduino Uno on COM18
```

Arduino

Designed for non-geeky artists



```
1 void setup() {  
2   // put your setup code here, to run once:  
3  
4 }  
5  
6 void loop() {  
7   // put your main code here, to run repeatedly:  
8  
9 }  
10
```

Definition of

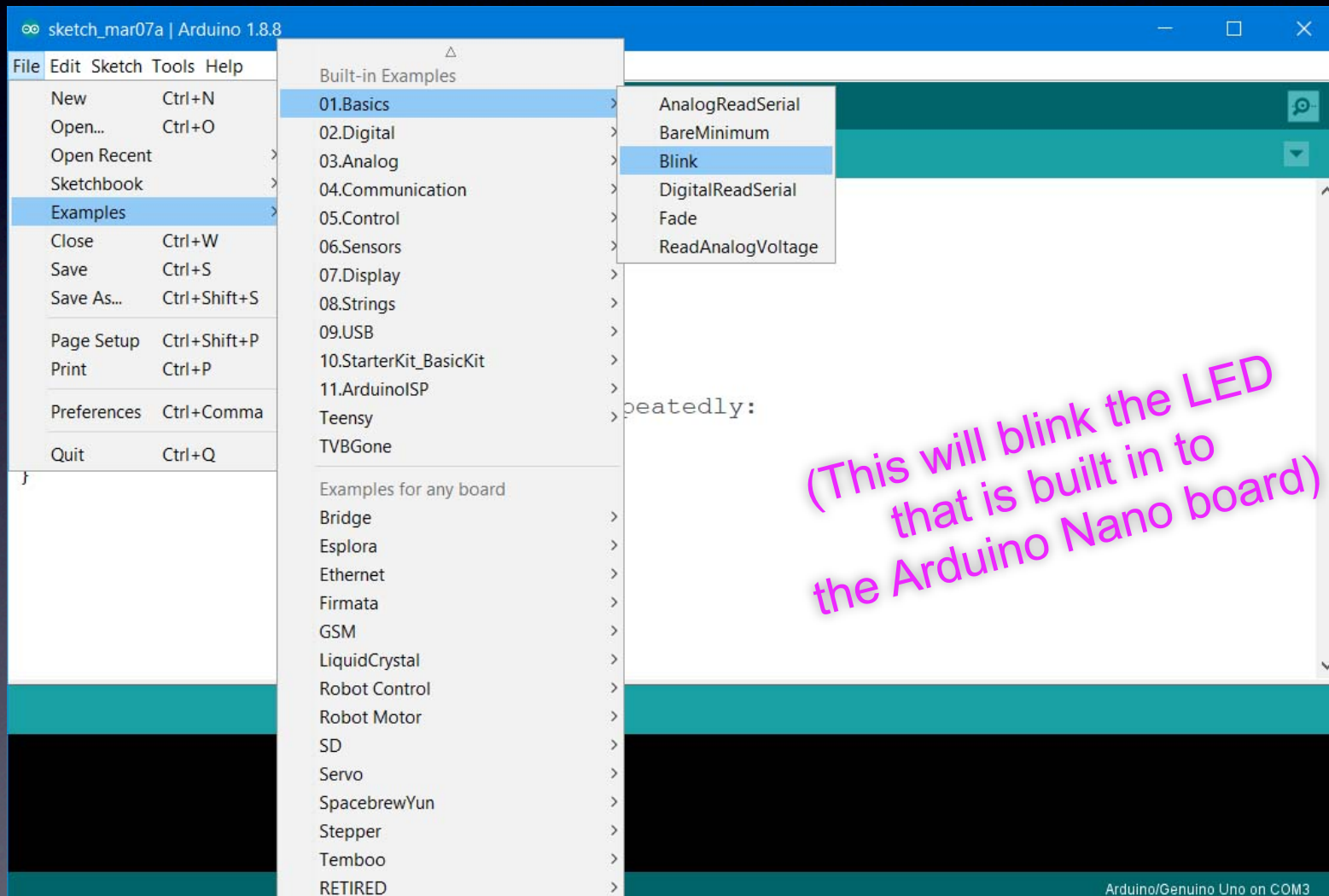
“Sketch” :

an Arduino program

Arduino

Let's start simple!

Let's all make an LED blink!



Arduino

Example “sketch”: Blink

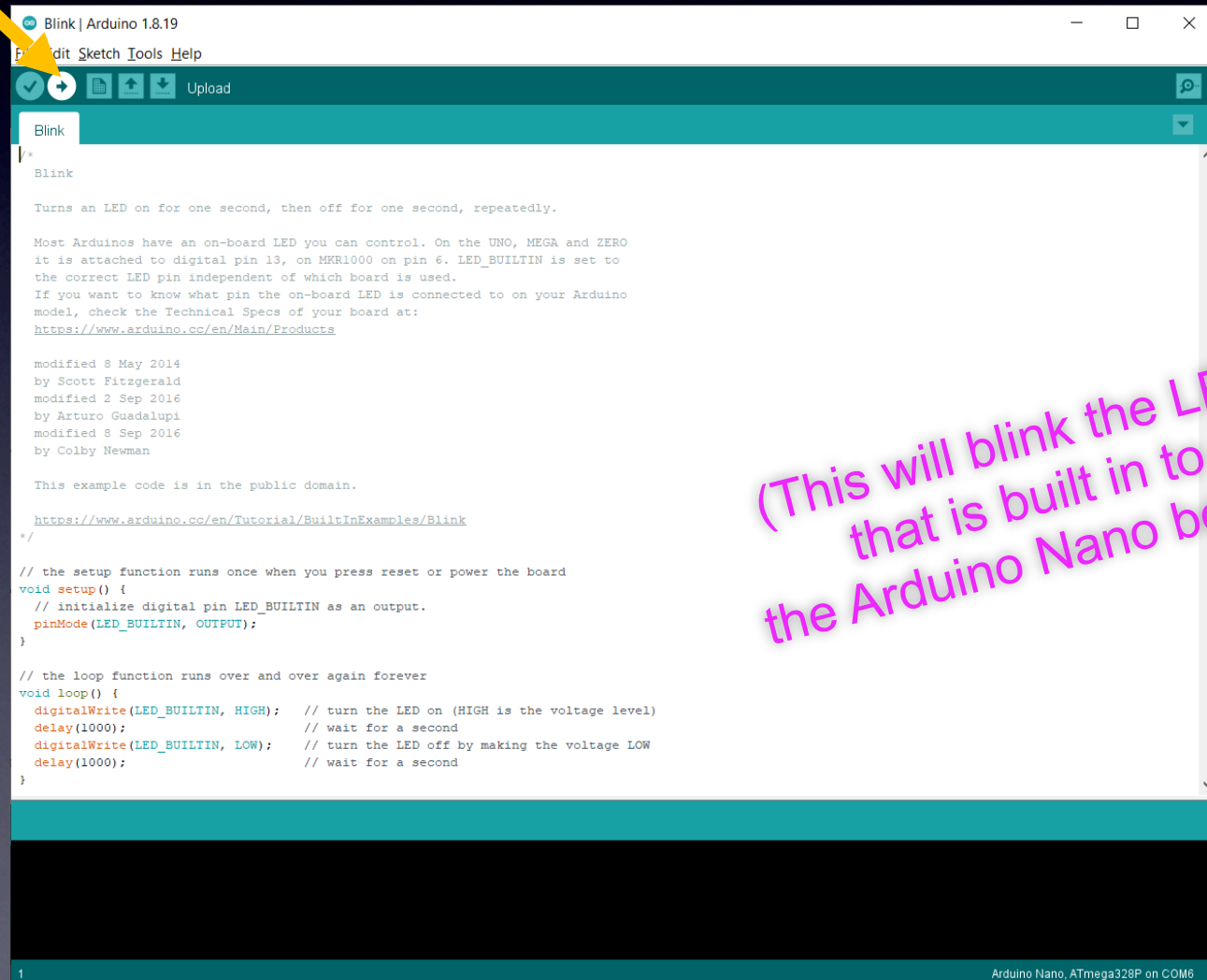
A screenshot of the Arduino IDE interface. The window title is "Blink | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for saving, undo, redo, and other functions. The main editor area shows the "Blink" sketch. The code is as follows:

