

# Scratch for Arduino

## Lesson 2 – Dimmer Switch

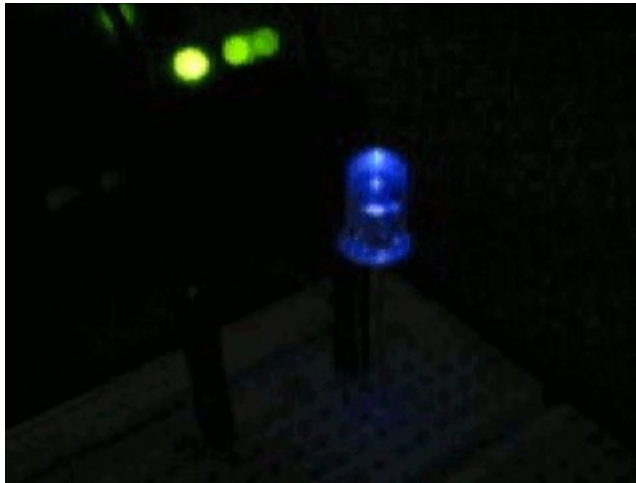
Variables, Loops, and Light Shows\*

Light Shows may be omitted due to time constraints.

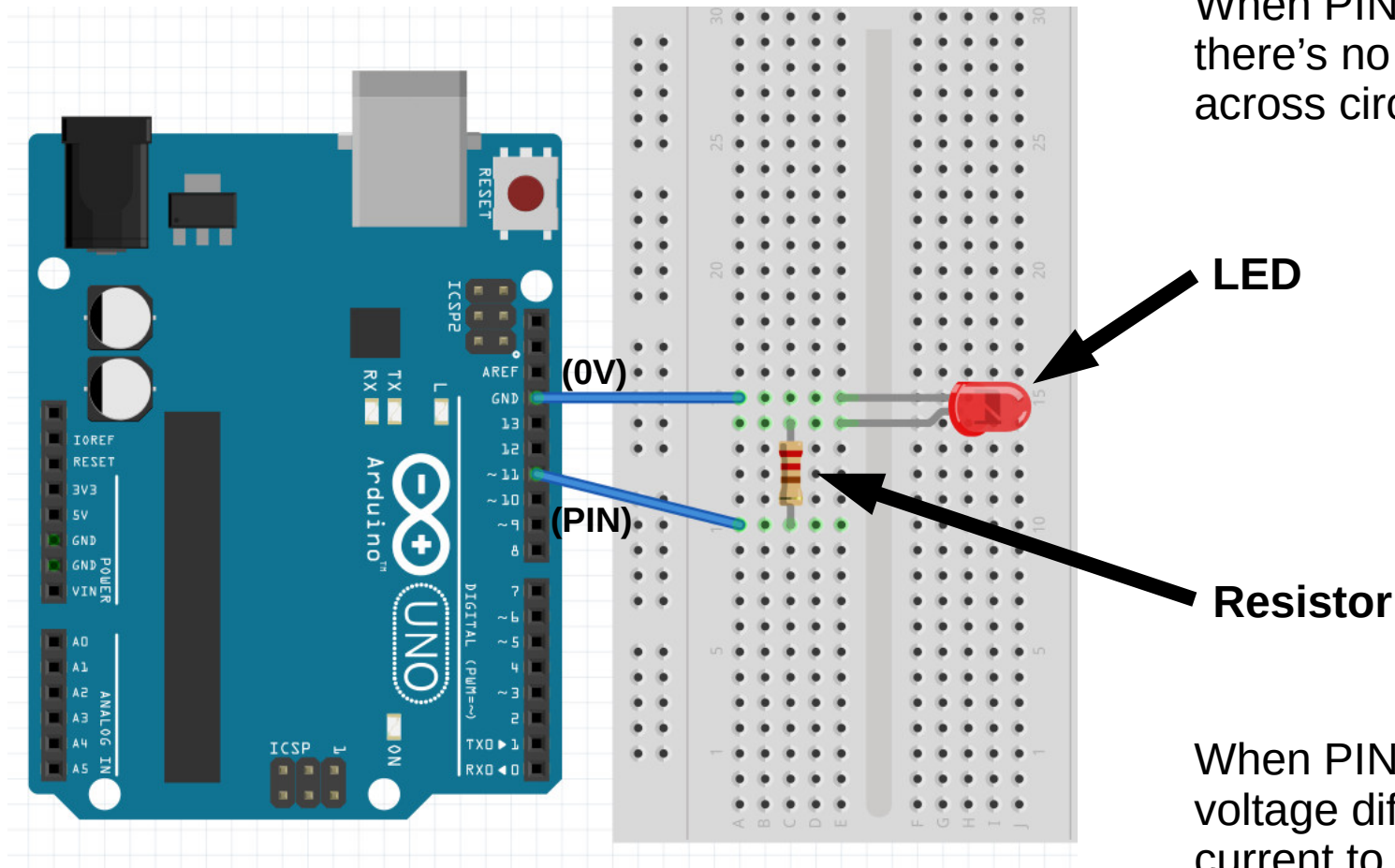
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# Light Control

- Today we will improve the Basic LED project by introducing dimmer effect



# Review LED Circuit



# Controlling Brightness

So, how can we control Brightness?

⚡ Change Resistor  
(not really programmable, but let's **revisit in the next lesson!**)

⚡ Change Power  
But, all of our Output pins are **Digital (On/Off)**

We need PWM!!!

# What is PWM?

## Pulse Width Modulation (PWM)

- An efficient method to vary and control power
- Used in various electrical systems
  - Lights
  - Motors
  - Comms & others



# Change Power

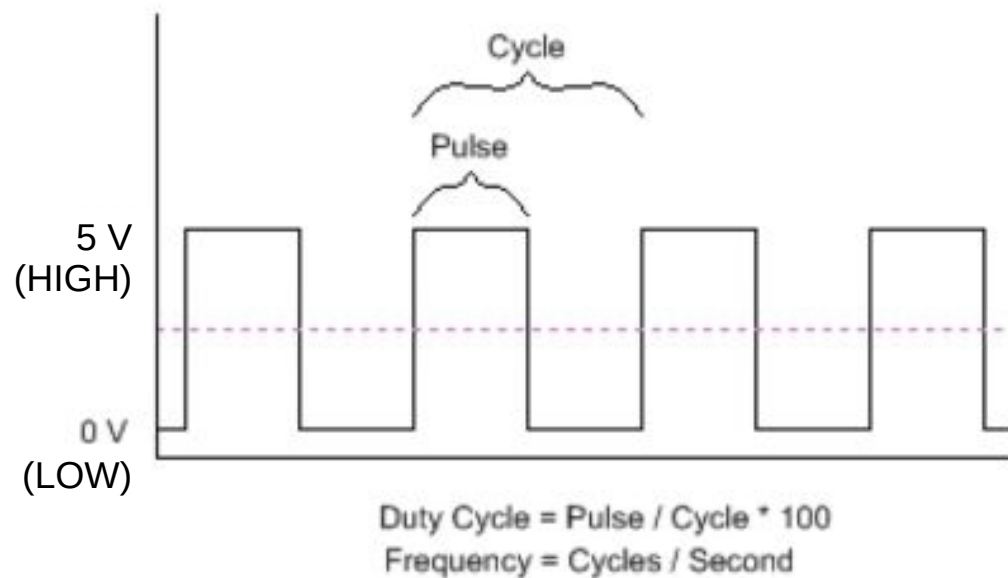
- We can On/Off or HIGH/LOW or 5V/0V

But, what if we wanted %50 power?

- Can't set digital output to 2.5V....
  - So, add ***Time*** to the equation!

# %50 Duty Cycle

- Pick some Interval or Period (1 ms, or 1000 Hz)
- Set signal to HIGH  $\frac{1}{2}$  of the period (0.5 ms)
- Set signal to LOW rest of the period (0.5 ms)
- Run signal over and over...



