陽明交大
NYCU

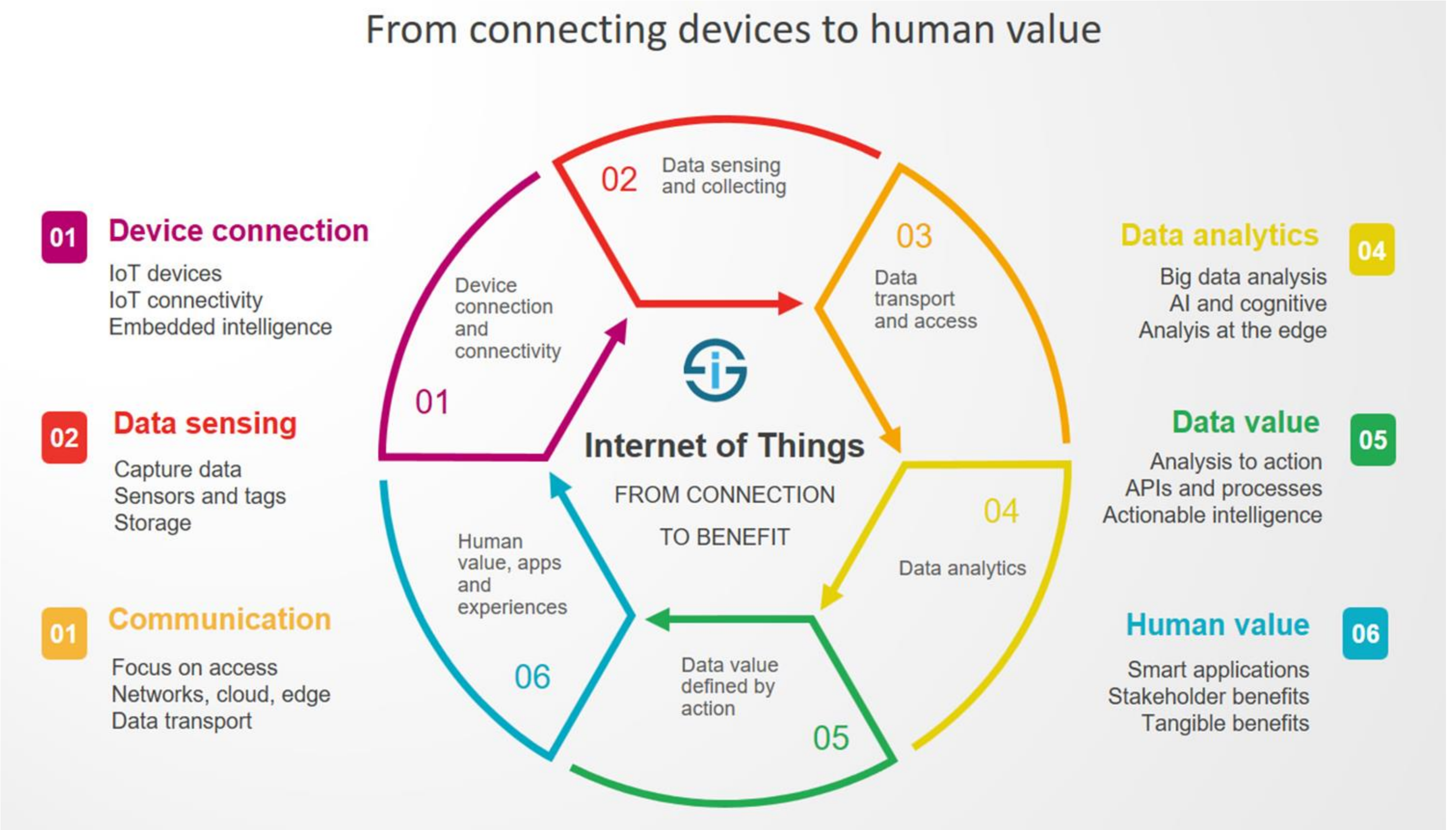
物聯網裝置與平台
IoT Devices and Platforms

曾煜棋、吳昆儒

National Yang Ming Chiao Tung University

What is IoT?

- Finding Human value from connecting devices
  - Collecting data from **sensors** via **Internet**.

