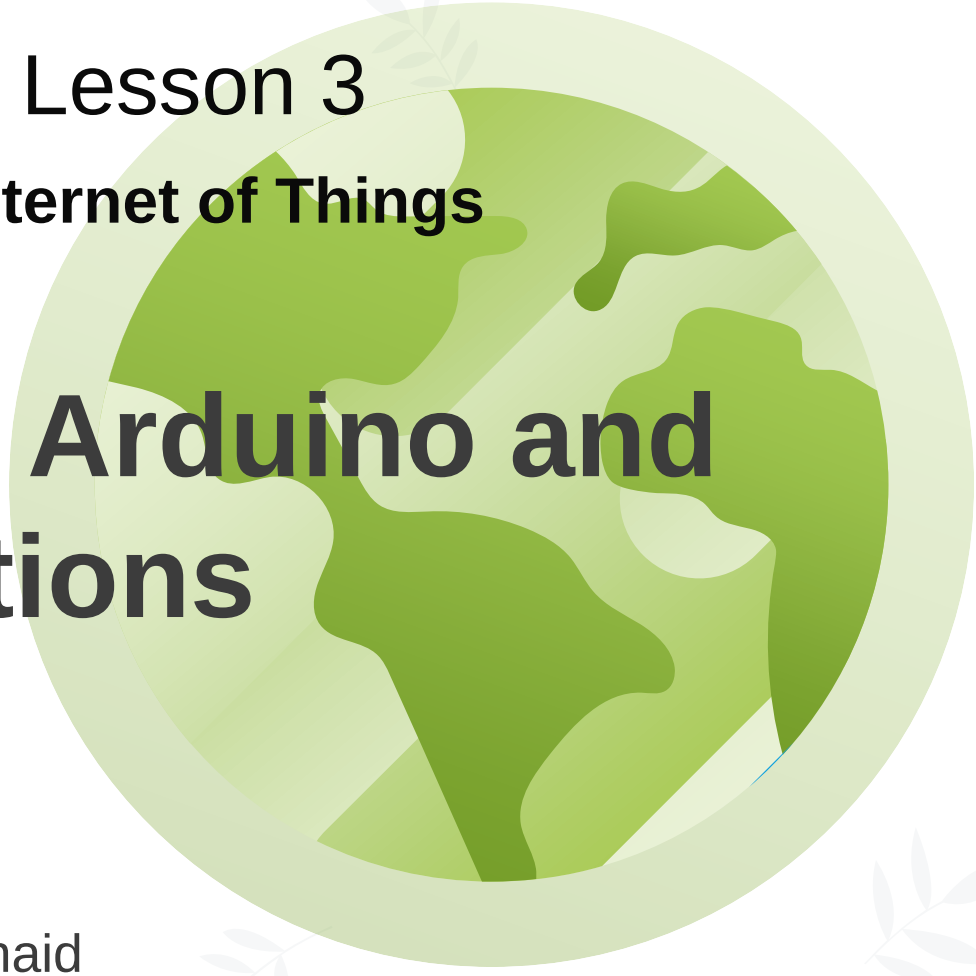
Steam Up 2gether – Lesson 3

Flip Our Perspective using Internet of Things

Getting Started with Arduino and IoT Applications



July 21st, 2020

Stephen Chen & Junaid

Opening and Introduction

P1 World air pollution issues

P2 Basic introduction to Air Quality Monitor (AQM)

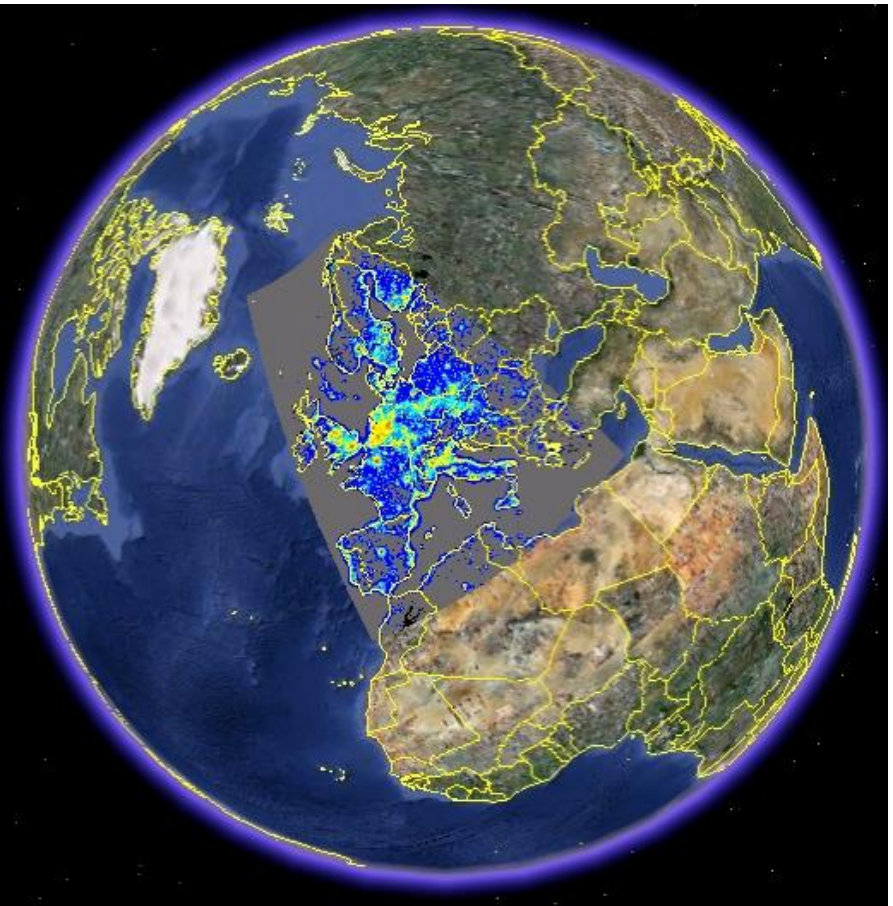
P3 Study and implementation of IoT AQM (1/5)

P4 Study and implementation of IoT AQM (2/5)

PART 1

- World air pollution issues
- What is particulate matter and PM2.5? How do we monitor Air pollution worldwide?
- What is IoT?

World air pollution issues



- World air pollution issues
- What is particulate matter and PM2.5?
- How do we monitor air pollution worldwide?
- What is IoT?