```
/*  
 * 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  
}
```

The status bar at the bottom of the IDE shows "1" on the left and "Arduino Nano, ATmega168 on COM4" on the right. A large, pink, slanted text overlay on the right side of the code editor reads: "(This will blink the LED that is built in to the Arduino Nano board)".

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.
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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
*/

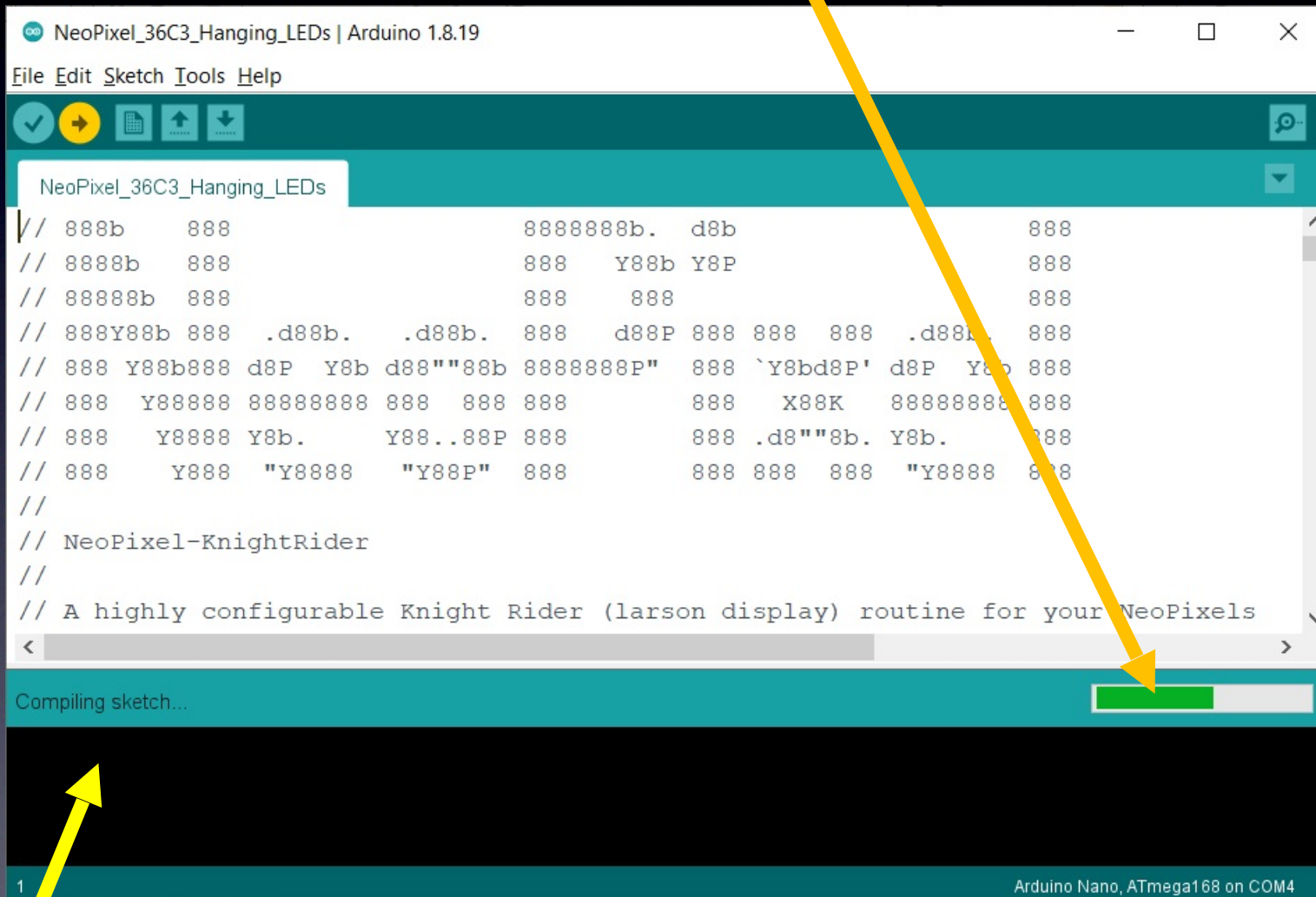
// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// 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, ATmega328P on COM6
```