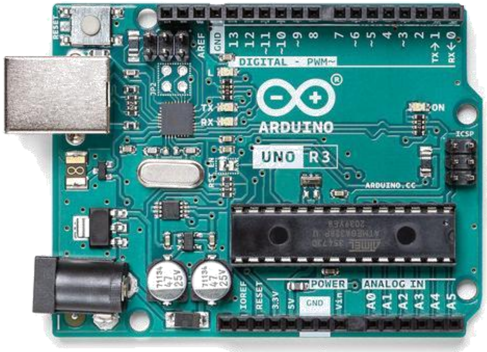


https://www.i-scoop.eu/internet-of-things/

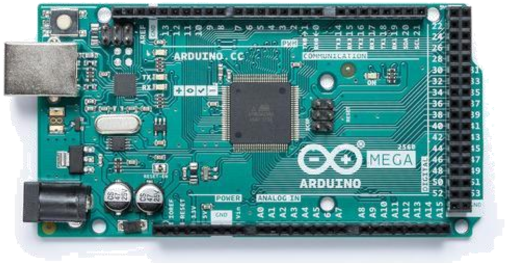
Arduino

https://store-usa.arduino.cc/collections/boards

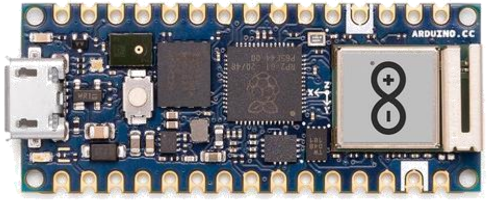
Arduino boards



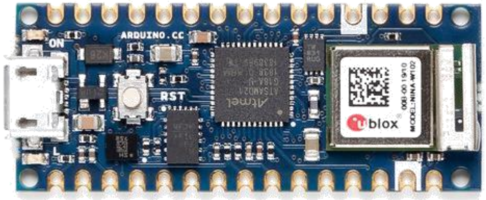
Arduino Uno Rev3



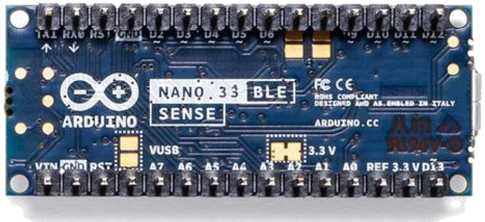
Arduino Mega 2560 Rev3



Arduino Nano RP2040 Connect



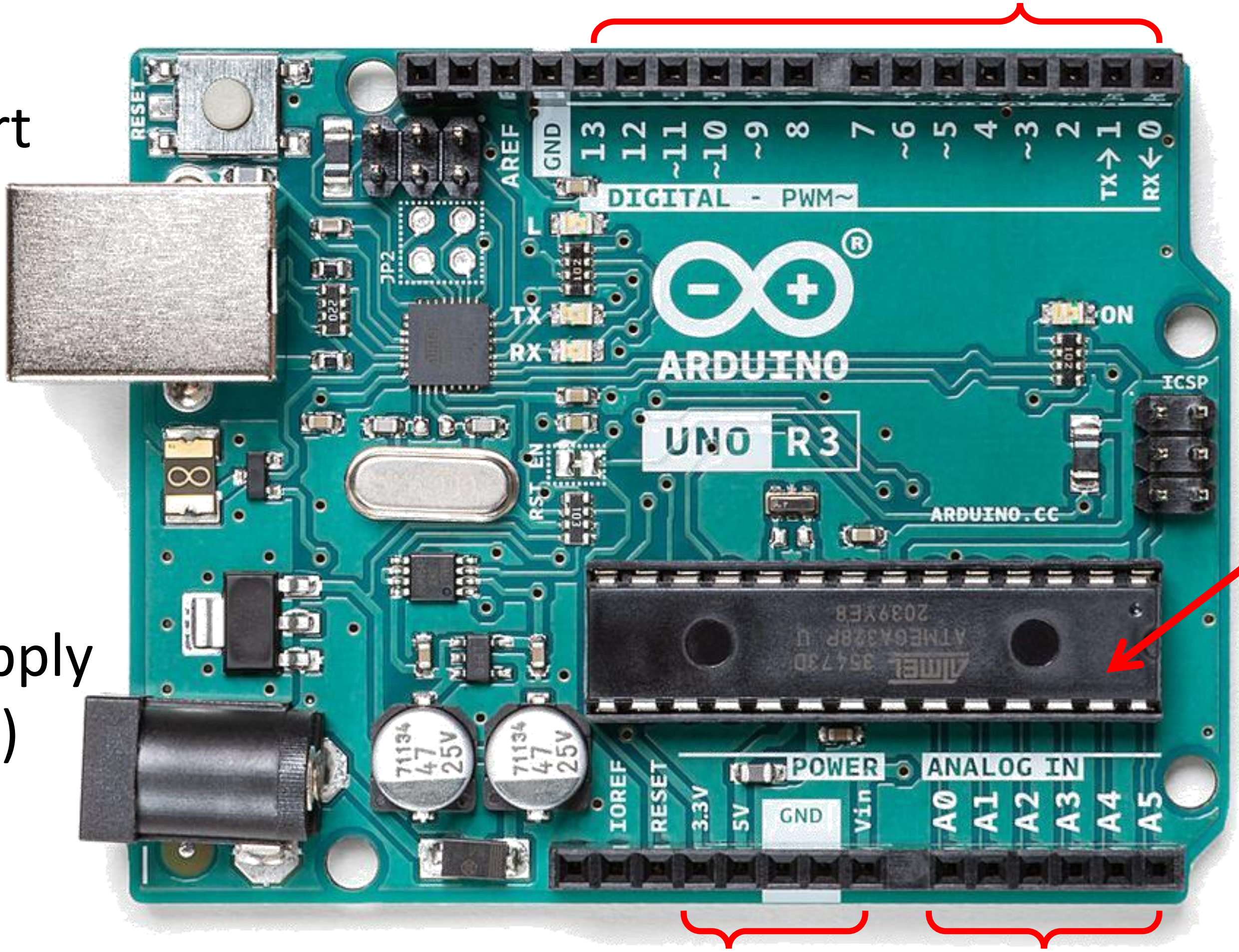
Arduino Nano 33 IoT



Arduino Nano 33 BLE Sense

Arduino MKR ZERO

Arduino uno rev3



Digital In/Out Pins

USB Port

Atmega328p

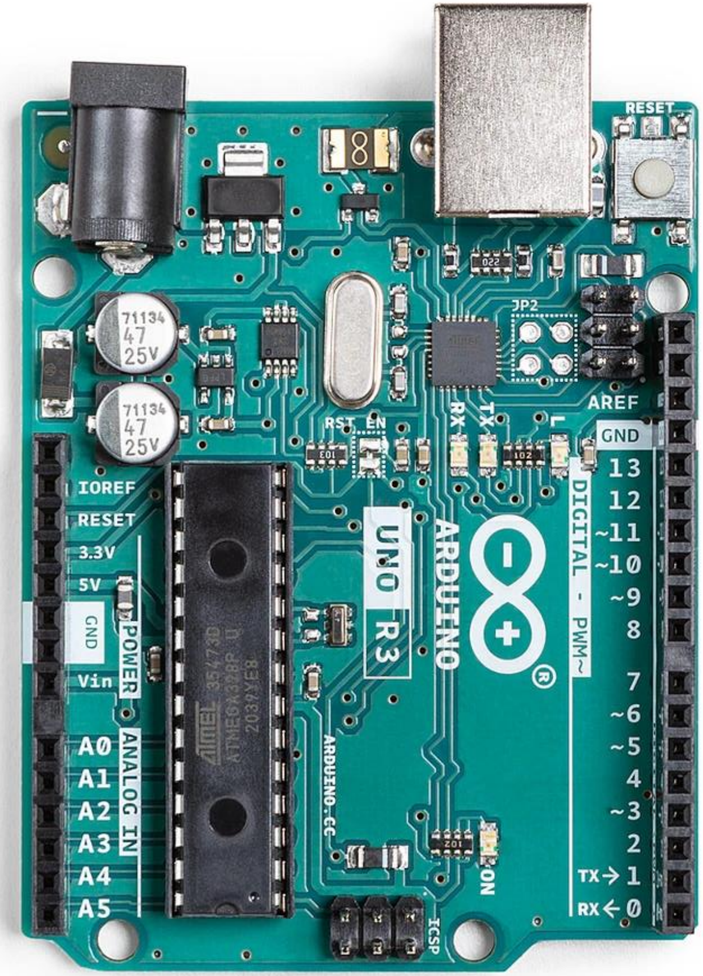
Power Supply
(7~12V)

Power Pins

Analog Input Pins

https://store-usa.arduino.cc/collections/boards/products/arduino-uno-rev3

Tech specs

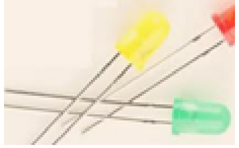


MICROCONTROLLER	ATmega328P
OPERATING VOLTAGE	5V
INPUT VOLTAGE (RECOMMENDED)	7-12V
