Summer Session KINGS 2019

Internet of Things Developments using NodeMCU and IoT Platform

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Set status

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PRO

Hello, I am an old programmer & educator, DIT(Dong-Eui Institute of Technology), Busan. Korea

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Organizations

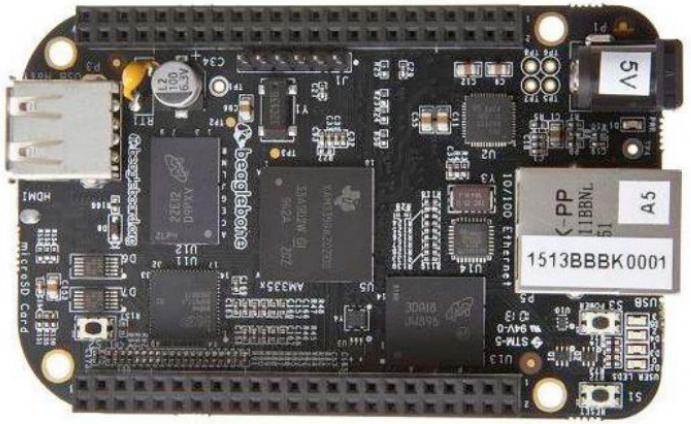
Table of Contents

IoT Development Toolkits

- Open Source Hardware Platforms

Arduino Uno

Raspberry Pi 3 B+



Beaglebone Black

Intel Edison

Intel Galileo

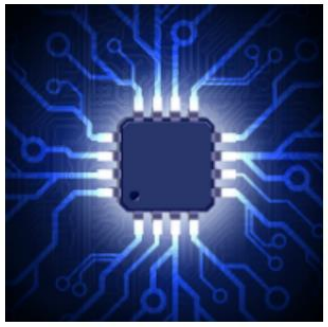
NodeMCU

NodeMCU/ ESP8266

• NodeMCU : An open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

• ESP8266 : a low cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.

Open-source, Interactive, Programmable, Low cost, Simple, Smart, WI-FI enabled



Arduino-like hardware IO

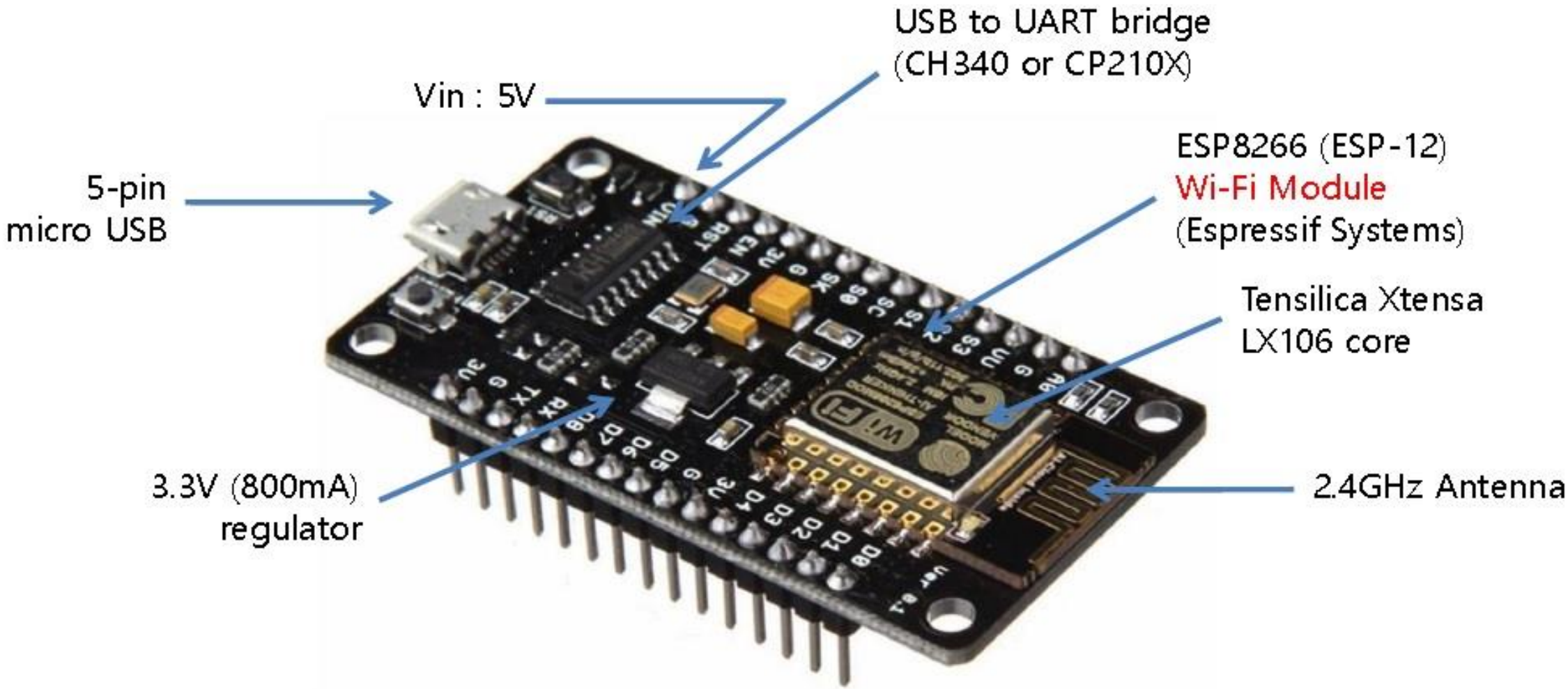
Nodejs style network API

Lowest cost WI-FI

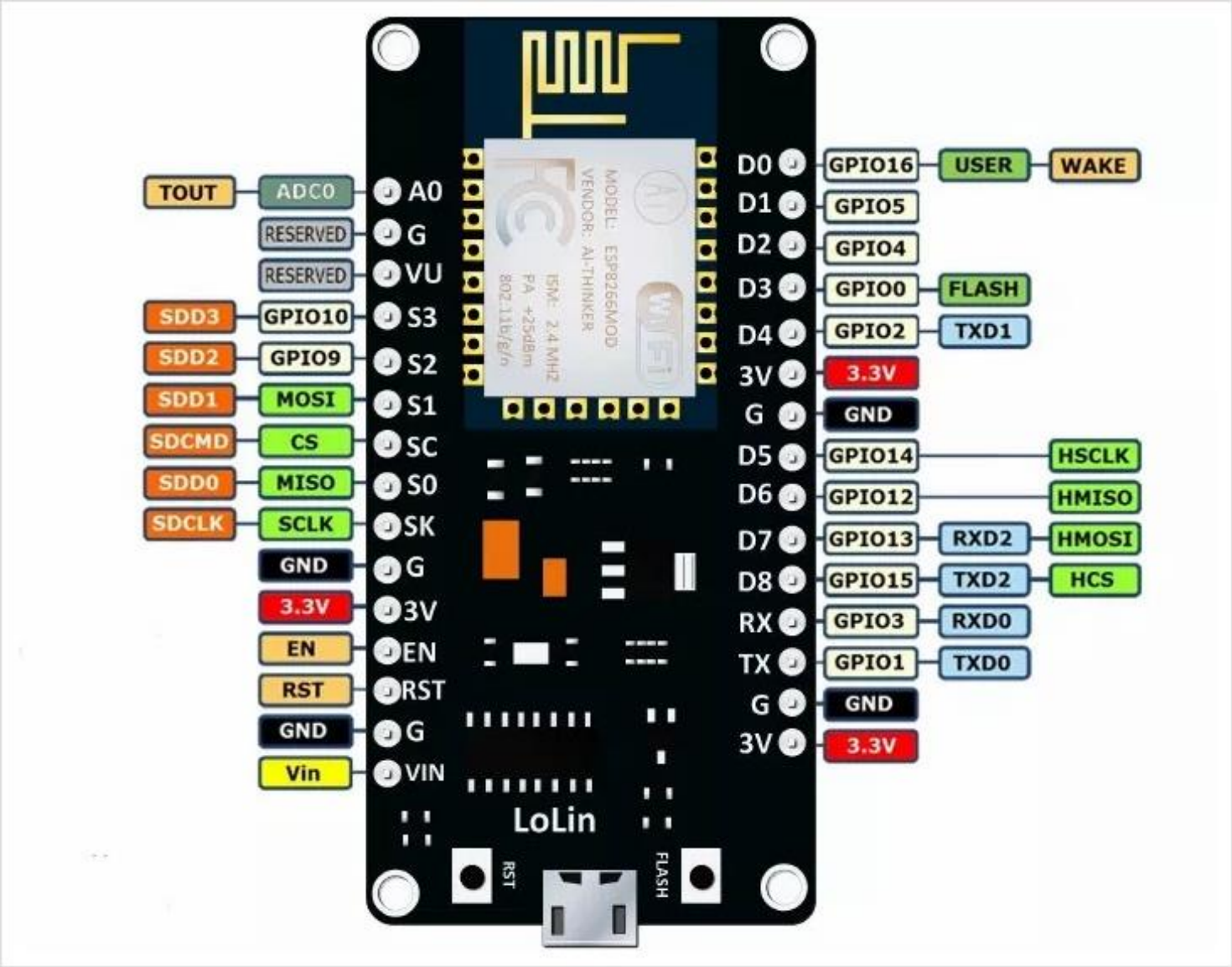
NodeMCU Development Kits

- The Development Kit based on ESP8266
- Integrates GPIO, PWM, I2C, 1-Wire and ADC all in one board
- Growth of ESP8266 modules

NodeMCU : Open Source H/W Platform



NodeMCU GOIP



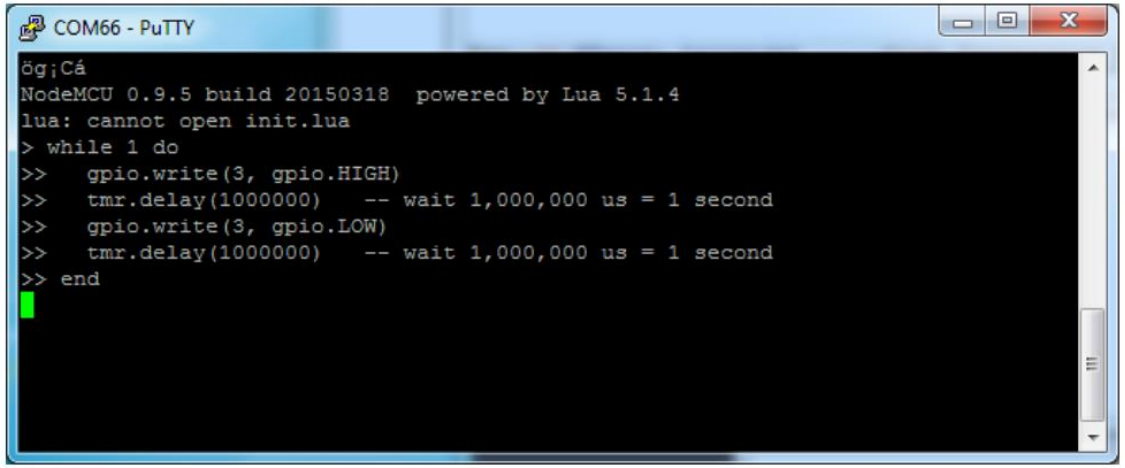
NodeMCU GOIP

- GPIO 0,2,15 : booting mode setting
- GPIO 1,3 : Serial Communication
- GPIO 6~11 : flash memory
- GPIO 16 : sleep mode
- Unrestricted GPIO Pins
  - GPIO 4(D2), GPIO 5(D1), GPIO 12~14(D6,D7,D5)
  - internal LED : GPIO 2(D4)

NodeMCU Development Environments

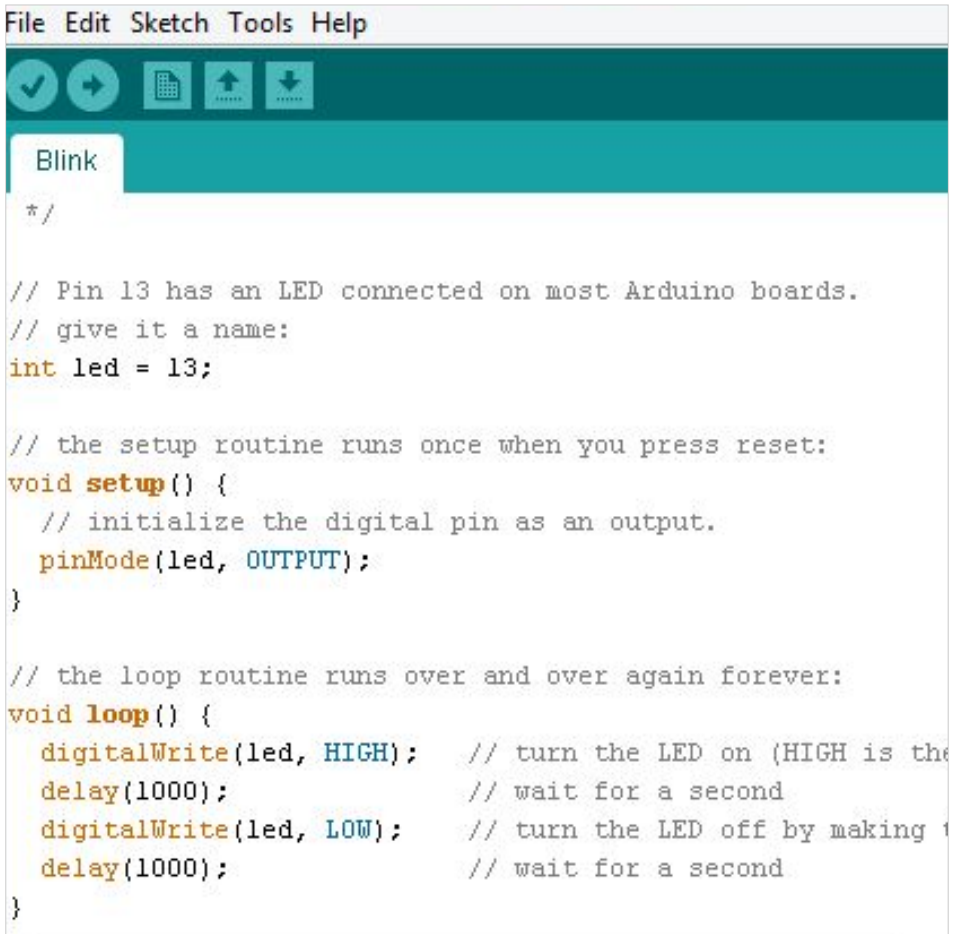
- LUA : Script language, Interpreter

```
1.  gpio.mode(3, gpio.OUTPUT)
2.  while 1 do
3.    gpio.write(3, gpio.HIGH)
4.    tmr.delay(1000000)   -- wait 1,000,000 us = 1 second
5.    gpio.write(3, gpio.LOW)
6.    tmr.delay(1000000)   -- wait 1,000,000 us = 1 second
7.  end
```



NodeMCU Development Environments

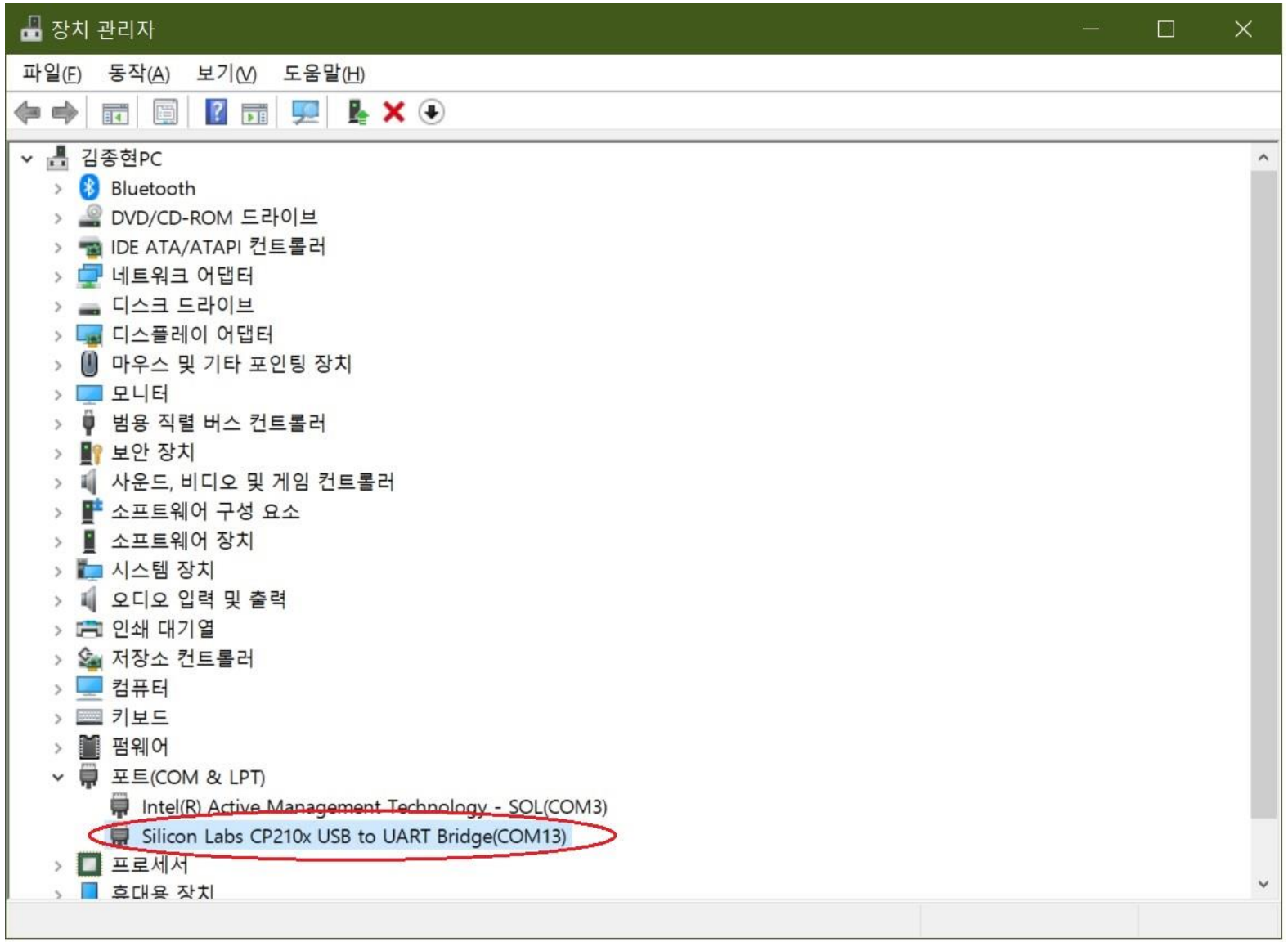
- Ardunio IDE : CC++, Compiler



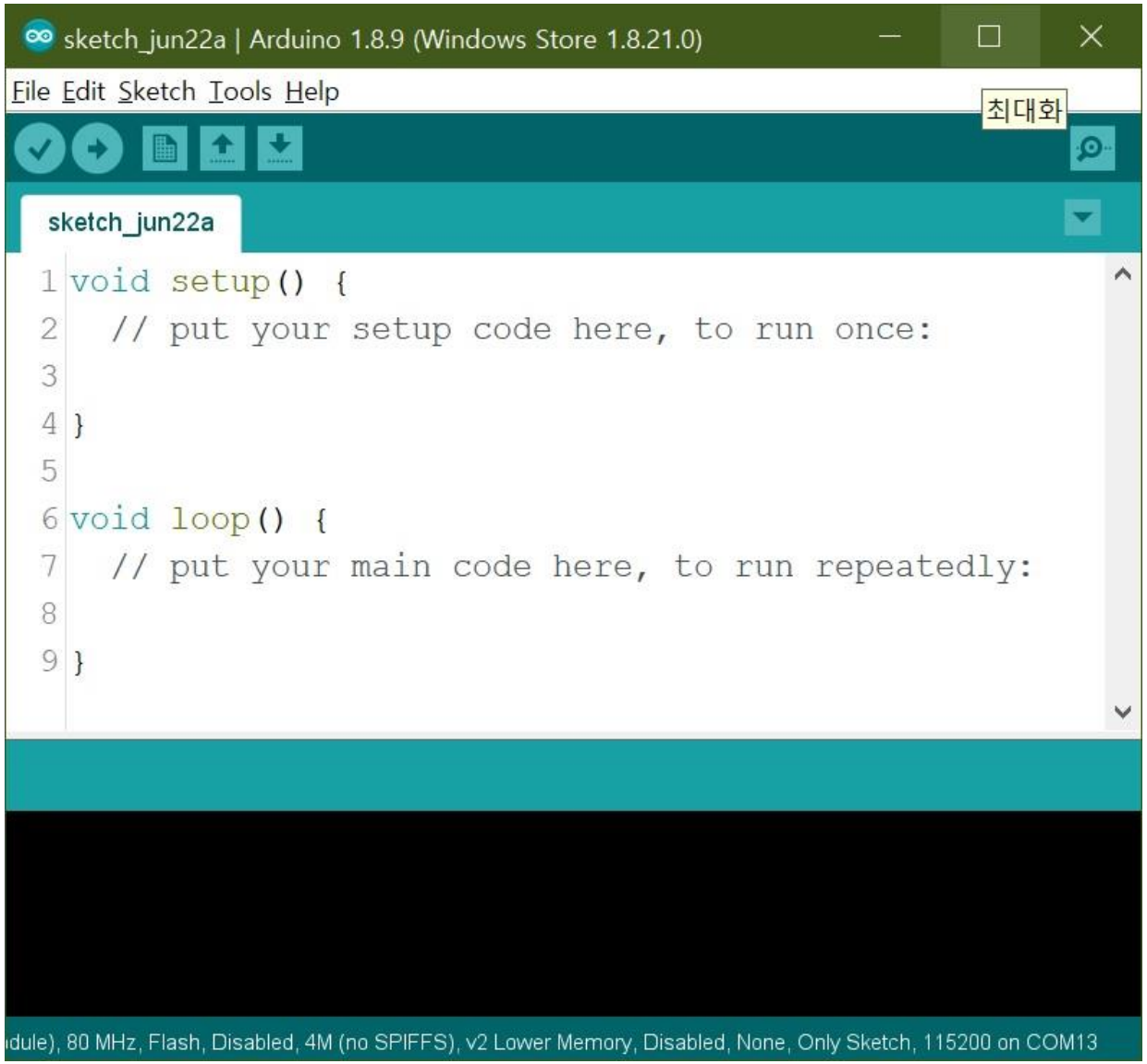
Adruino Programming for NodeMCU

- https://www.ardunio.cc

- Connect USB microcable to PC
- Open Device manager of PC, check Silicon Labs CP201x USB to UART Bridge