# Duty Cycle

**50% Duty Cycle**



**75% Duty Cycle**

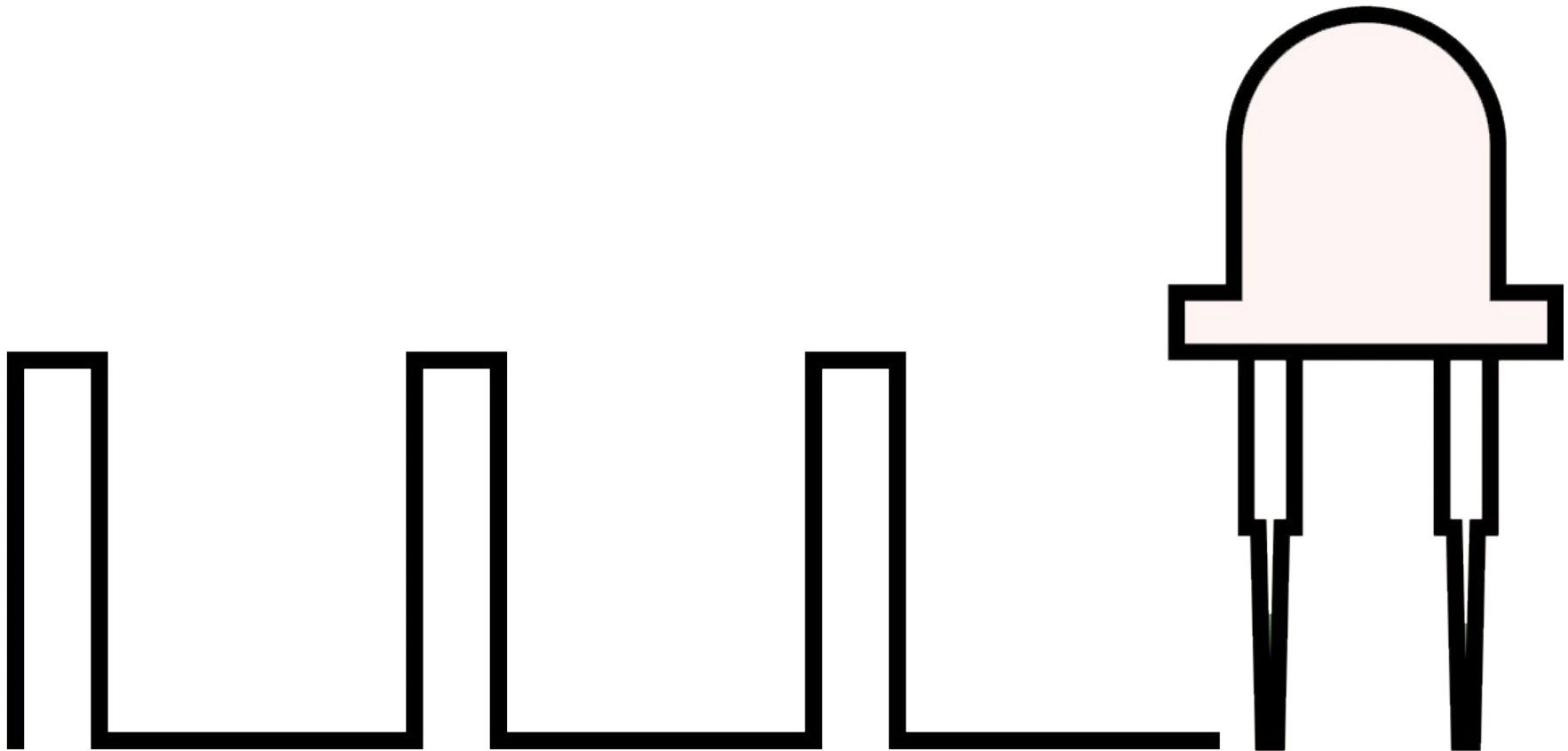


**25% Duty Cycle**



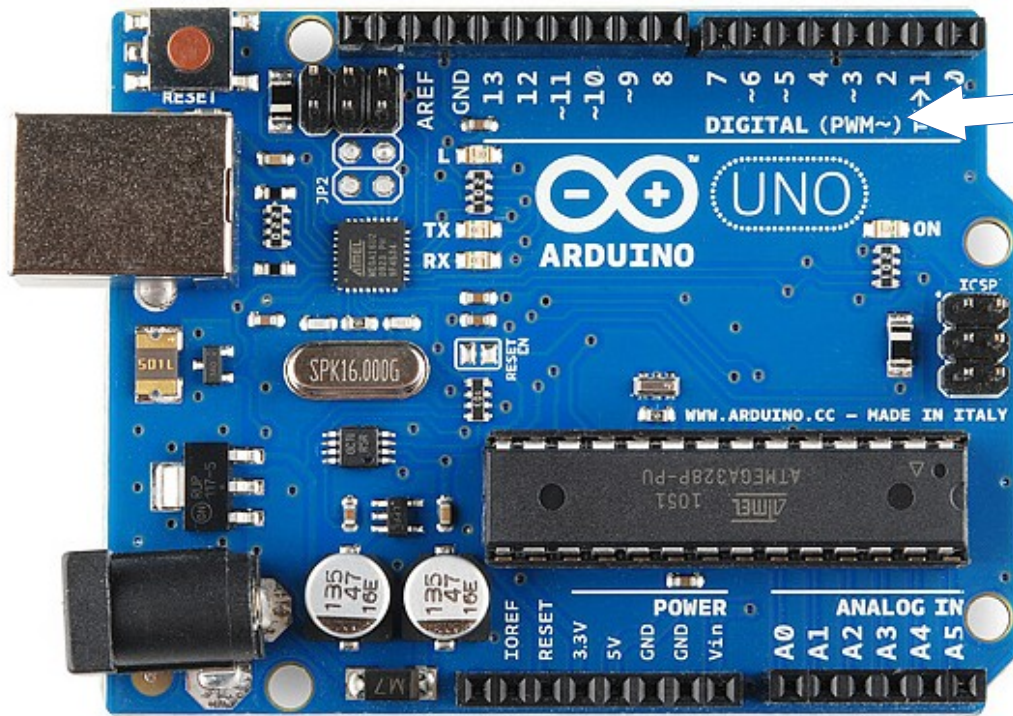


# Duty Cycle



# PWM Pins

- Today we'll work with Pulse Width Modulation (PWM)
- Take note which pins support PWM



The board usually indicates which pins have PWM built-in support

In this case Pins  
3,5,6,9,10,11  
(see '~')