World air pollution issues

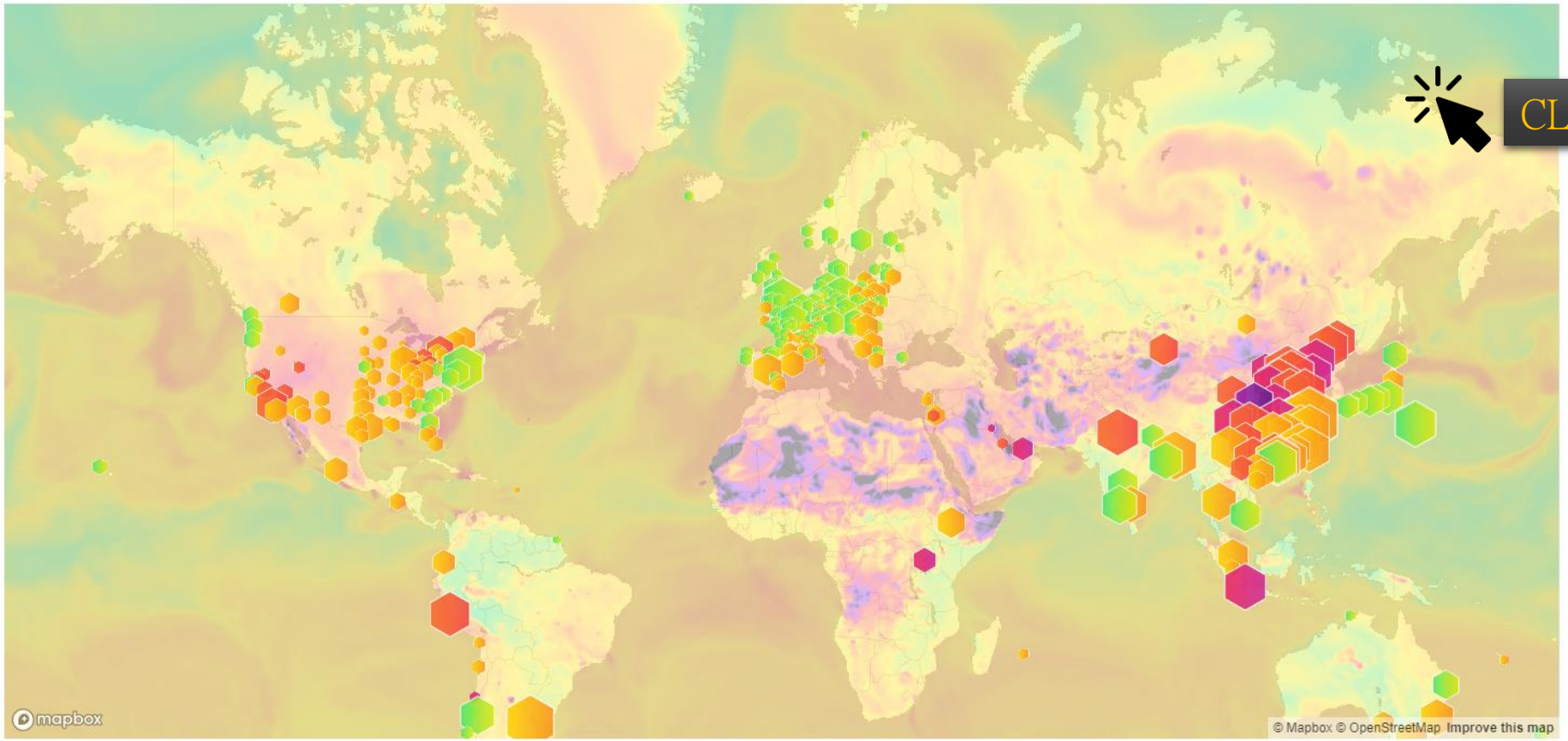
Air quality index (AQI) and PM2.5

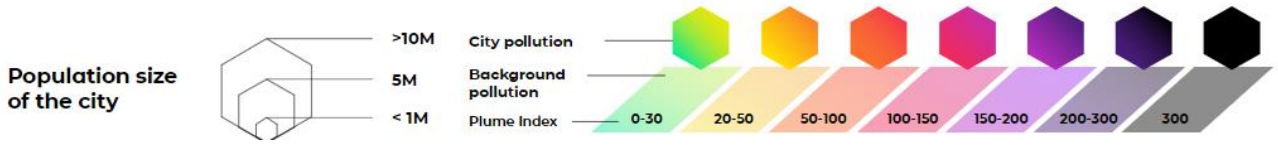
Risk: Low **(1–3)** Moderate **(4–6)** High **(7–10)** Very high **(above 10)**

AQI Monitor item

O_3 (ppb)	O_3 (ppb)	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	CO (ppm)	SO_2 (ppb)	NO_2 (ppb)	AQI	AQI
C_{low} - C_{high} (avg)	C_{low} - C_{high} (avg)	C_{low}- C_{high} (avg)	C_{low} - C_{high} (avg)	C_{low} - C_{high} (avg)	C_{low} - C_{high} (avg)	C_{low} - C_{high} (avg)	I_{low} - I_{high}	**Category**
0-54 (8-hr)	-	0.0-12.0 (24-hr)	0-54 (24-hr)	0.0-4.4 (8-hr)	0-35 (1-hr)	0-53 (1-hr)	0-50	Good
55-70 (8-hr)	-	12.1-35.4 (24-hr)	55-154 (24-hr)	4.5-9.4 (8-hr)	36-75 (1-hr)	54-100 (1-hr)	51-100	Moderate
71-85 (8-hr)	125-164 (1-hr)	35.5-55.4 (24-hr)	155-254 (24-hr)	9.5-12.4 (8-hr)	76-185 (1-hr)	101-360 (1-hr)	101-150	Unhealthy for Sensitive Groups
86-105 (8-hr)	165-204 (1-hr)	55.5-150.4 (24-hr)	255-354 (24-hr)	12.5-15.4 (8-hr)	186-304 (1-hr)	361-649 (1-hr)	151-200	Unhealthy
106-200 (8-hr)	205-404 (1-hr)	150.5-250.4 (24-hr)	355-424 (24-hr)	15.5-30.4 (8-hr)	305-604 (24-hr)	650-1249 (1-hr)	201-300	Very Unhealthy
-	405-504 (1-hr)	250.5-350.4 (24-hr)	425-504 (24-hr)	30.5-40.4 (8-hr)	605-804 (24-hr)	1250-1649 (1-hr)	301-400	Hazardous
-	505-604 (1-hr)	350.5-500.4 (24-hr)	505-604 (24-hr)	40.5-50.4 (8-hr)	805-1004 (24-hr)	1650-2049 (1-hr)	401-500	

Air pollution data worldwide



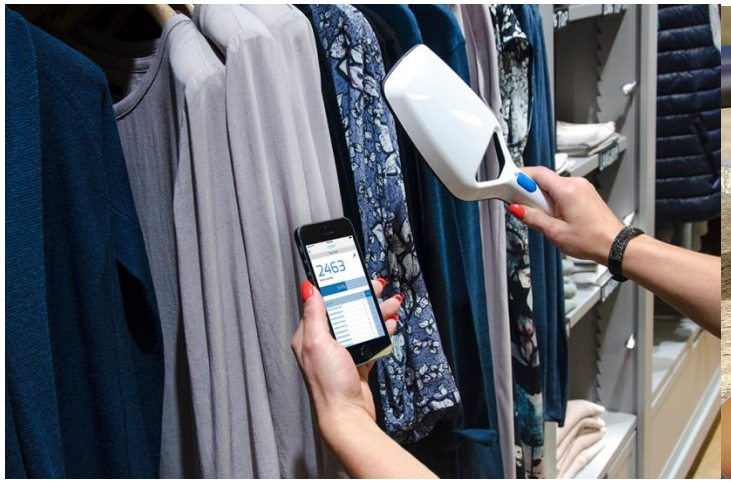


How do we monitor air pollution worldwide?

What is IoT?

IoT = Internet of thing

RFID in retail

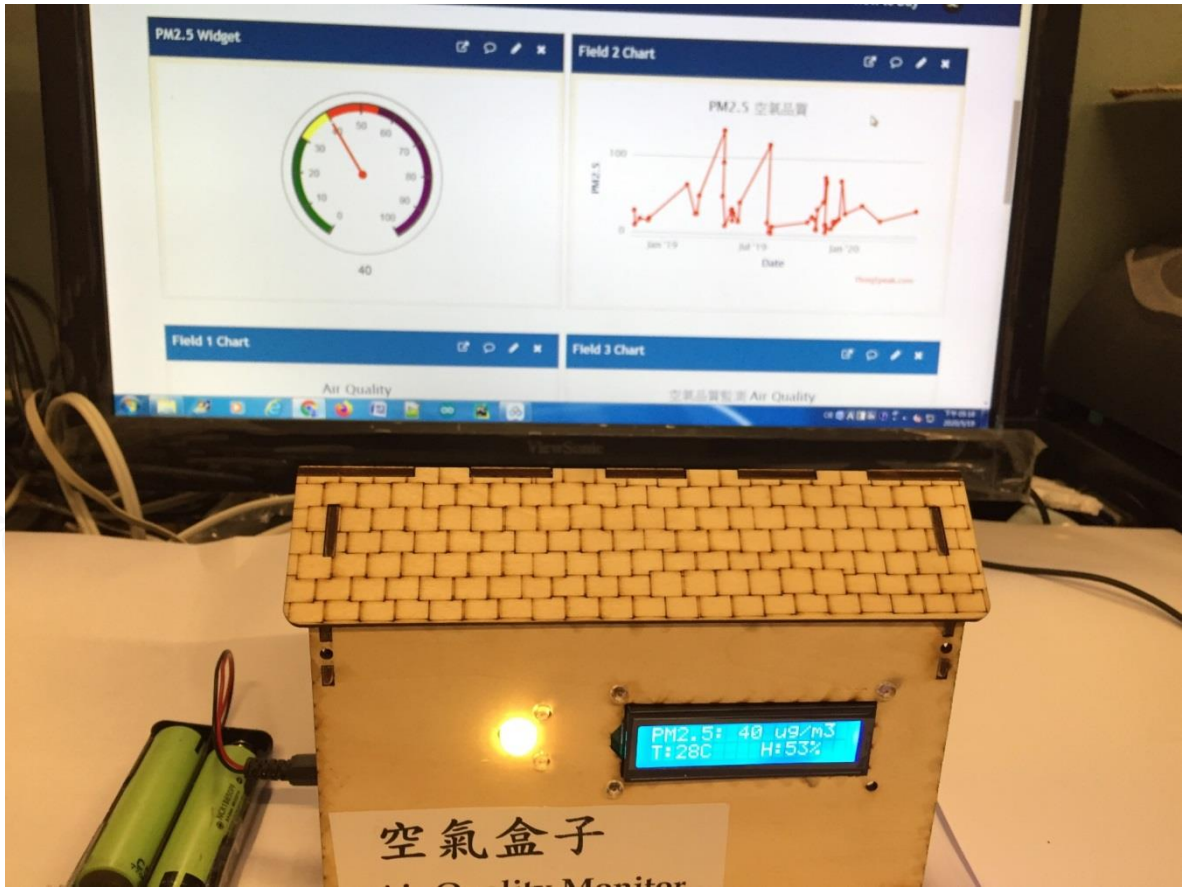


Monitor water pressure

PART 2

- Basic introduction to Air Quality Monitor.
- Introduction to AQM composite.
- IoT AQM function defined: 1. monitor PM2.5, 2. monitor temperature 3. humidity
- Function MAP of IoT AQM.
- Basic parts introduction to IoT AQM.