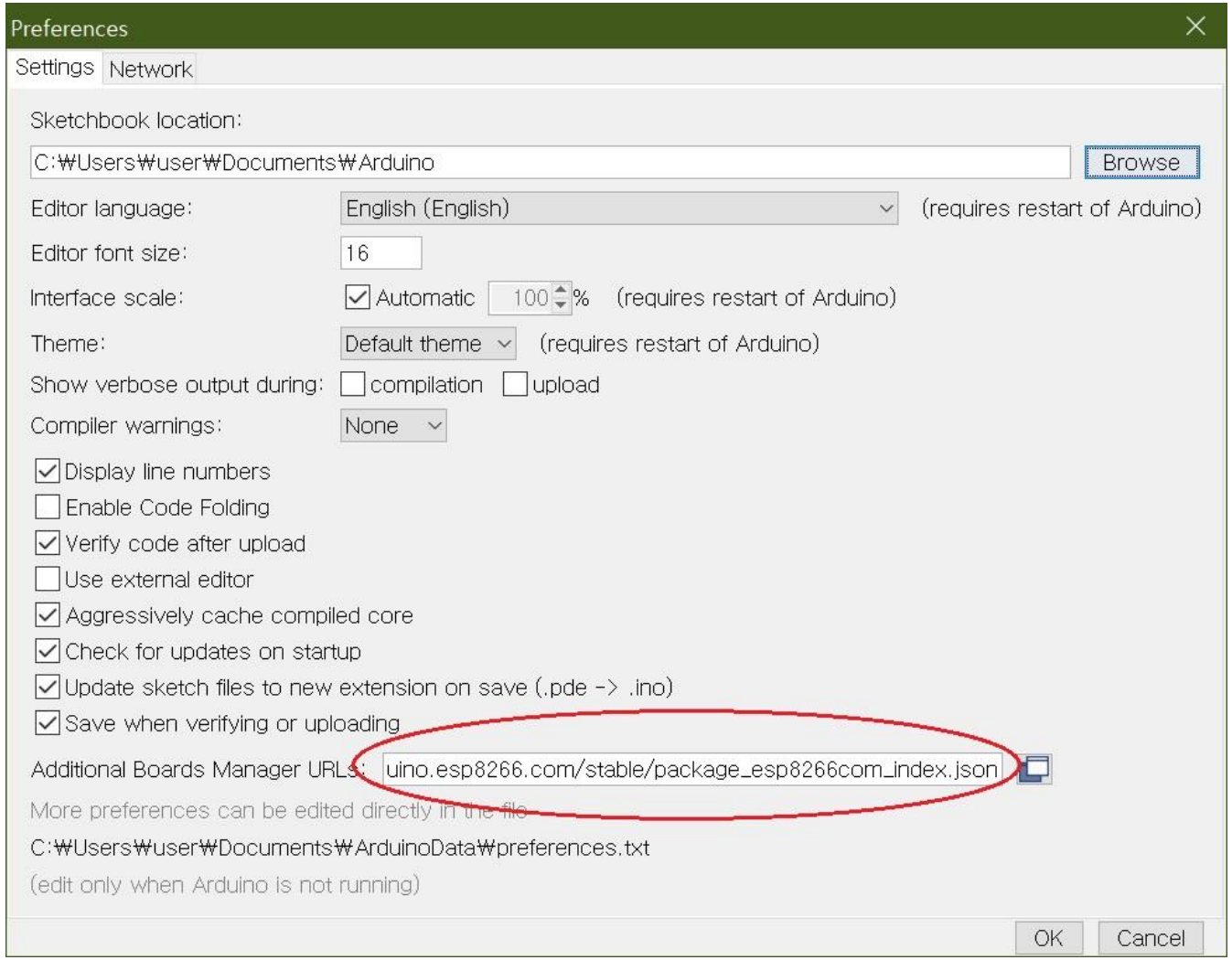


- Executing Arduino IDE

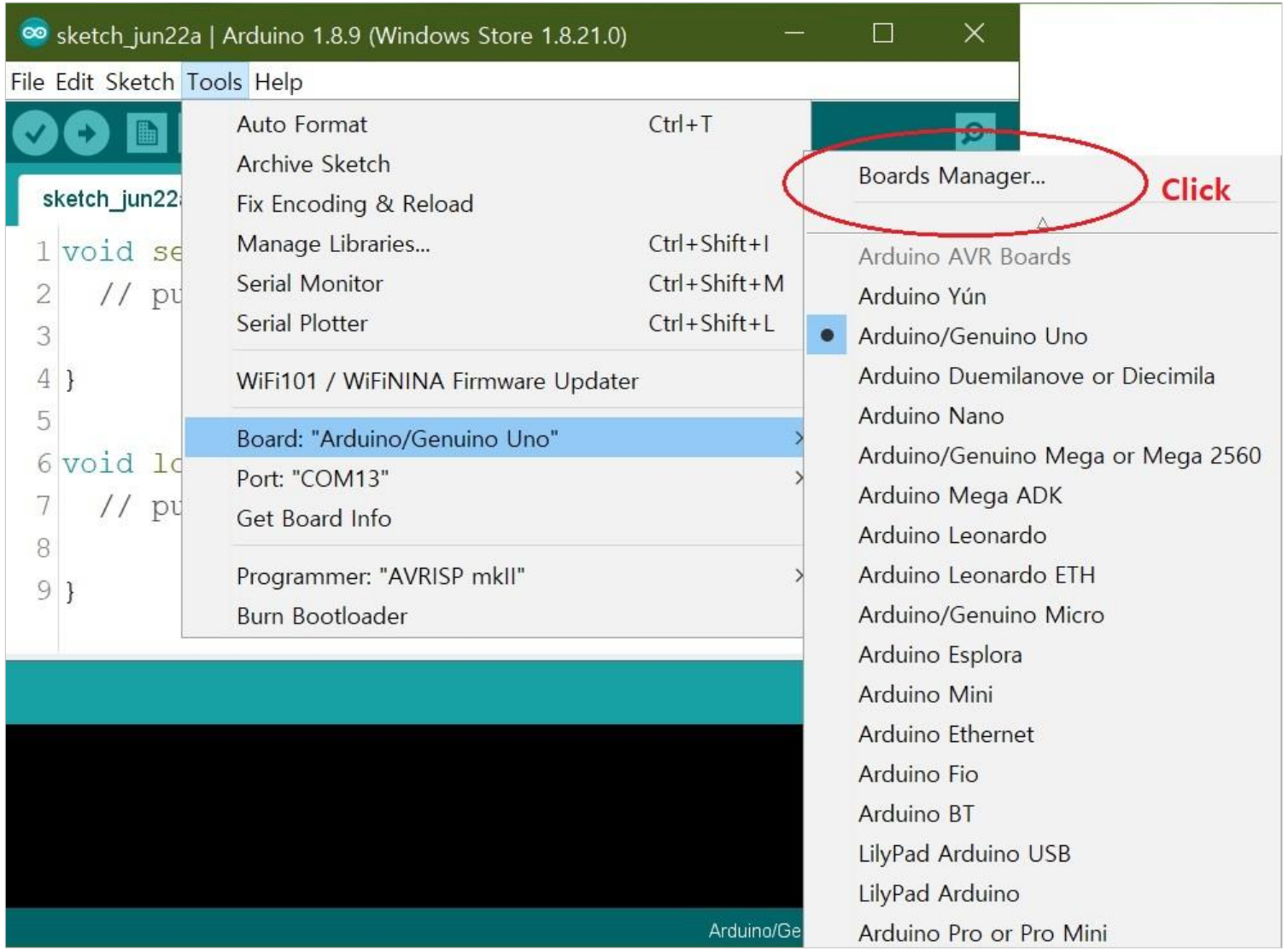


- Setting Board Manager URLs
  - Preferences -> Additional Board Manager URLs

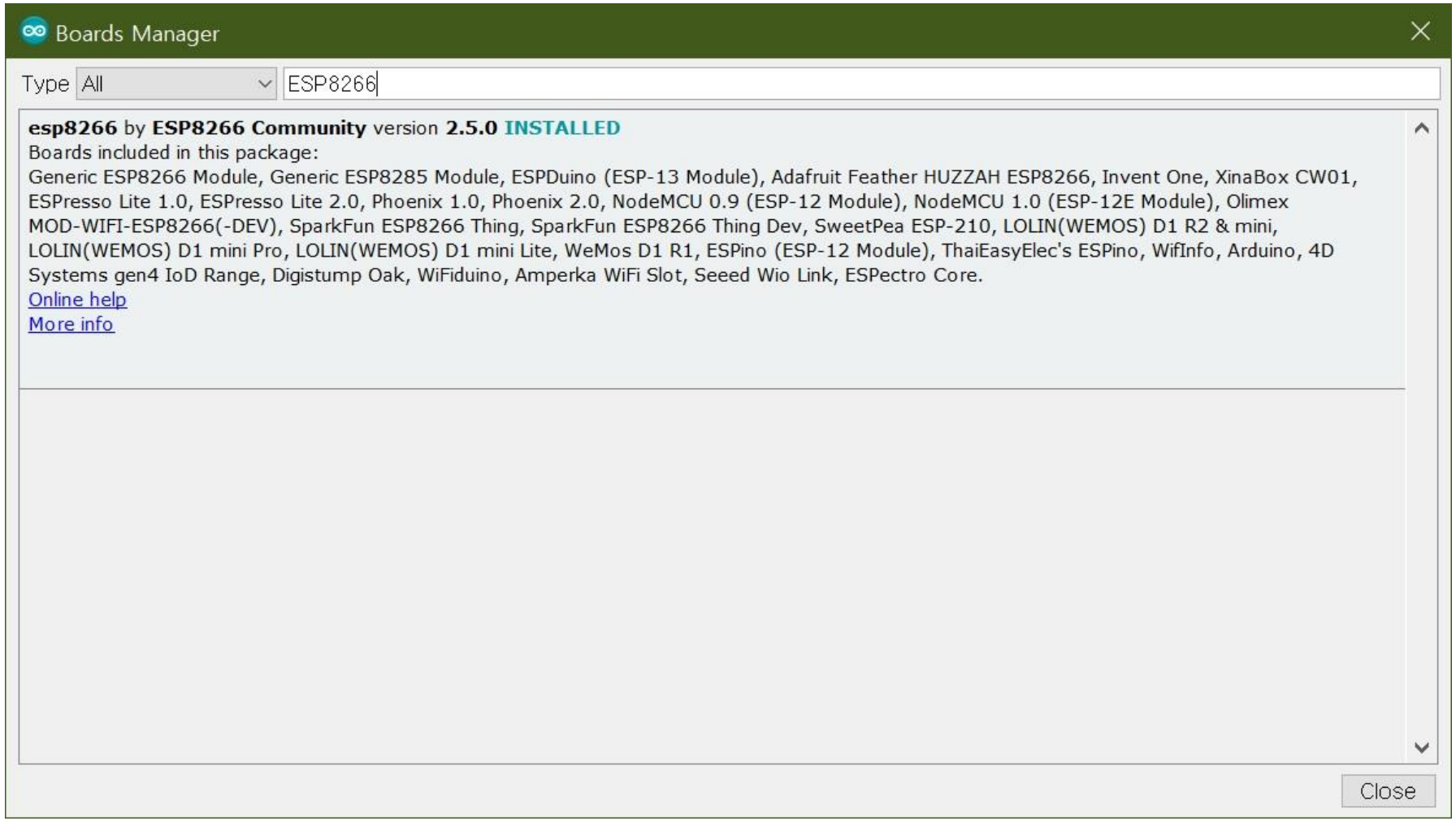
"**http://arduino.esp8266.com/stable/package_esp8266com_index.json**"



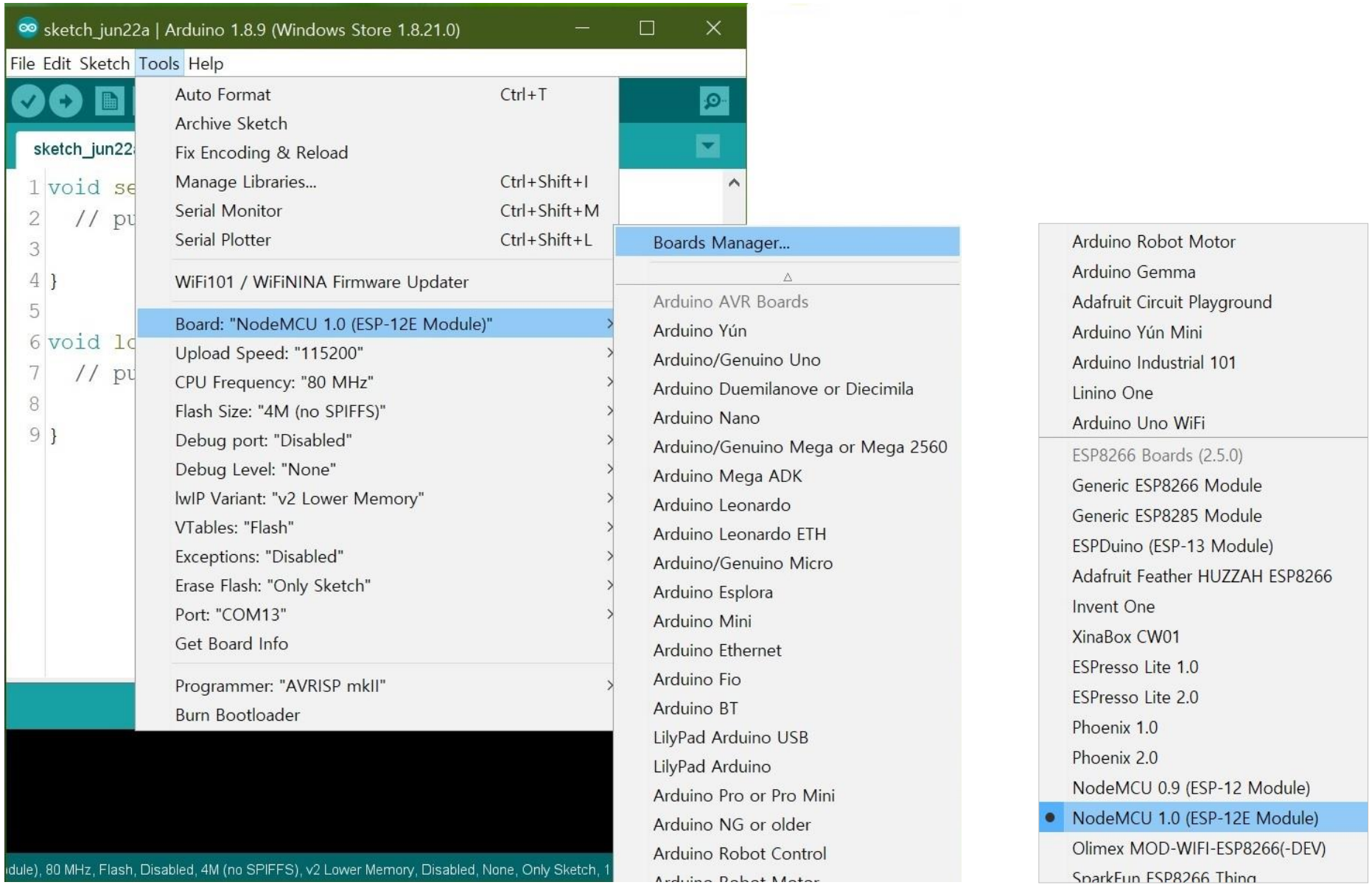
- Setting Board Manager



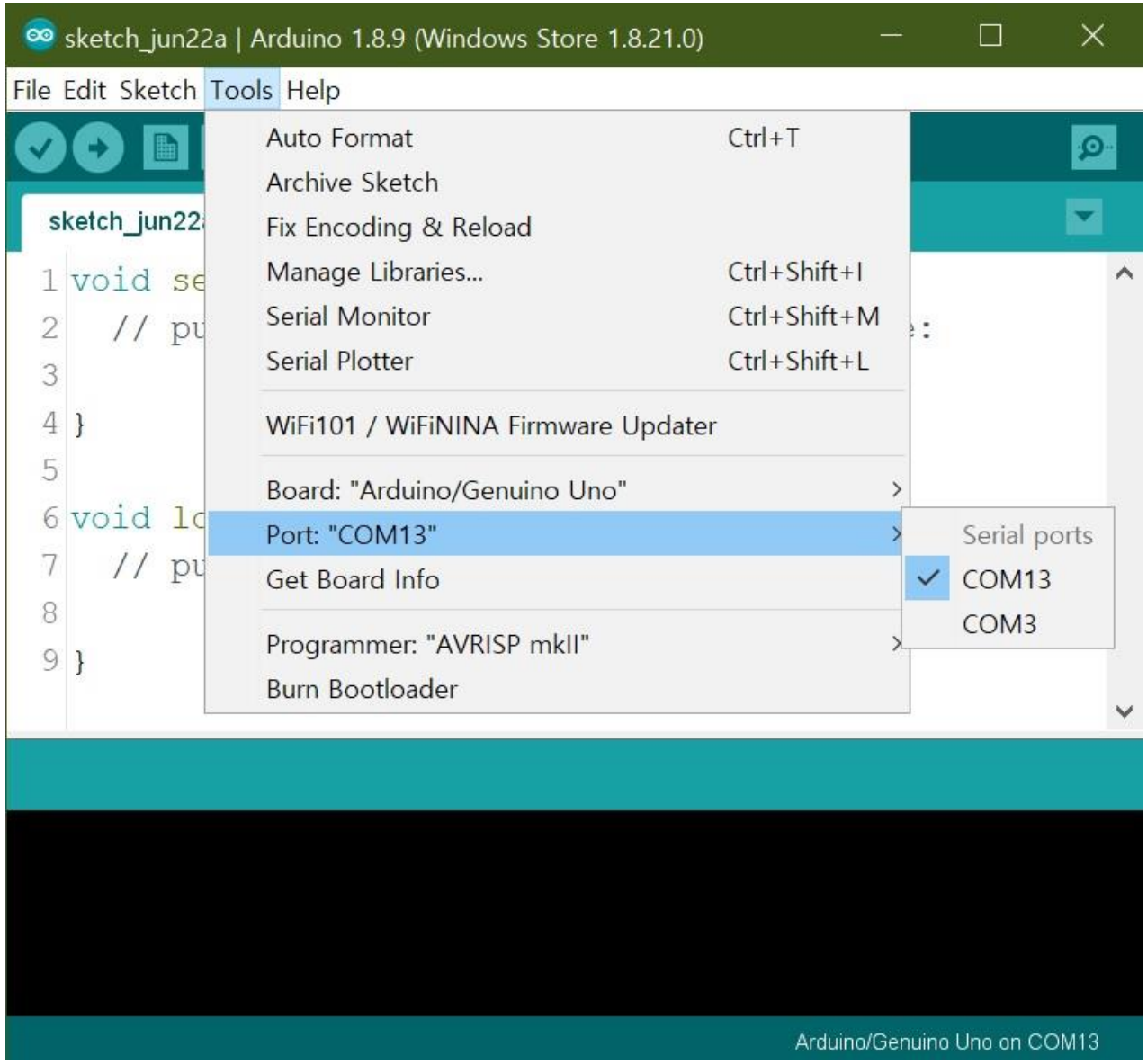
- Setting Board Manager : Search “esp8266 by ESP8266 Community”



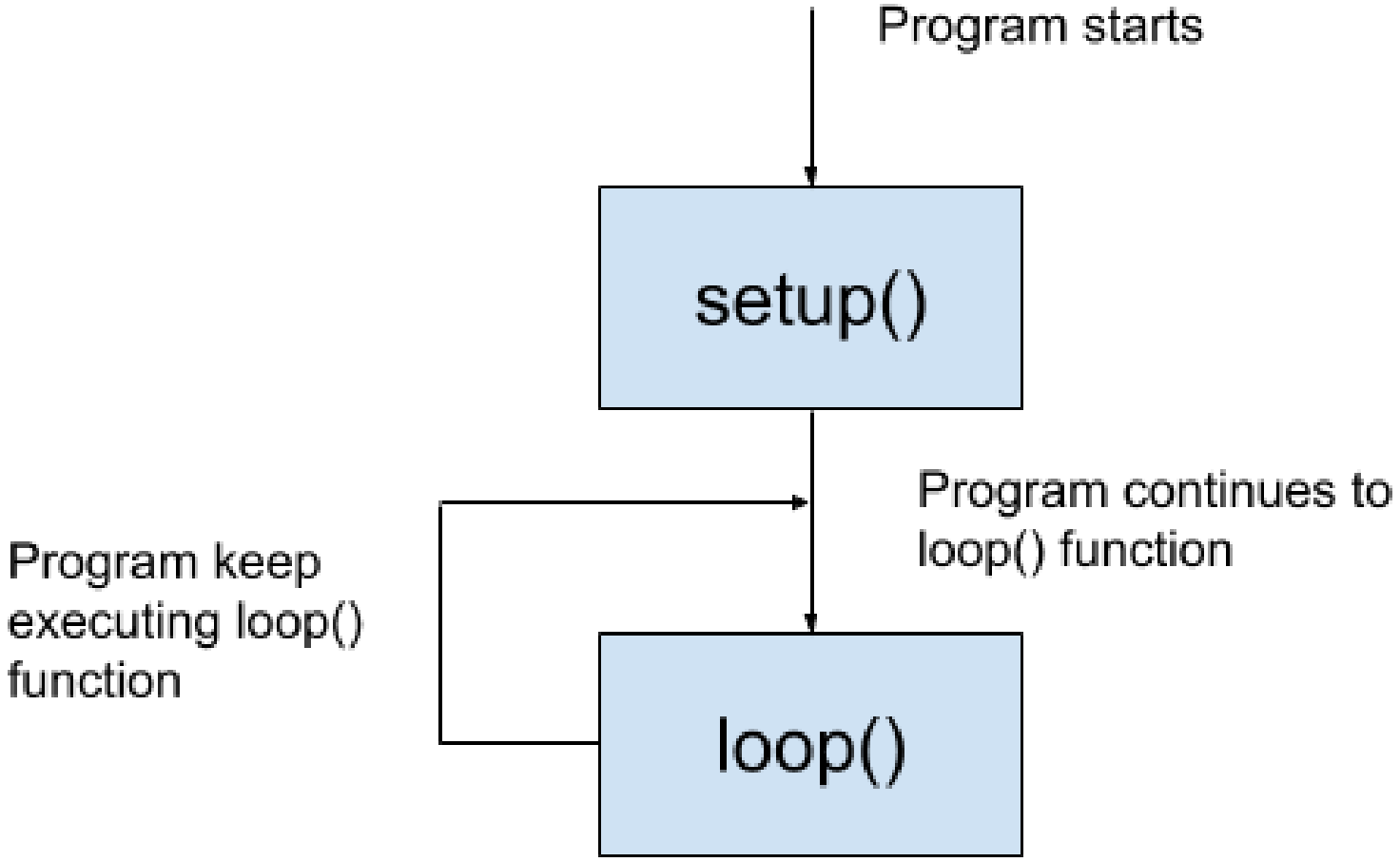
- Setting Board Manager : Select NodeMCU 1.0(ESP-12E Module)



- Setting serial port



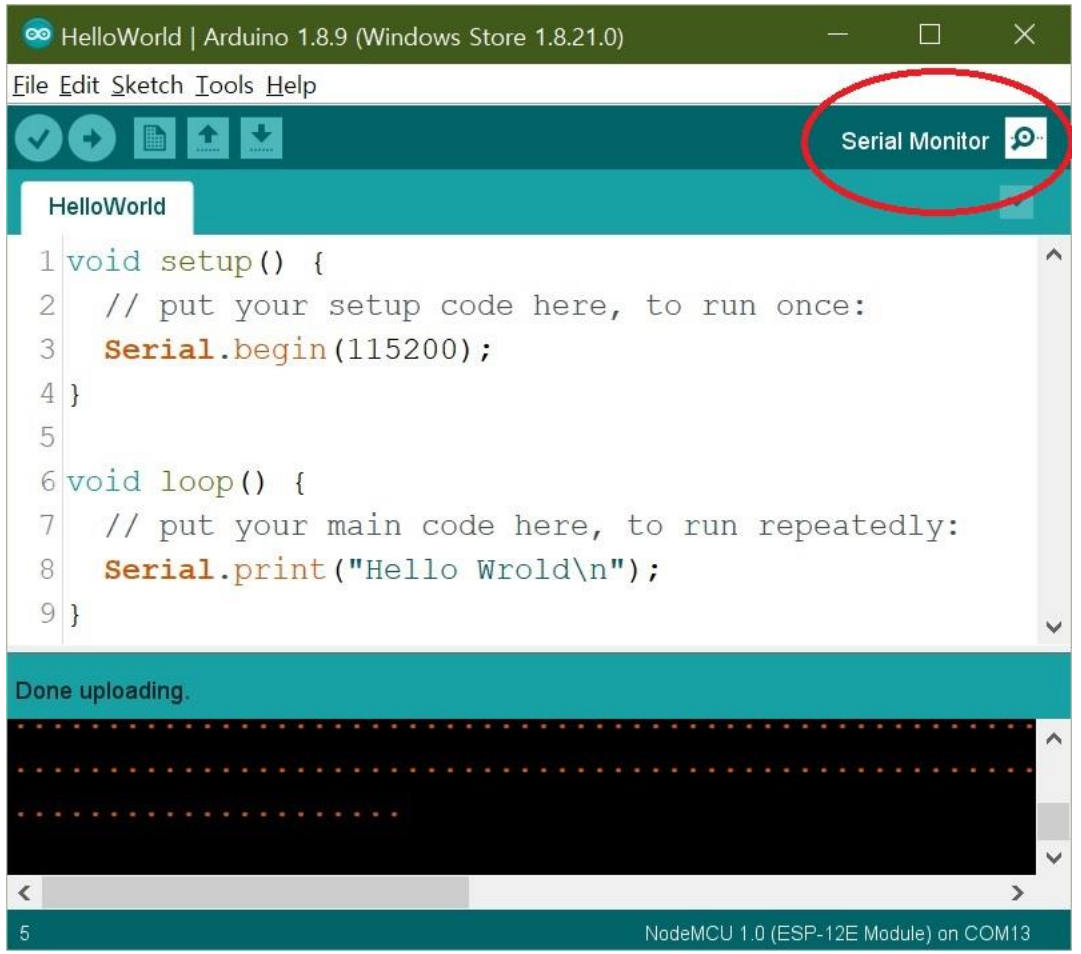
Arduino Programming Basics



Hello World!

```
void setup() {
    // put your setup code here, to
run once:
    Serial.begin(115200);
}

void loop() {
    // put your main code here, to run
repeatly:
    Serial.print("Hello World\n");
}
```

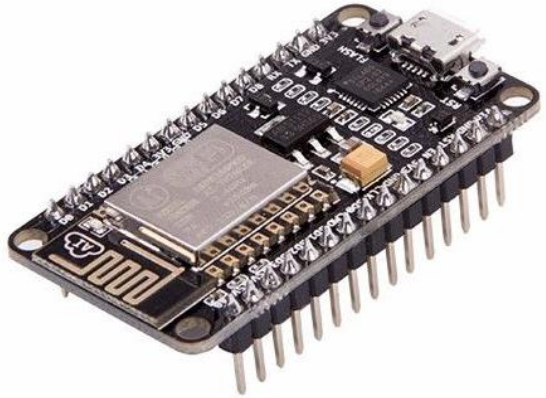


Arduino Digital I/O functions

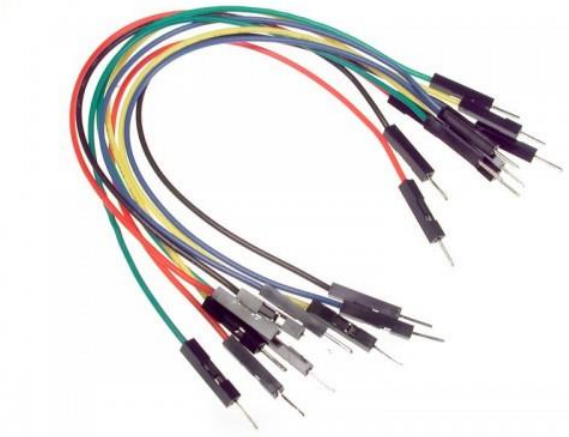
- **`pinMode(pin, mode)`**
  - Configures the specified pin to behave either as an input or an output.
- **`digitalWrite(pin, value)`**
  - Write a **HIGH(5V or 3.3V)** or a **LOW(0V or ground)** value to a digital pin
- **`delay(ms)`**
  - Pauses the program for the amount of time (in milliseconds) specified as parameter.
- https://www.arduino.cc/reference/en/