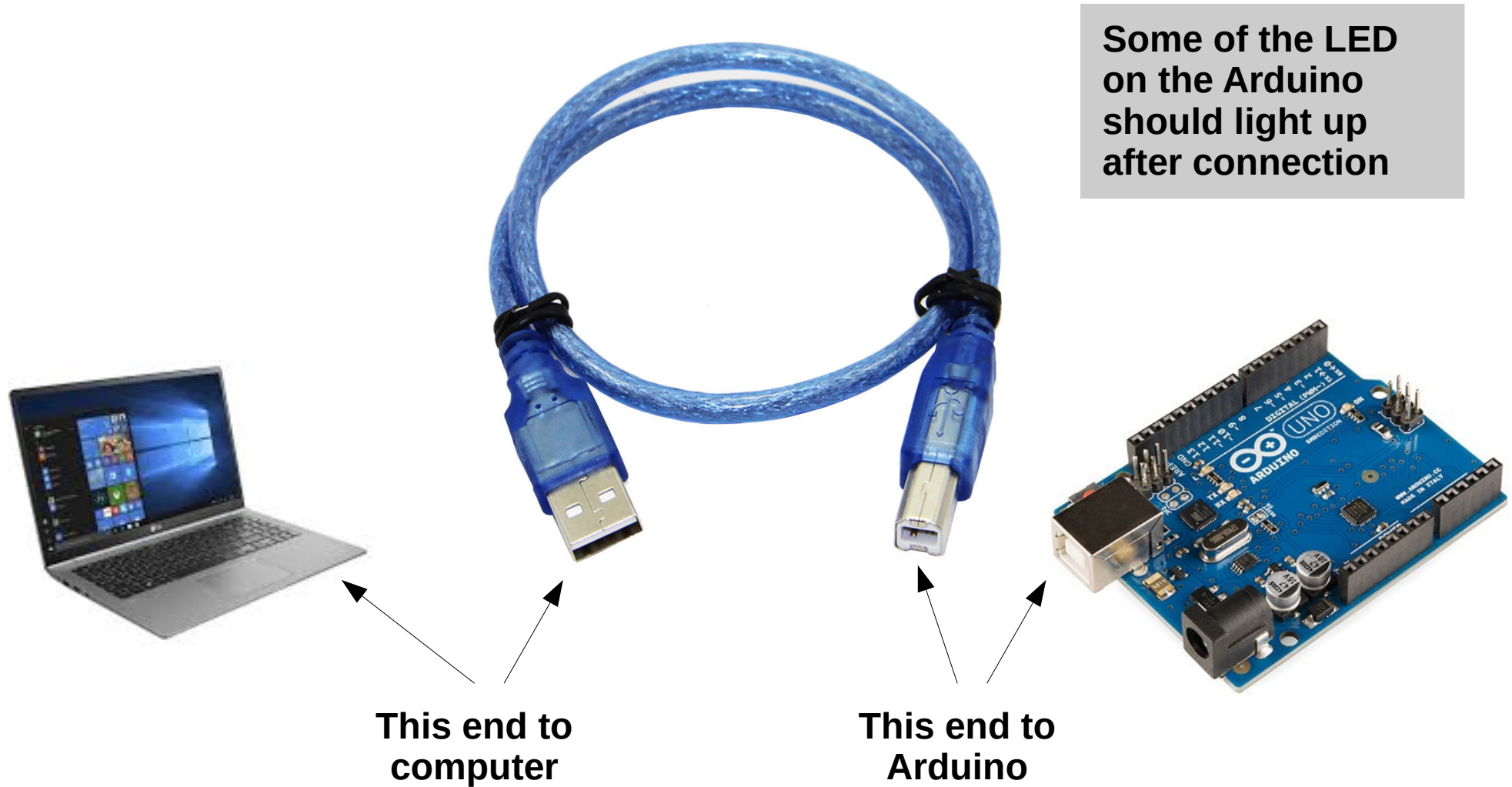
All output pins are **digital** (LOW/HIGH), so we can only vary power using something like the PWM method

# Let's Get Hands-On

(The fun part...?)

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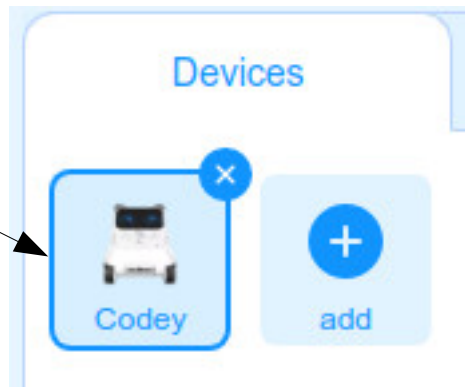
# Physical Connection



# Start up mBlock

- Don't forget **mLink** 
- Then go to **<https://ide.mblock.cc>**
- **File** → **New**

Get rid of  
this guy

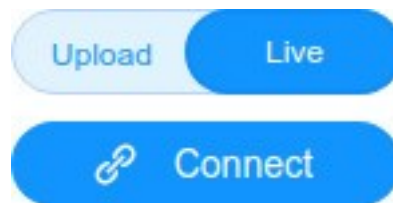


Add this one  
instead

**Arduino Uno**  
Developers: Ablock

# Connect with Arduino

- Switch to **“Live”** mode and click **“Connect”**



- **Select a COM port**

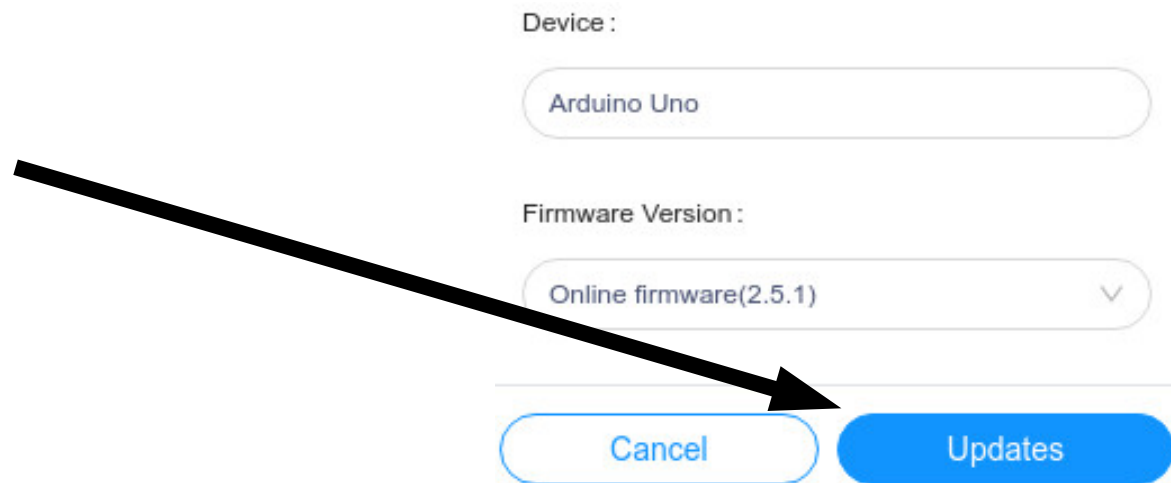
*You may need to [x] “Show all connectable devices”*

- **Click “Connect”**

# Connect with Arduino

- If  appears, click on it!

Followed by  and “Updates”