Basic introduction to Air Quality Monitor

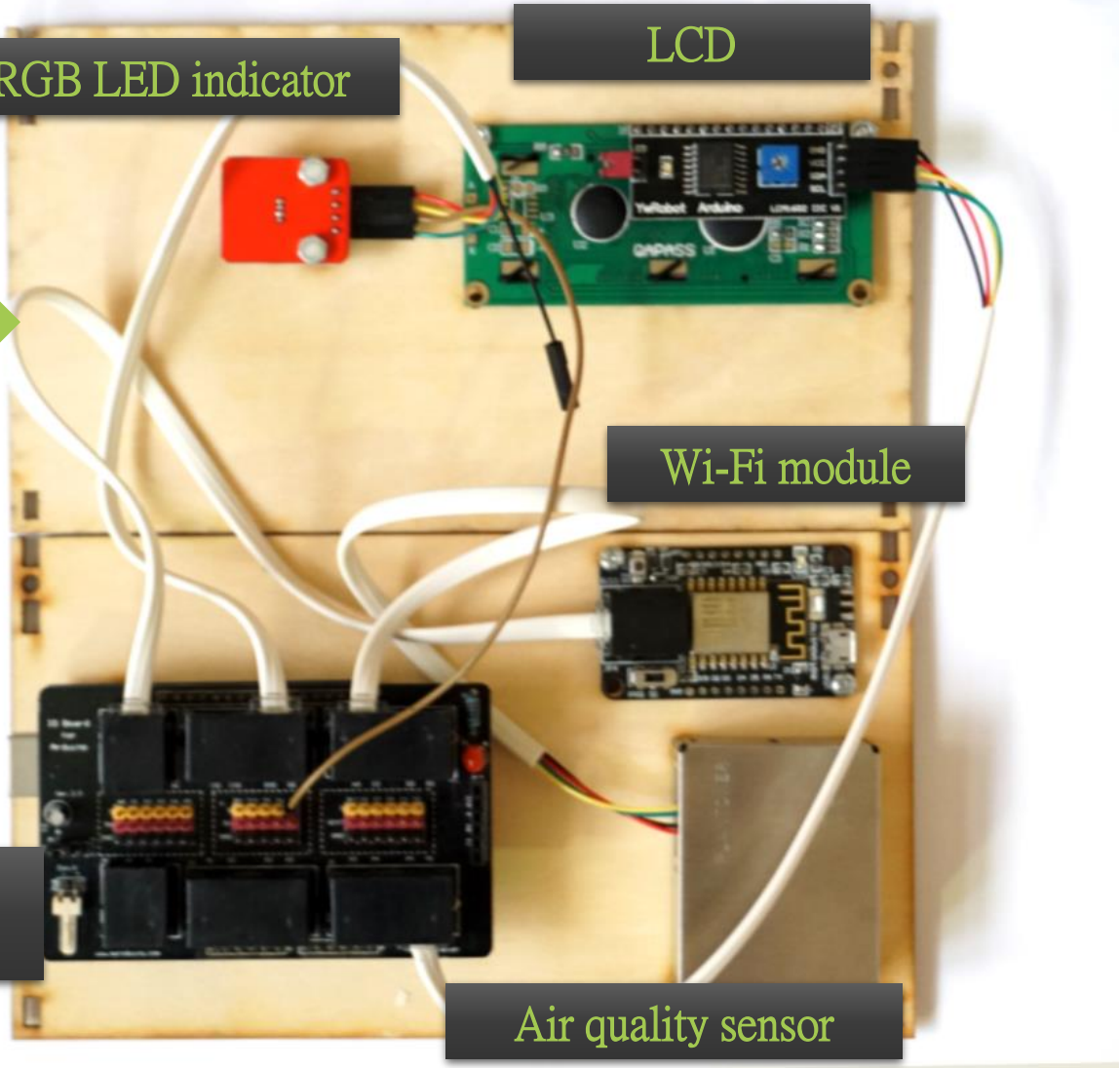


- Monitor PM2.5
- Monitor Temperature & humidity
- Uploaded date above to server
- LCD show data
- RGB LED indicator

Introduction to AQM composite

RGB LED indicator

LCD



RGB LED indicator

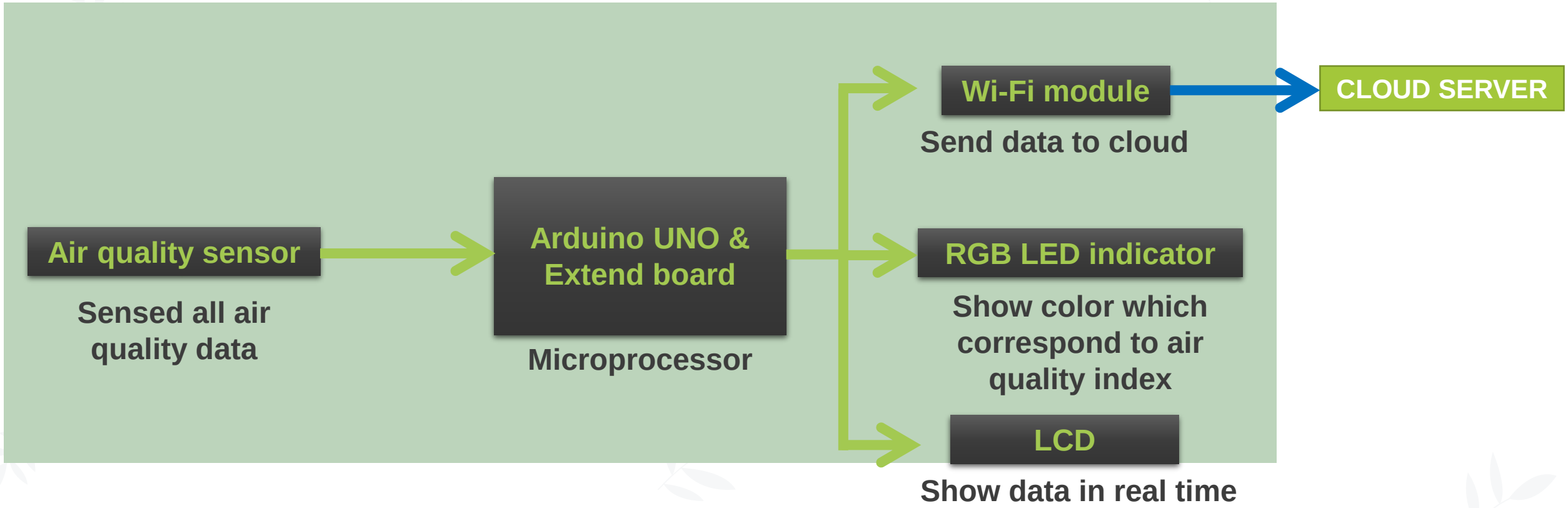
LCD

Wi-Fi module

Arduino UNO &
Extend board

Air quality sensor

Function MAP of IoT AQM



BLOCK DIAGRAM of IoT air quality monitor

Basic parts introduction to IoT AQM

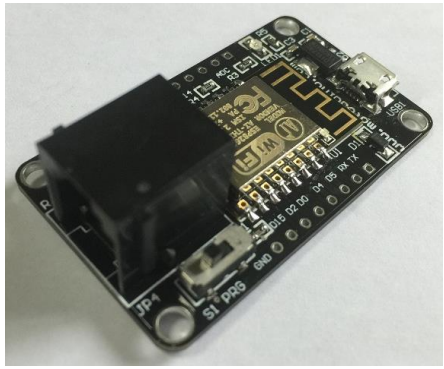
Air quality sensor

Datasheet :
PMS5003T G5 PM2.5

Arduino UNO

Datasheet :
Arduino UNO

Wi-Fi module



Datasheet :
ESP8266

RGB LED indicator

Datasheet :
N/A

LCD

- **Datasheet :**
  I2C LCD1602

Google and check datasheet before you use any new device for more understanding

Pop Quiz – Please complete in Corelab

Question (1)

What is the key component of Air quality monitor mention in Lession3 to achieve data sharing?

1. Air quality sensor
2. Wi-Fi module
3. LCD
4. RGB LED

PART 3

- Study and implementation of IoT AQM (1/5).
- Introduction to device protocol
- Connect air quality monitor (PMS5003T), LCD (I2C LCD1602), Wifi module(ESP8266), and RGB LED to Arduino

Introduction to device protocol

“Protocol” is a general name of Morse code like communication form between microprocessor and device, or device to device

Morse code

…___…

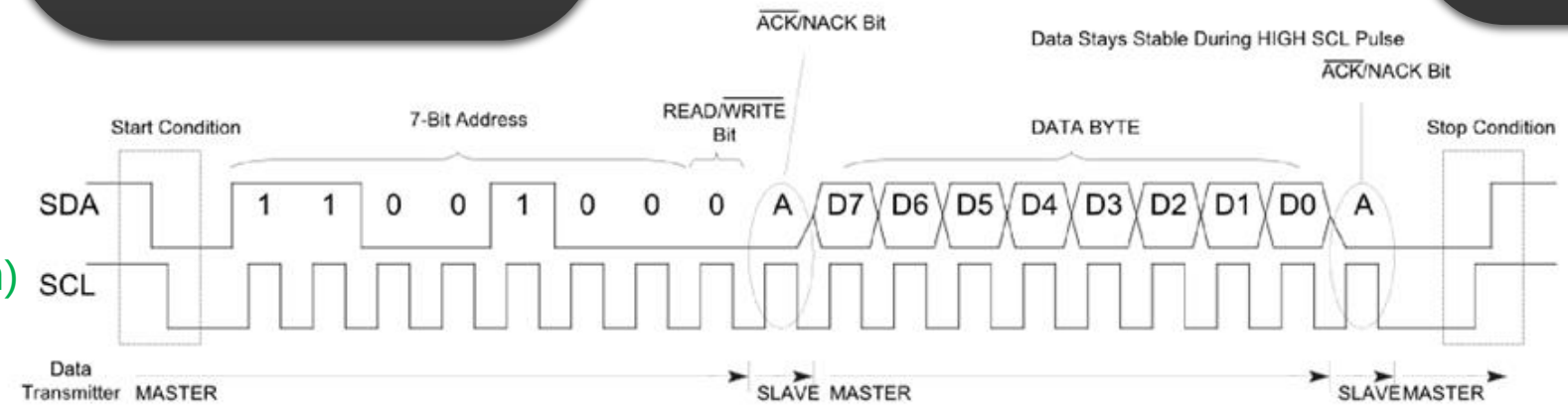
PERSON A ⇄ PERSON B

·_·

Digital Protocol I2C

Arduino ⇄ Device

SDA (DATA pin)
SCL (CLOCK pin)