Basic LED Control on NodeMCU

- Preparation materials



NodeMCU

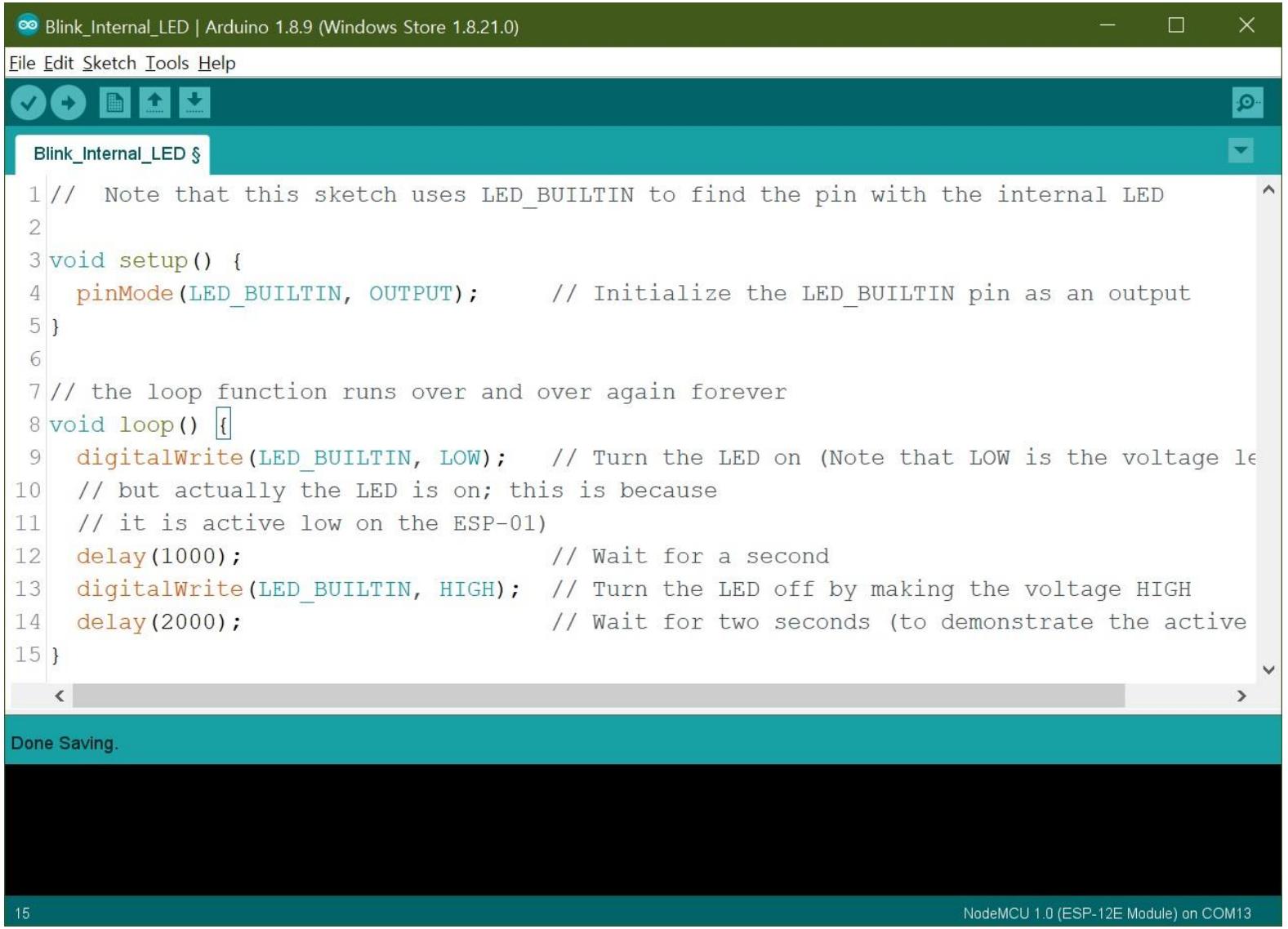


Jump Cables

LED

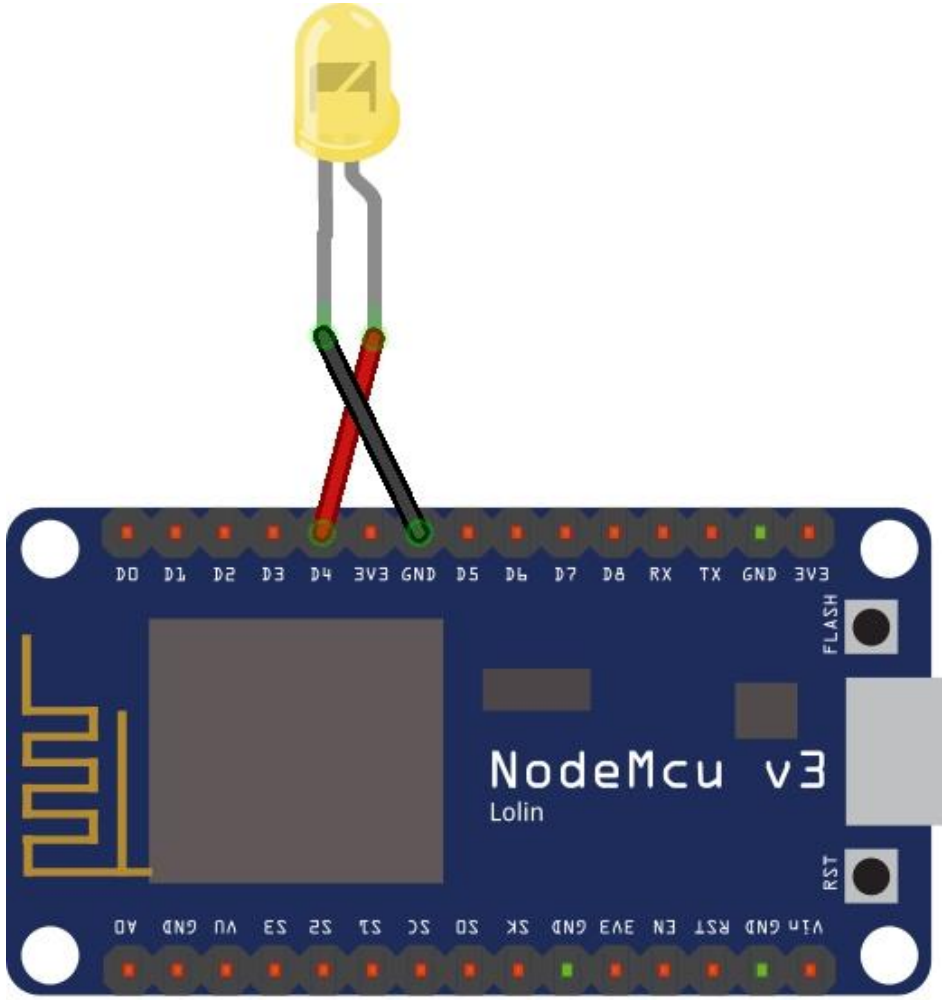
Register
220 Ω

Internal LED : LED_BUILTIN

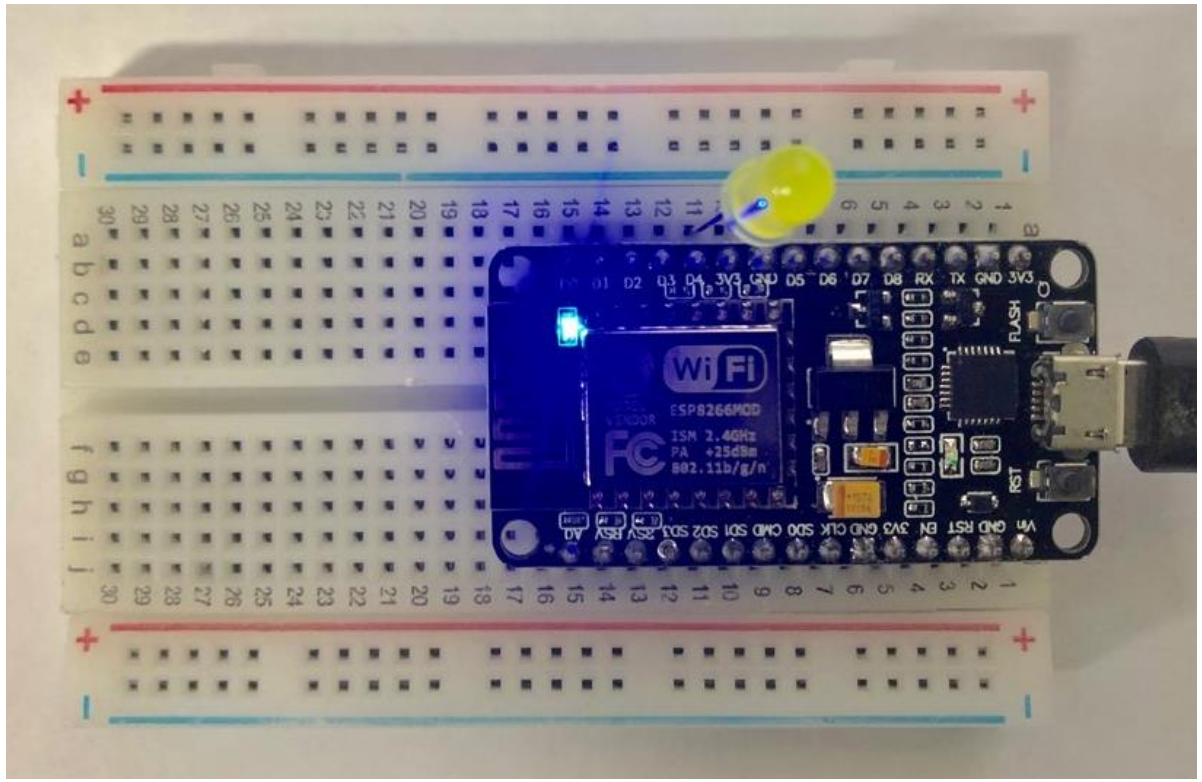


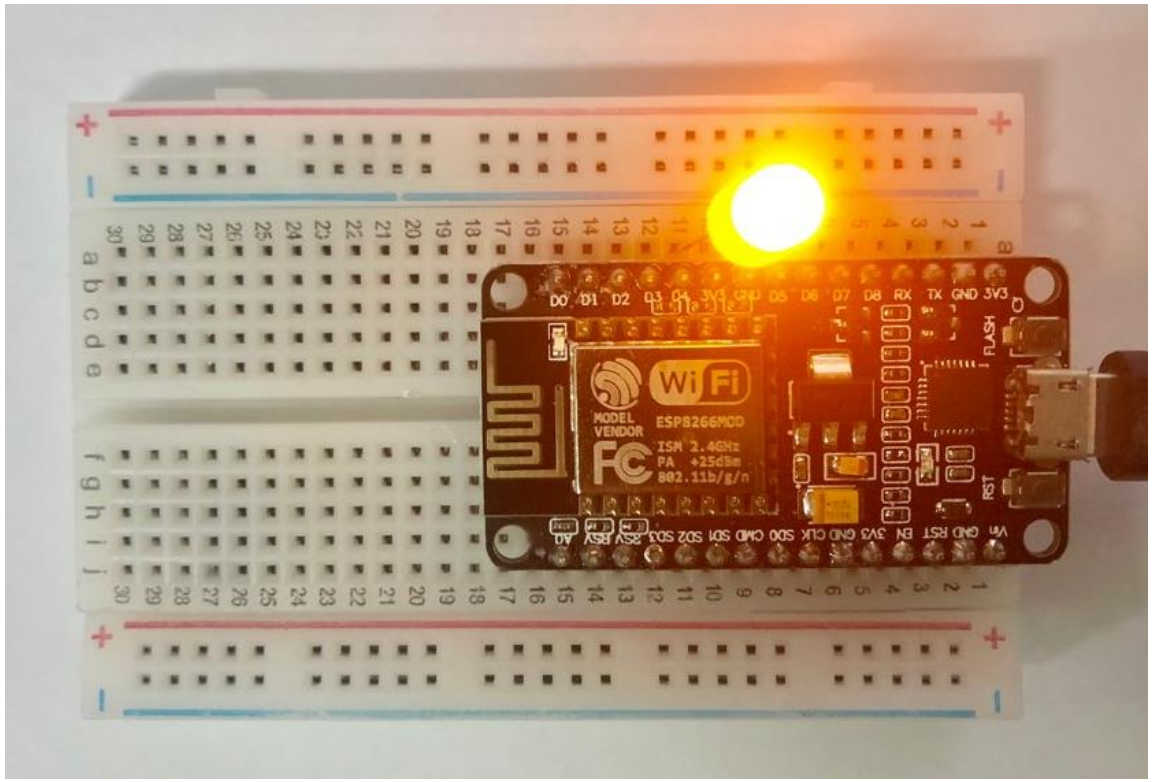
Circuit Wiring

- LED_BUILITIN -> D4

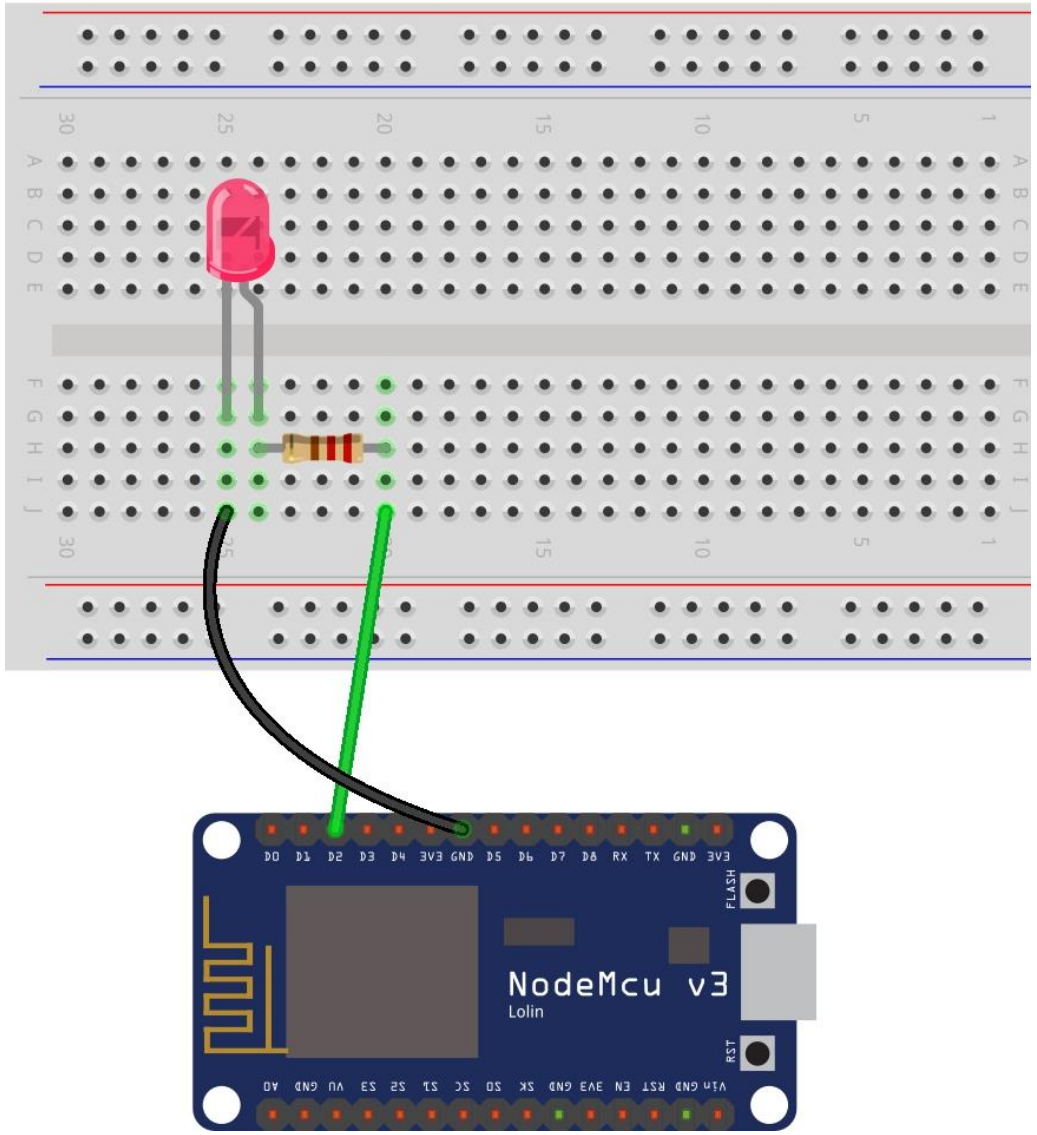


Operation of Internal LED : D4 pin

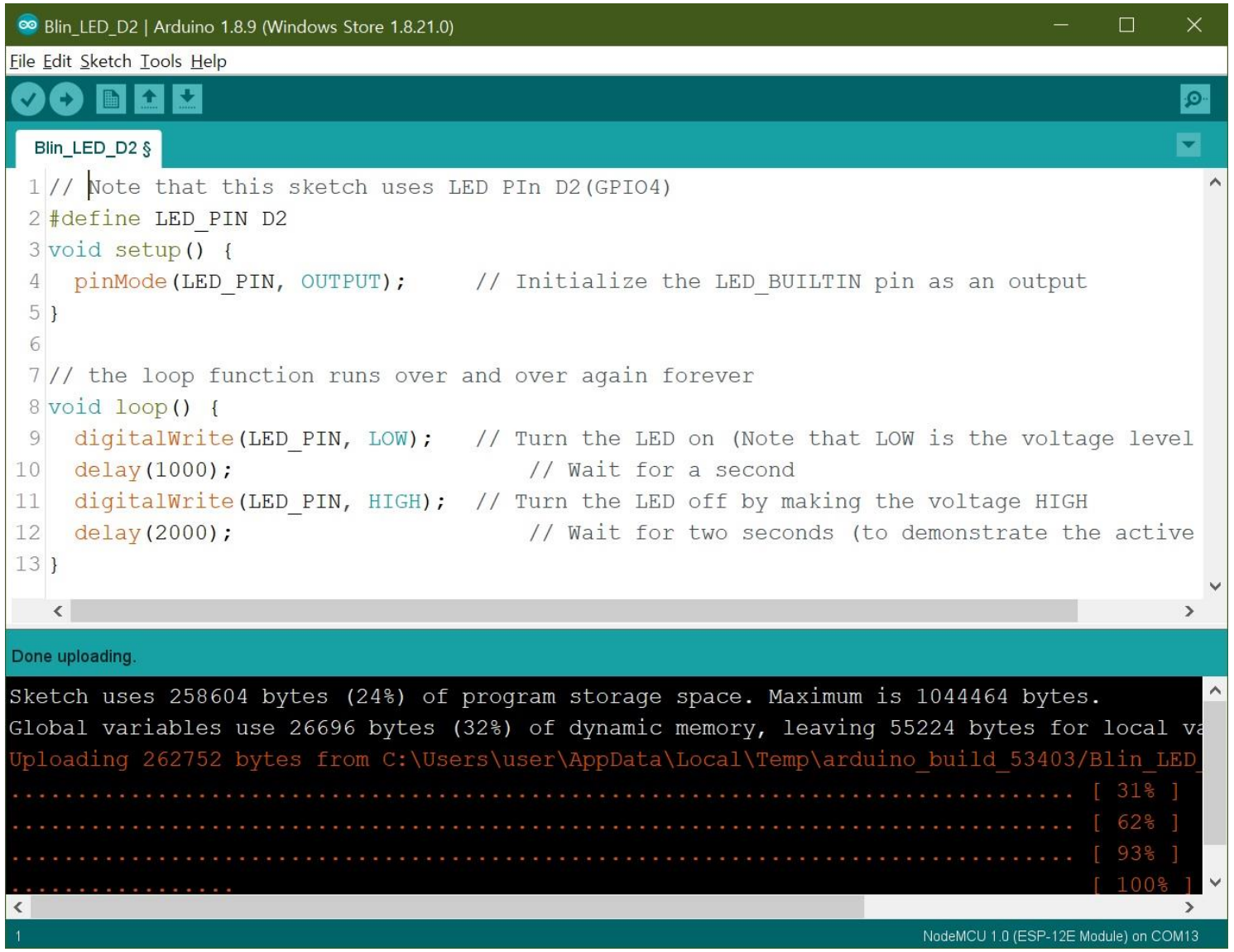




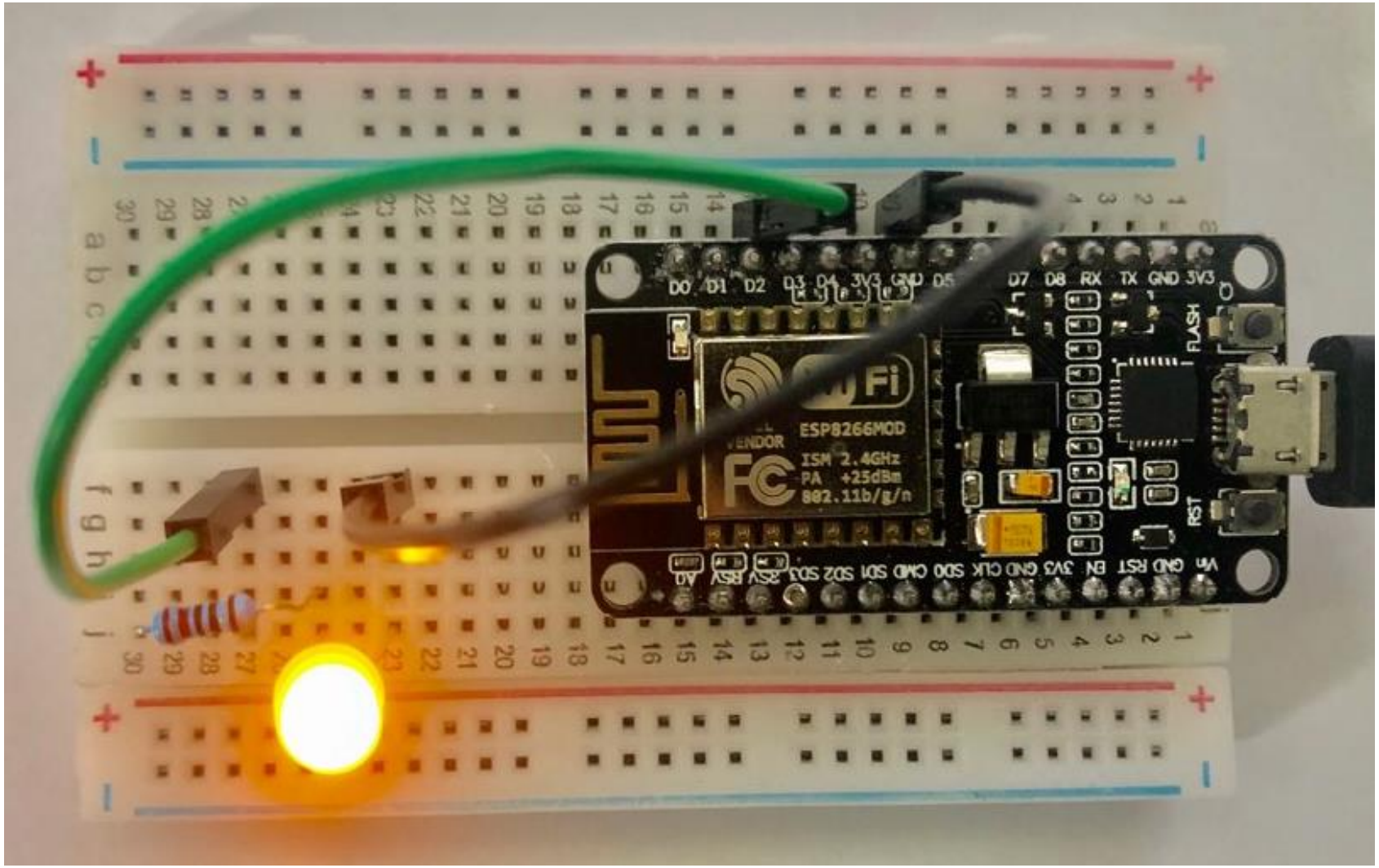
LED Control : D2 pin



LED Control : D2 pin

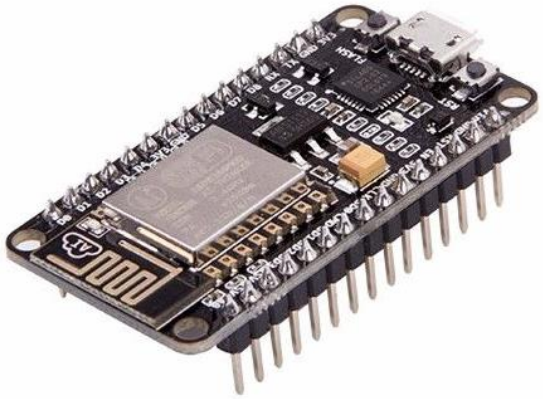


Operation of LED : D2 pin

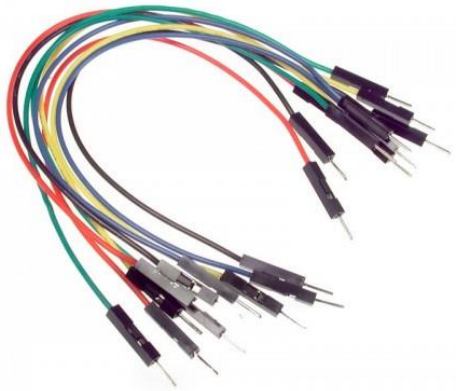


Reading Humidity and Temperature on NodeMCU

- Preparation materials

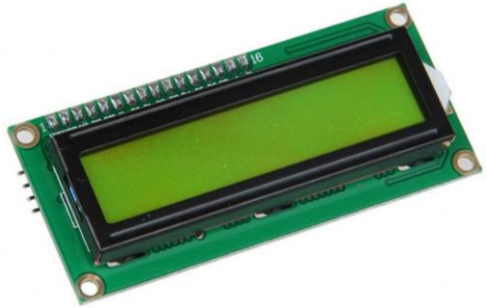


NodeMCU



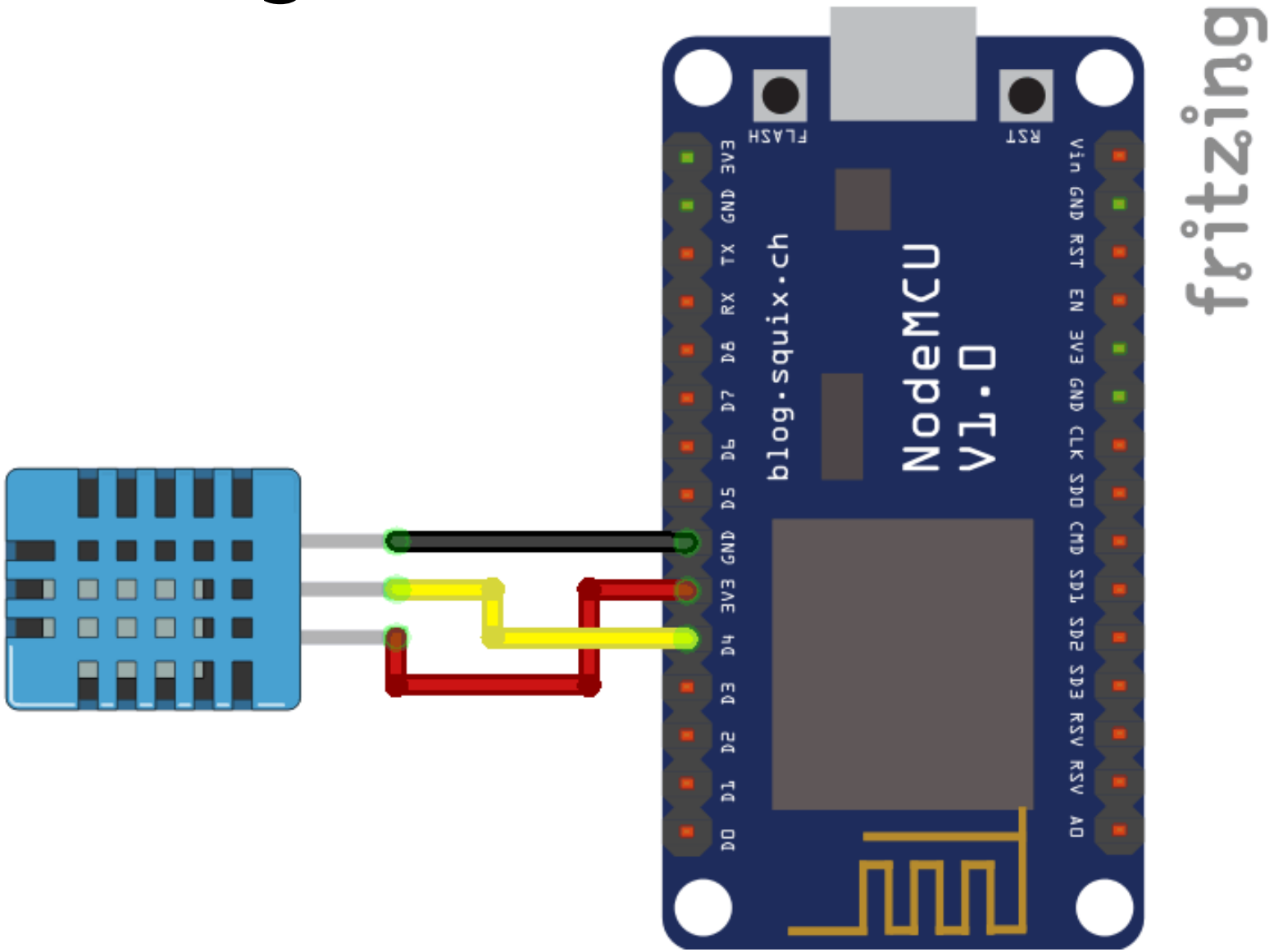
Jump Cables

DHT11 Sensor



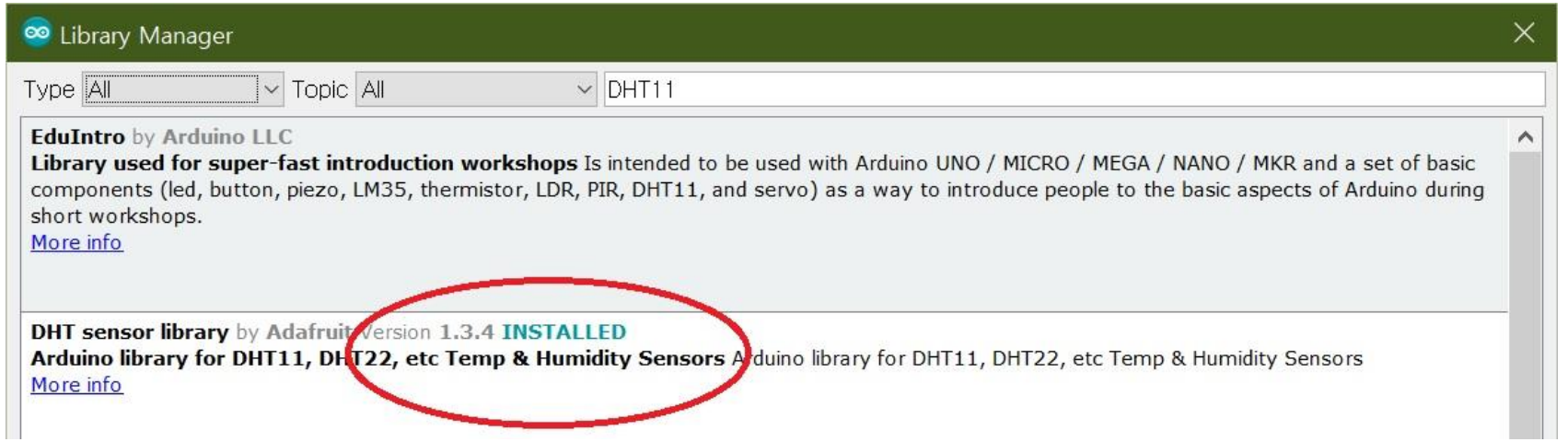
16x2 LCD Module

Circuit Wiring



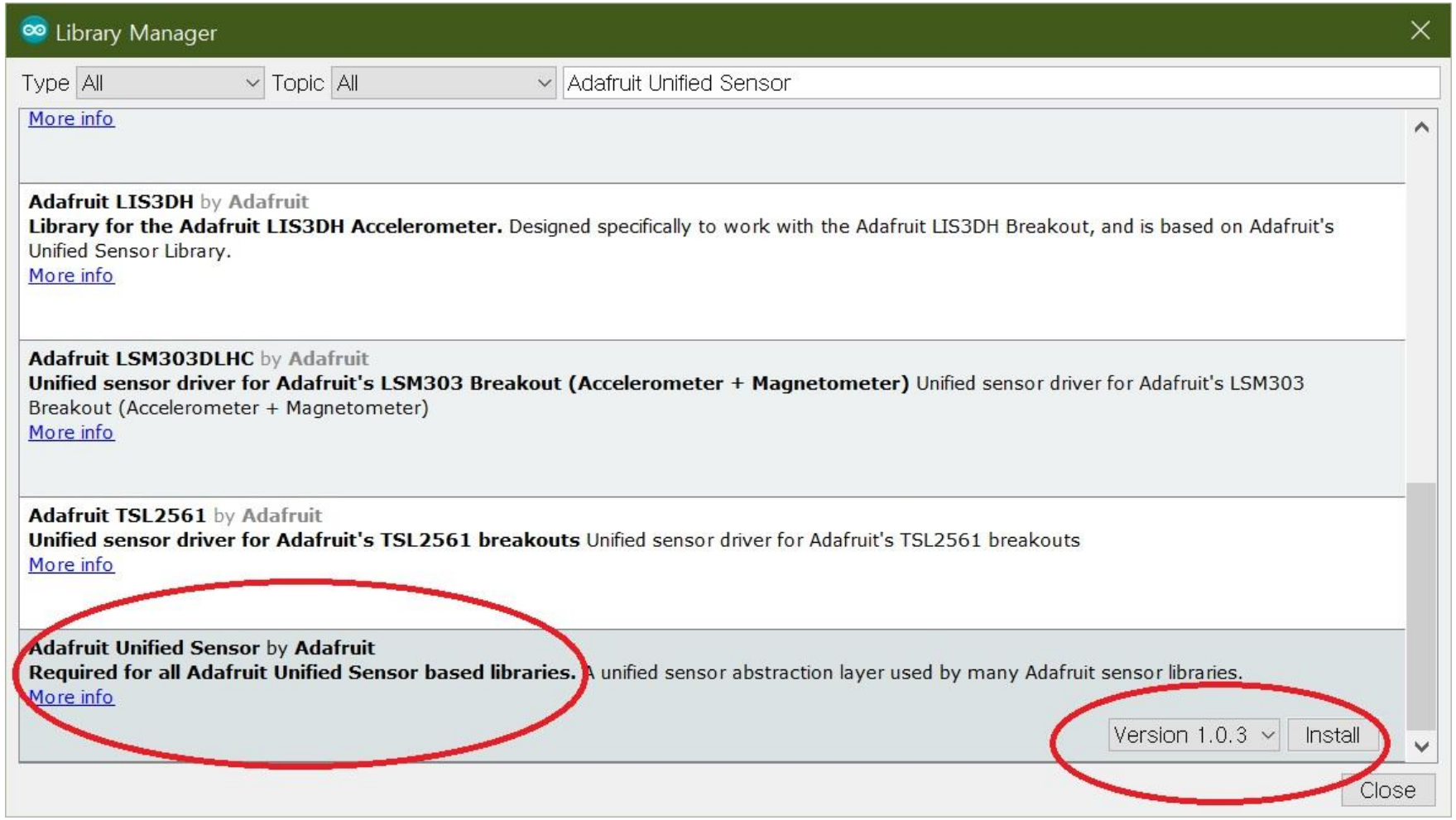
DHT Sensor Library(1)