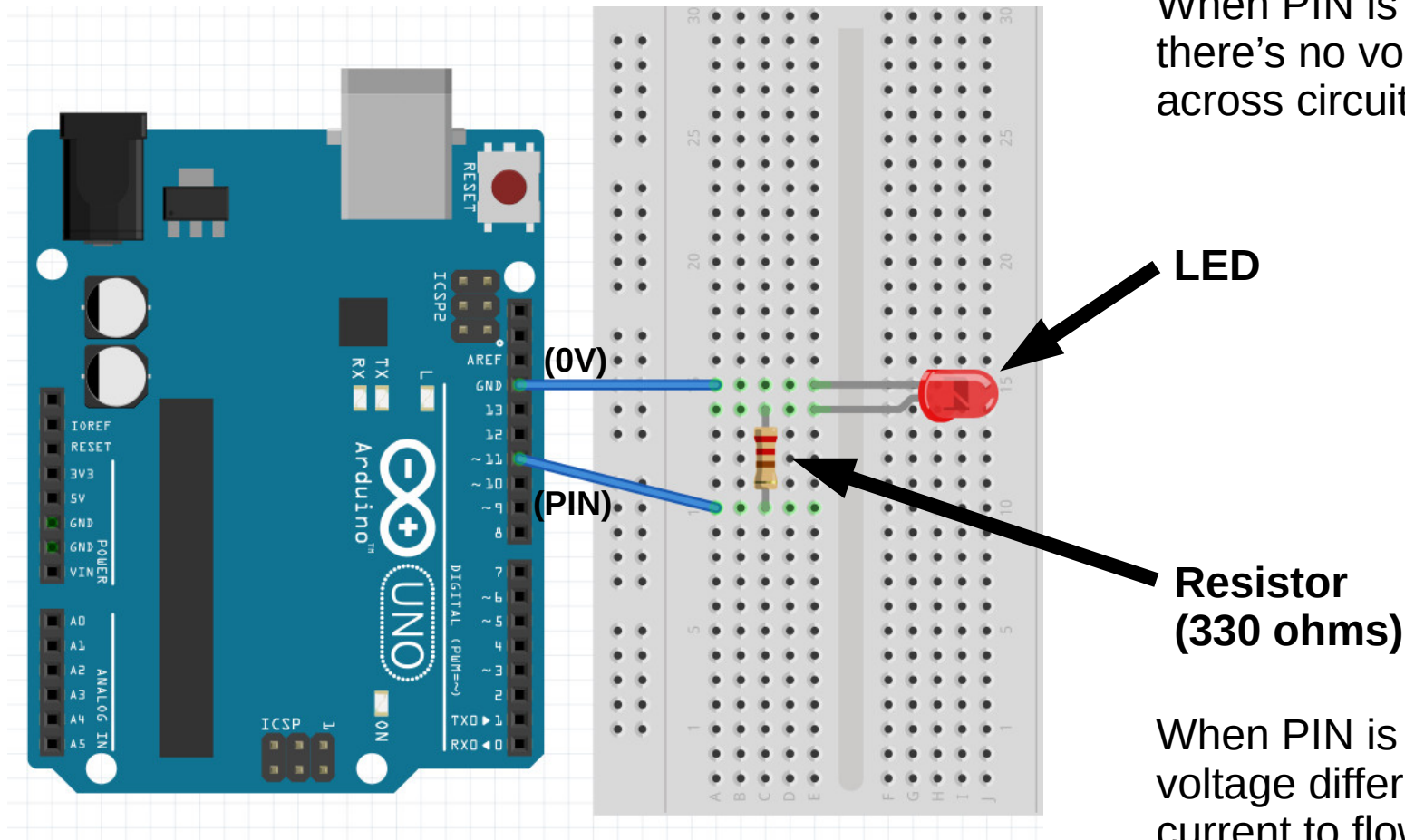


## Exercise 2a

# Control LED Brightness

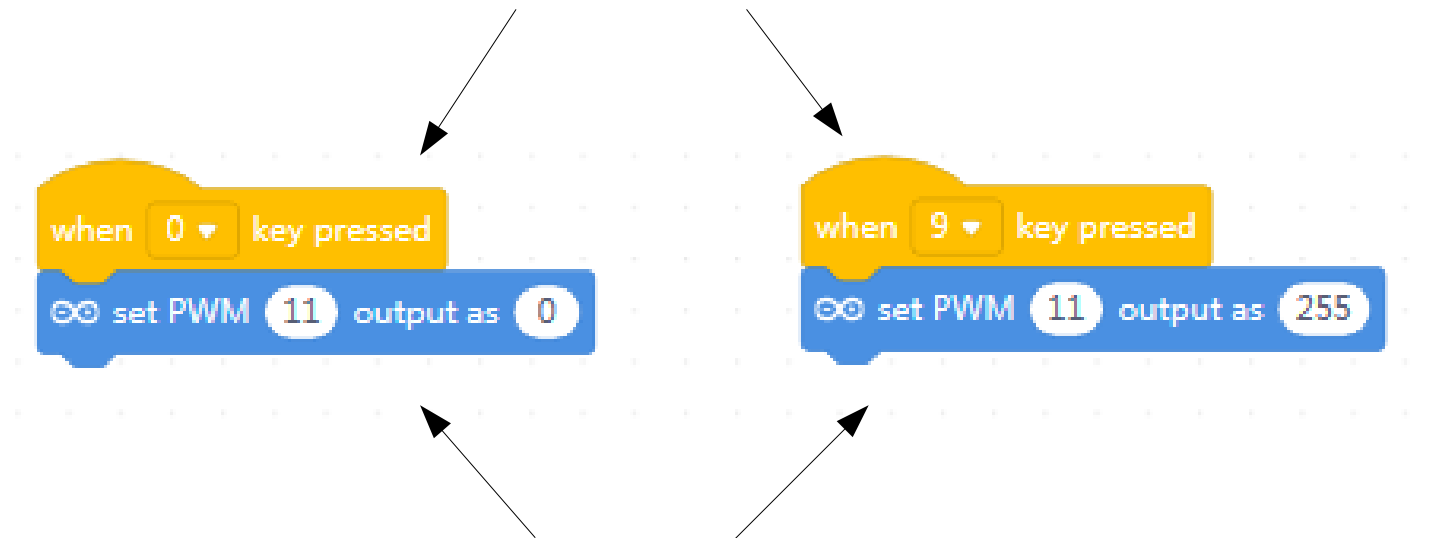


# Review LED Circuit



# Set PWM on LED Pin

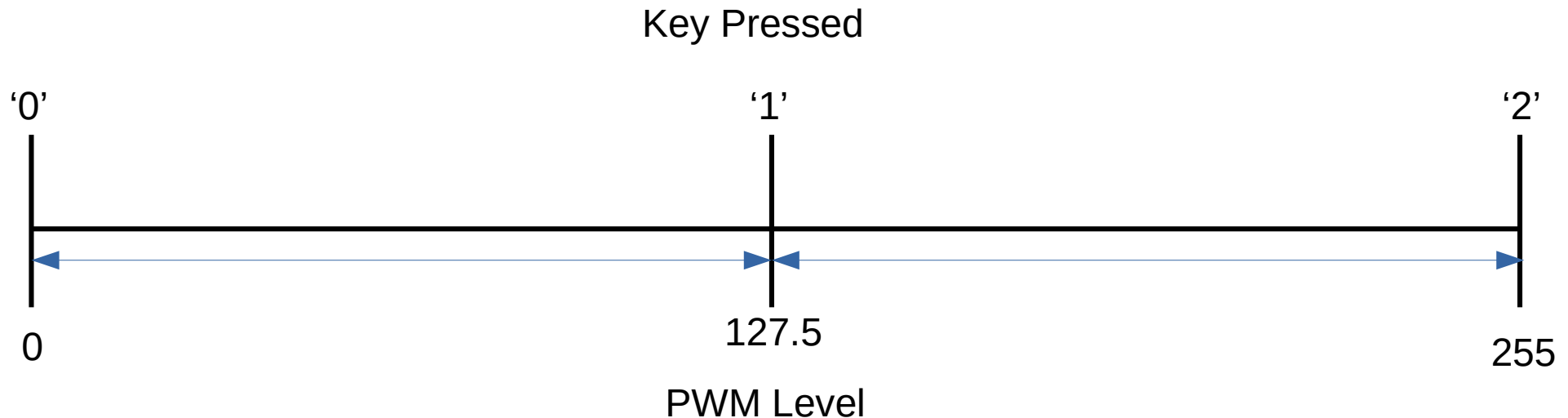
Let's use Keys 0-9 to set Brightness Levels.  
Find the **When-Key-Pressed** block under **Control**.  
For starters, let's deal with our limits – 0 (off) and 9 (full power)



Find the **Set-PWM-Output** block under **Pin**.  
Set the Pin to the one which you connected your LED Long(+) leg.  
(to see the reference for this block, right click "Help")

Test it out!