Arduino

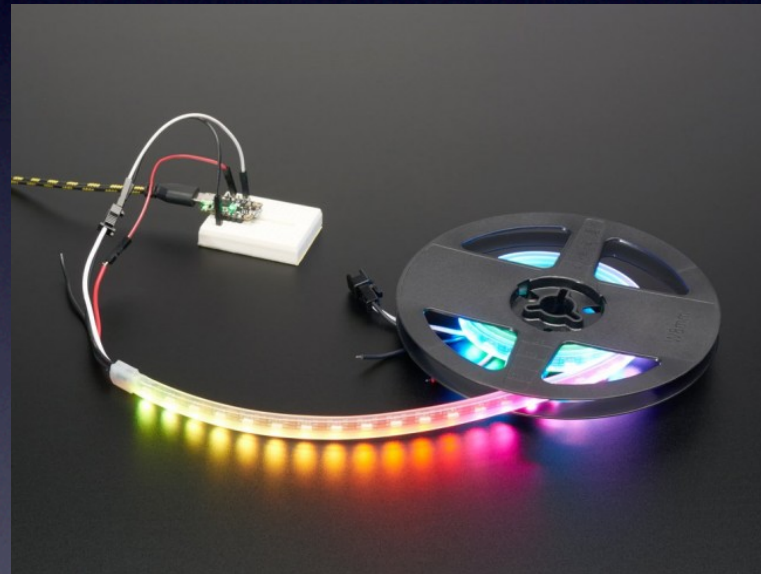
While uploading, you will see a progress bar...



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

Now,

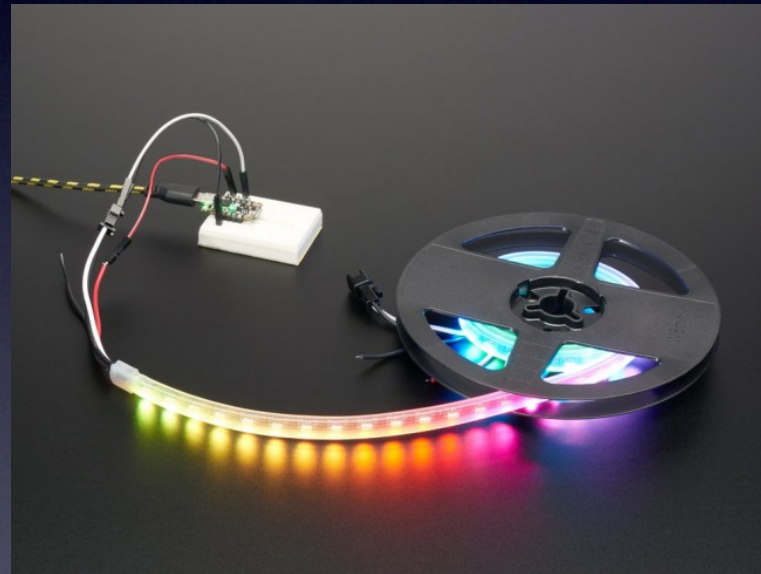
Let's Program Some LED Strips!



Let's Program Some LED Strips!

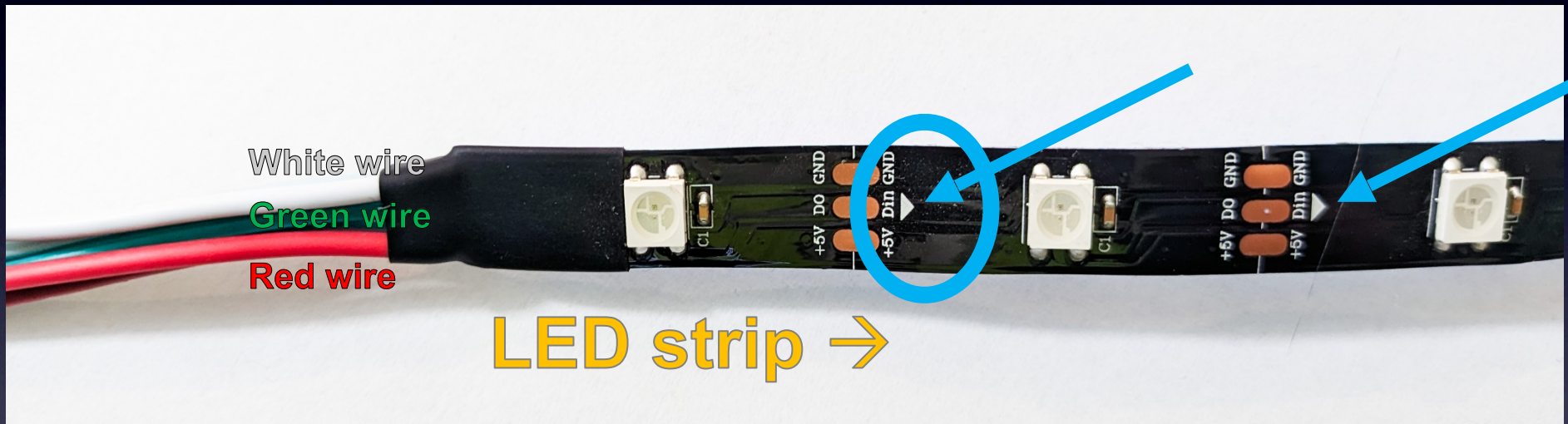
First,

we need to connect the LED strip
to our Arduino Nano board



Let's Program Some LED Strips!

We use the INPUT side of the LED strip



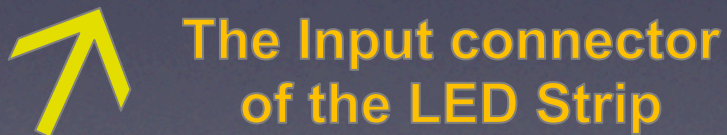
The Input side of the LED Strip
has arrows at each LED pointing into the strip

Let's Program Some LED Strips!