- Menu -> Sketch -> Include -> Library -> Manage Libraries

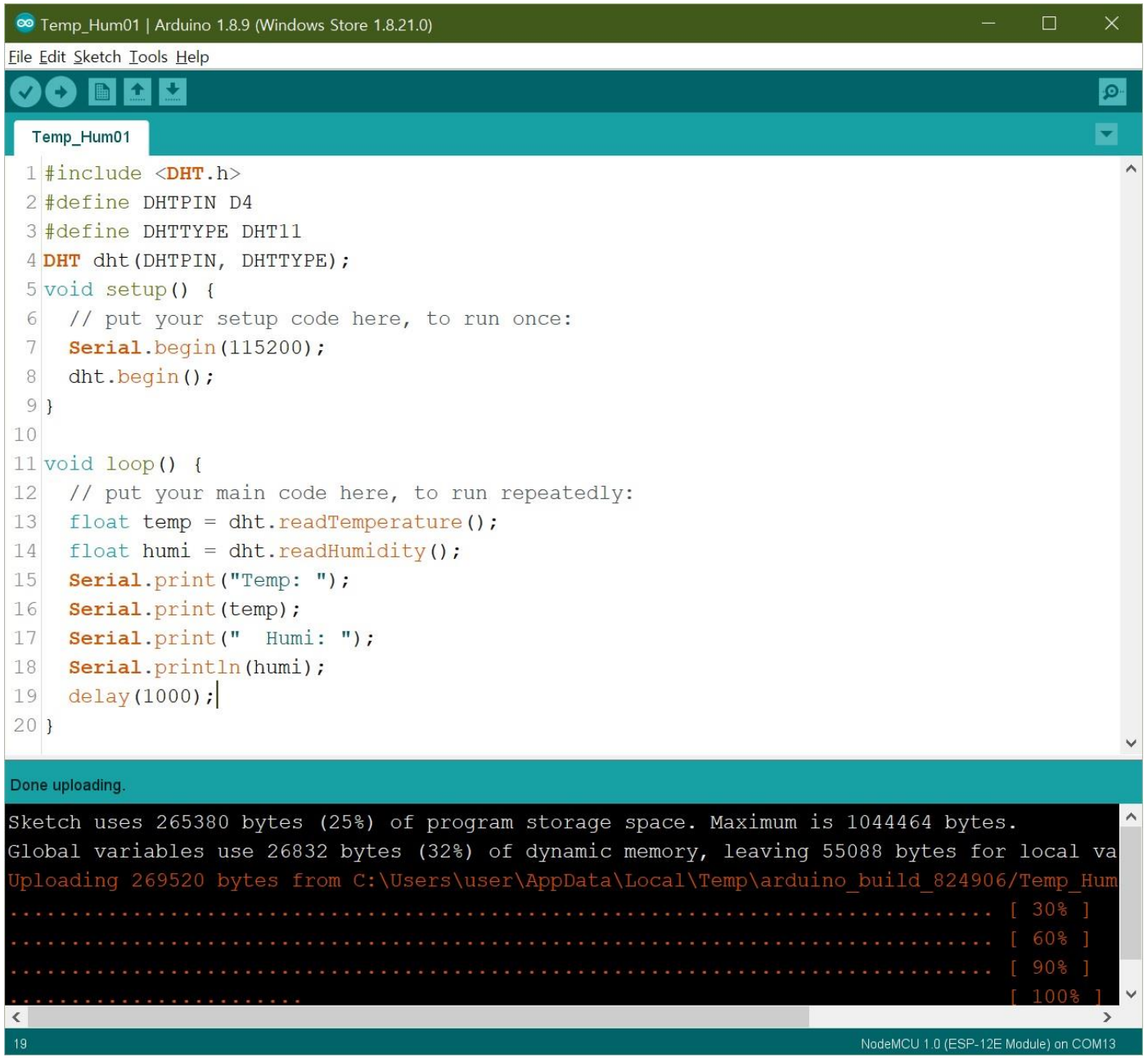


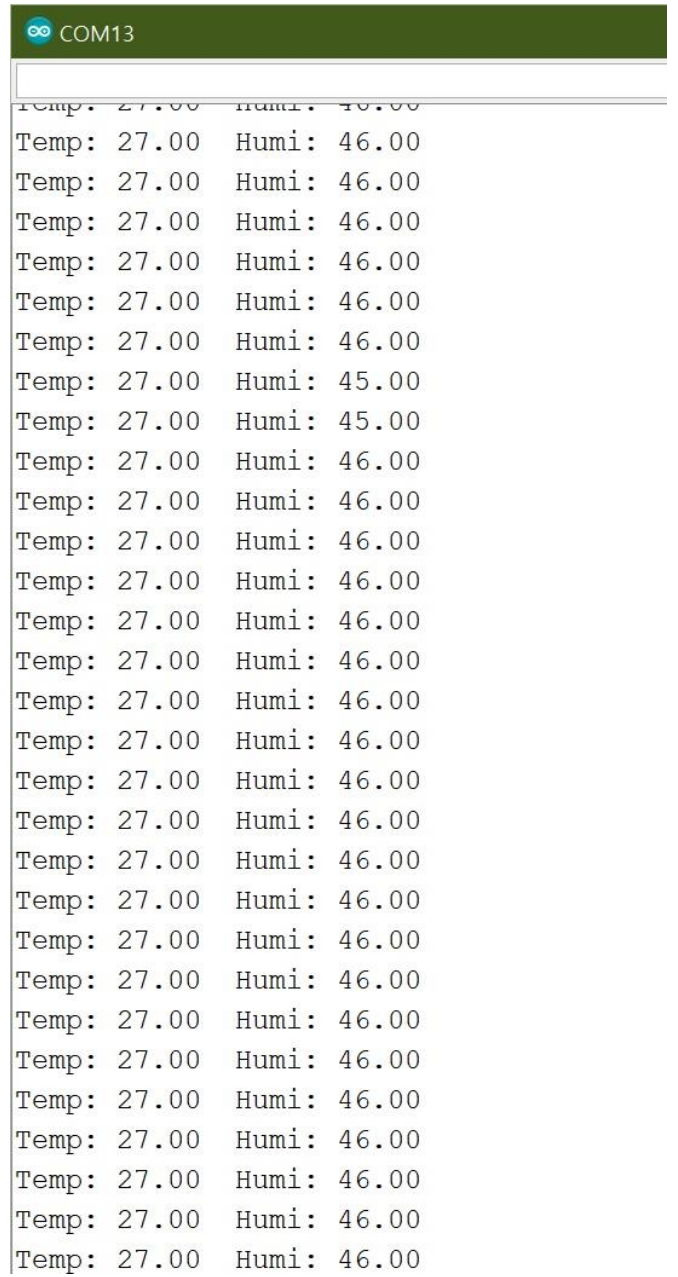
Adafruit Unified Sensor Library(2)

- Menu -> Sketch -> Include -> Library -> Manage Libraries



Sketch


Temp_Hum01 | Arduino 1.8.9 (Windows Store 1.8.21.0)
File Edit Sketch Tools Help
Temp_Hum01
#include <DHT.h>
#define DHTPIN D4
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
void setup() {
// put your setup code here, to run once:
Serial.begin(115200);
dht.begin();
}
void loop() {
// put your main code here, to run repeatedly:
float temp = dht.readTemperature();
float humi = dht.readHumidity();
Serial.print("Temp: ");
Serial.print(temp);
Serial.print(" Humi: ");
Serial.println(humi);
delay(1000);
}
Done uploading.
Sketch uses 265380 bytes (25%) of program storage space. Maximum is 1044464 bytes.
Global variables use 26832 bytes (32%) of dynamic memory, leaving 55088 bytes for local va
Uploading 269520 bytes from C:\Users\user\AppData\Local\Temp\arduino_build_824906/Temp_Hum
[30%]
[60%]
[90%]
[100%]
19
NodeMCU 1.0 (ESP-12E Module) on COM13


COM13
Temp: 27.00 Humi: 46.00
Temp: 27.00 Humi: 46.00
Temp: 27.00 Humi: 46.00
Temp: 27.00 Humi: 46.00
Temp: 27.00 Humi: 46.00
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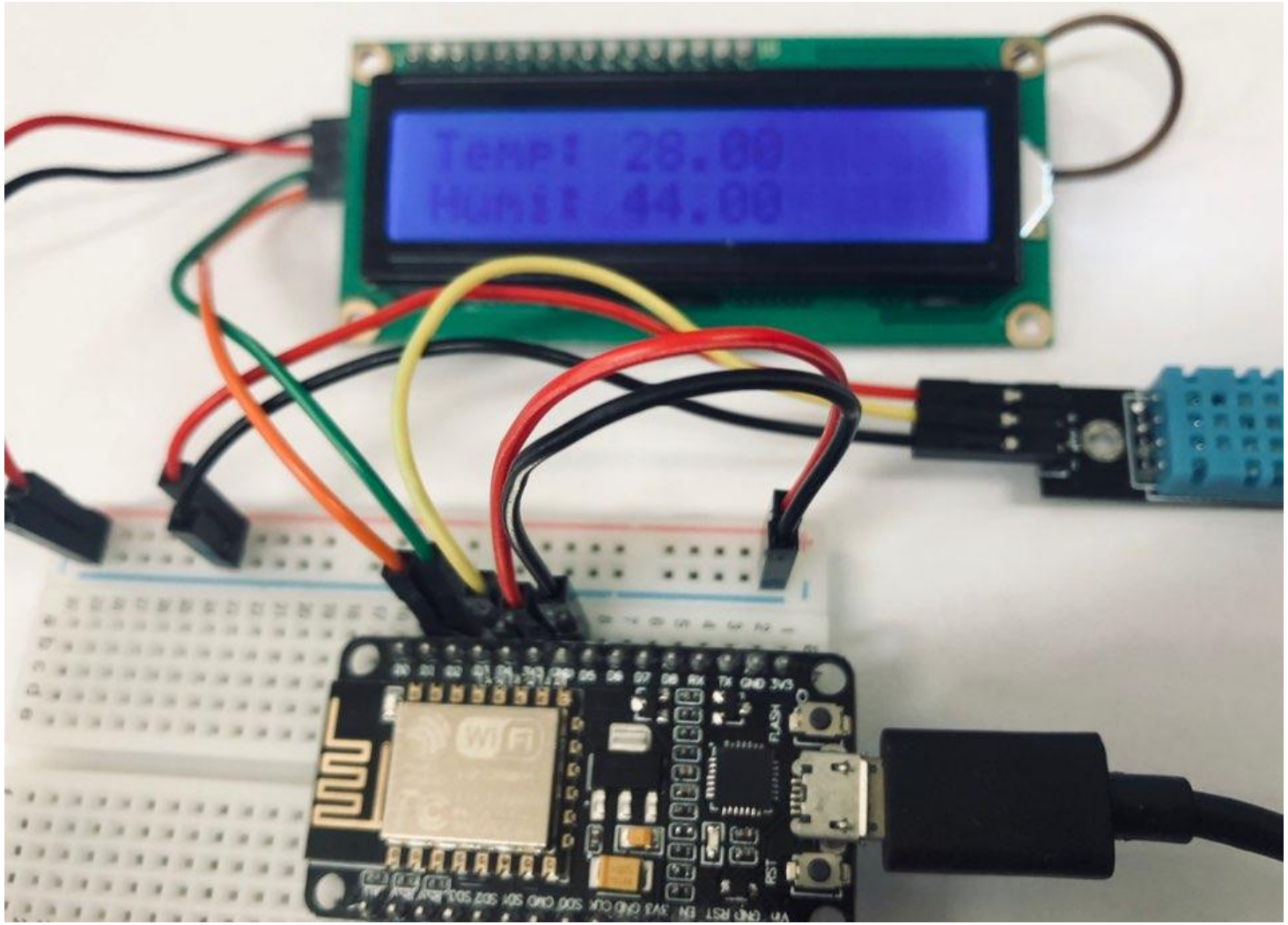
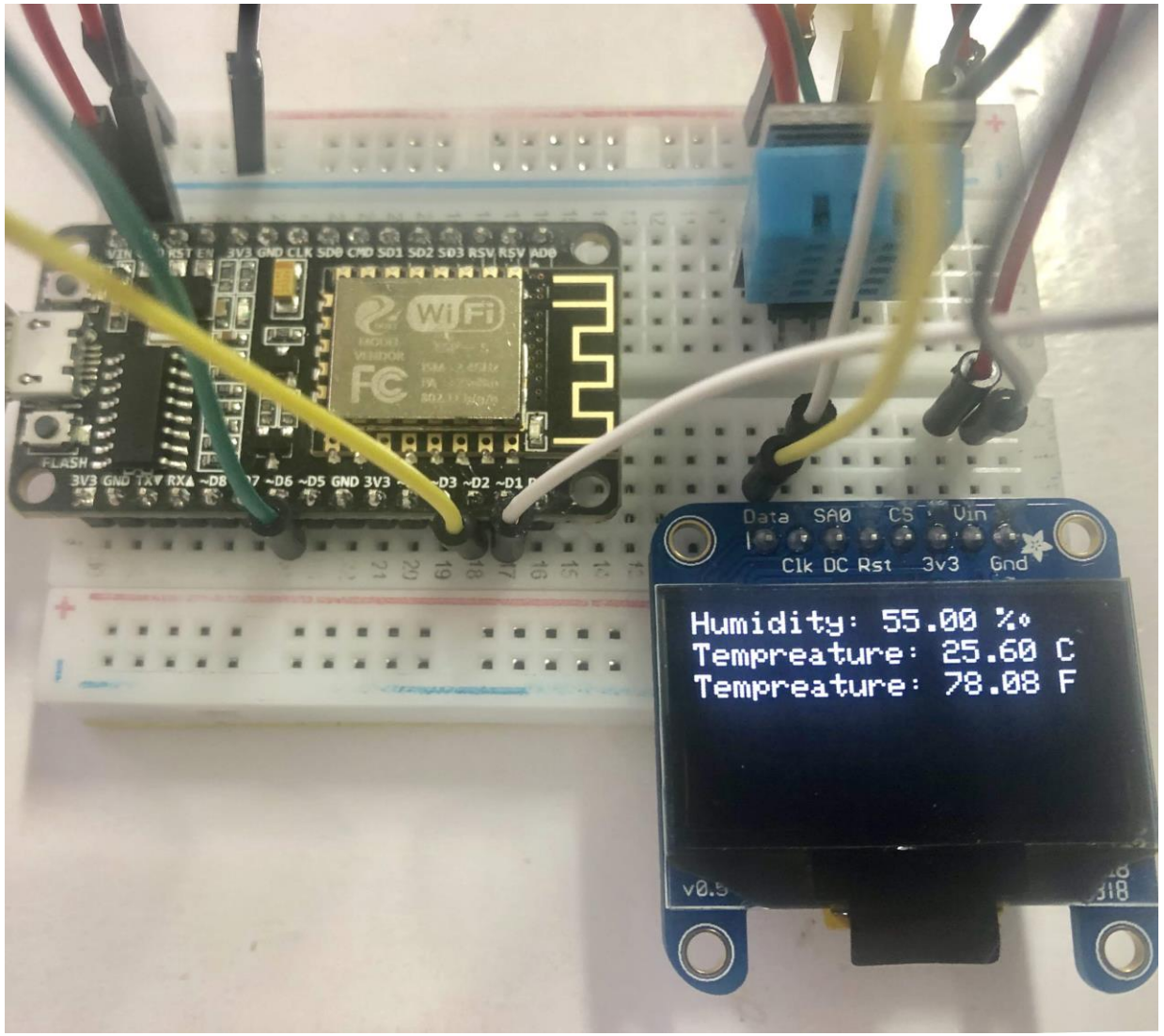
16x2 I2C LCD Display



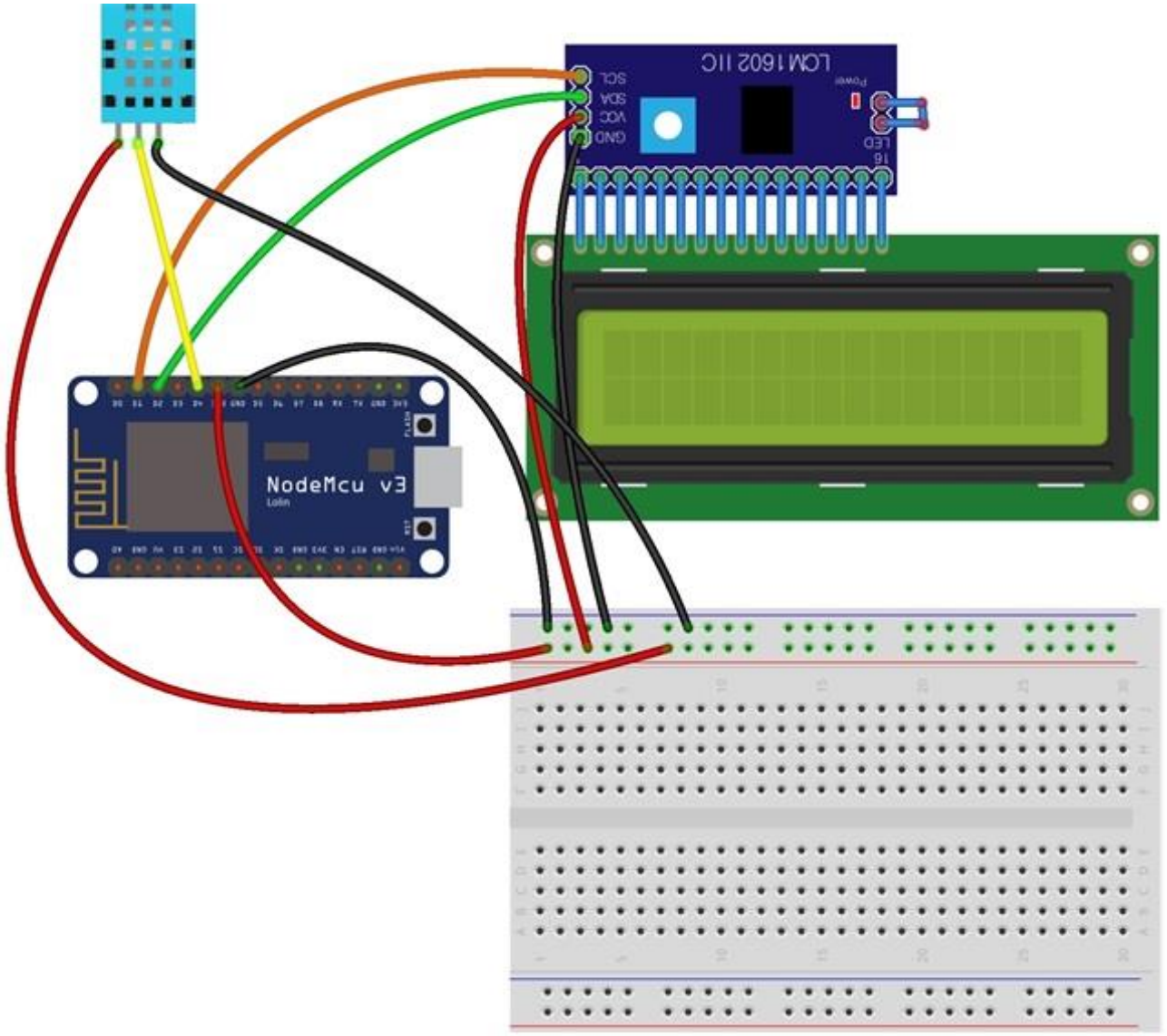
OLED Display



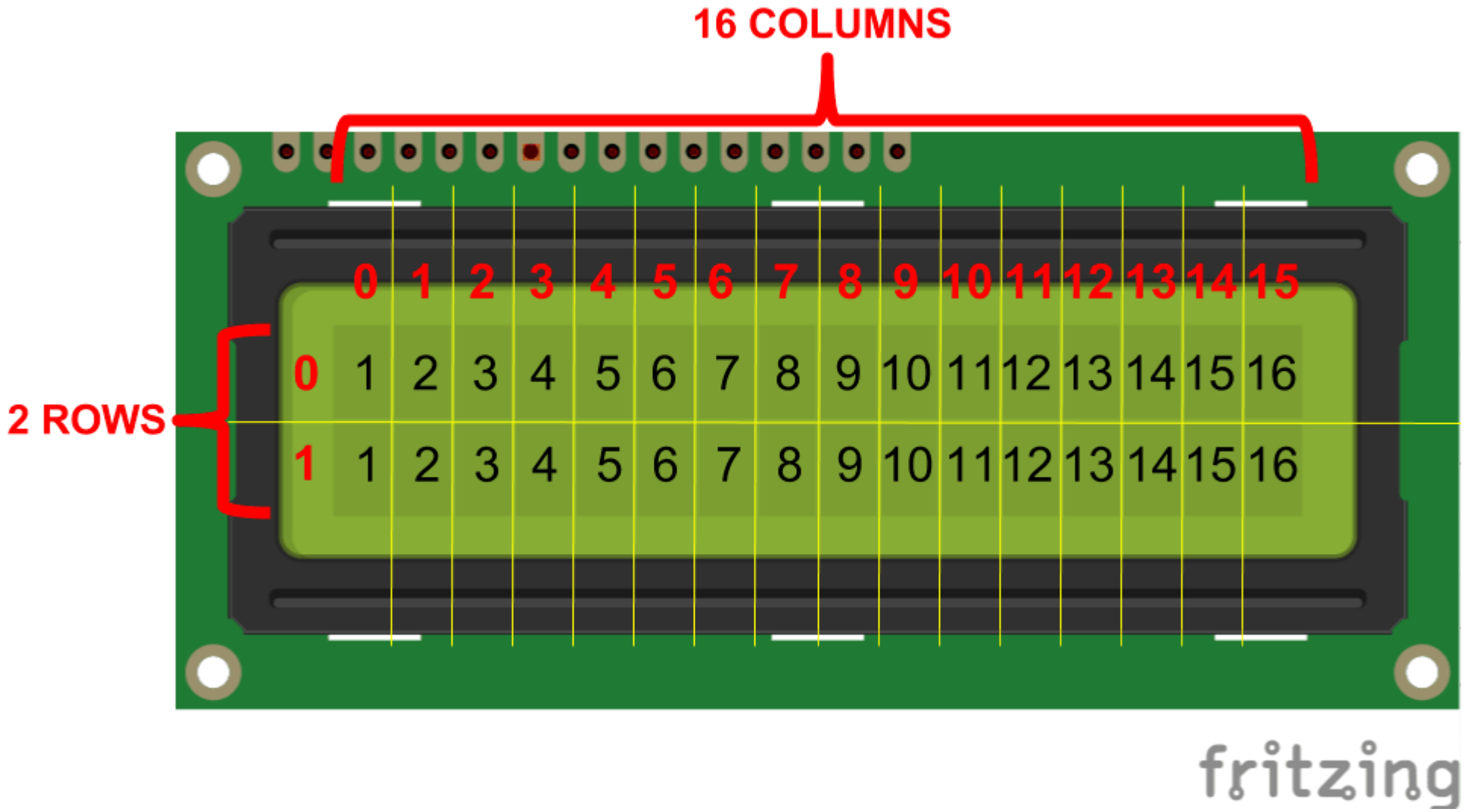
LCD I2C Pin connection

LCD	NodeMCU
GND	GND
VCC	3.3V
SDA	D2
SCL	D1

Circuit Wiring

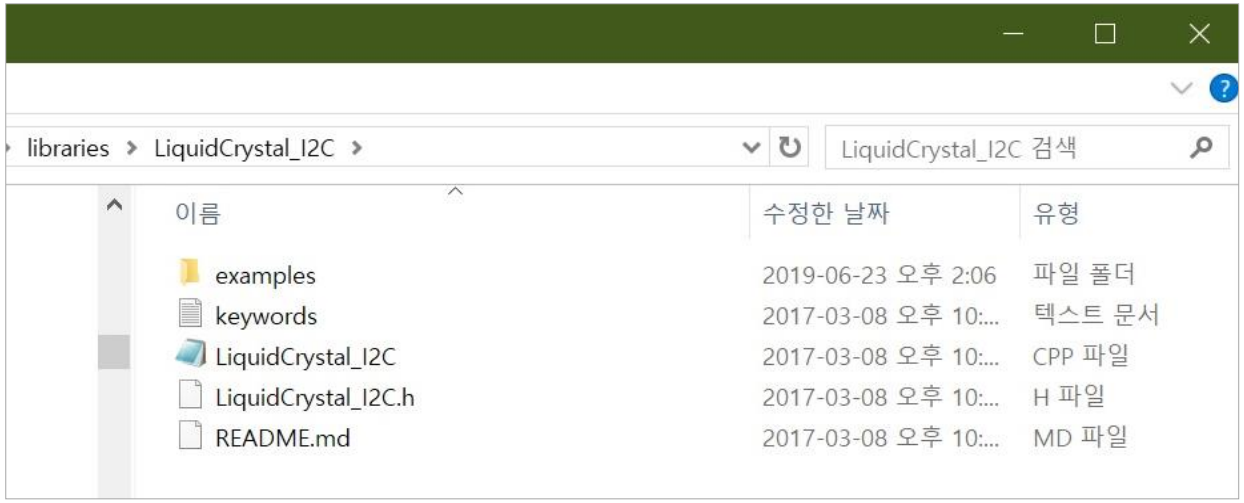


16x2 LCD Cursor Matrix



LiquidCrystal-I2C-library

- Create a new folder called "LiquidCrystal_I2C" under the folder named "libraries" in your Arduino sketchbook folder.
- Create the folder "libraries" in case it does not exist yet. Place all the files in the "LiquidCrystal_I2C" folder.
  - https://github.com/fdebrabander/Arduino-LiquidCrystal-I2C-library