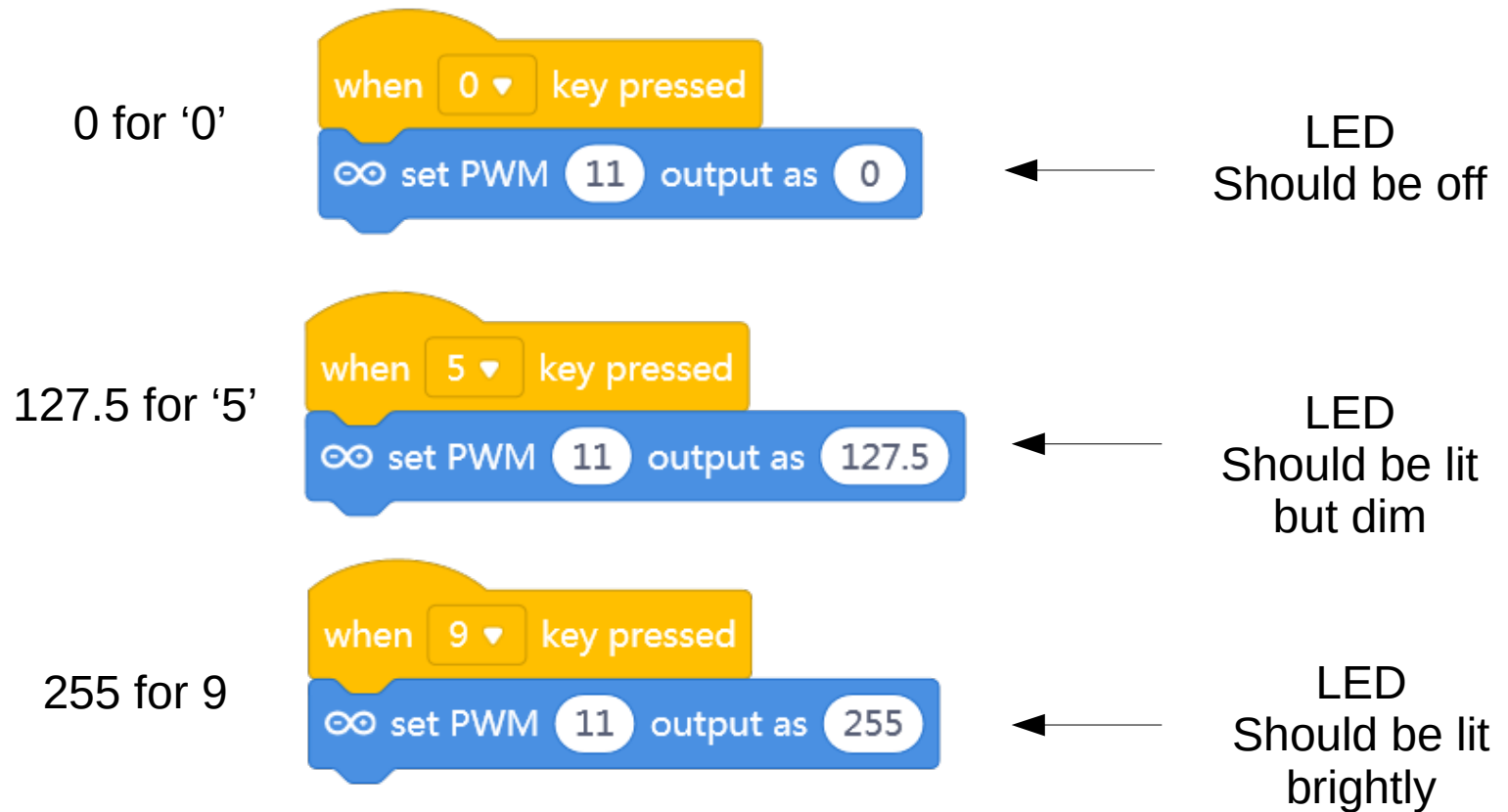
# Challenges



For 3 levels – **off, medium, high** –  
we would use this key mapping...

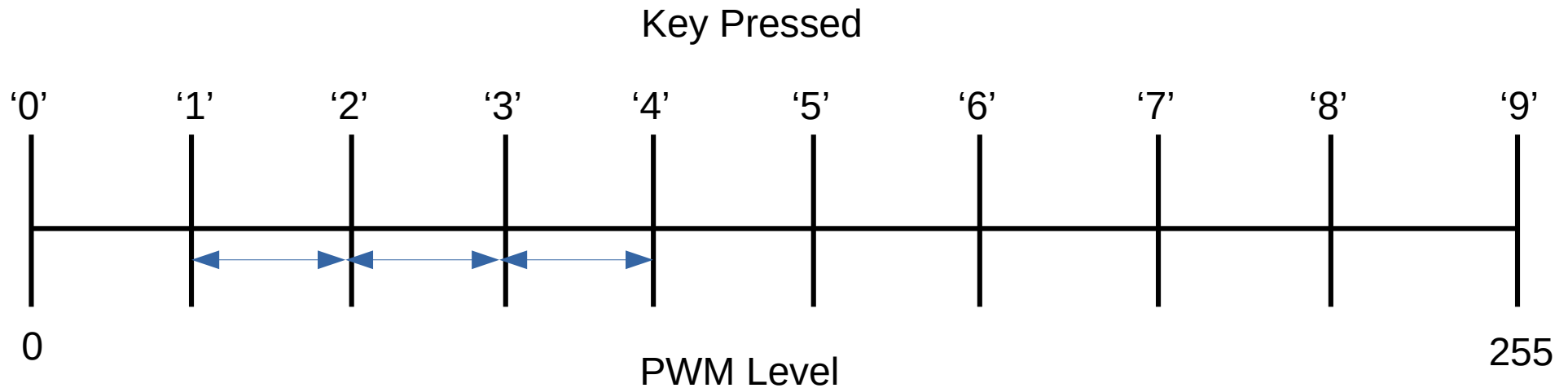
# Set PWM on LED Pin

Let's add 1 extra level for medium power.



Test it out!

# Challenges



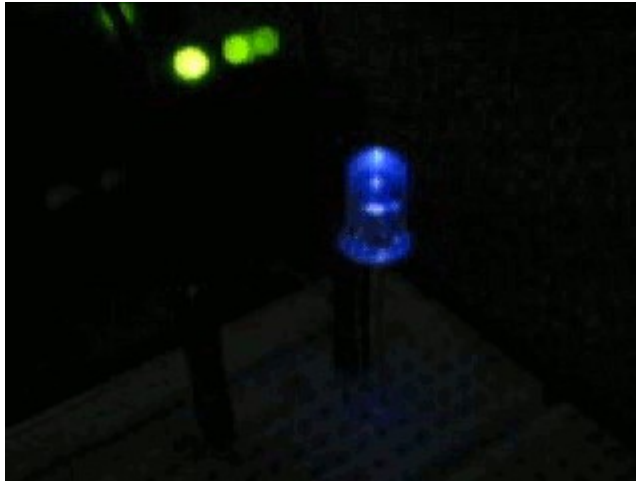
What are the appropriate PWM levels for each Key Press '0' - '9'?  
10 power levels

# Challenges

- Add code to control LED brightness levels using **all ten digit (0-9) keys**
- In your Student Handout
  - Note down the **PWM levels** you used for all 10 keys
  - Note down **math formula** to generate appropriate PWM levels for each user input (0-9)
    - Generalize for **N number of inputs**

# Light Control

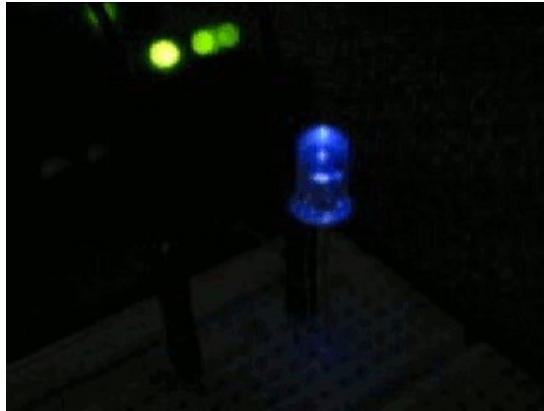
- Back to our dimmer effect...



- Can you use your program to create this effect?

# Light Control

- Sort of...  
If we want a smooth dimmer effect we need to run LED through all/many PWM levels 0-255



- But we don't have enough keys or patience to press all of them, so let's try something new!