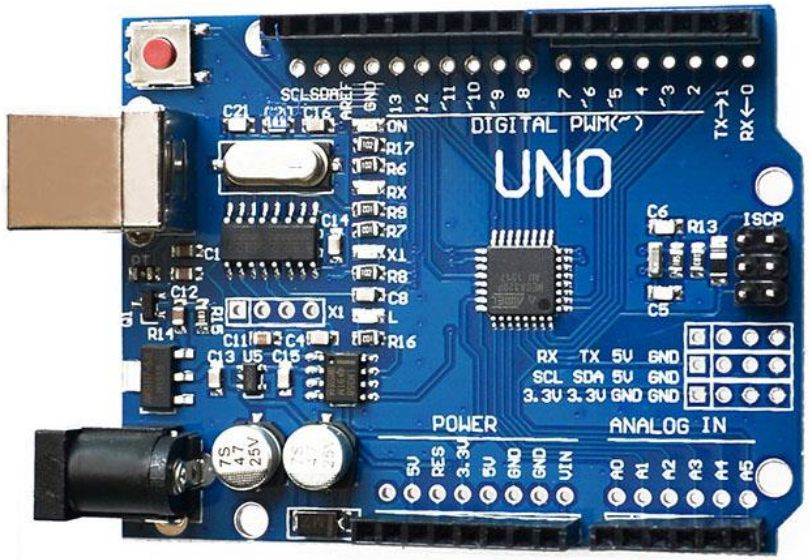
Google and check I2C for more understanding

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

GND D13 ~ D2

RESET Digital I/O pin

USB



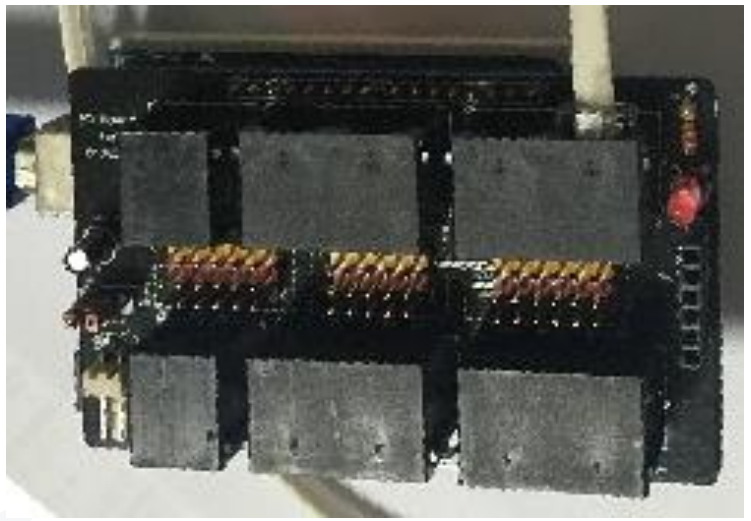
5V . RES . 3.3V . 5V . GND . GND . VIN

power

Analog I/O pin

Digital I/O pin

D11.D12 D10.D11 D9.D10 D3.D4 D2.D3



A0.A1 A1.A2 A2.A3 A3.A4 A4.A5

Analog I/O pin

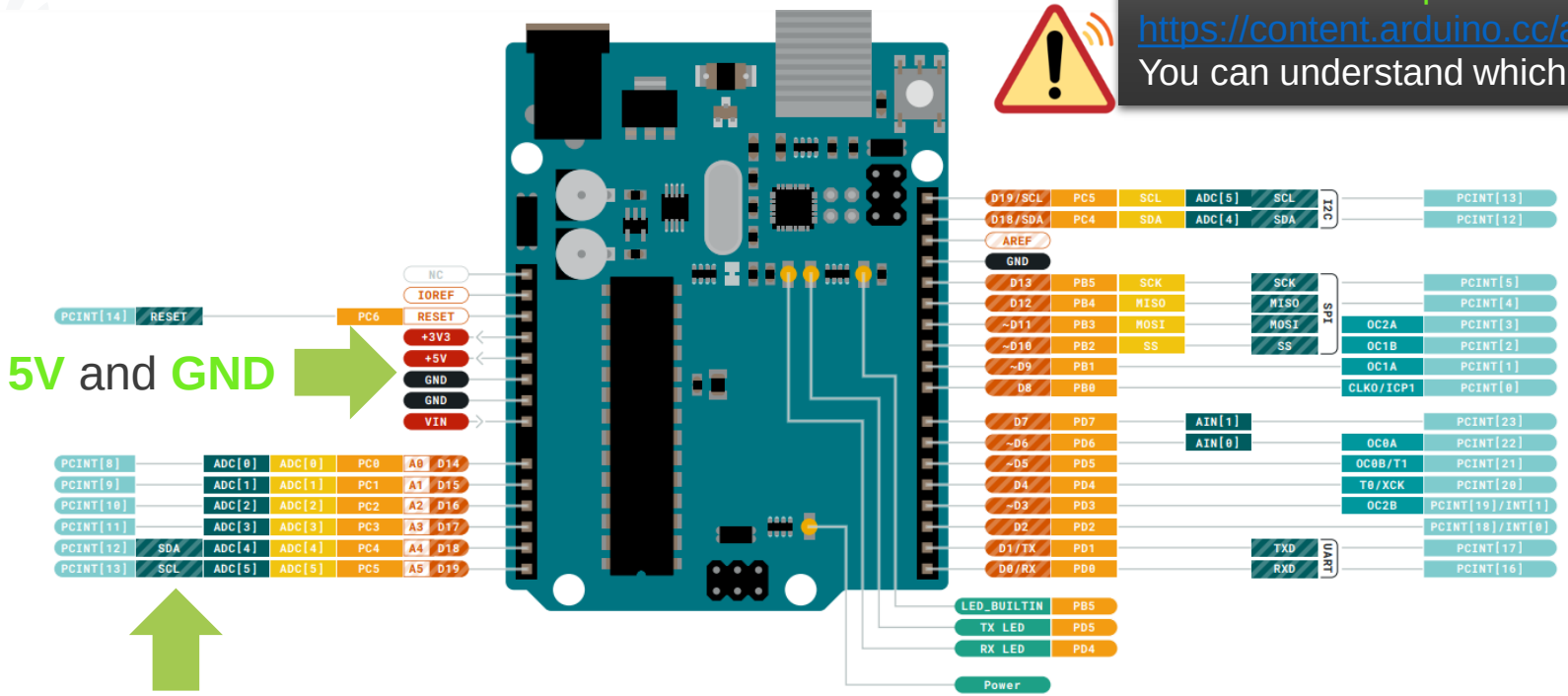
Arduino UNO R3

S4A IO board

We will see what happened to **5V** pin and **GND** on next 2 page. Watch out!

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

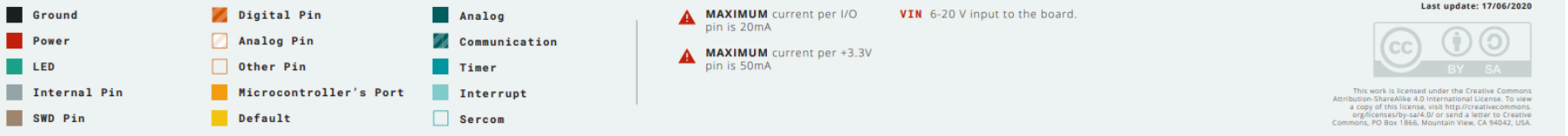
Arduino UNO V3 pin MAP Download
https://content.arduino.cc/assets/Pinout-UNOrev3_latest.pdf
You can understand which pin you can use.



PIN	Protocol/ Function	Device
A4	I2C	LCD
A5	I2C	LCD
D3	I2C	AQM
D4	I2C	AQM
D11	UART	WIFI
D12	UART	WIFI
D9	PWM	RGB LED
D10	PWM	RGB LED
D5	PWM	RGB LED

Pin MAP

For I2C protocol, you should use A4 as SDA, A5 as SCL



Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

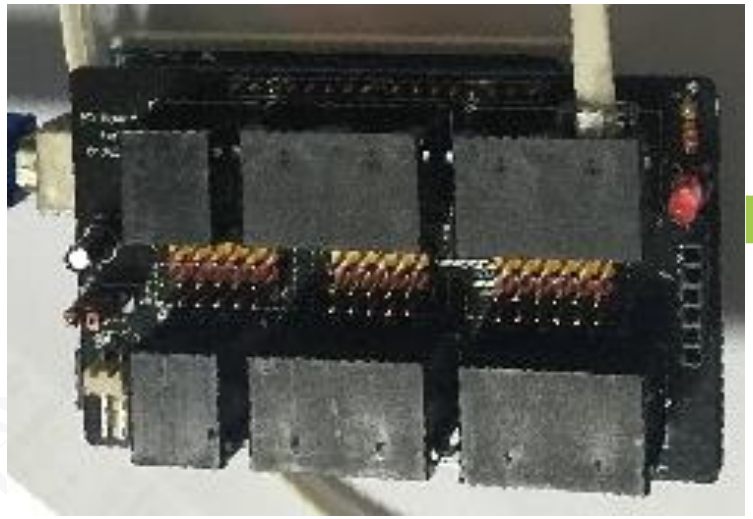
Why use S4A board?