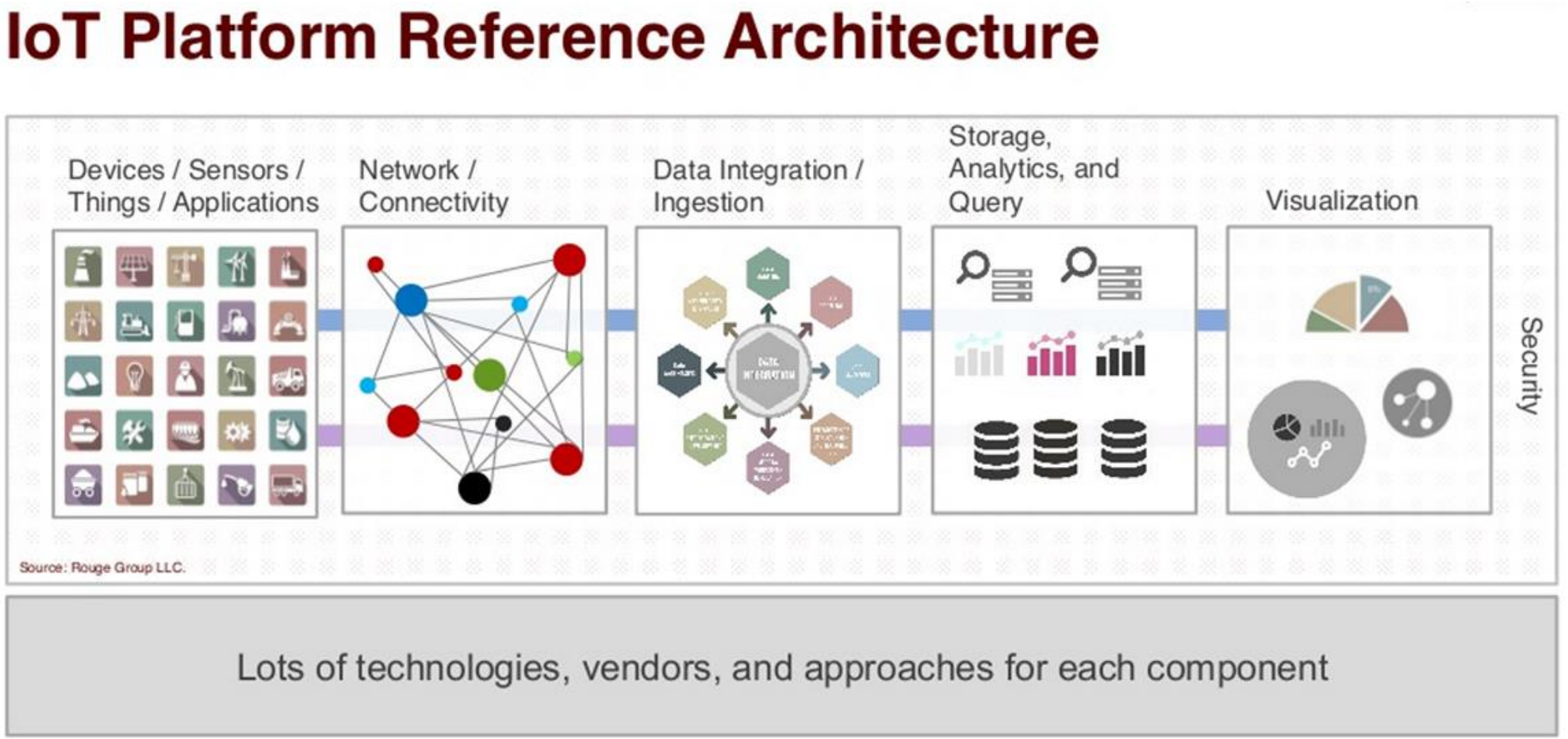
Sketch

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <DHT.h>
#define DHTPIN D4
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
LiquidCrystal_I2C lcd(0x27,16,2);

void setup() {
  Serial.begin(115200);
  dht.begin();

  // lcd init
  lcd.begin();
  // lcd back light on
  lcd.backlight();
  //lcd.print("Test");
}
```

```
void loop() {
  float temp = dht.readTemperature();
  float humi = dht.readHumidity();
  Serial.print("Temp: ");
  Serial.print(temp);
  Serial.print("  Humi: ");
  Serial.println(humi);

  // LCD Display
  // LCD Cursor change to (0,0)
  lcd.setCursor(0,0);
  lcd.print("Temp: ");
  lcd.print(temp);

  // LCD Cursor change to (0,1)
  lcd.setCursor(0,1);
  lcd.print("Humi: ");
  lcd.print(humi);

  delay(1000);
}
```

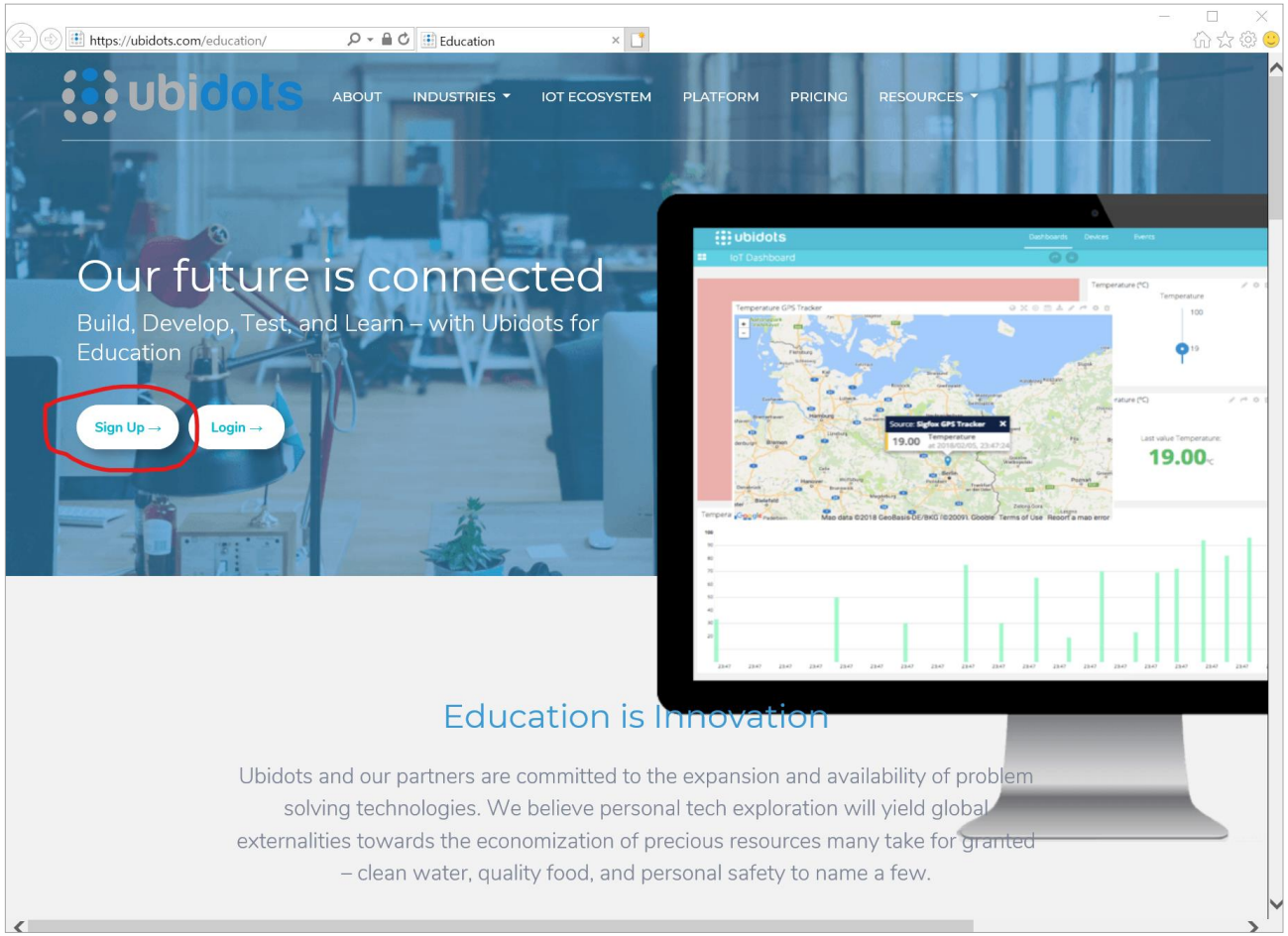
IoT Cloud Platform Landscape

- https://www.postscapes.com/internet-of-things-platforms/



Ubidots : IoT Cloud Platform

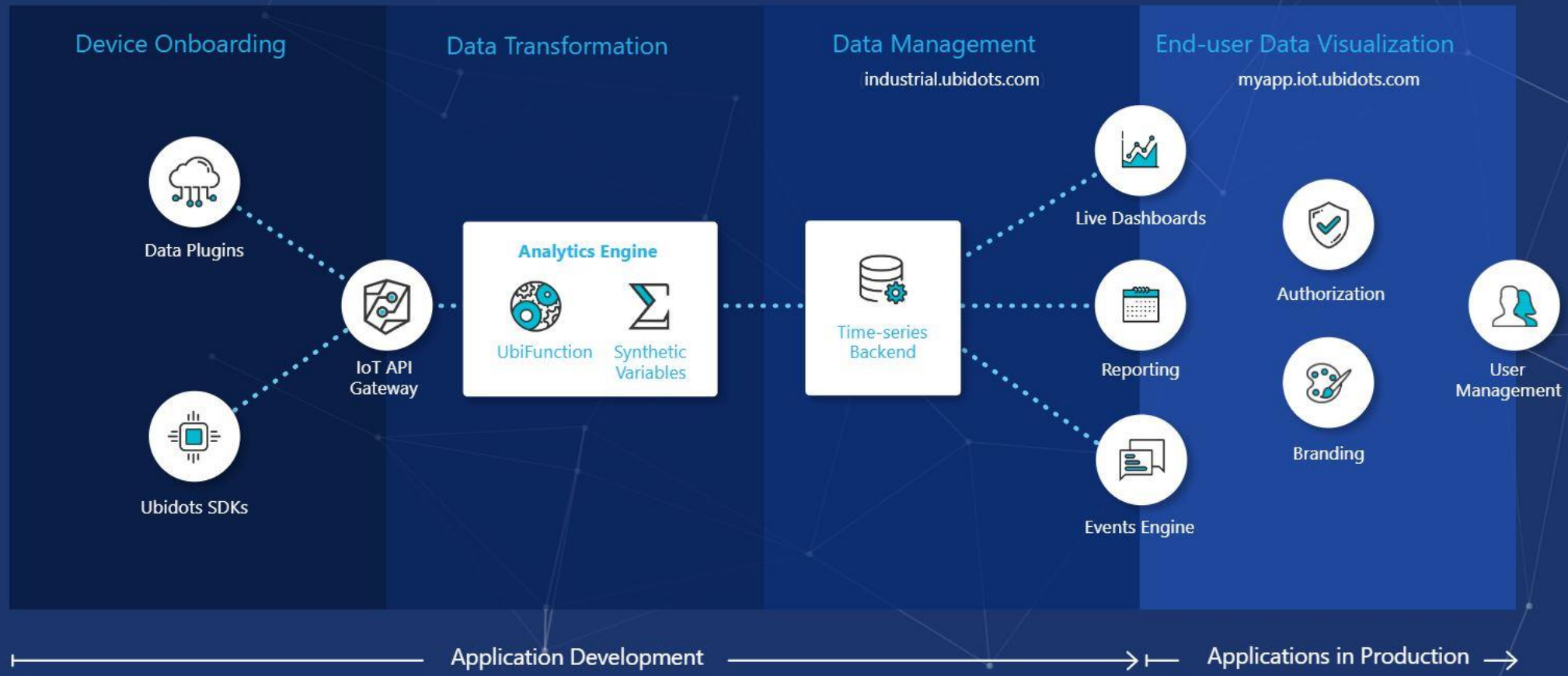
- Ubidots Education : https://ubidots.com/education/
  - Sign Up ->



https://ubidots.com/platform/

IoT and Cloud tools to build your business

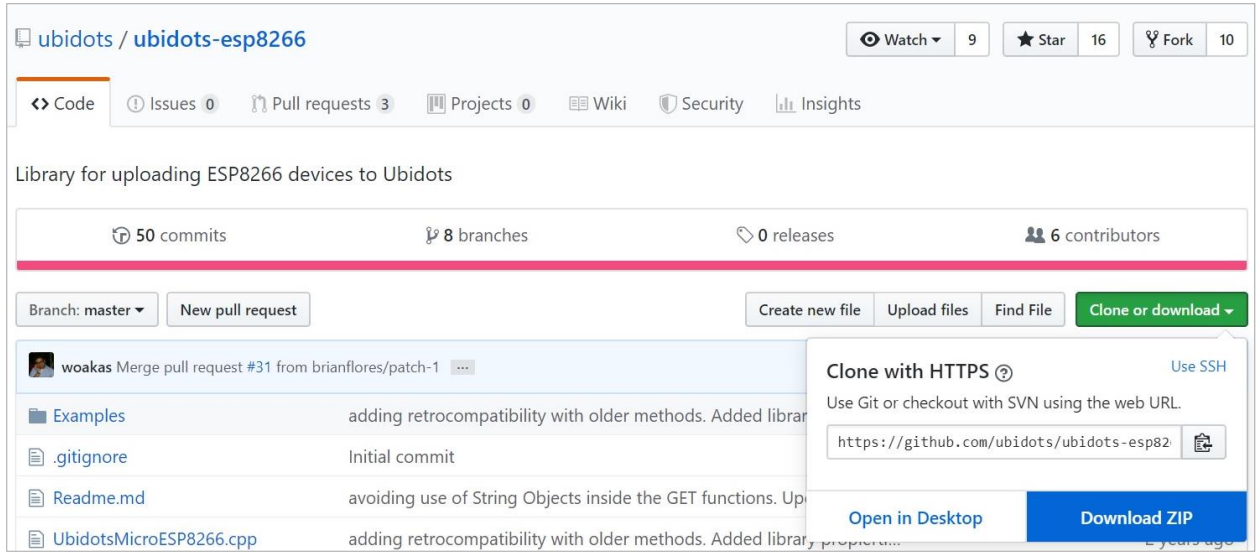
Merge the physical and digital worlds into deployable, end-user ready IoT Applications that deliver insights and solve problems.

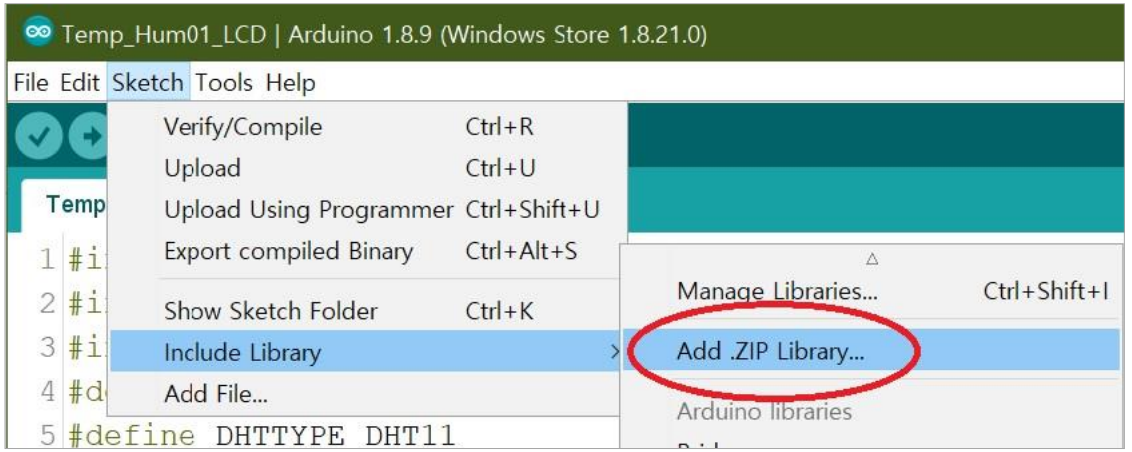


Lab 01 : IoT based Real Time Humidity/ Temperature Monitor

Ubidots Library(1)

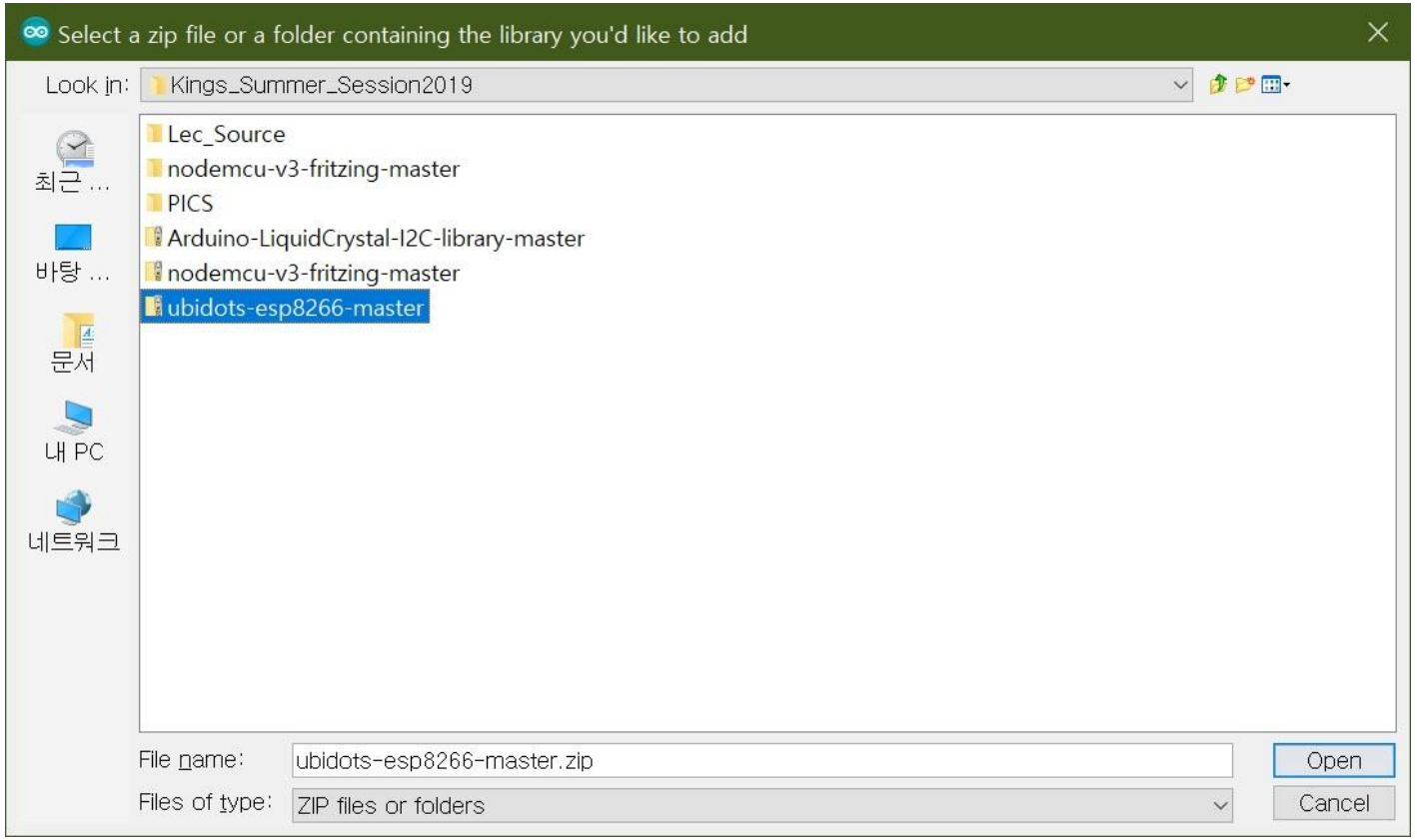
- Download the UbidotsMicroESP8266 library
  - https://github.com/ubidots/ubidots-esp8266
- Select Download ZIP file



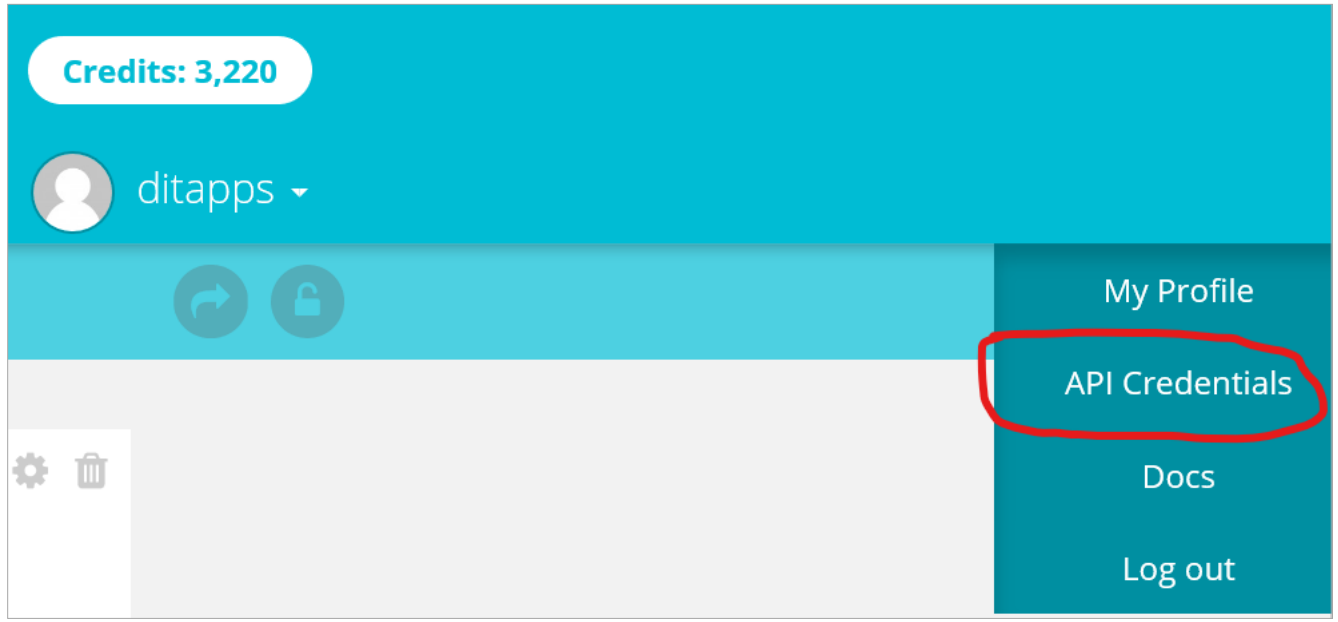


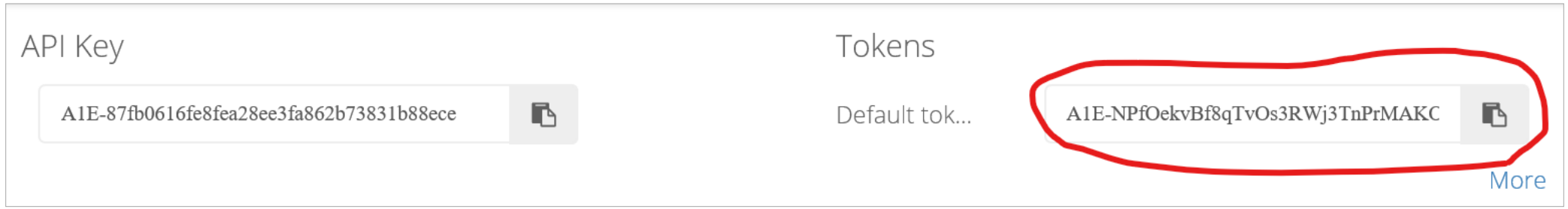
Ubidots Library(2)

- Click on Sketch -> Include Library -> Add .ZIP library
- Select the .ZIP file of UbidotsMicro8266 and the “Accept”
- Close the Ardunio IDE and open it again.



Copy your Ubidots Token





Sending DHT11 Sensor Values to Ubidots Cloud

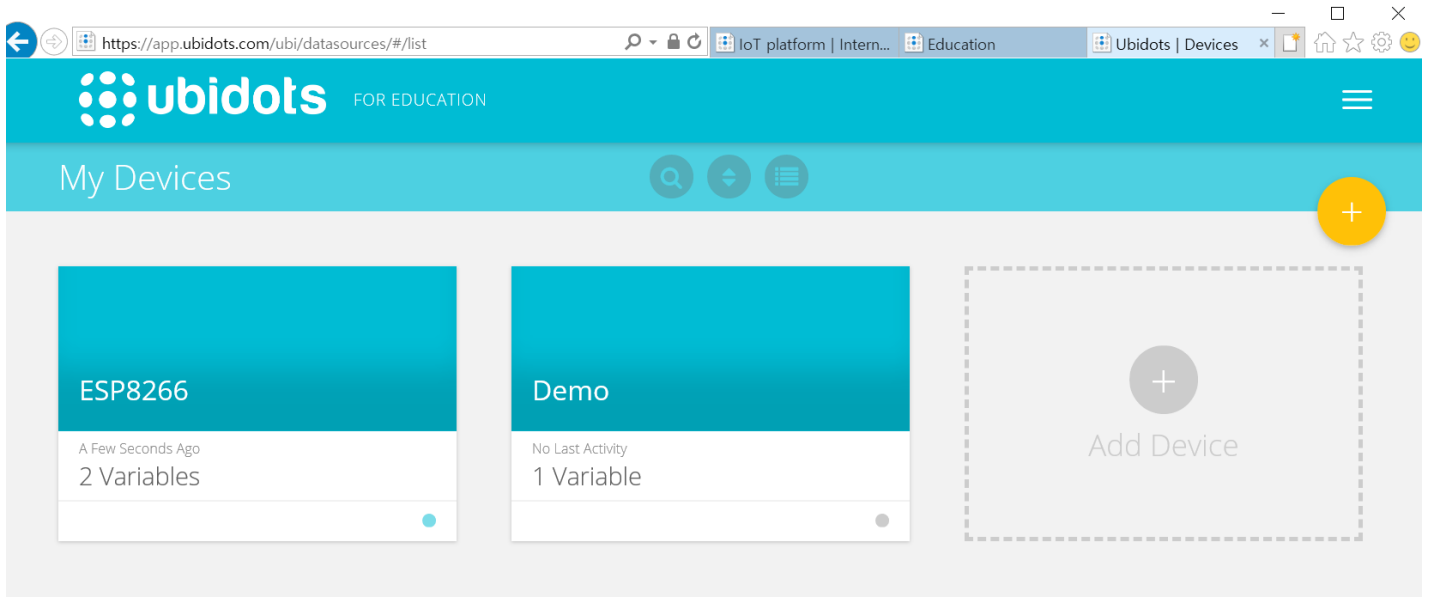
- Input code, upload and execute