The Input side of the LED Strip:

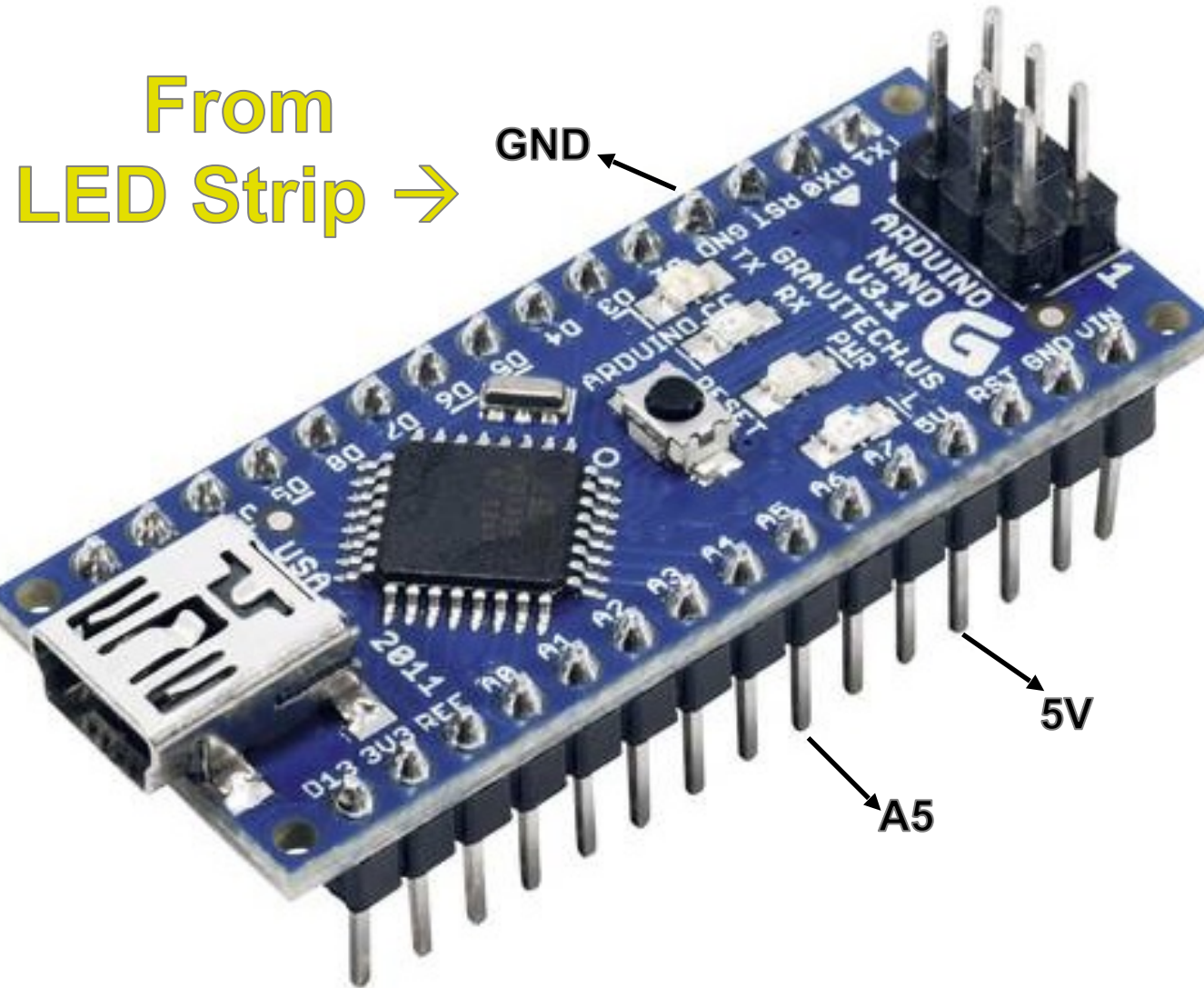


The Input side of the LED Strip



Let's Program Some LED Strips!

Arduino Nano



Let's Program Some LED Strips!

Arduino Uno

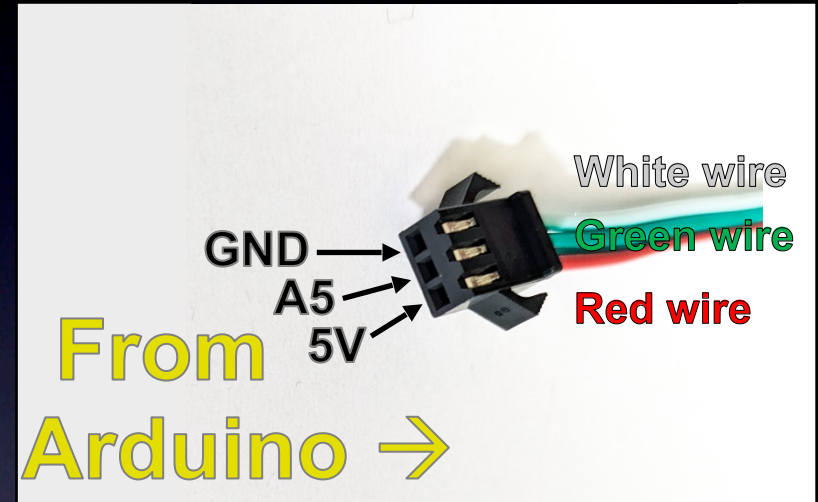
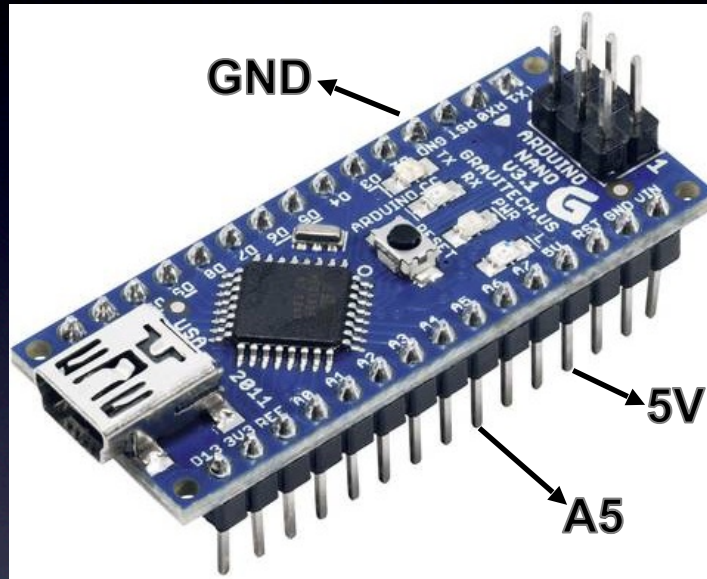


From LED Strip →

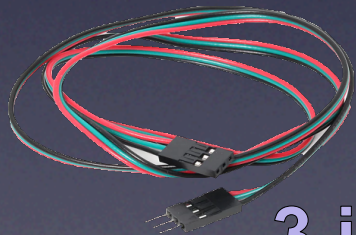
5V GND A5

Let's Program Some LED Strips!