How can S4A board help you?

Which 4 pins composite as a RJ11 connector ?

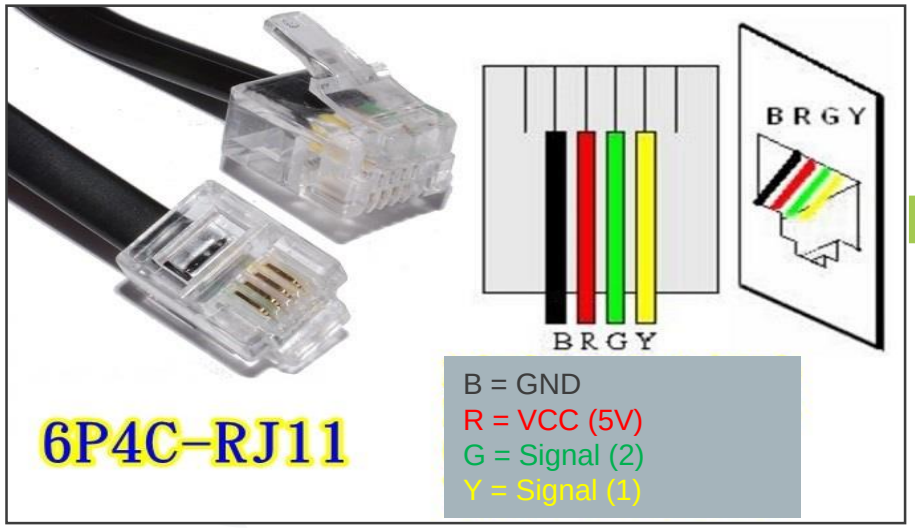
Digital I/O pin

D11.D12 D10.D11 D9.D10 D3.D4 D2.D3



A0.A1 A1.A2 A2.A3 A3.A4 A4.A5

Analog I/O pin



Example : connect to D2.D3 port

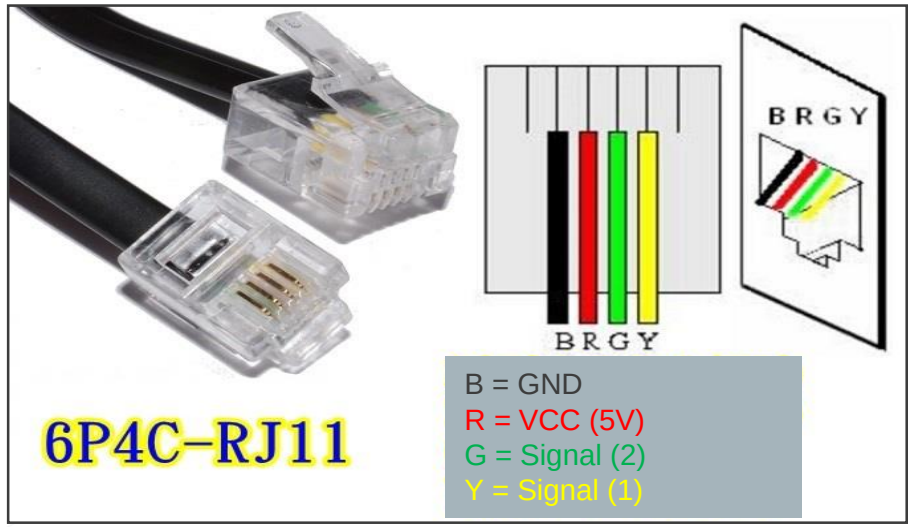
B = GND
R = VCC (5V)
G = D3
Y = D2

Simplify way to connect device to Arduino.

- **S4A IO board**

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

Why use S4A board? **How can S4A board help you?** **Which 4 pins composite as a RJ11connector ?**



simplify way to connect I2C,
Or other 4 pin **protocol**

Hardware connection of I2C:

SCL (CLOCK pin)
SDA (DATA pin)
VCC (POWER pin)
GND (GROUND)

Note: You need to define Signal (2) as SDA (A4)and Signal (1) as SCL (A5) first before you start programming.

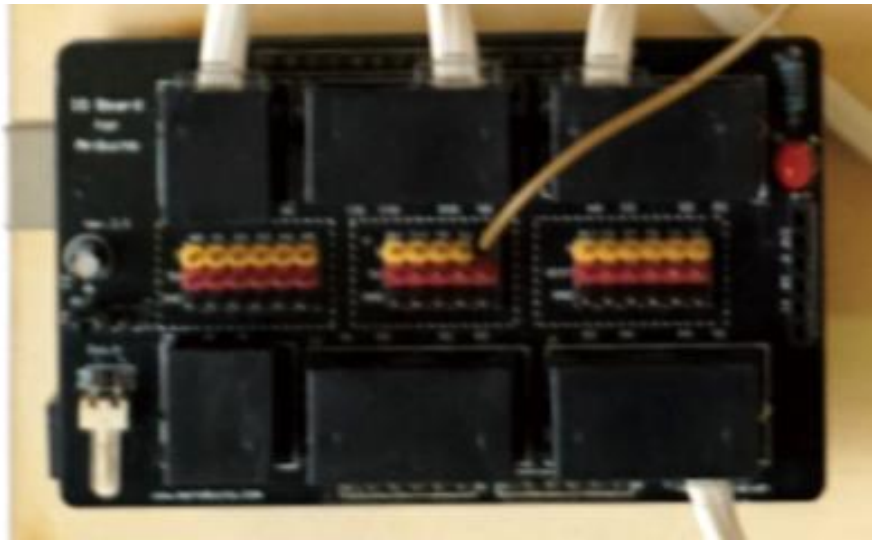
YES you can change different define in IDE. It also means you need to connect the hardware pin in right way.

DO NOT connect 5V and GND together if you want to do it by yourself !

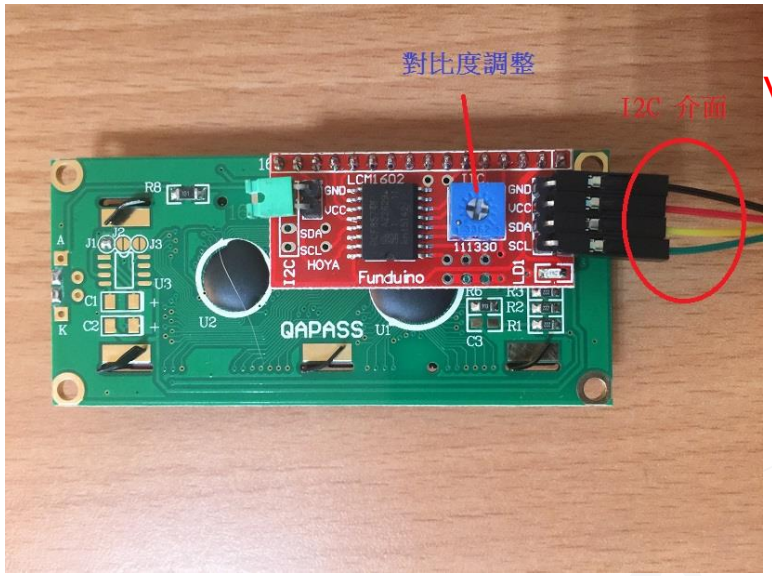
Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

Connect LCD to Arduino. I2C protocol

Note : A4/A5 is special design for I2C communication. A4=SDA, A5=SCL.
Download https://content.arduino.cc/assets/Pinout-UNOrev3_latest.pdf
Read P.2 for more understanding.



LCD to A4/A5 pin



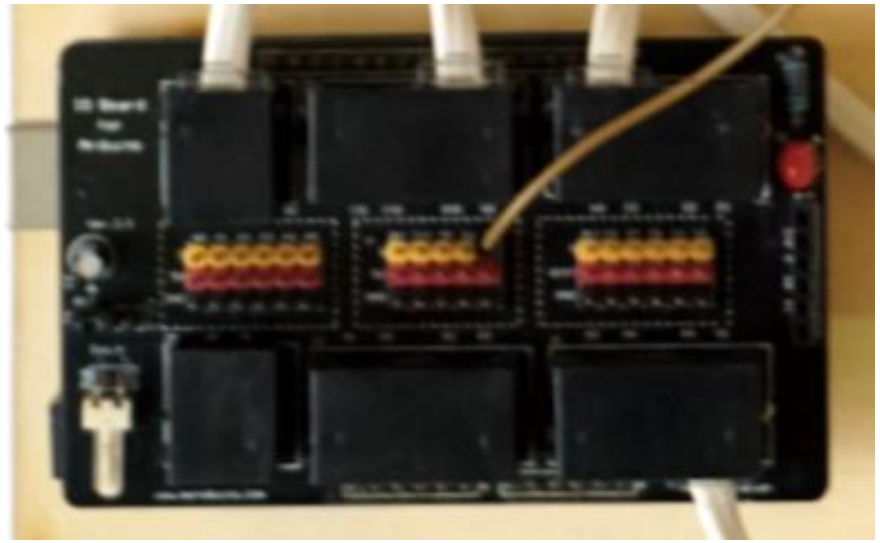
I2C protocol

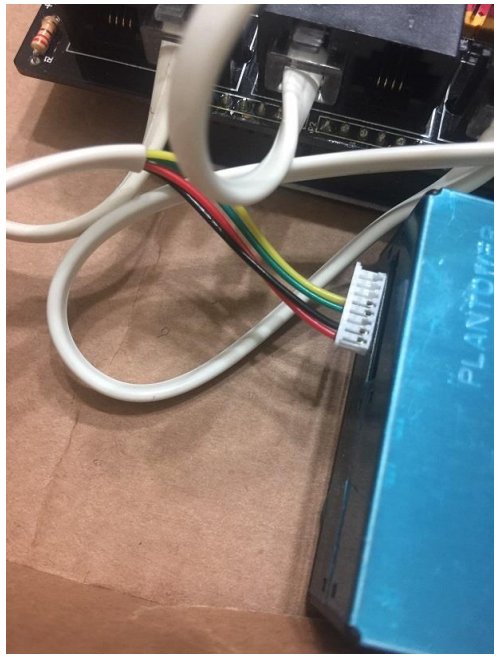
GND (GROUND)
VCC (POWER pin)
SDA (DATA pin)
SCL (CLOCK pin)