```
#include <DHT.h>
#include "UbidotsMicroESP8266.h"
#define TOKEN "xxxxx" // put here your Ubidits token
#define WIFISSID "melon"
#define PASSWORD "deitcs3217"
#define DHTPIN D4
#define DHTTYPE DHT11

DHT dht(DHTPIN, DHTTYPE);

Ubidots client(TOKEN);
void setup() {
  Serial.begin(115200);
  dht.begin();
  client.wifiConnection(WIFISSID, PASSWORD);
}
```

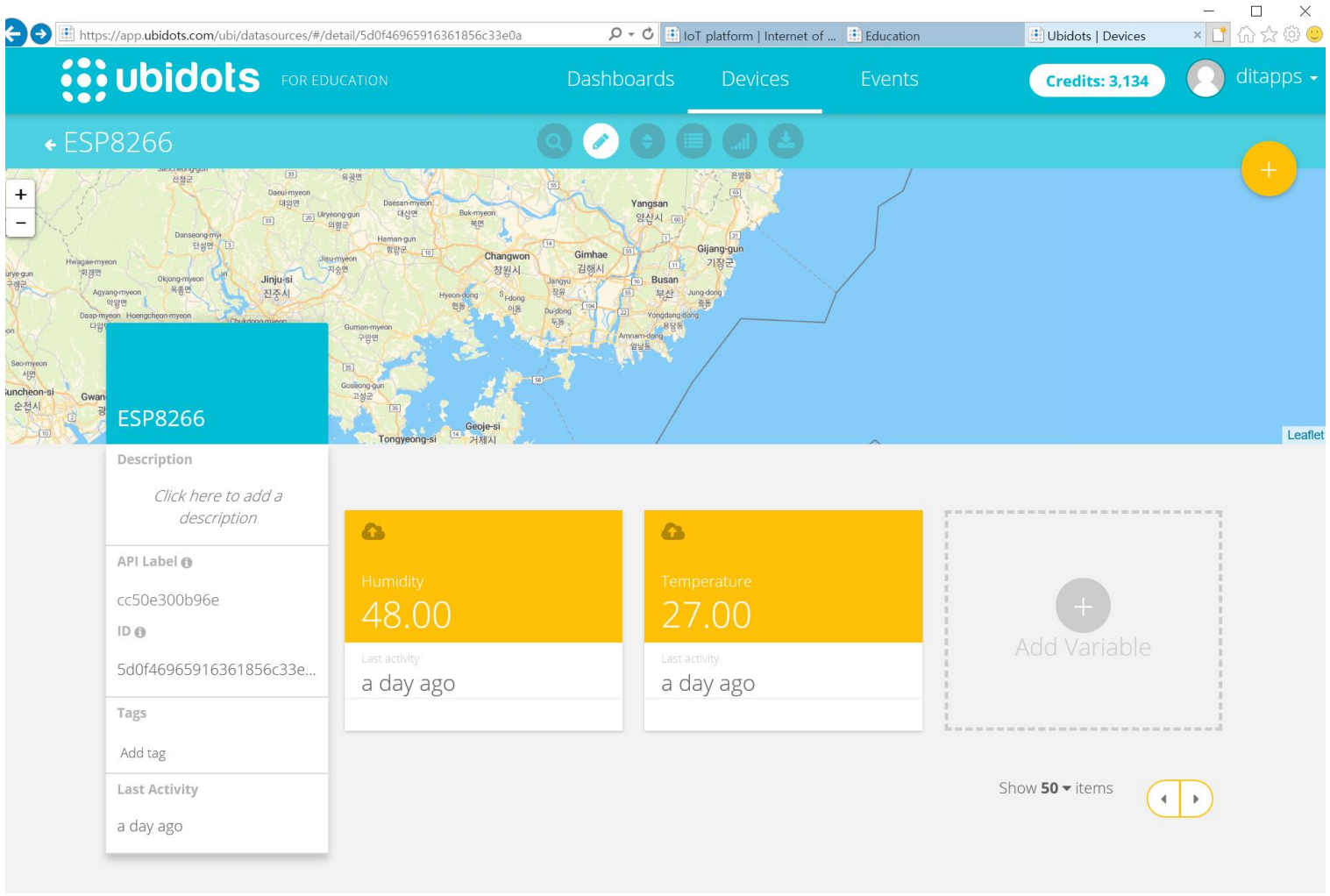
```
void loop() {
  float temp = dht.readTemperature();
  float humi = dht.readHumidity();
  Serial.print("Temp: ");
  Serial.print(temp);
  Serial.print("  Humi: ");
  Serial.println(humi);

  // Temperature, Humidity is variable  labels
  // of Ubidots
  client.add("Temperature", temp);
  client.add("Humidity", humi);
  client.sendAll(true);
  delay(1000);
}
```

Devices Creation : ESP8266

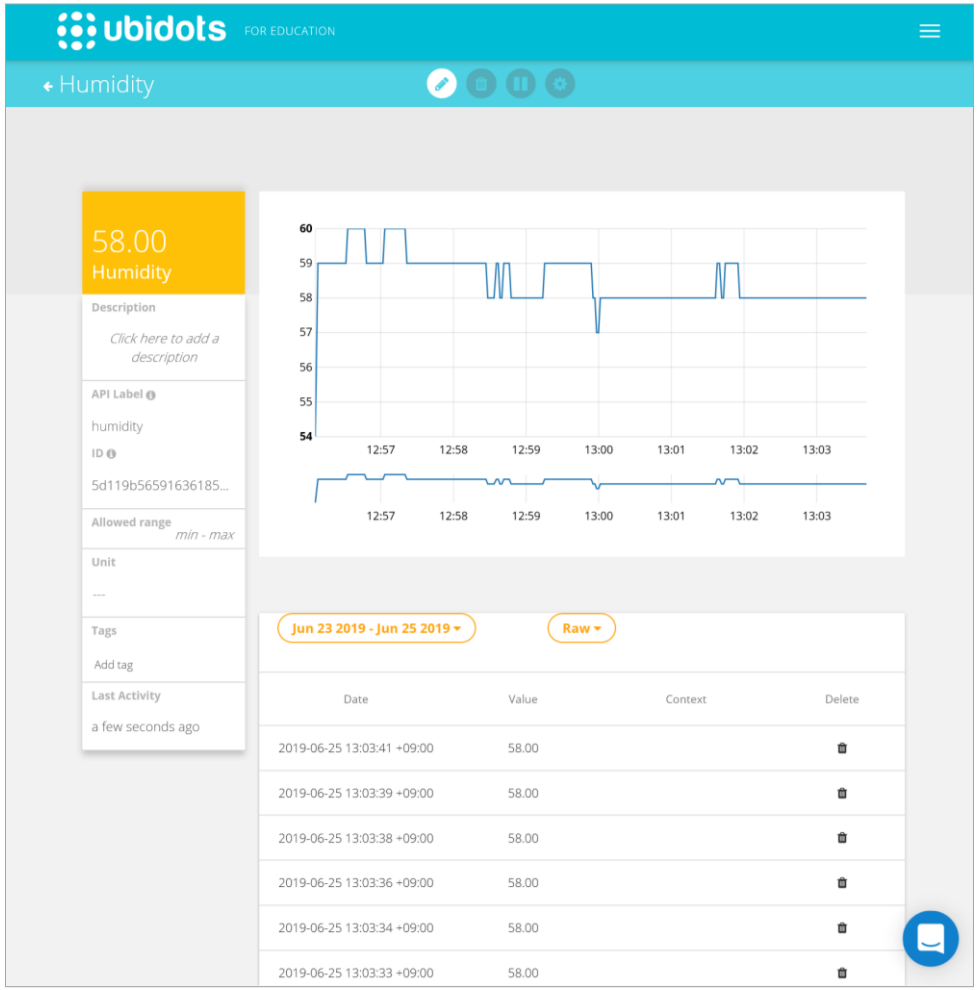
- Wait for the device(ESP8266) to appear

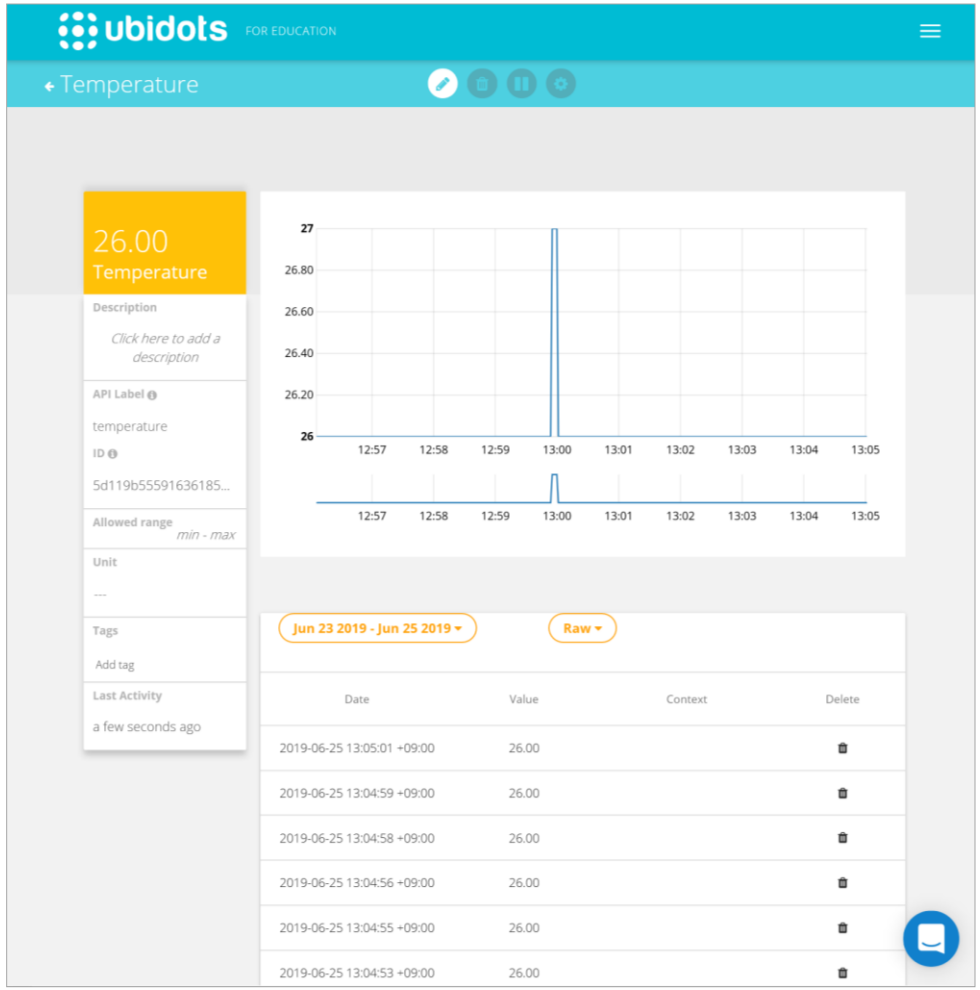


Devices Status(1)

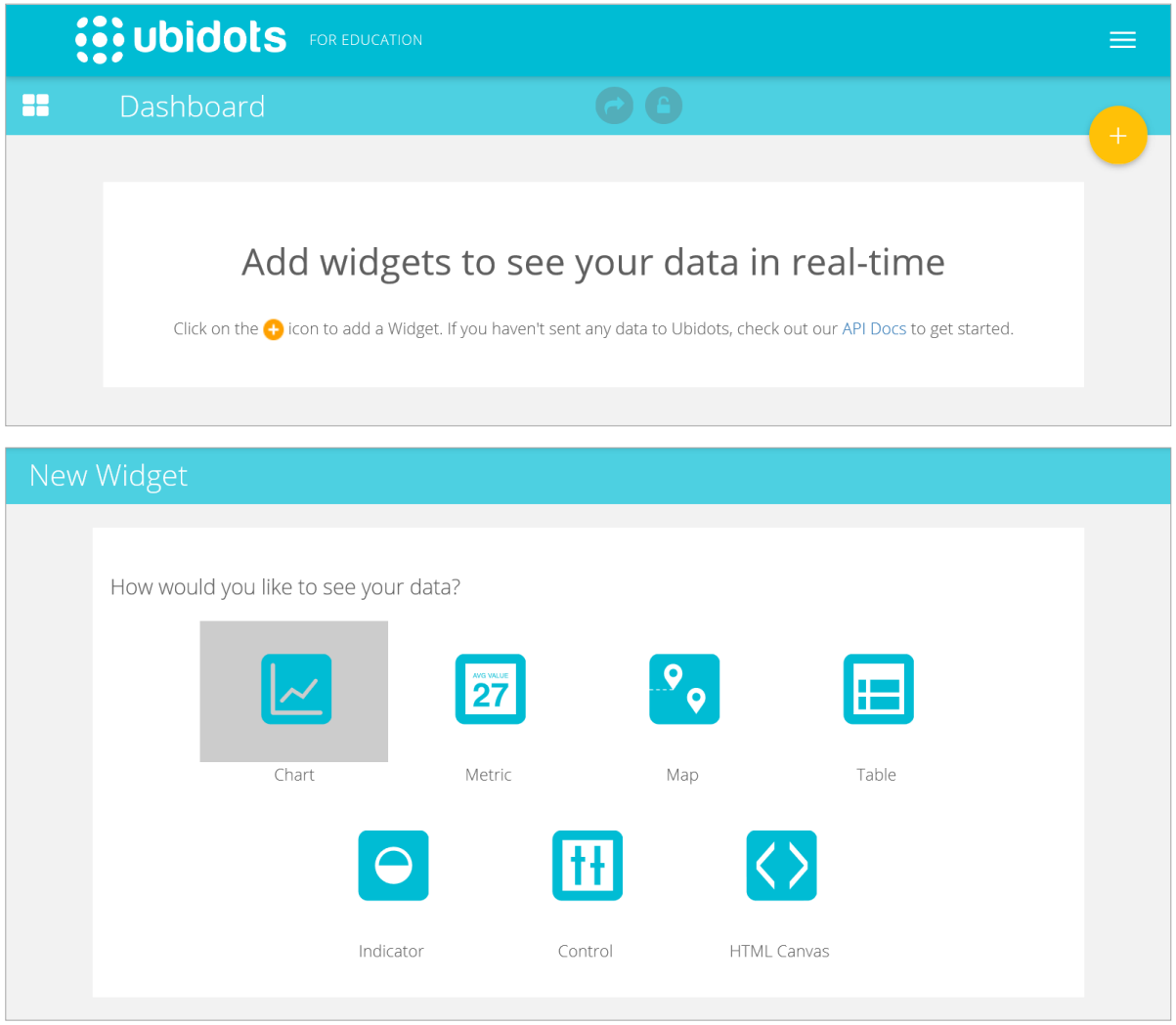


Devices Status(2)

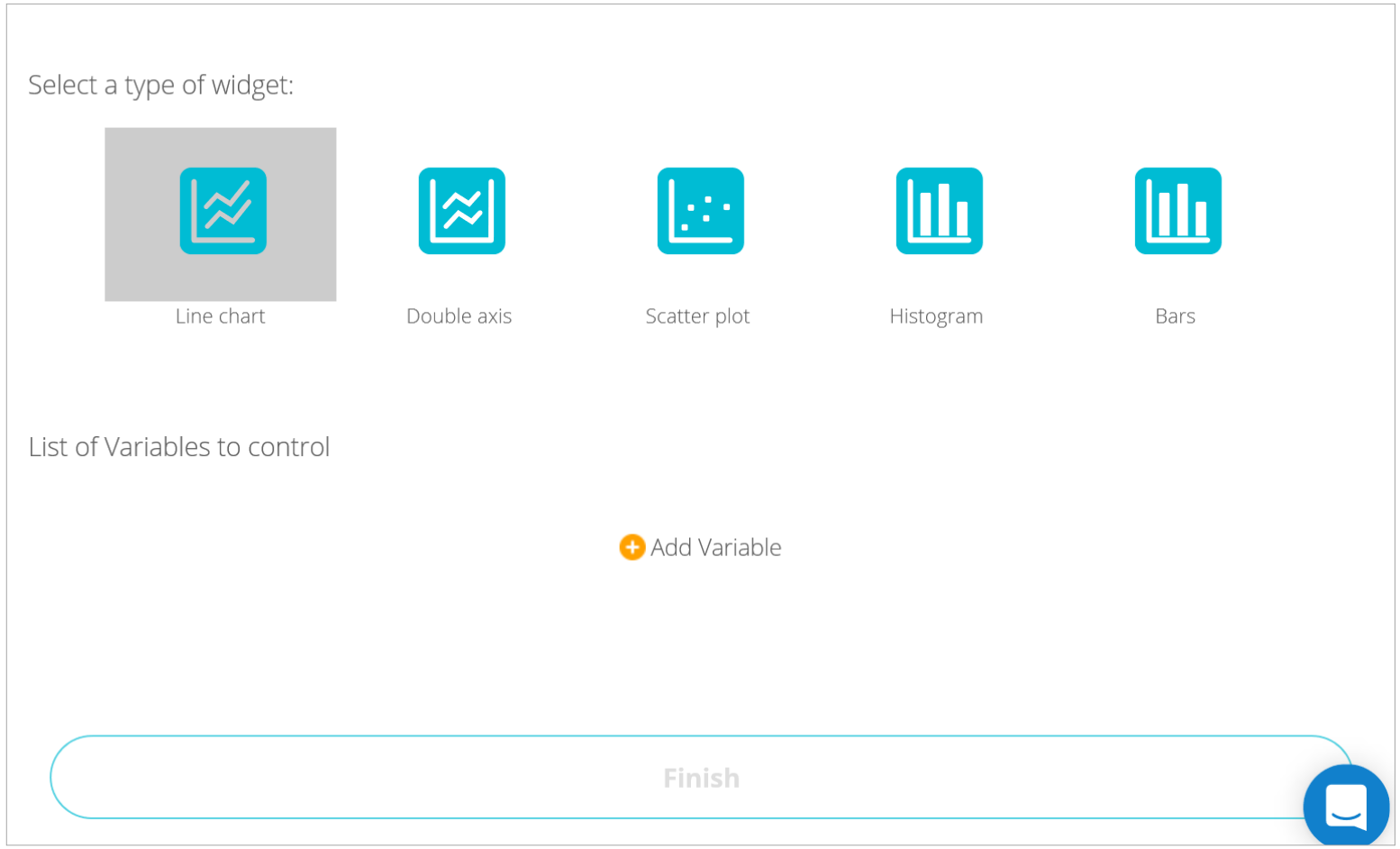




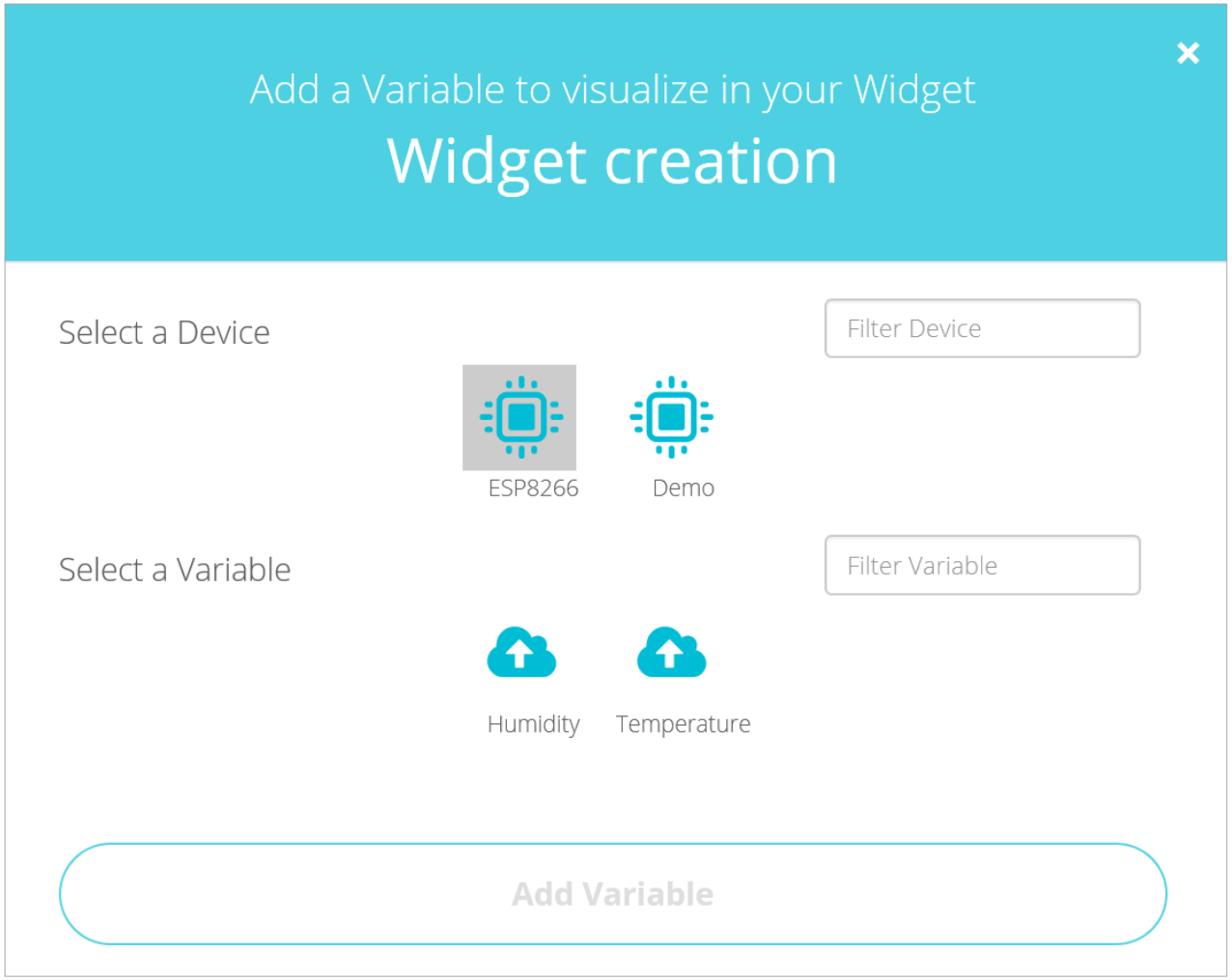
Dashboards Creation : Add new widget



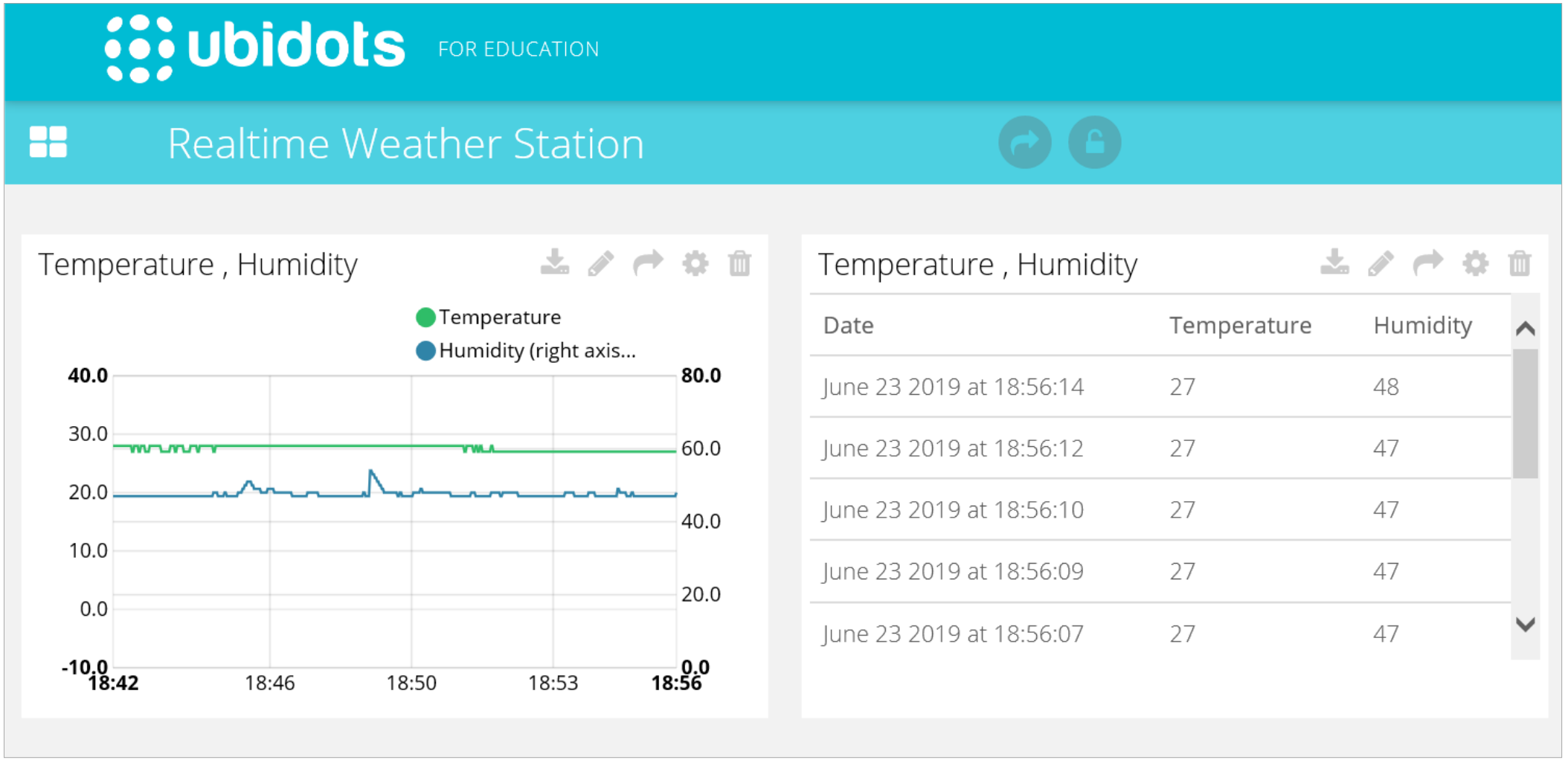
Dashboard Creation : Add Variable



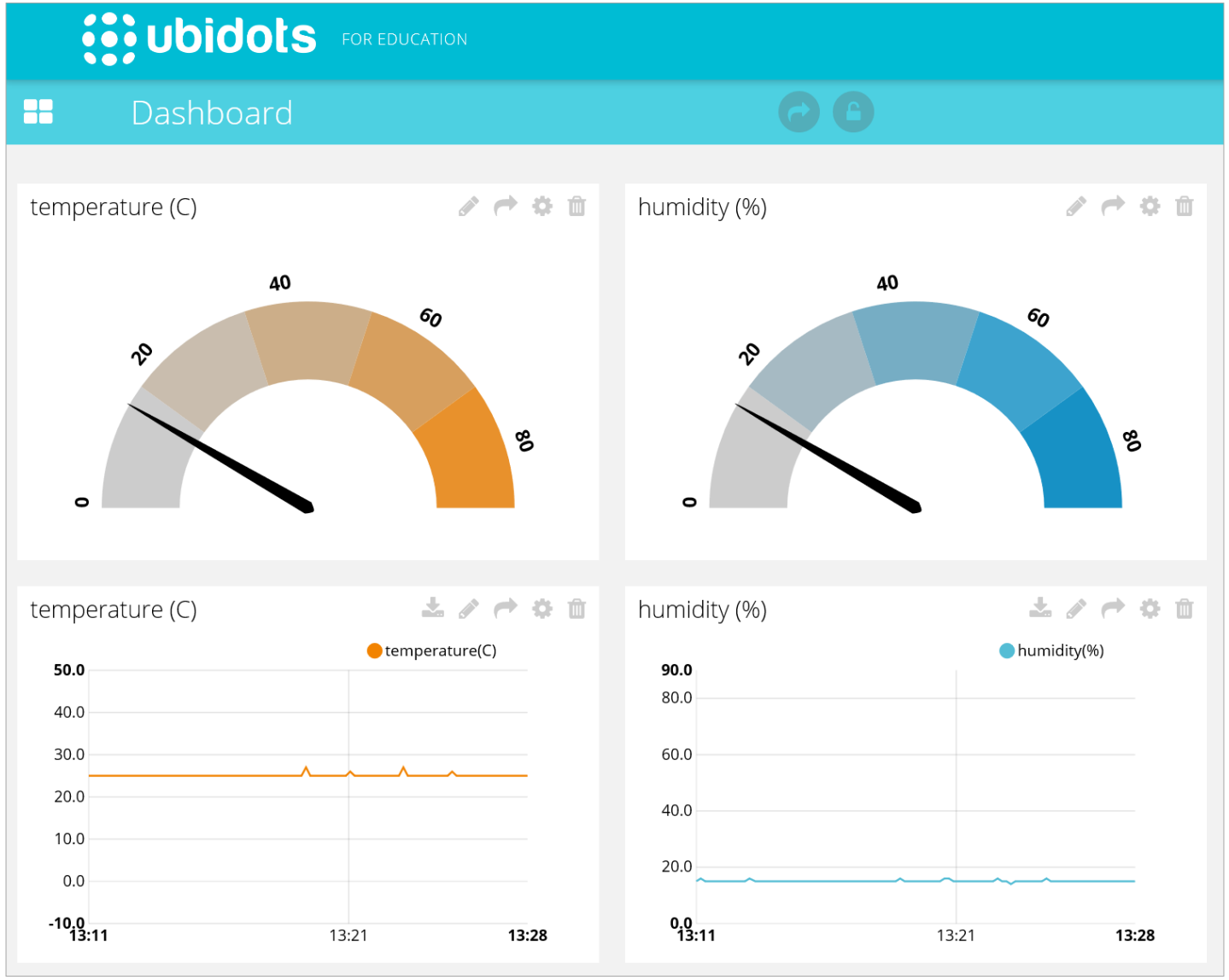
Dashboard Creation: Select a Device, a Varibale



Dashboards : Chart, Table -> Historical Data

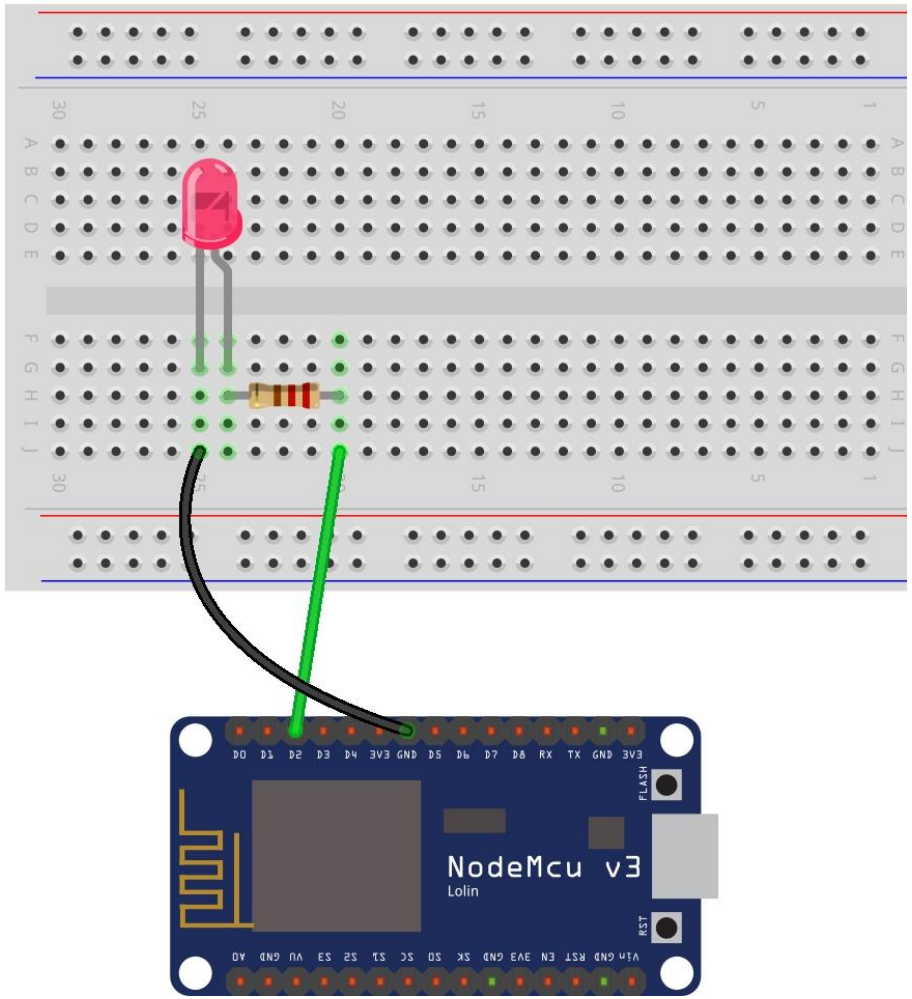


Dashboards : Indicator -> Gauge



Lab 02 : Smart Switch Controller

Circuit Wiring



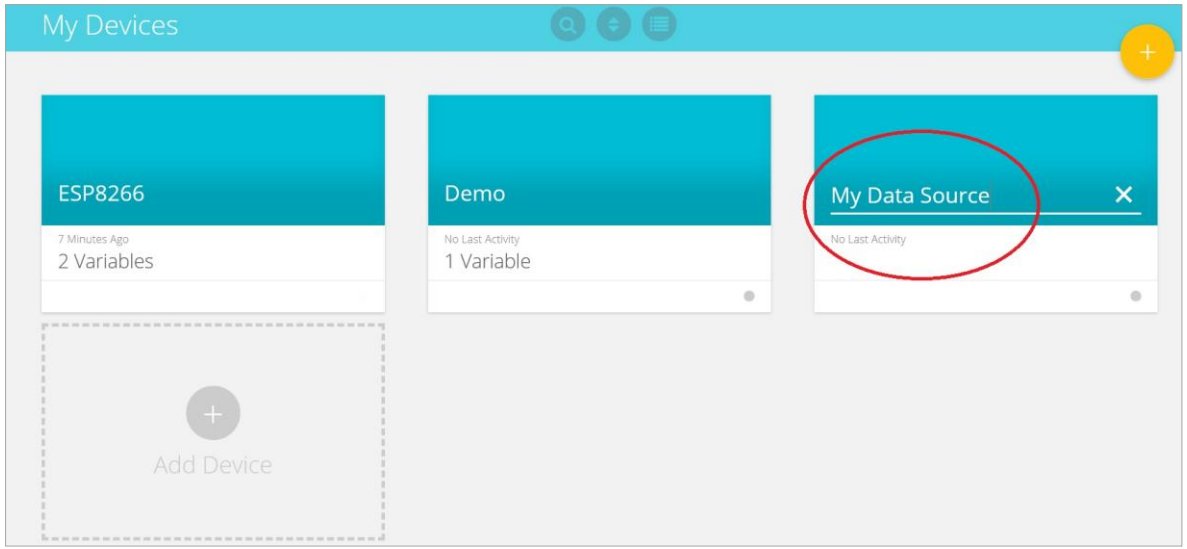
Input Code, upload & Execute

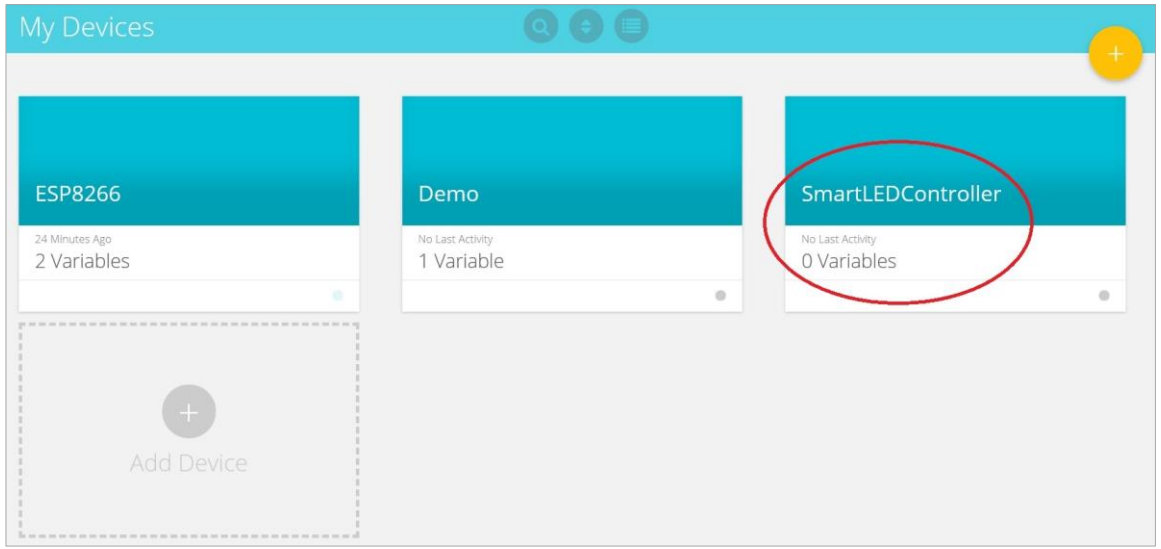
```
#include "UbidotsMicroESP8266.h"