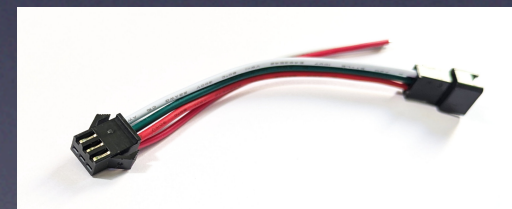
Arduino Nano



The Input connector
of the LED Strip



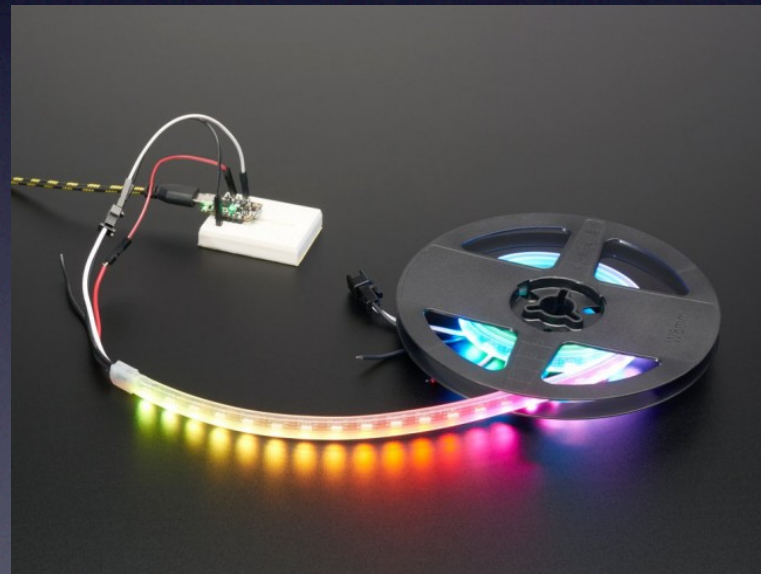
Use your
3 jumper wires



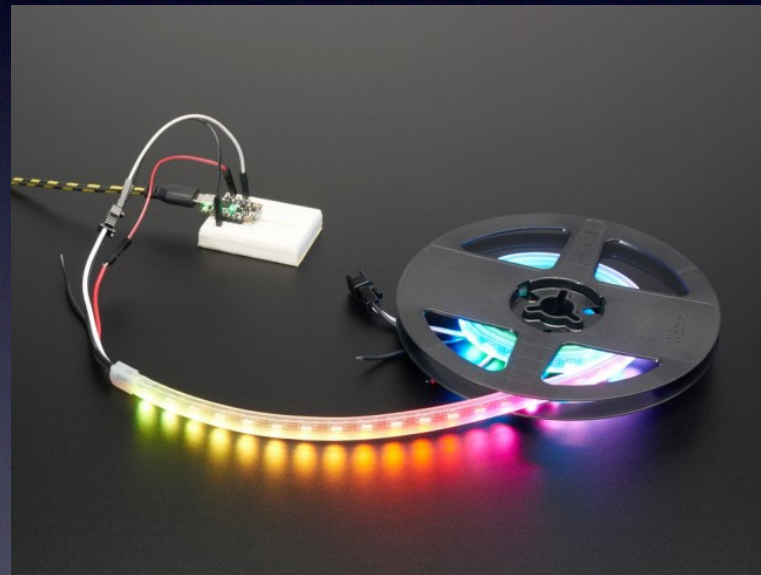
and the cable
that came with your LED strip

Let's Program Some LED Strips!

We are now ready to program
our LED Strips!



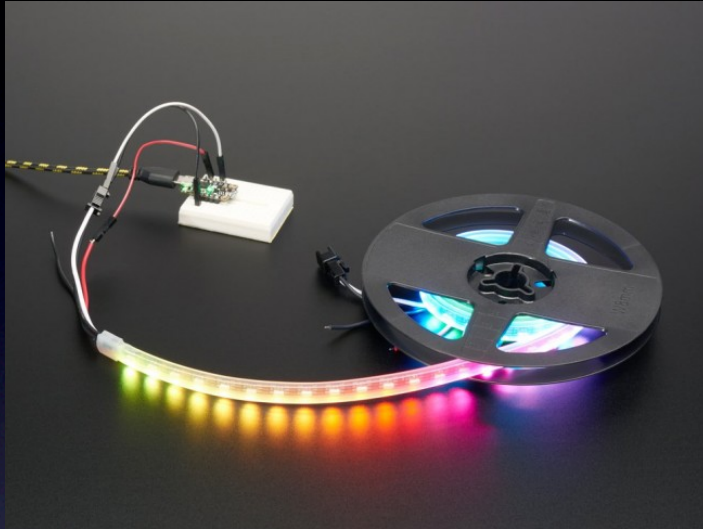
Let's Program Some LED Strips!



Download some Arduino “sketches”:

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

Let's Program Some LED Strips!