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

Connect Air monitor sensor (PMS5003T). I2C protocol

PMS5003T to D3/D4 pin



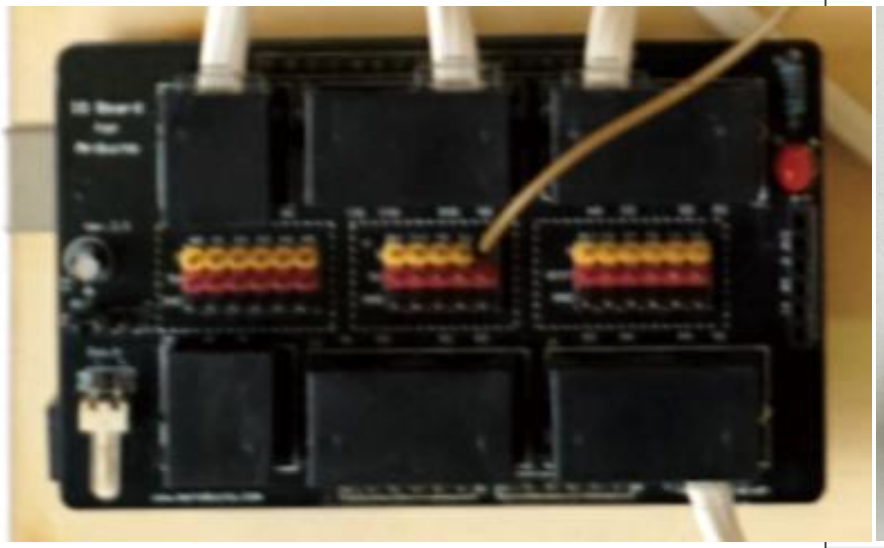


Hardware connection of I2C:

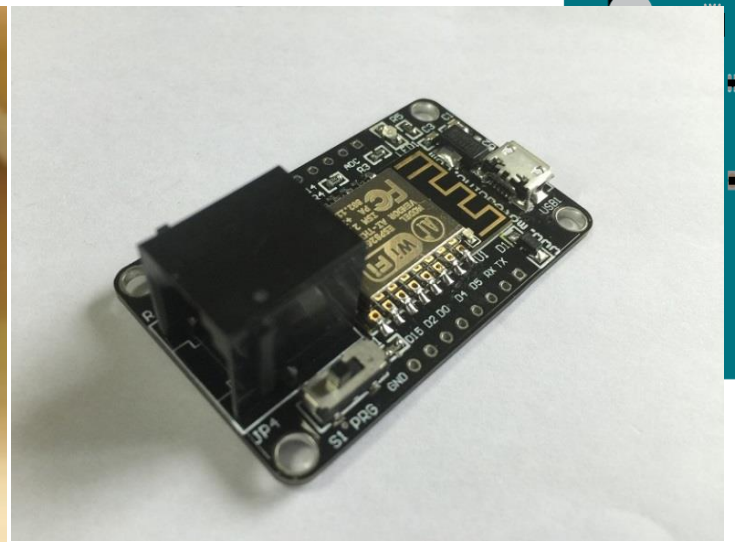
- SCL (CLOCK pin)
- SDA (DATA pin)
- VCC (POWER pin)
- GND (GROUND)

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

PMS5003T to D11/D12 pin



Connect ESP8266 WiFi Module. UART protocol

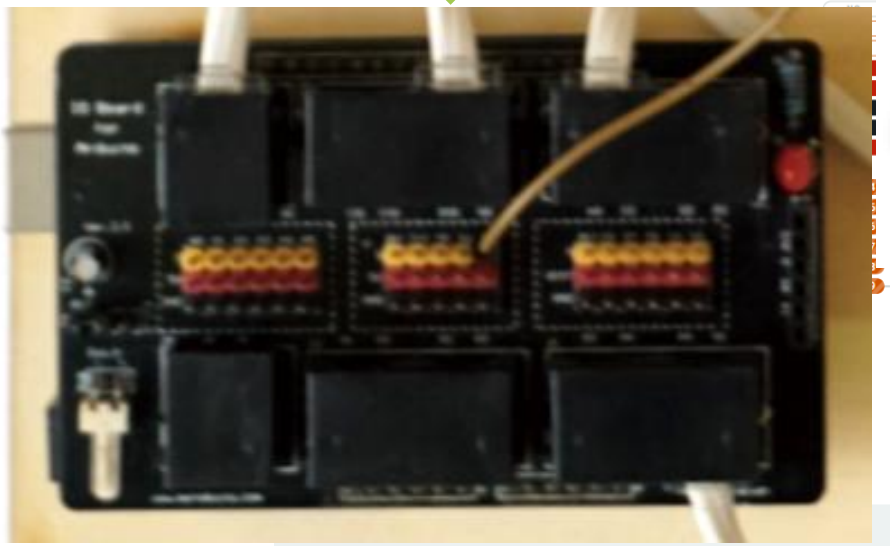


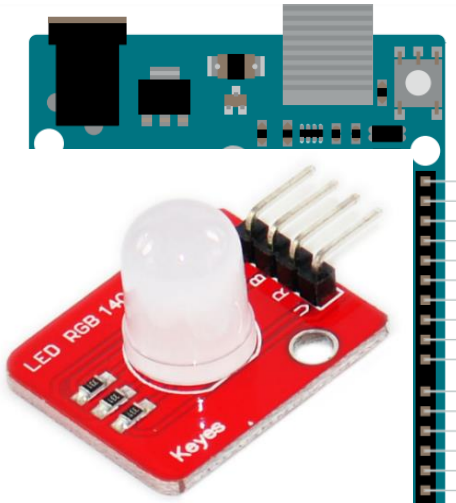
D11/D12 support SPI

Connect air monitor, LCD, Wi-Fi module, and RGB LED to Arduino

Connect RGB LED indicator

RGB LED indicator to D9/D10 pin and D5.





5V RGB LED

V – VCC (5V)

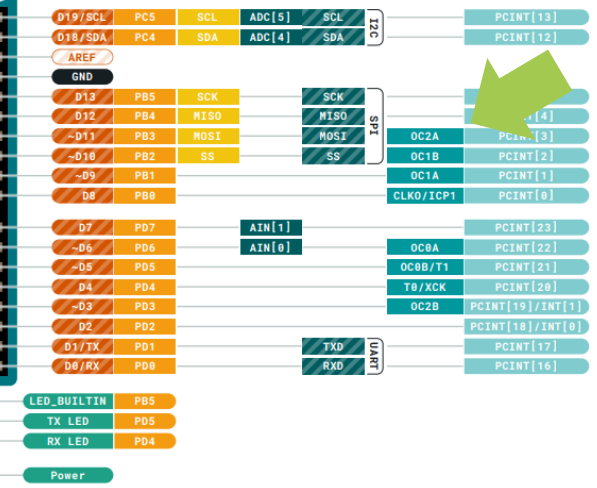
R – D9

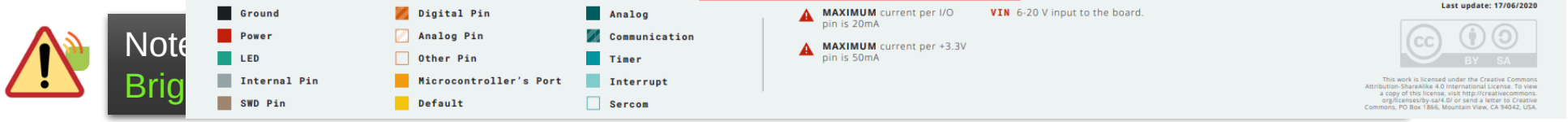
B – D5

G– D10

Why use D5, D10, D9 to control LED color change?

Only D3, D5, D6, D9, D10, D11 support PWM function in Arduino UNO





Note
Brig

Pop Quiz – Please complete in Corelab

Question (2)
What is the function digital pin can't do?
1. A/D converter
2. Generator PWM signal
3. To communication with digital protocol
4. Be the VCC or GND function.