#define DEVICE  "led-control"  // your Ubidots device label

#define VARIABLE  "led-value"  // your Ubidots variable label

 // Put here your Ubidots TOKEN

#define TOKEN  "A1E-btnEp0we6d27oA5sRLjlexPvxL02ro"

#define WIFISSID "melon"

#define PASSWORD "deitcs3217"

#define LED_PIN D2

Ubidots client(TOKEN);

void setup() {

    Serial.begin(115200);

    client.wifiConnection(WIFISSID, PASSWORD);

    pinMode(LED_PIN, OUTPUT);

    digitalWrite(LED_PIN, 1);

}
```

```
void loop() {

    float value = client.getValueWithDevice(DEVICE, VARIABLE);

    if (value != ERROR_VALUE){

      Serial.print("value obtained: ");

      Serial.println(value);

      if(value == 1) digitalWrite(LED_PIN, HIGH);

      else digitalWrite(LED_PIN, LOW);

    }else{

      Serial.println("Error getting value");

    }

    delay(1000);

}
```

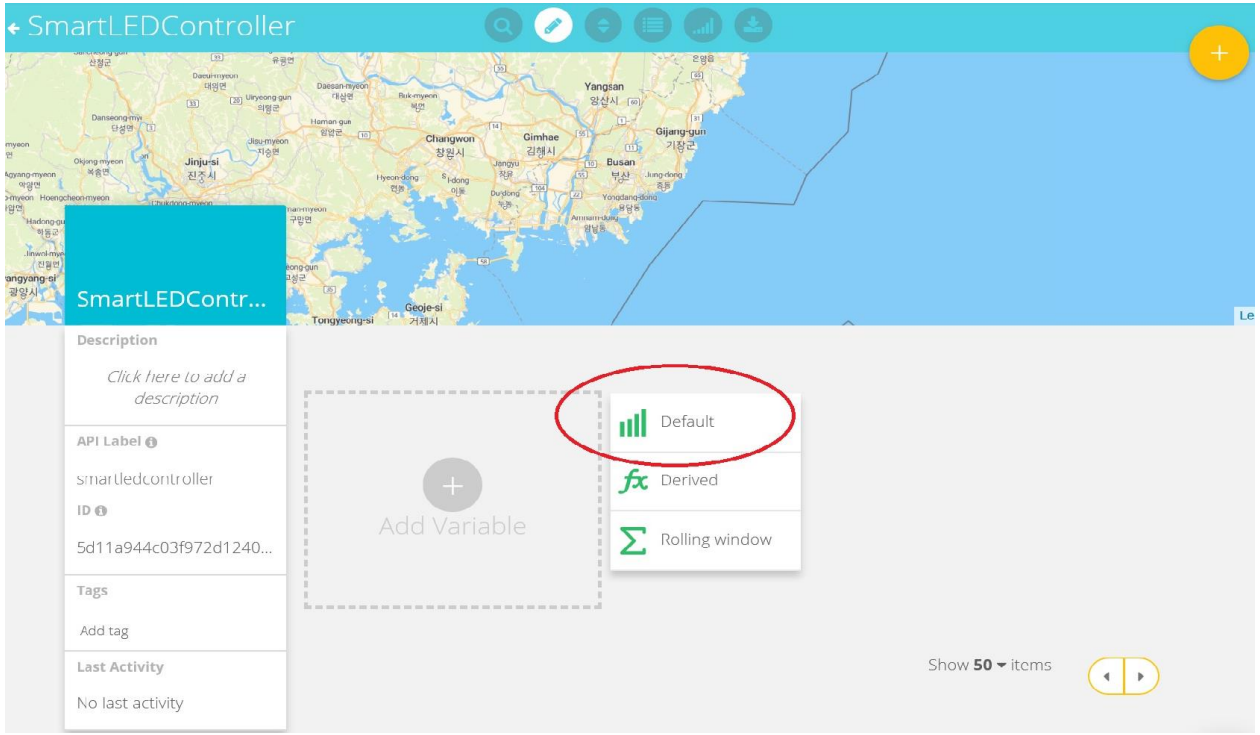
Device Creation

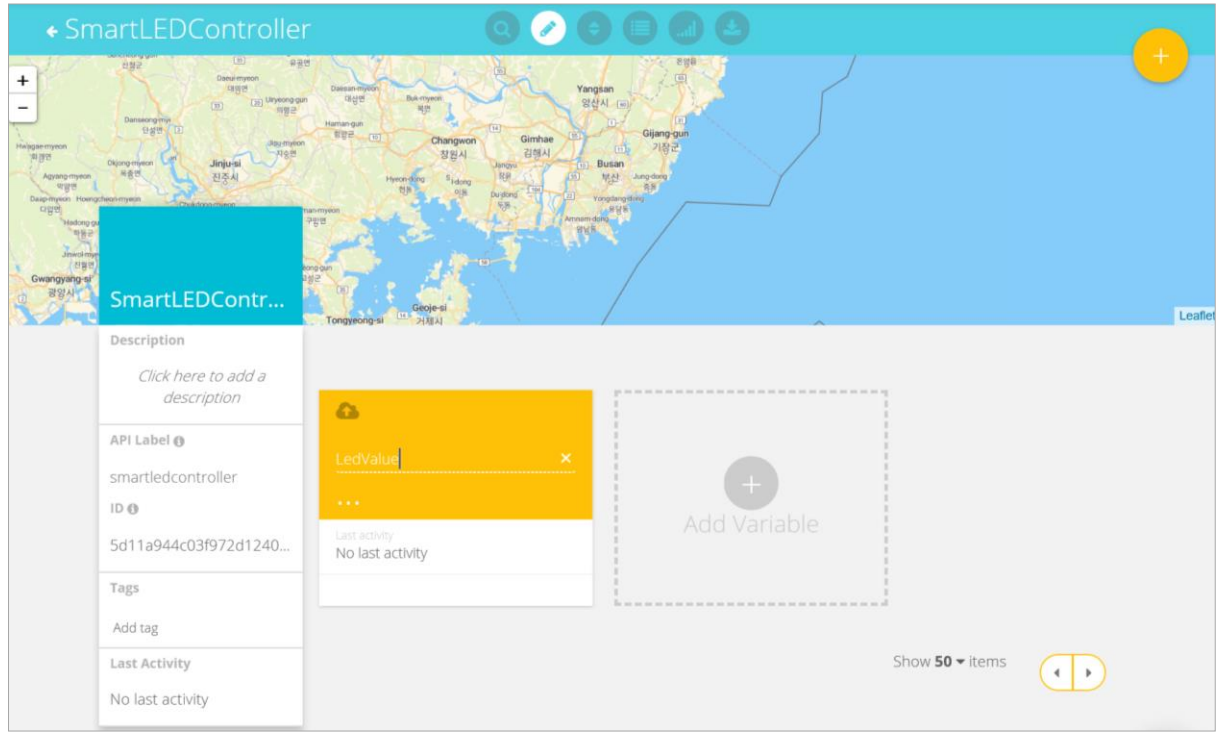
- MyDevices -> My Data Source -> SmartLEDController



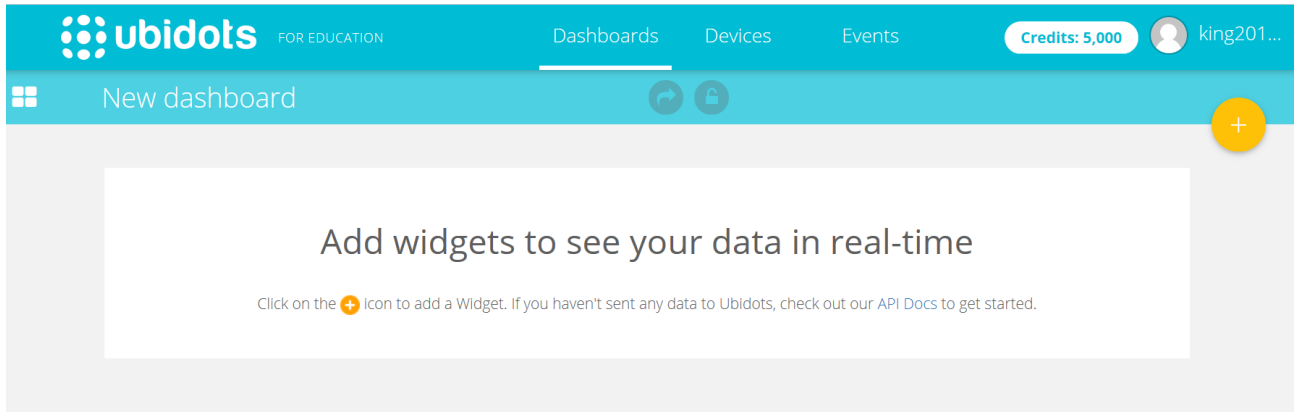


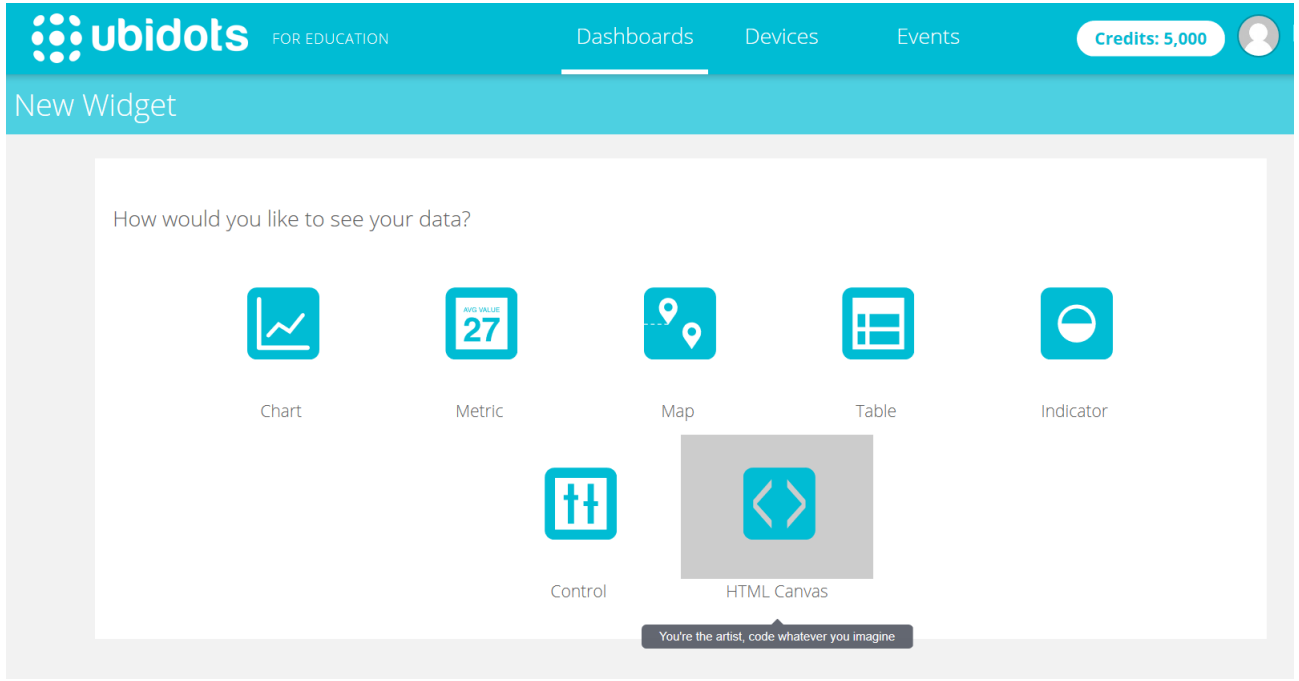
Setting Variables



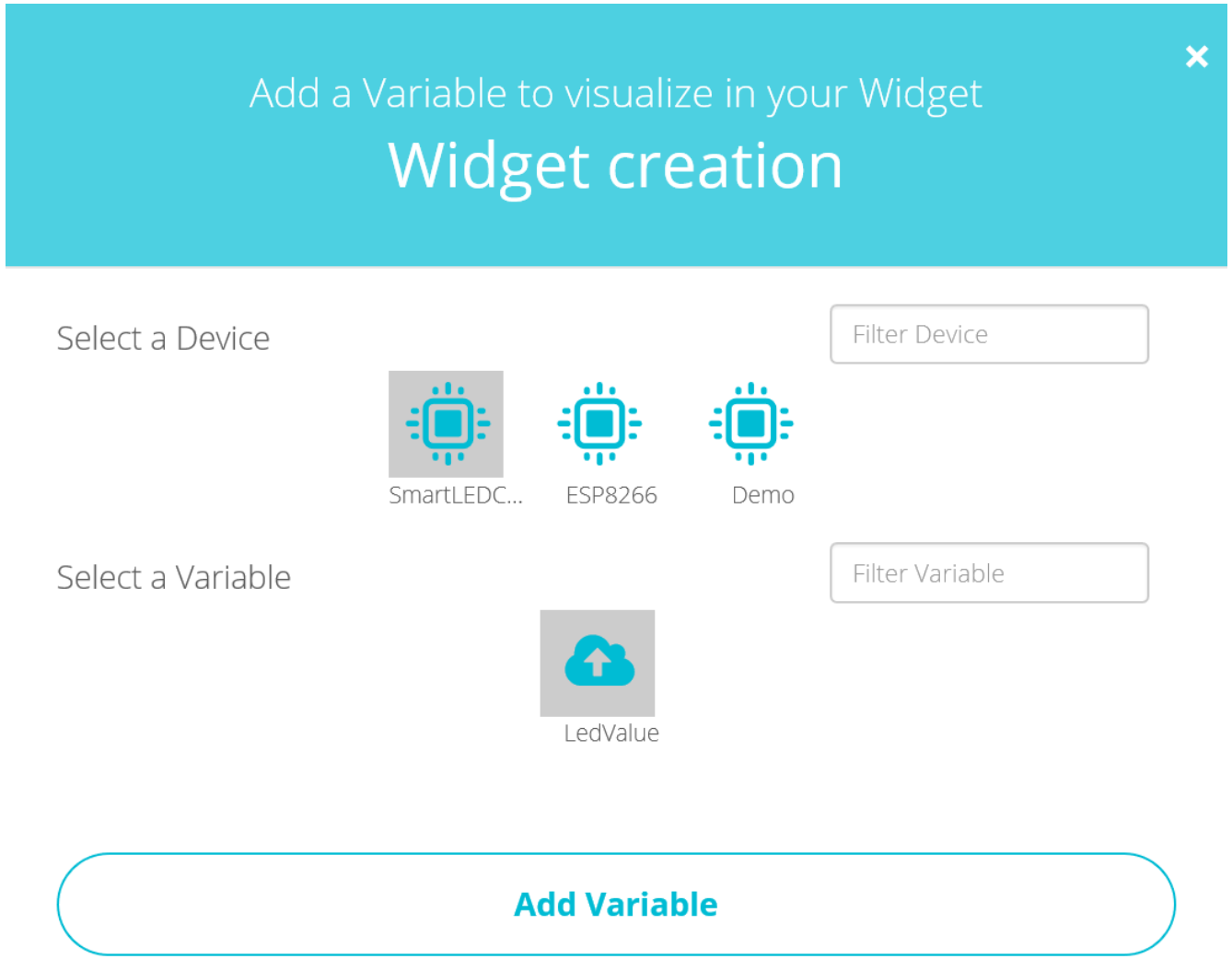


Dashboard : Add widgets

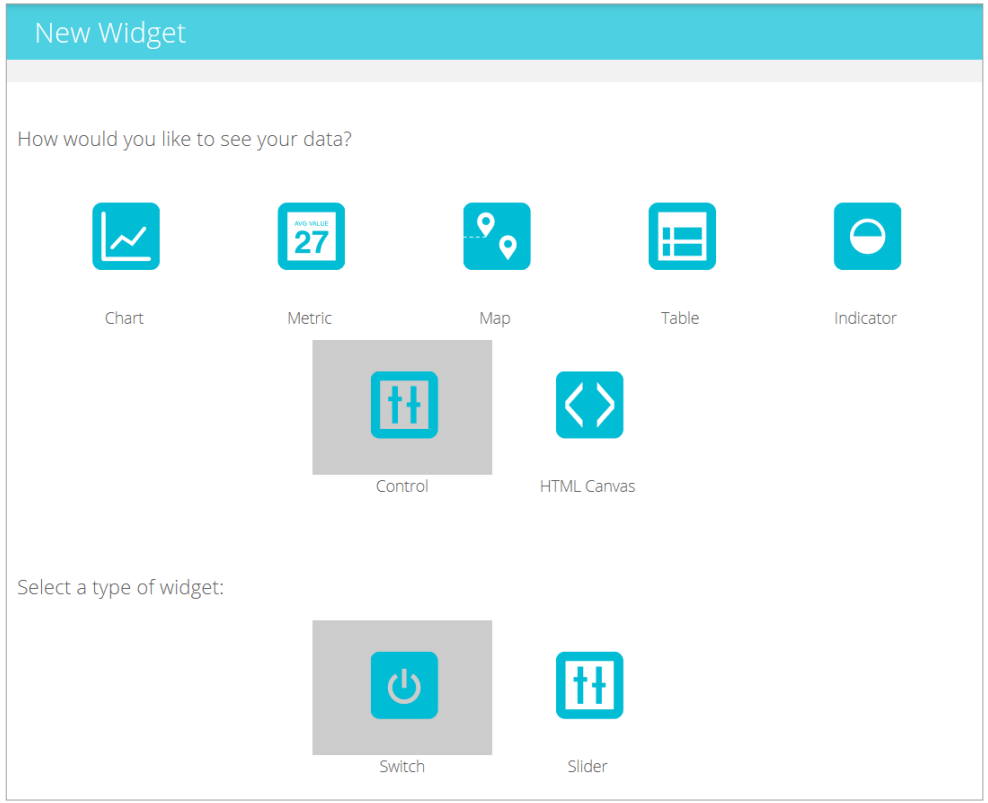


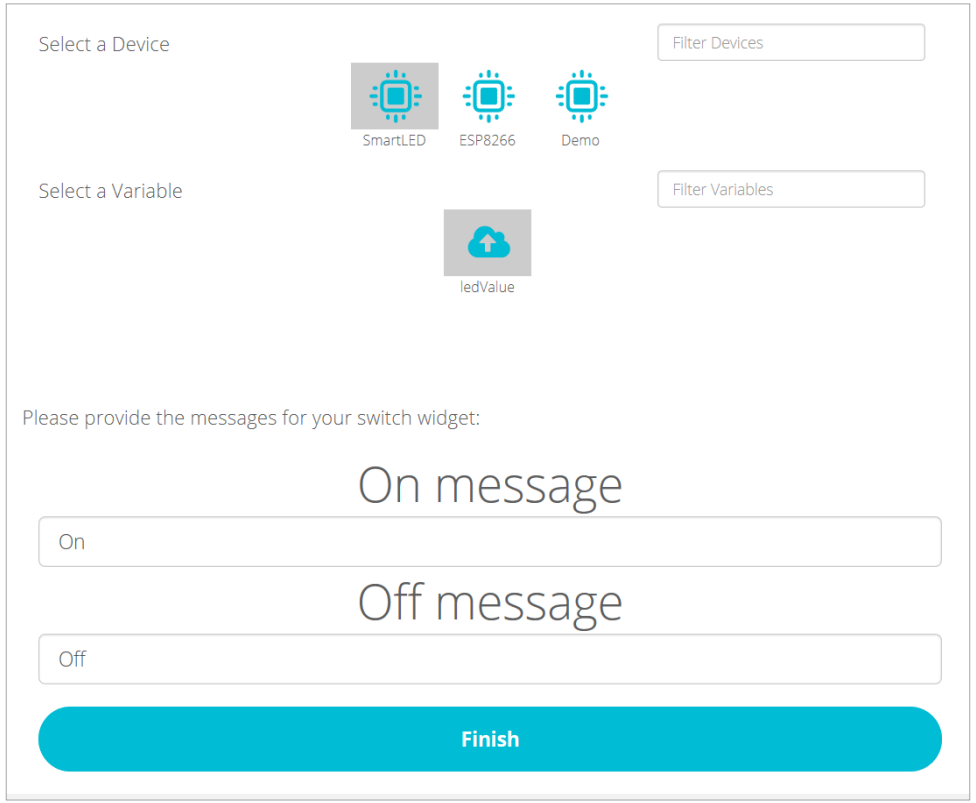


Dashboard : Select a Device, a Variable

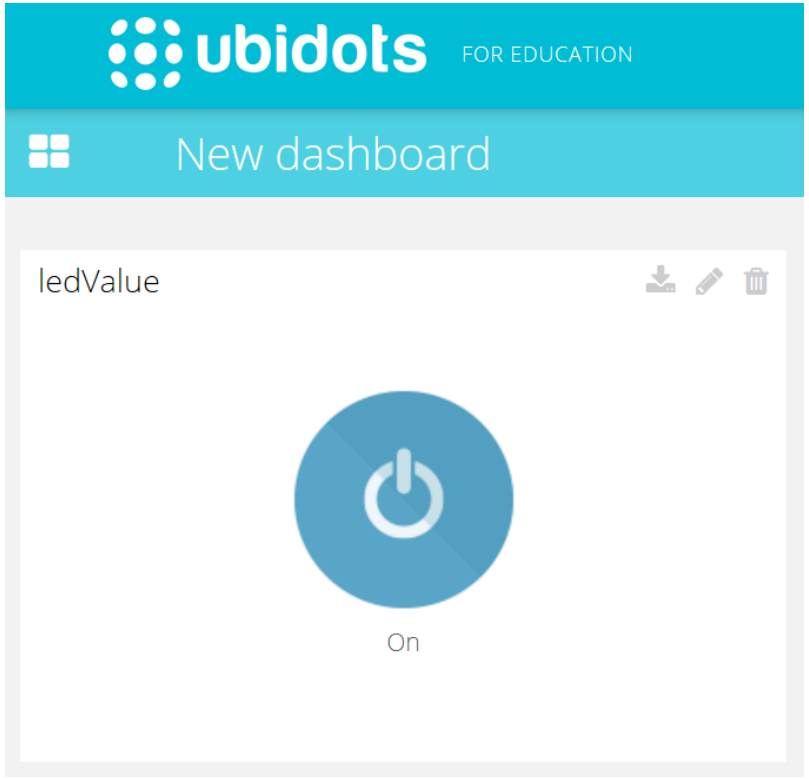