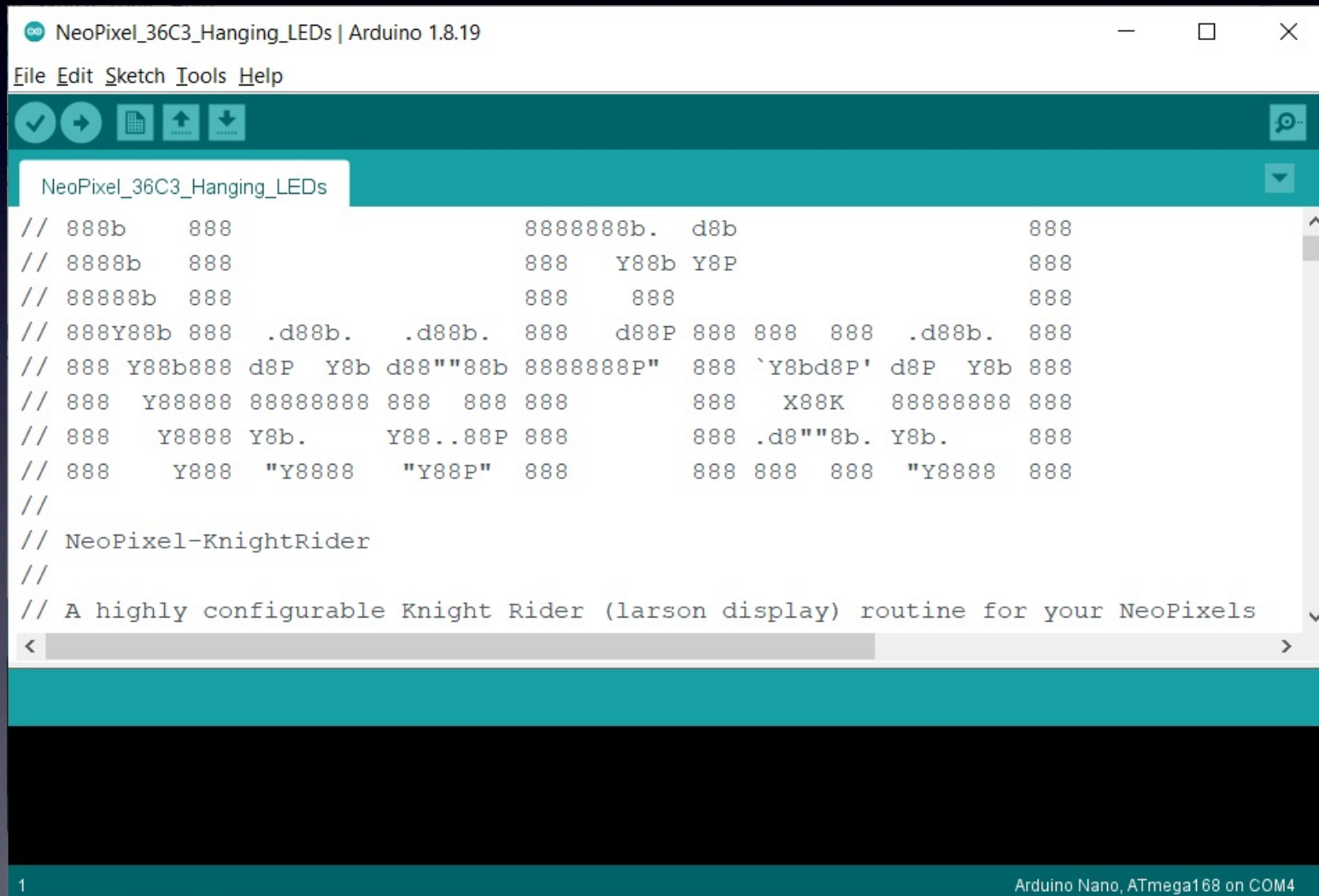
You can also

Search for: *“RGB LED Strip Sketches”*

Store them on your computer anywhere you like.

Let's Program Some LED Strips!

Open the "sketch" you want to program



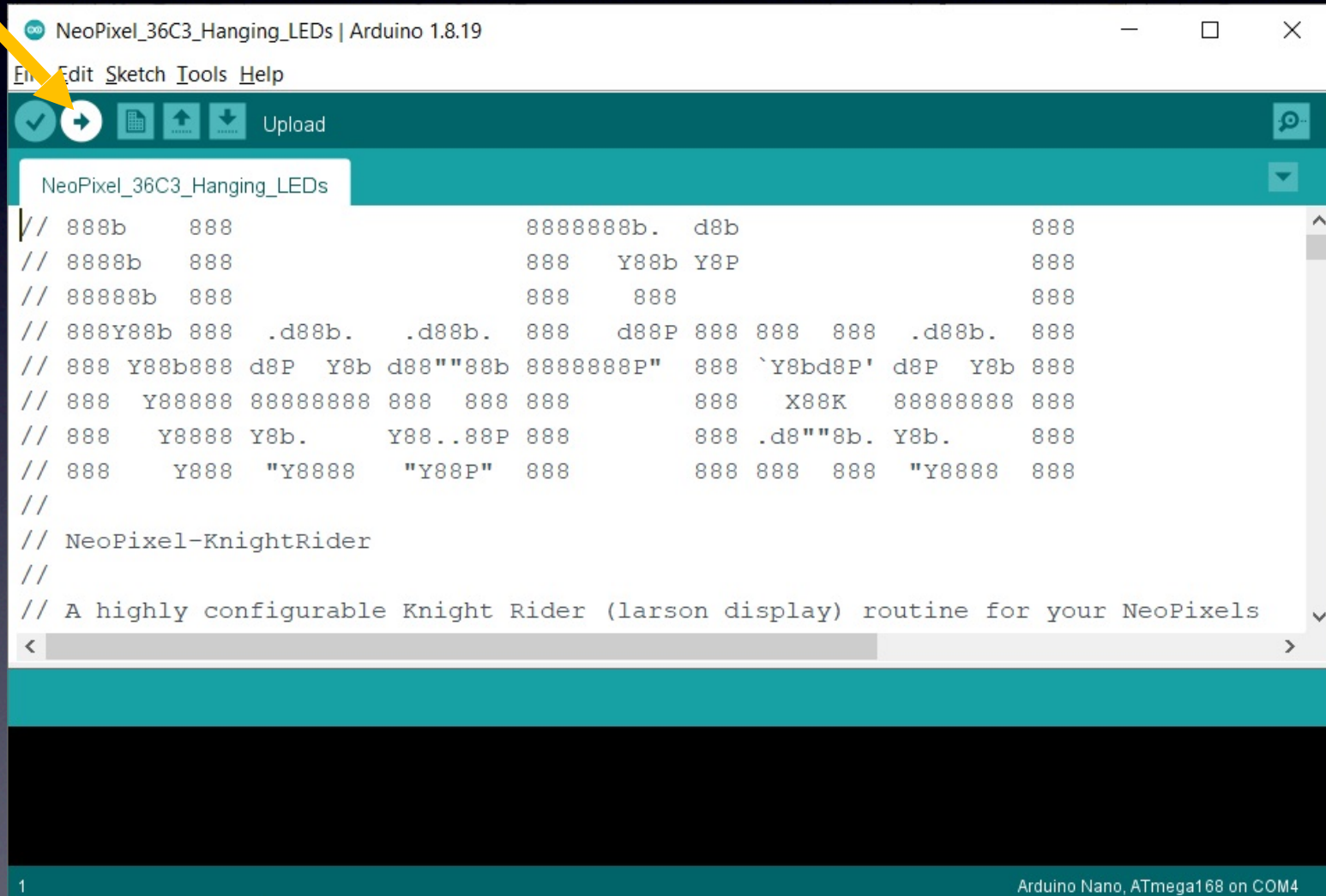
The screenshot shows the Arduino IDE interface. The title bar reads "NeoPixel_36C3_Hanging_LEDs | Arduino 1.8.19". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for saving, undo, redo, and uploading. The sketch name "NeoPixel_36C3_Hanging_LEDs" is displayed in the top bar. The main text area contains the following code:

```
// 888b 888 88888888b. 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
```

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!