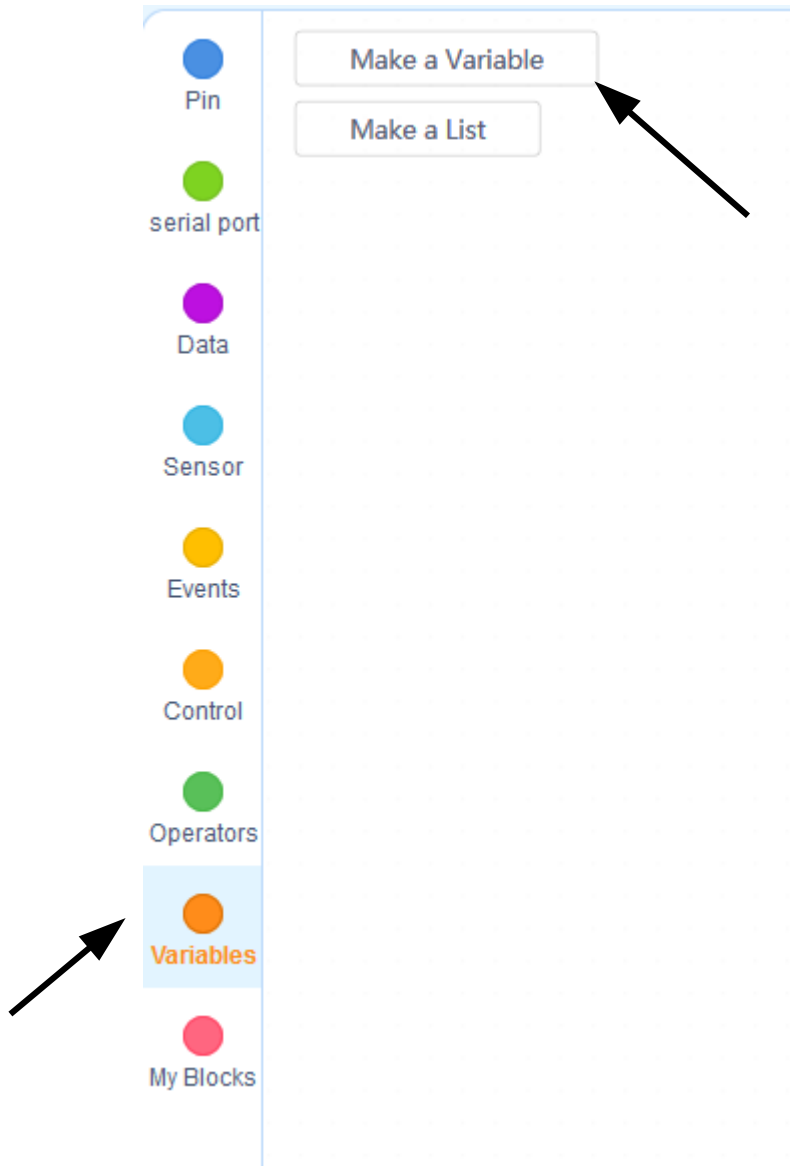


## Exercise 2b

Create a Dimmer Effect

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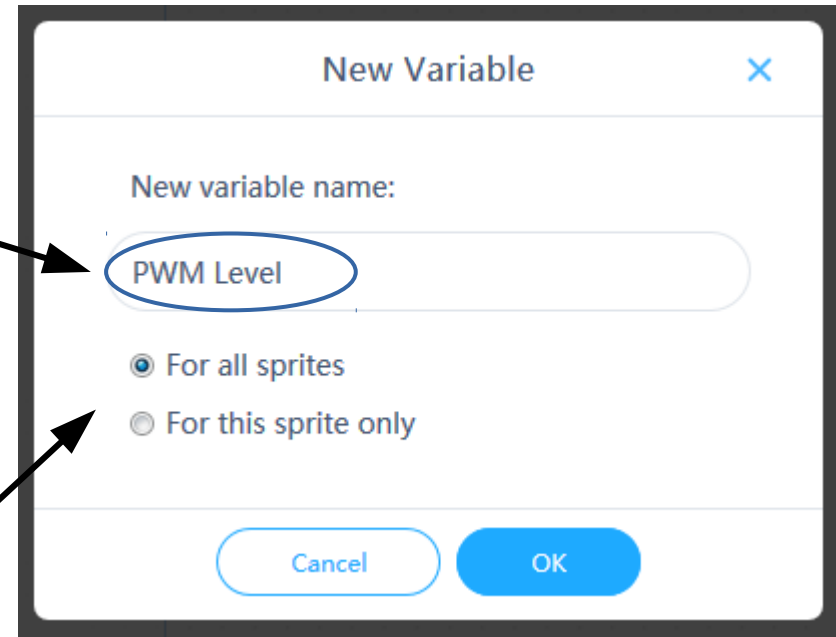
# Variables



- First, Let's create a new Variable. A variable is a named piece of memory that stores information like numbers or strings. Its value can change, hence it is variable...
- Click on “Make a Variable” Under **Variables** menu

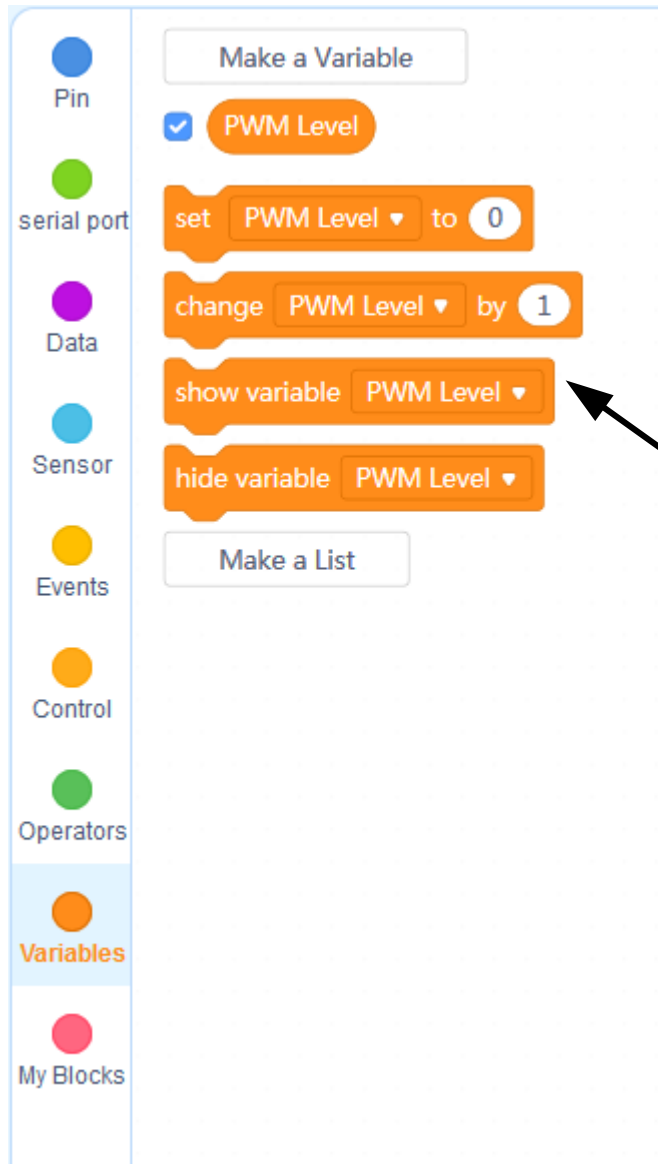
# Variables

Pick a meaningful Name



Doesn't matter much for today,  
but keep it "For all sprites"

# Variables



Now we have a new variable!

These are helper function blocks associated with variables:

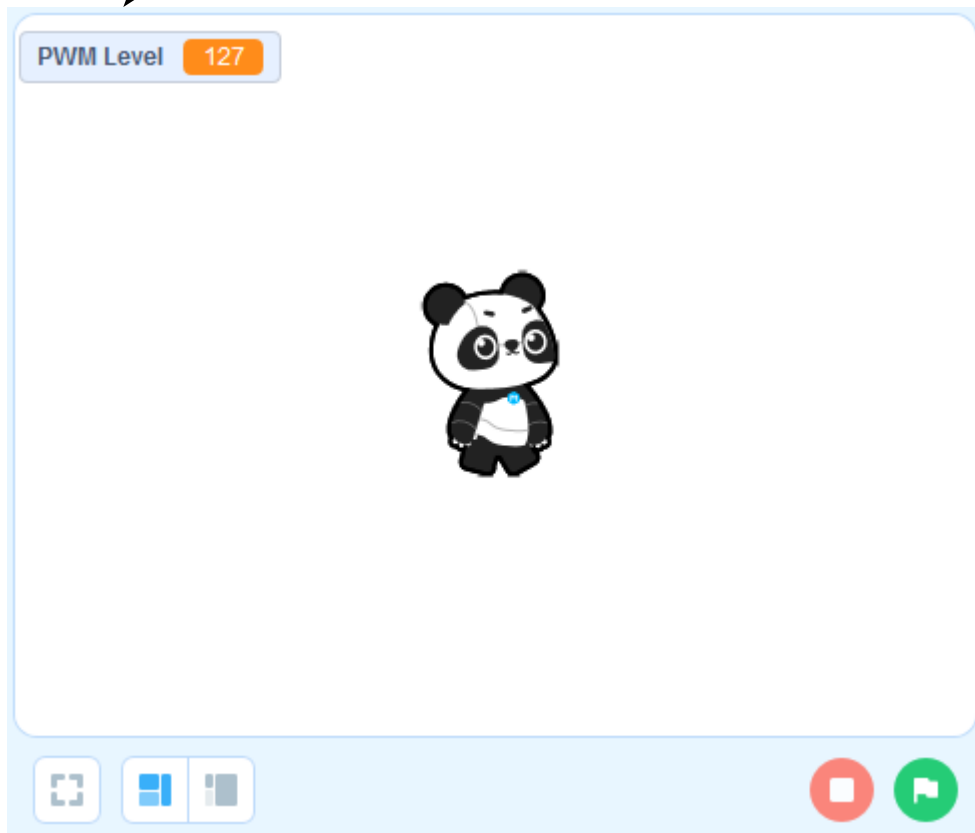
“set Var to 0” → “Var = 0”

“change Var by 1” → “Var = Var + 1”

We will use those now.