Question (3)
What is the function analog pin can't do?
1. A/D converter
2. Light a LED at varying brightnesses.
3. Drive a motor at various speeds.
4. D/A converter

Pop Quiz – Please complete in Corelab

Question (4)
Which pin can use as UART digital communication in Arduino UNO R3?
1. D0, D1
2. D2, D3
3. A0, A1
4. A2, A3

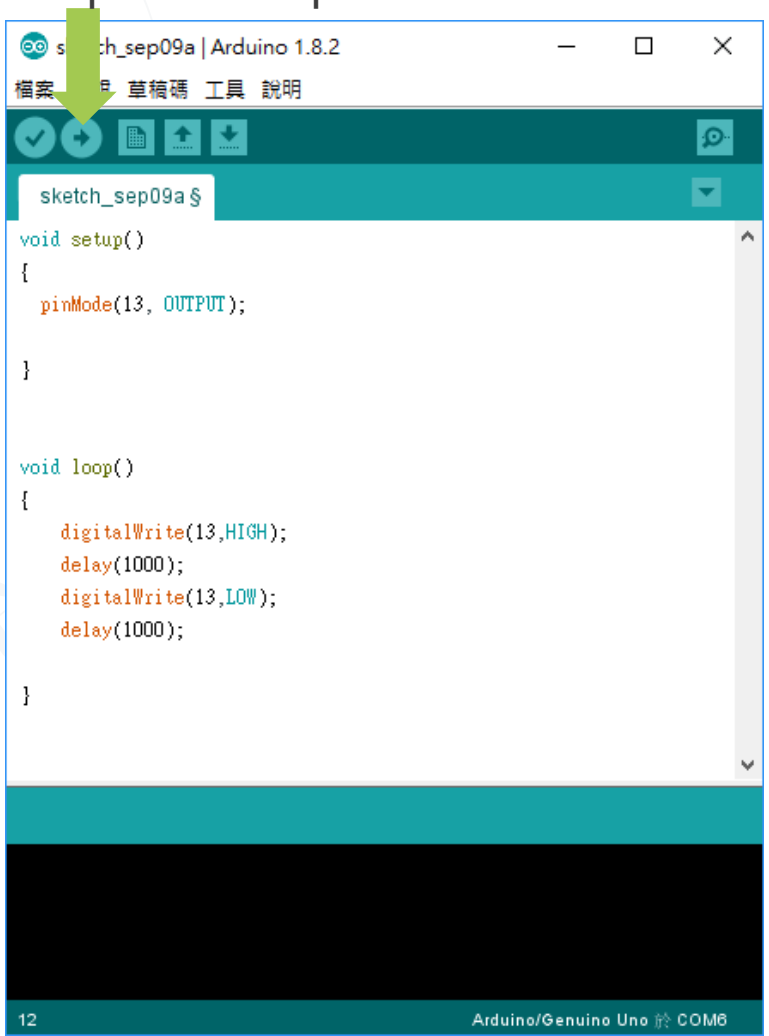
Question (5)
Which pin can use as I2C digital communication in Arduino UNO R3?
1. D16, D17
2. D18, D19
3. A16, A17
4. A18, A19

PART 4

- Study and implementation of IoT AQM (2/5)
- Introduction to develop environment
- Explain IoT AQM MotoBlockly code step by step (1)

Arduino IDE environment

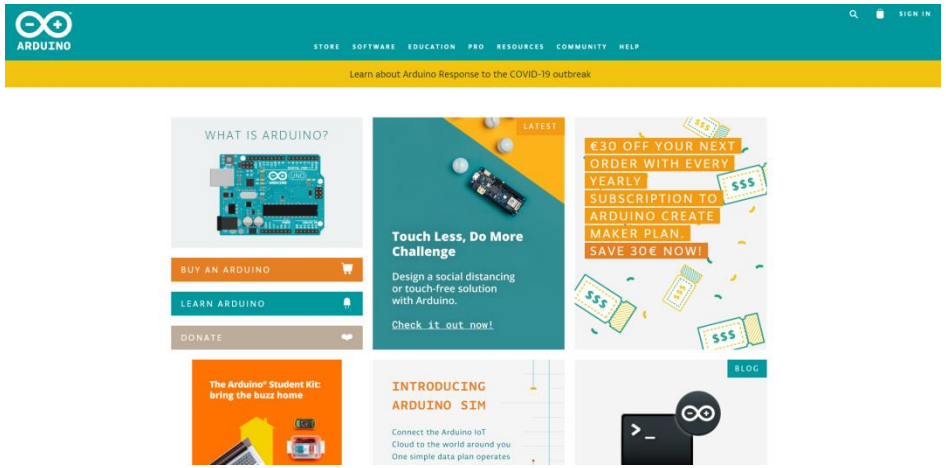
Compiler and upload code to Arduino



IDE = Integrated Development Environment

- **C (programming language) base envirement**
- **Simplify way to develop → use library include function**

You can check https://www.arduino.cc/ for further information

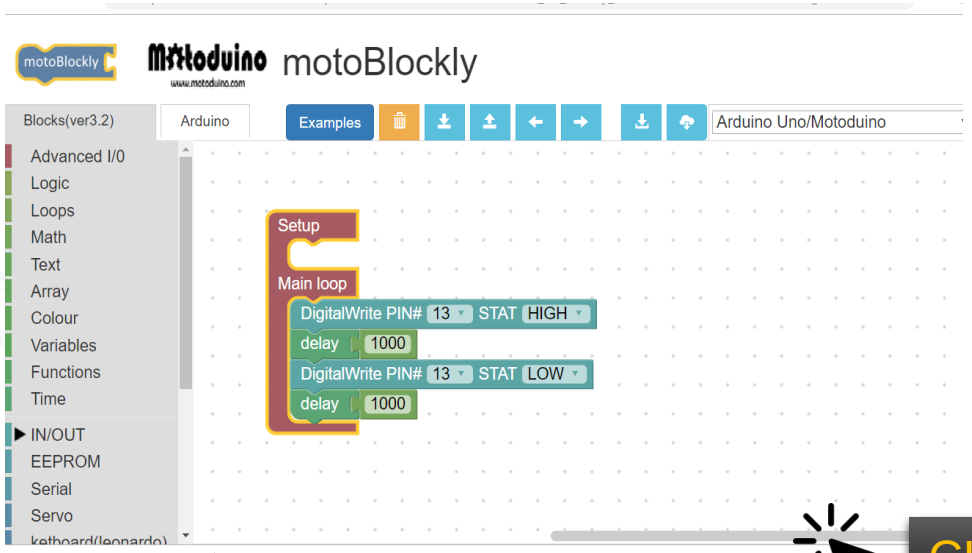


MotoBlockly environment

Simplify develop way for beginner : “Blockly”Build the code by using blocks

MotoBlockly : Clcick "MotoBlockly" icon on home page of https://www.motoduino.com/

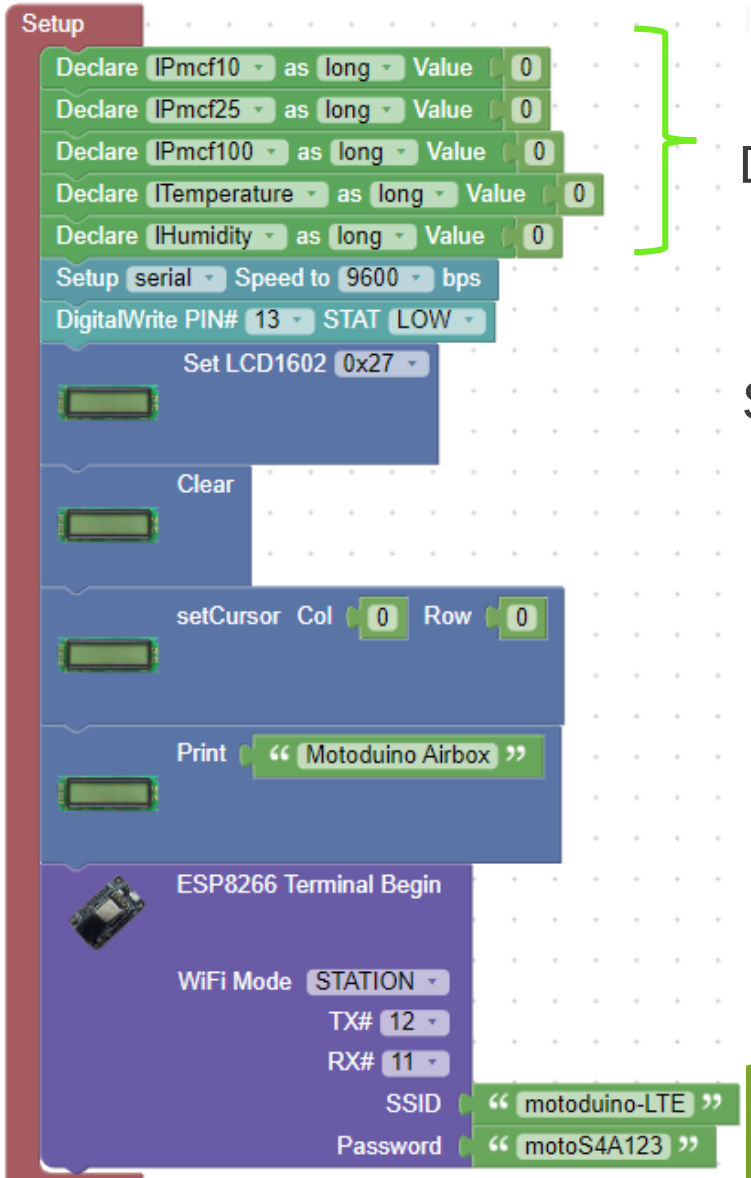
For Arduino/Motoduino/ESP8266 use only.



MotoBlockly (Example : LED Blink)

Arduino IDE

Explain IoT AQM MotoBlockly code step by step (1)



Variable set up and wifi set up

Define different variables so data from AQM can be storage.