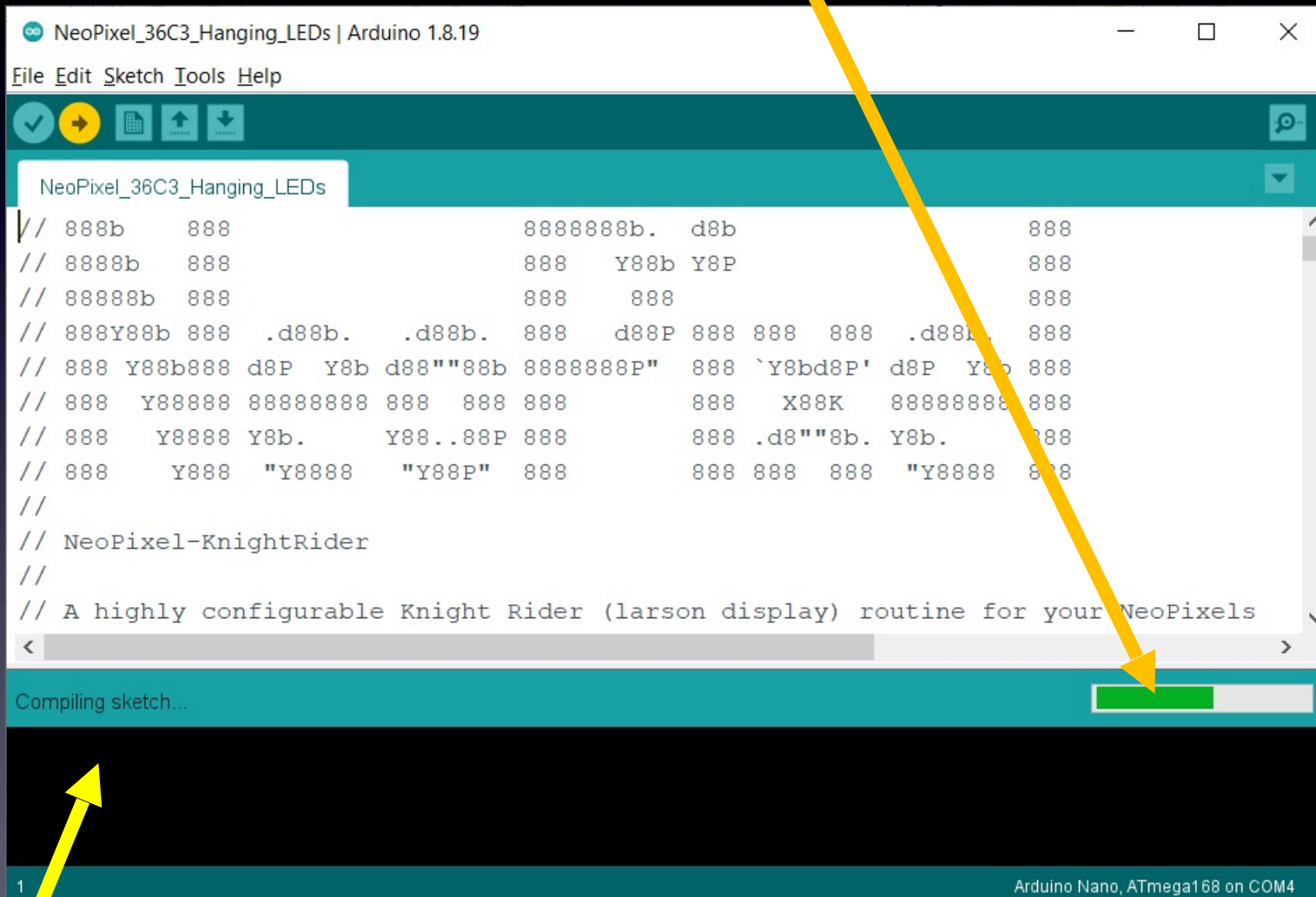
With the USB cable connected to your Arduino board
press the Upload button



```
NeoPixel_36C3_Hanging_LEDs | Arduino 1.8.19
File Edit Sketch Tools Help
Upload
NeoPixel_36C3_Hanging_LEDs
// 888b 888 88888888b. 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 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
1 Arduino Nano, ATmega168 on COM4
```