# Variables

Let's play with this variable...



We can change the value in a simple program, and see the Display change



To test, keep changing this value and clicking **space** key to change the variable.

# Light Control - Variable

We want to use the value in our program to change the PWM output of our LED pin

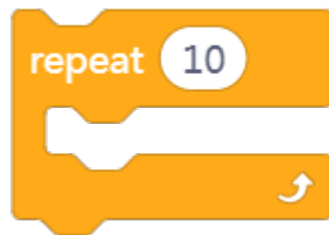
Any ideas how?



# Light Control - Loops

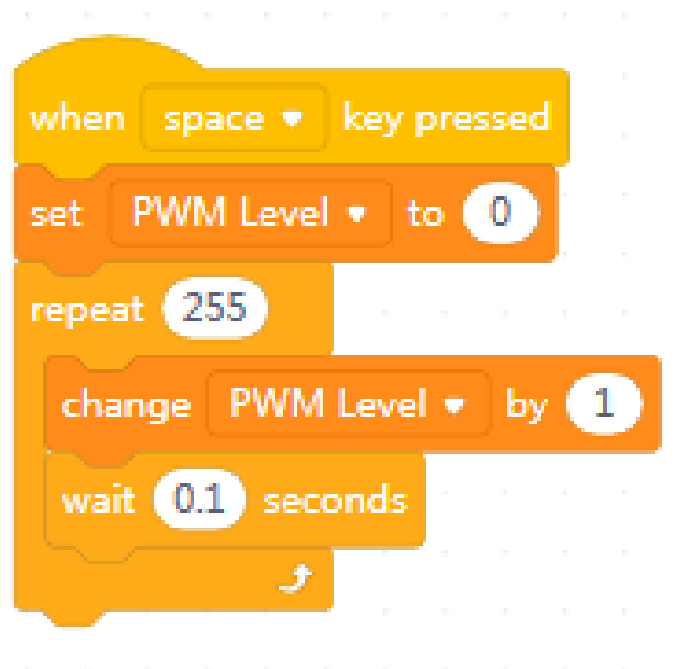
What about the Dimmer Effect?

We Use Loops



# Light Control – Loops & Variables

For instance, let's make a simple counter:



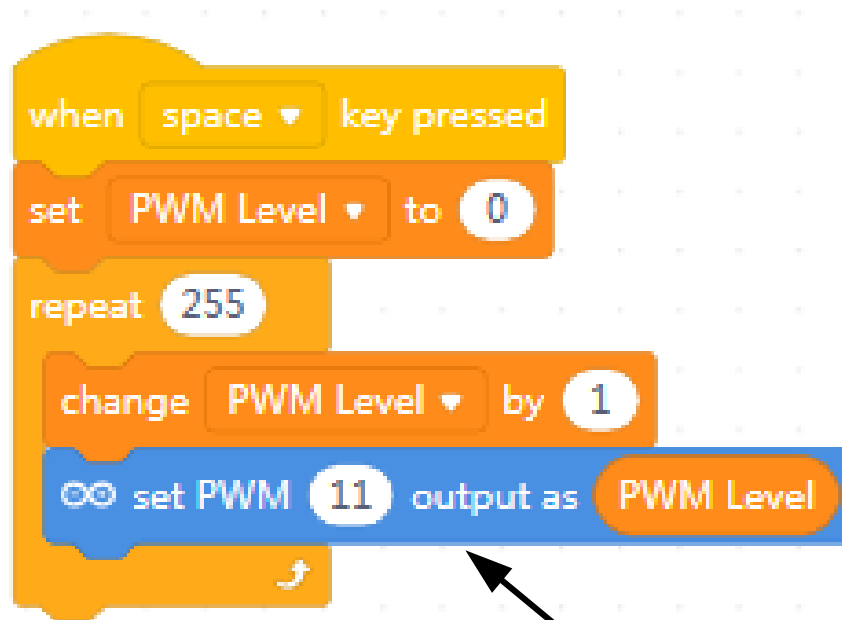
See the variable value change:





# Dimmer Effect

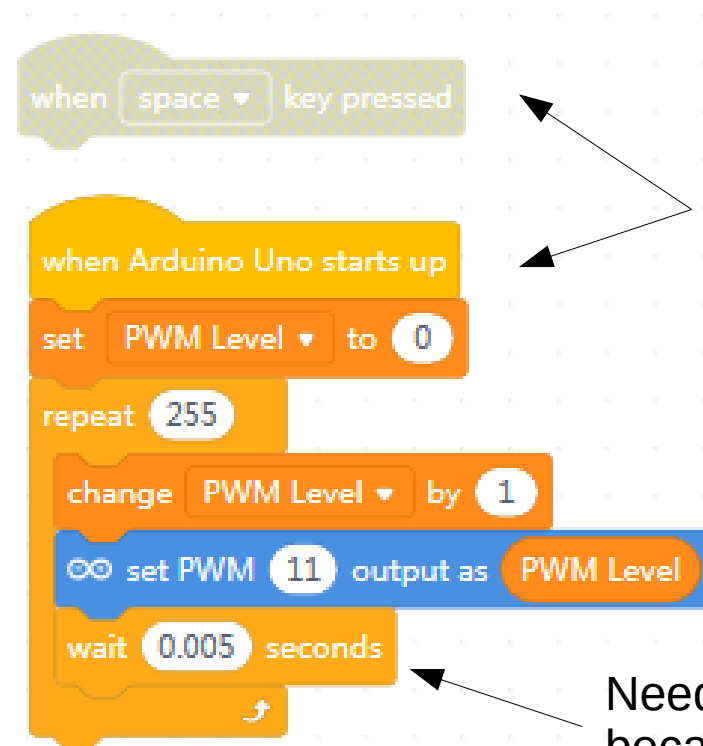
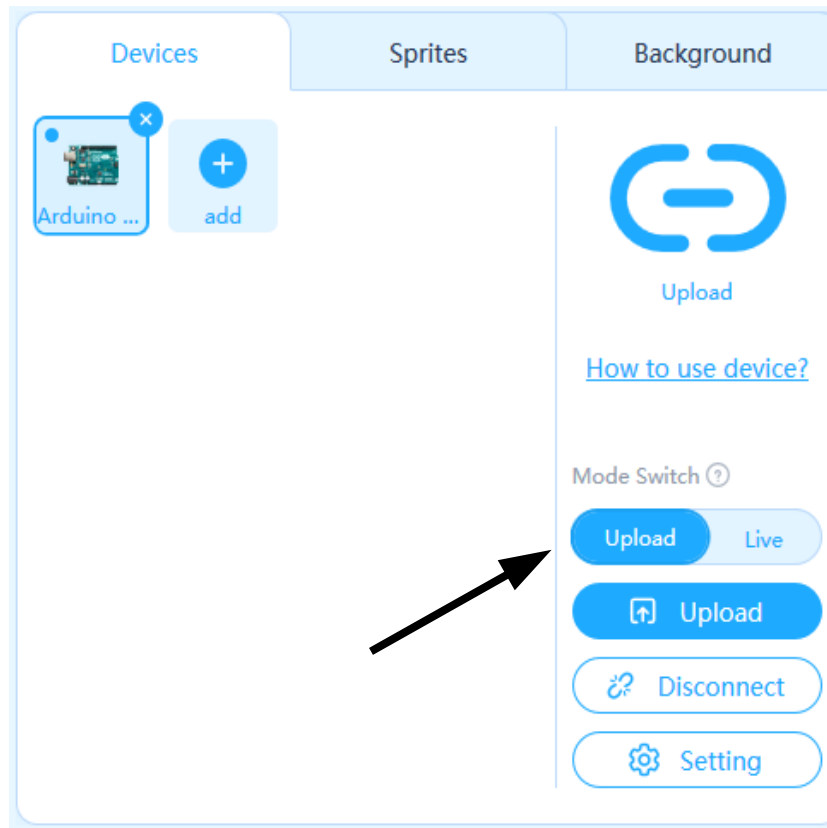
- Instead of **wait** block, set the LED pin to the increasing PWM levels



Waits for a fraction of second..