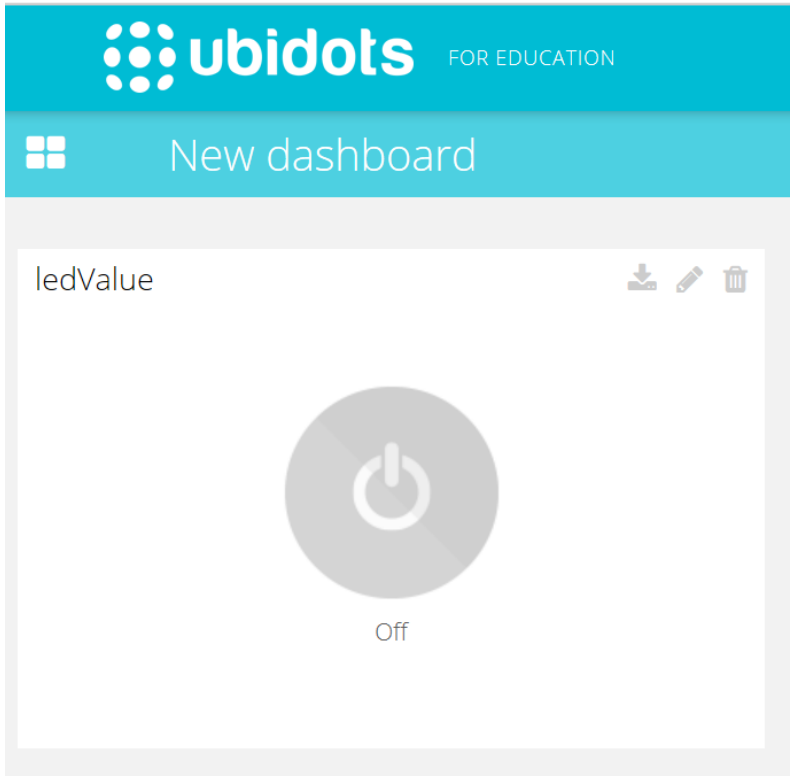
Dashboard Creation : Control -> Switch



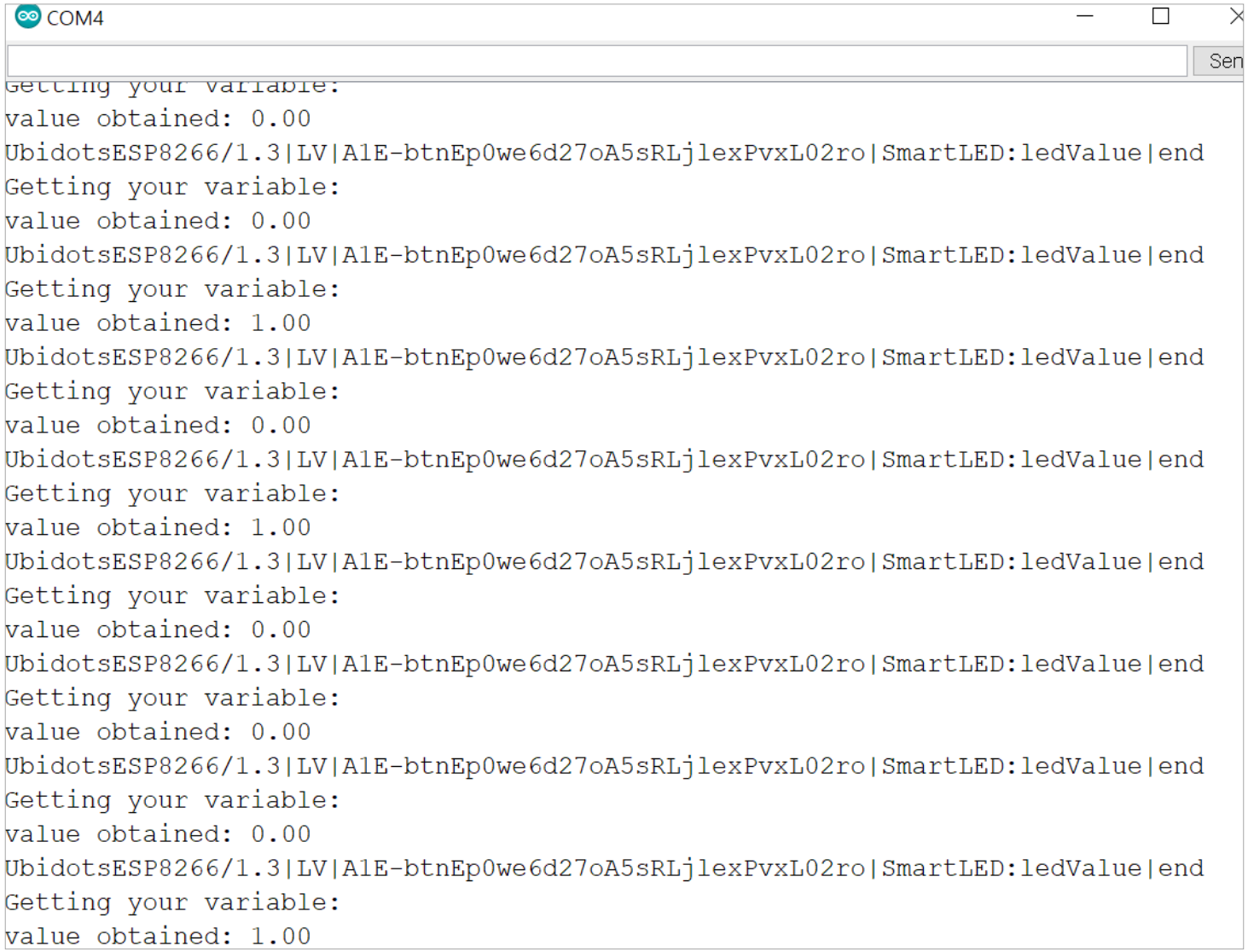


Dashboard : Smart Switch Controller

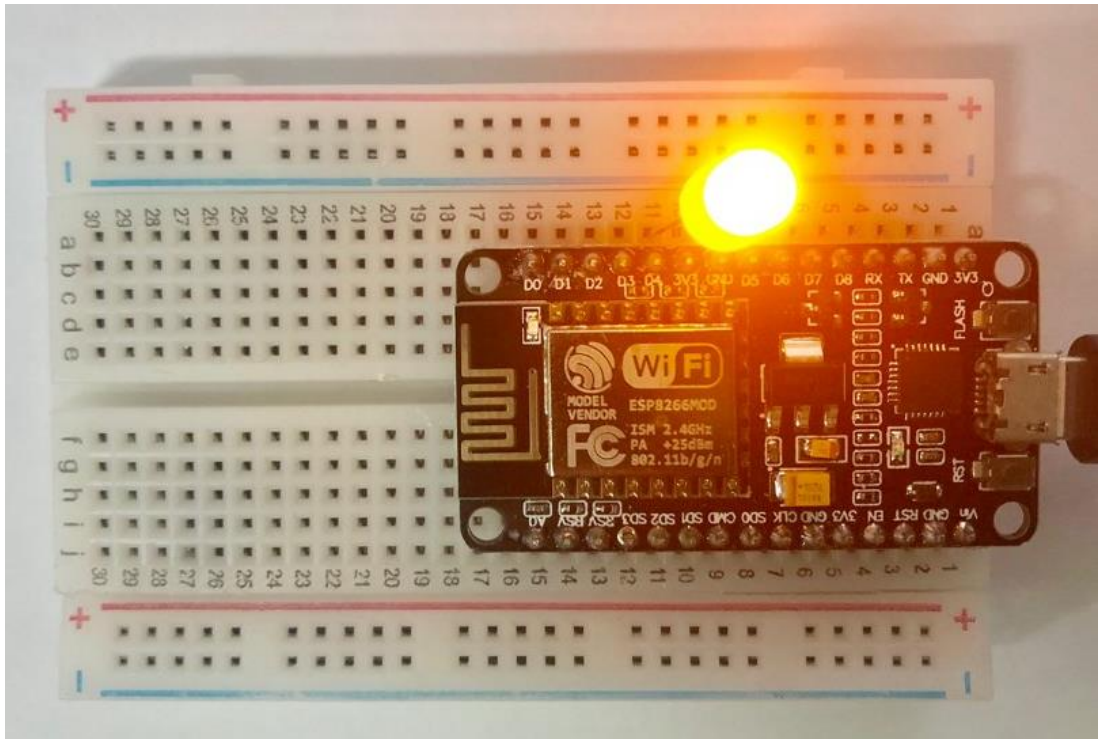


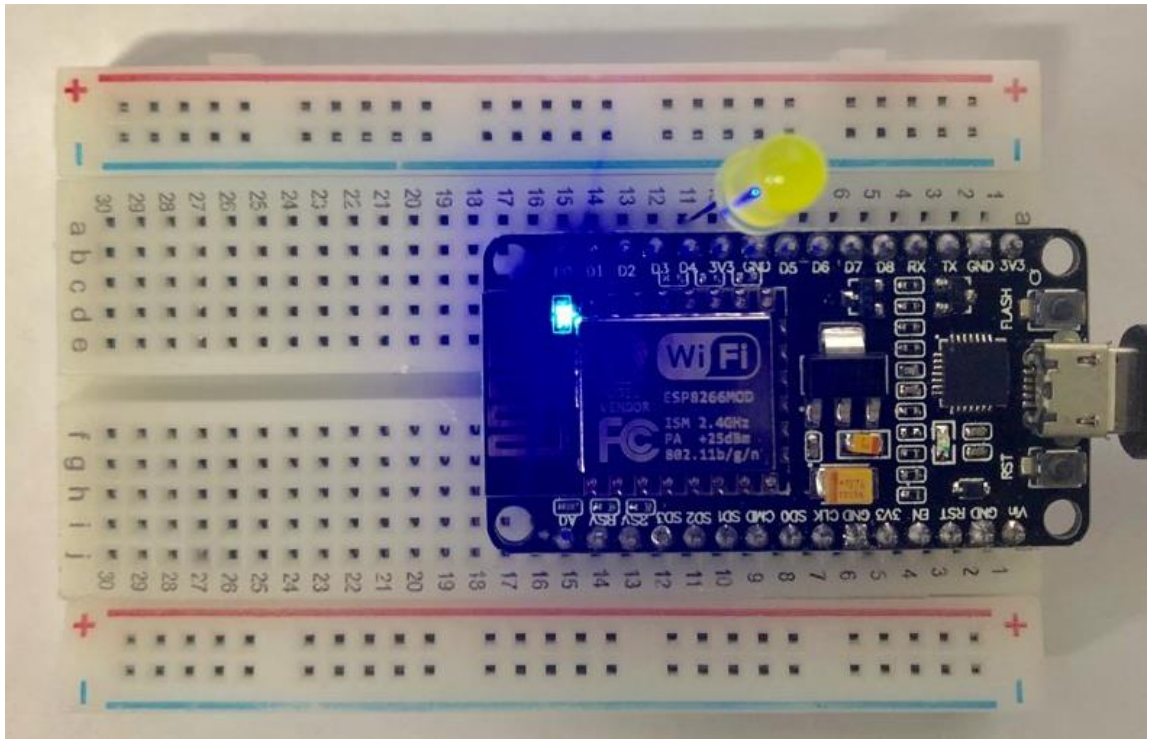


Serial Monitor of LED Control



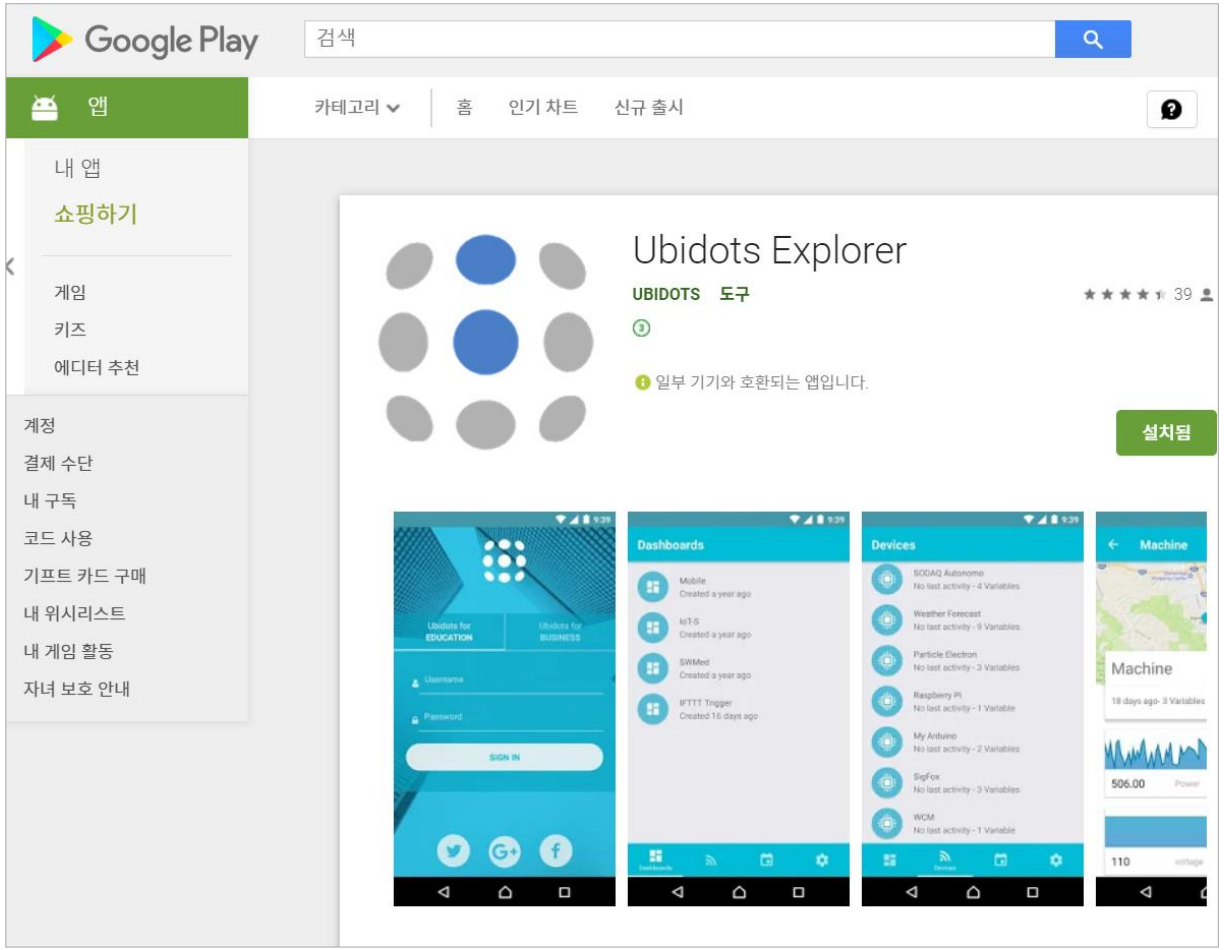
Operation of IoT Devices





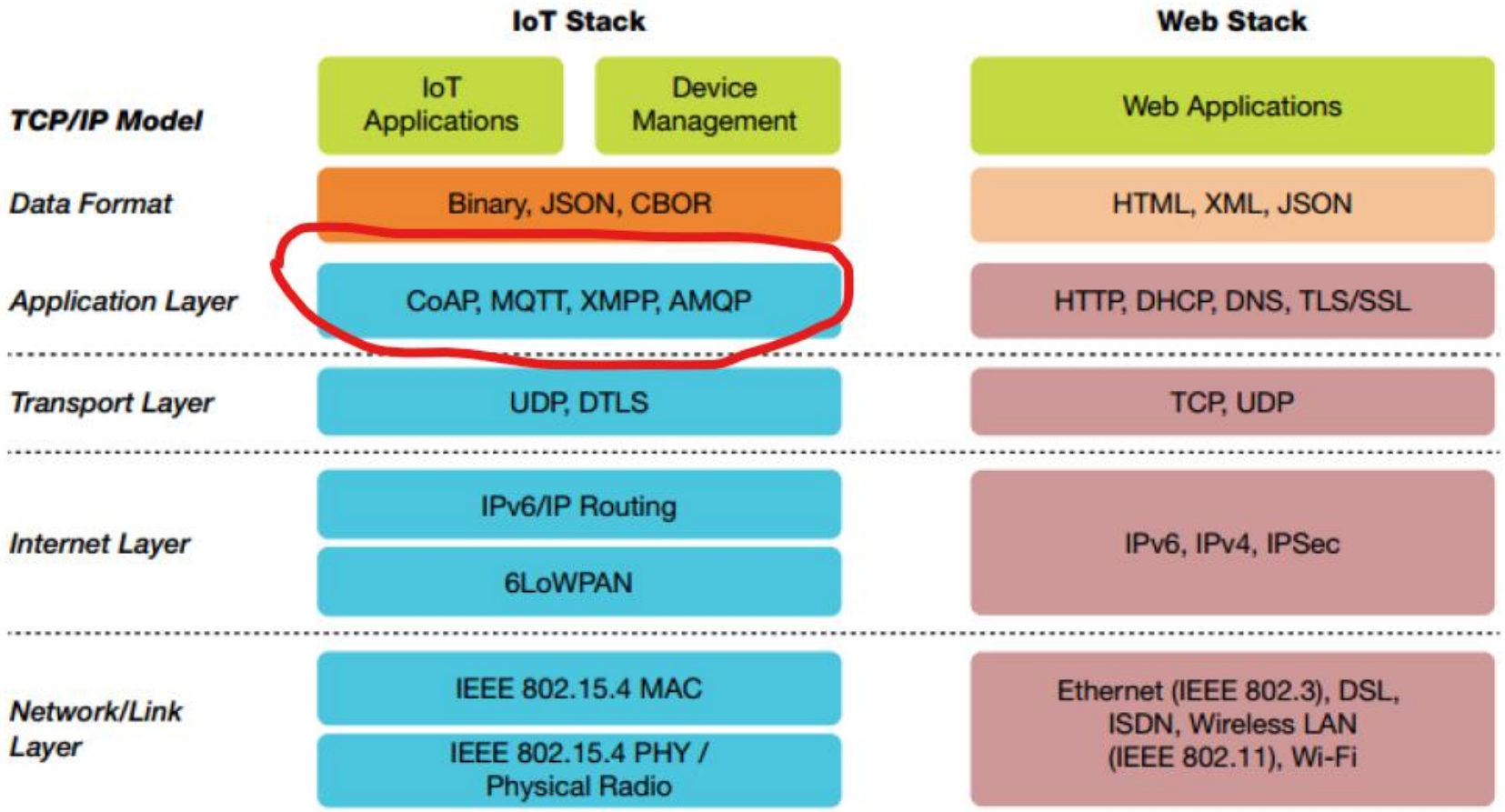
Mobile Application : Ubidots Explorer

- https://play.google.com/store/apps/details?id=com.ubidots.ubiapp

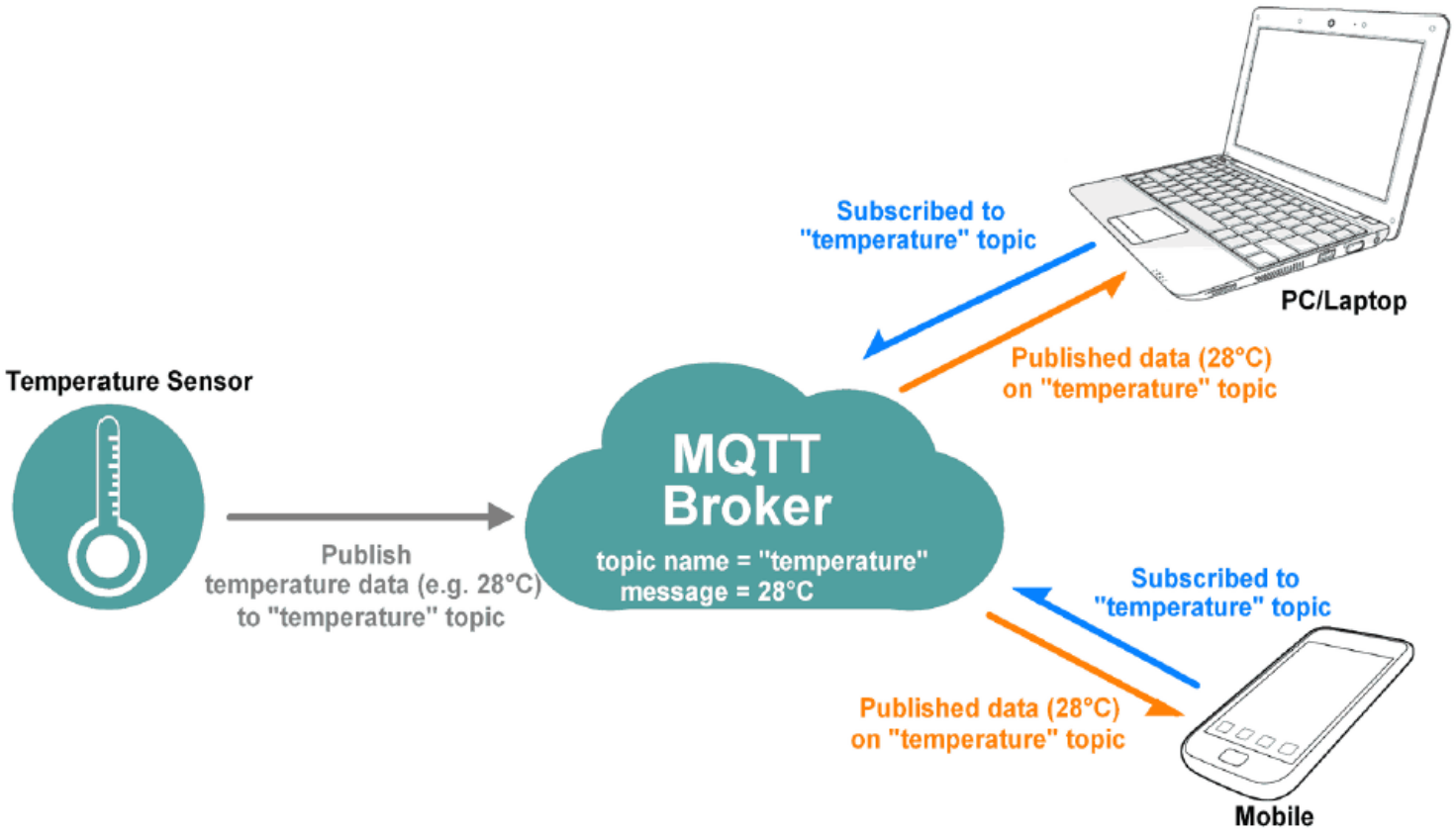


Future Study Topics

- IoT Communication Protocols



- Use Ubidots MQTT…
  - https://github.com/ubidots/ubidots-mqtt-esp
  - https://ubidots.com/blog/temperature-control-with-ubidots/



- Big Data Analytics, Machine Learning
- Apply IoT to field areas
  - Smart Energy :
    - Energy-As-A-Service : http://tiny.cc/iigb9y
  - Smart Farm
  - Smart Home
  - Smart Healthcare
  - Smart Transportation
  - Smart Factory …

Program Sources & Libraries

- GitHub : https://github.com/kings-iot-2019

References

1. https://www.theengineeringprojects.com/2018/10/introduction-to-nodemcu-v3.html
2. http://pdacontrolen.com/tutorial-platform-iot-ubidots-esp8266-sensor-dht11/
3. https://www.hackster.io/ubidots/projects
4. https://ubidots.com/education/
5. https://ubidots.com/docs/