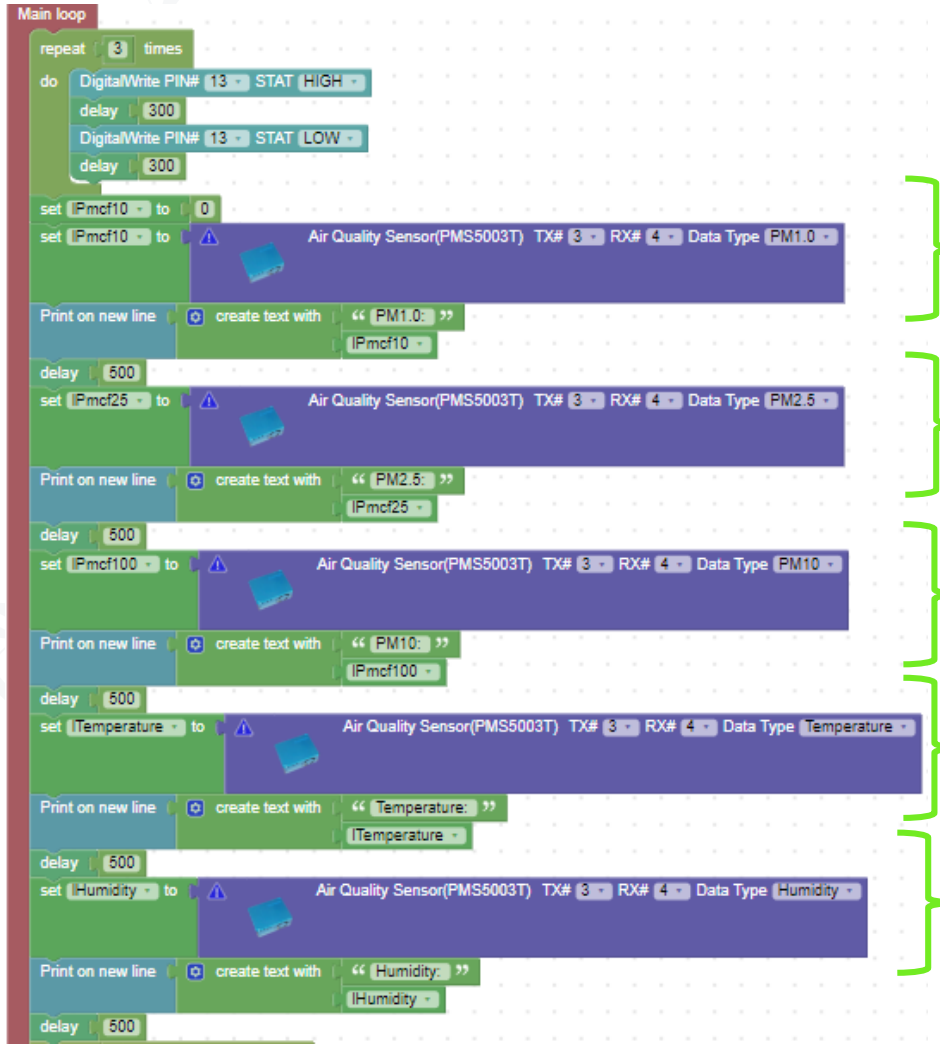
Set up LCD I2C address

Set up LCD text show location.

Make LCD show text.

Link to your WIFI to access internet

Explain IoT AQM MotoBlockly code step by step (1)



Main loop: storage data from AQM to variable

Get data from AQM and store in variable “IPmcf10”

Get data from AQM and store in variable “IPmcf25”

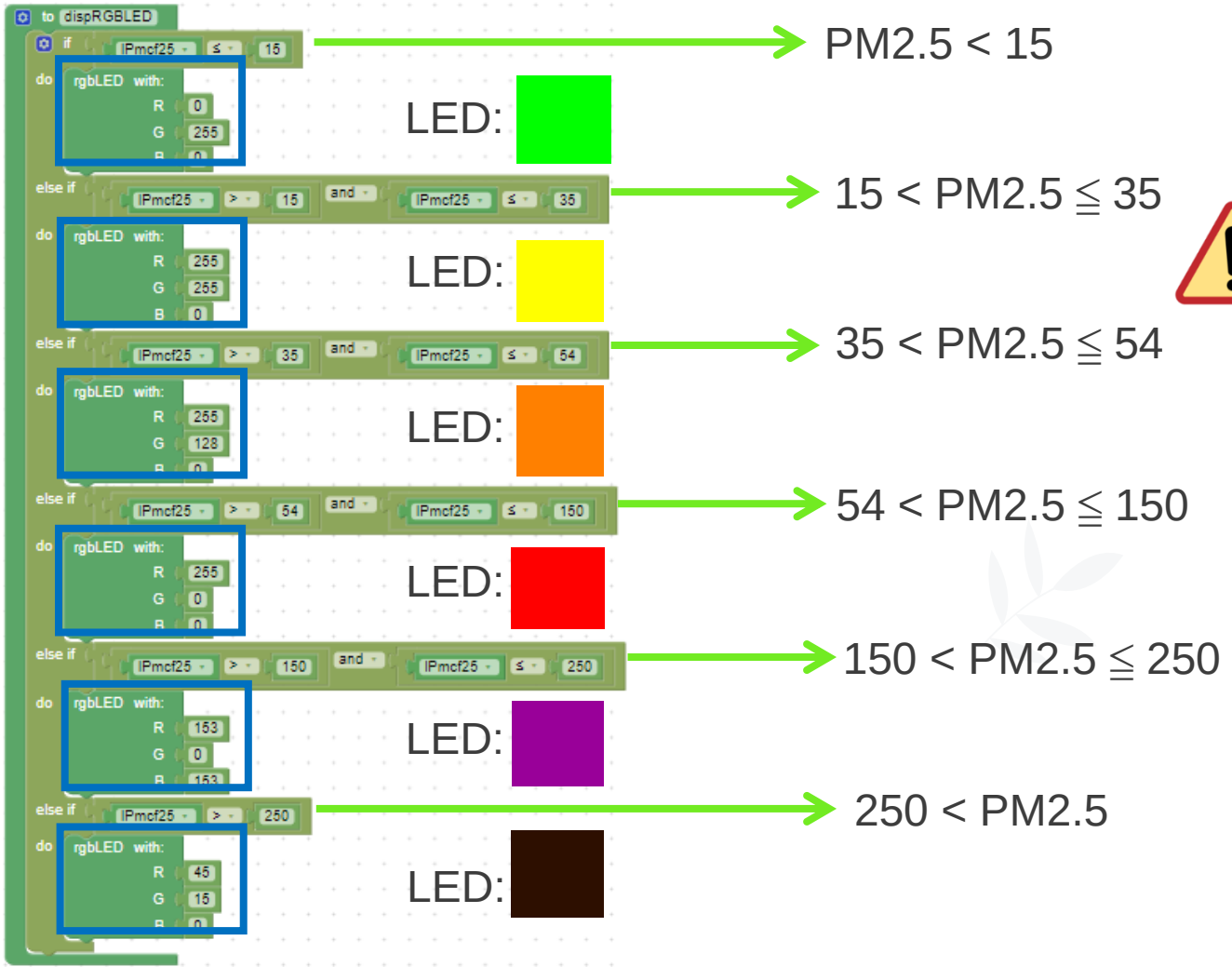
Store data in variable “IPmcf100”

Store data in variable “Temperature”

Store data in variable “Humidity”

Explain IoT AQM MotoBlockly code step by step (1)

Subroutine calls : RGB LED show different color as an indicator



PM2.5 < 15

LED:

15 < PM2.5 ≦ 35

LED:

35 < PM2.5 ≦ 54

LED:

54 < PM2.5 ≦ 150

LED:

150 < PM2.5 ≦ 250

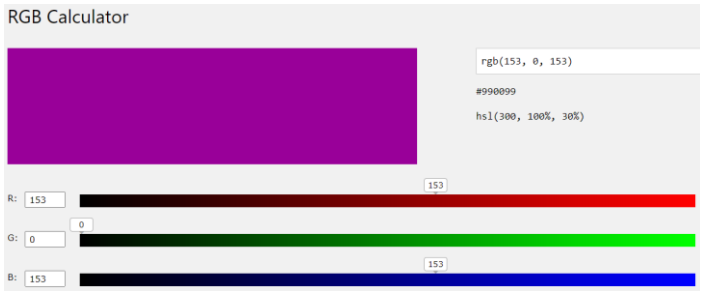
LED:

250 < PM2.5

LED:

Risk: Low **(1–3)** Moderate **(4–6)** High **(7–10)** Very high **(above 10)**

Note: You can use this website to know how to hybrid the LED color by CODE.
https://www.w3schools.com/colors/colors_rgb.asp



CLICK ME!

Week 2

Student of the Week Contest

Topic: Block Diagram / Creative IoT Applications

Project Description

Make an interesting example of IoT application, use BLOCK DIAGRAM to explain how and why it works which include all the connected components and devices.

Project Format

Block Diagram + Description + Hashtag

#STEAMup

#Studentoftheweek

Deadline

July 23rd, 12:00PM

Example of an interesting Iot Application:

"Stephen installs a camera and a machine water gun at his home front door. One day, Junaid come to visit Stephen and stood in front of the door, Stephen saw Junaid from the CCTV. Stephen pushed a button to launch the water gun and Junaid got wet.

***Note:** You can see the "Block Diagram" example in Lesson 3 PPT slide p12 to create your own BLOCK DIAGRAM. This PPT is free to use and can be downloaded on Corelab.*

3 Winner, 3 Prizes:
Air Quality Monitor Box

MENTOR: Stephen Chen

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Steam Up 2gether – Lesson 3

Getting Started with Arduino and IoT Applications

Thank You !

July 21st, 2020

Stephen Chen & Junaid