# Dimmer Effect

- For smoother effect, change to “Upload” mode



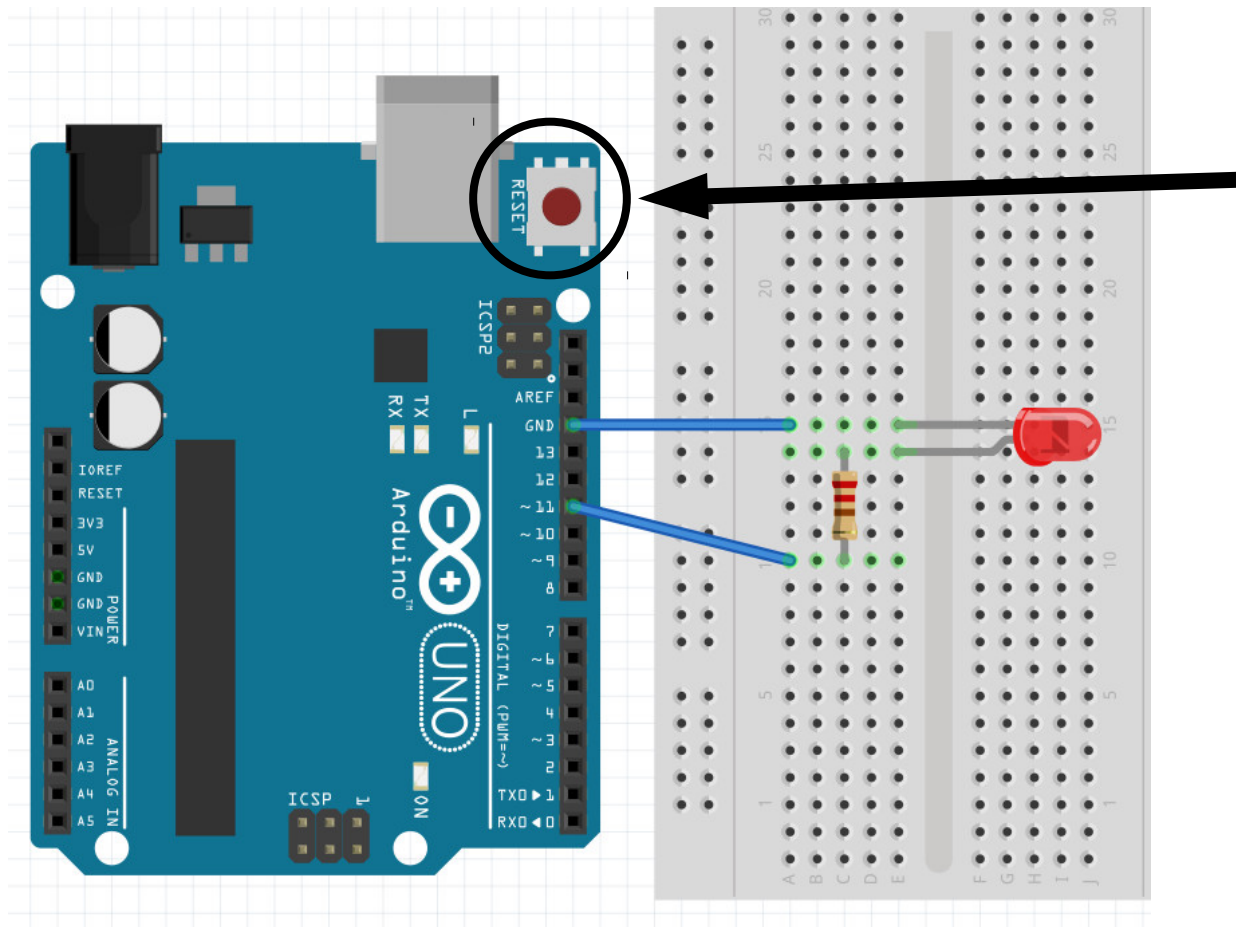
Can only use the **When Arduino Starts up** event now

Click **Upload** button when ready

Need a wait now, because local **set PWM** doesn't wait.

Try different speeds.

# RESET to Restart



Press **RESET** button to restart Arduino, and rerun the uploaded program

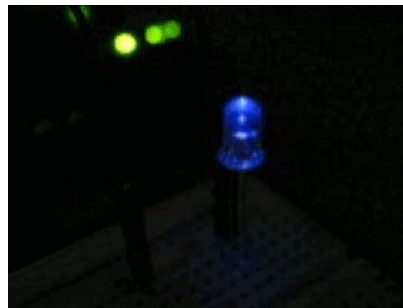
## Exercise 2b

Create a Dimmer Effect

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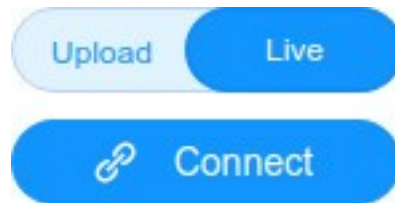
# Challenges

- After trying various durations, note the **Wait Time** that gave you the best dimmer effect in your Student Handout
  - You can also vary the PWM Level **Step Size**
- Extend the program to make dimmer effect run from low to high **and back to low again**
- Make the program run continuously like this:



# Re-Connect with Arduino

- Switch back to **“Live”** mode and click **“Connect”**

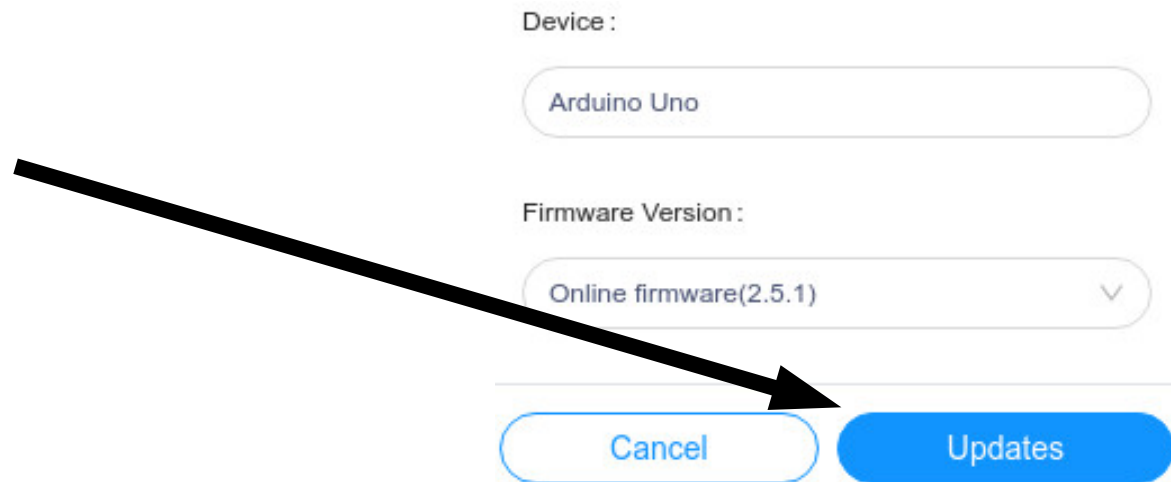


- **Select a COM port**  
*You may need to [x] “Show all connectable devices”*
- **Click “Connect”**

# Connect with Arduino

- When  appears, click on it!

Followed by  and “Updates”



# Extra Challenges

- Convert your variable to a **Slider** and use it as a graphical **Variable** Dimmer Switch
- Create a Graphical **Dashboard** to control Lights (on/off buttons, slider dimmers, blink buttons)
- Use a physical button to act as a **Toggle** Dimmer Switch (on/off)
- Use multiple LEDs to create a **Light Show** with blinking, dimming, and any other effects you can muster



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