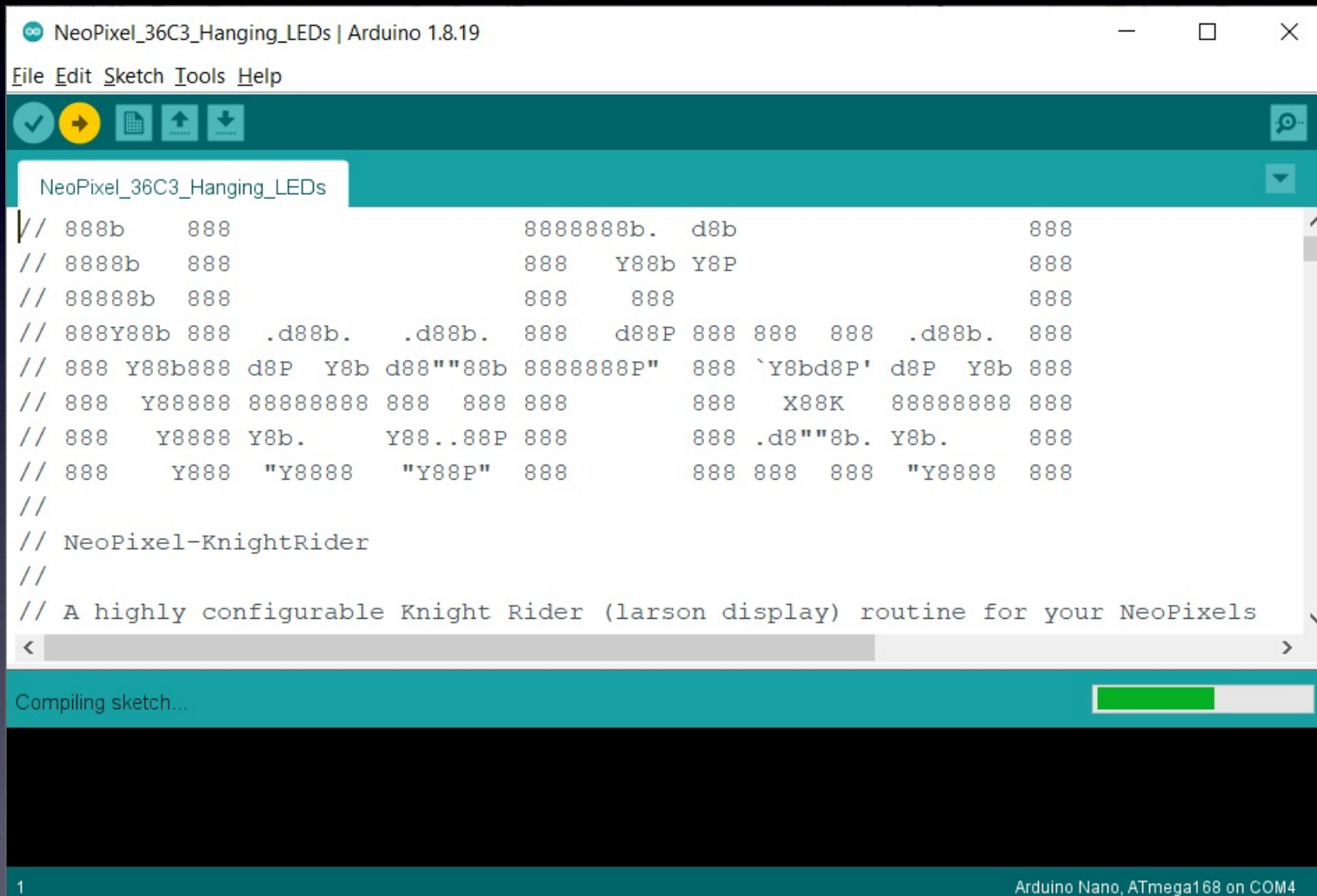
Let's Program Some LED Strips!

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



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

Let's Program Some LED Strips!



```
NeoPixel_36C3_Hanging_LEDs | Arduino 1.8.19
File Edit Sketch Tools Help
NeoPixel_36C3_Hanging_LEDs
// 888b 888 88888888b. 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 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
Compiling sketch...
1 Arduino Nano, ATmega168 on COM4
```

...and your LED strip is making colors!

Ordering LED Strips

File Edit View History Bookmarks Tools Help

https://www.aliexpress.com/wholesale?catId=0&initiative_id=SB_20220811021053&SearchText=led+strips+neopixel&spm=a2g0o.productlist.1000002.0

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led strips neopixel

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Ads may influence the rankings, see here how we organize our search results.

View: [Grid] [List]

Brand	Product Name	Price	Discount	New User Bonus	Sold	Rating	Shipping	Store
XnBaDa	DC5V WS2812B Led Strip 30/60/74...	6,75€	44,48€ -53%	New User Bonus	2131 sold	★ 4.8	Free Shipping	ANTVLED LIGHTING Store
SEZO	WS2812B Led Strip WS2812 RGB I...	0,01€	3,64€ -99%	New User Bonus	640 sold	★ 4.9	Free Shipping	SEZO Official Store
WS2812	1m/3m/5m WS2812B Smart led str...	1,57€			353 sold	★ 4.8	Free Shipping	YJBCo Official Store
WS2812	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

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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

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€ 0,01
~~€ 3,84~~ -99% **New User Bonus**

€ 19,90 Off Store Coupon Get coupons

Emitting Color: Black PCB

Black PCB White PCB

Wattage: 1M 30 IP30

- | | | | | |
|--|--------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|
| <input checked="" type="checkbox"/> 1M 30 IP30 | <input type="checkbox"/> 2M 30 IP30 | <input type="checkbox"/> 3M 30 IP30 | <input type="checkbox"/> 4M 30 IP30 | <input type="checkbox"/> 5M 30 IP30 |
| <input type="checkbox"/> 1M 30 IP65 | <input type="checkbox"/> 2M 30 IP65 | <input type="checkbox"/> 3M 30 IP65 | <input type="checkbox"/> 4M 30 IP65 | <input type="checkbox"/> 5M 30 IP65 |
| <input type="checkbox"/> 1M 30 IP67 | <input type="checkbox"/> 2M 30 IP67 | <input type="checkbox"/> 3M 30 IP67 | <input type="checkbox"/> 4M 30 IP67 | <input type="checkbox"/> 5M 30 IP67 |
| <input type="checkbox"/> 1M 60 IP30 | <input type="checkbox"/> 2M 60 IP30 | <input type="checkbox"/> 3M 60 IP30 | <input type="checkbox"/> 4M 60 IP30 | <input type="checkbox"/> 5M 60 IP30 |
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| <input type="checkbox"/> 1M 60 IP67 | <input type="checkbox"/> 2M 60 IP67 | <input type="checkbox"/> 3M 60 IP67 | <input type="checkbox"/> 4M 60 IP67 | <input type="checkbox"/> 5M 60 IP67 |
| <input type="checkbox"/> 1M 74 IP30 | <input type="checkbox"/> 1M 74 IP65 | <input type="checkbox"/> 1M 74 IP67 | <input type="checkbox"/> 1M 96 IP30 | <input type="checkbox"/> 1M 96 IP65 |
| <input type="checkbox"/> 1M 96 IP67 | <input type="checkbox"/> 1M 144 IP30 | <input type="checkbox"/> 1M 144 IP65 | <input type="checkbox"/> 1M 144 IP67 | |

Quantity:

Recommended For You



€ 3,24



€ 4,95



€ 5,02



LED Strips for Everyone Everywhere

Mitch Altman

Chief Scientist, **Cornfield Electronics**, San Francisco, CA

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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