INPUT VOLTAGE (LIMIT)	6-20V
DIGITAL I/O PINS	14 (of which 6 provide PWM output)
PWM DIGITAL I/O PINS	6
ANALOG INPUT PINS	6
DC CURRENT PER I/O PIN	20 mA
DC CURRENT FOR 3.3V PIN	50 mA
FLASH MEMORY	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
CLOCK SPEED	16 MHz
LED_BUILTIN	13
LENGTH	68.6 mm
WIDTH	53.4 mm
WEIGHT	25 g

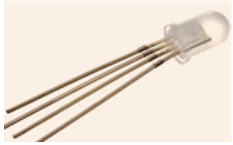
Arduino package

Arduino UNO

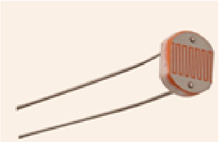
LED



RGB LED



Photocell
光敏電阻



Button Switch

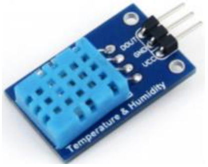
Potentiometer
可變電阻

Speaker

超音波 Ultrasonic
HC-SR04

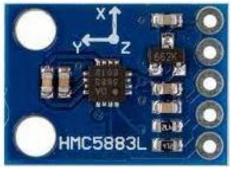
伺服馬達 Servo motor
SG-90

溫溼度
DHT11



氣壓計
BMP180

電子羅盤
HMC-5883L



加速度&陀螺儀
MPU-6050

人體紅外線
HC-SR505

心率感測
xd-58c

聲音感測器
KY-038

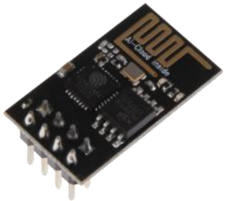
細懸浮微粒感測
PPD42NS

水位感測器

通訊模組 Bluetooth
HM-10

通訊模組 LoRa

通訊模組 WiFi
ESP8266

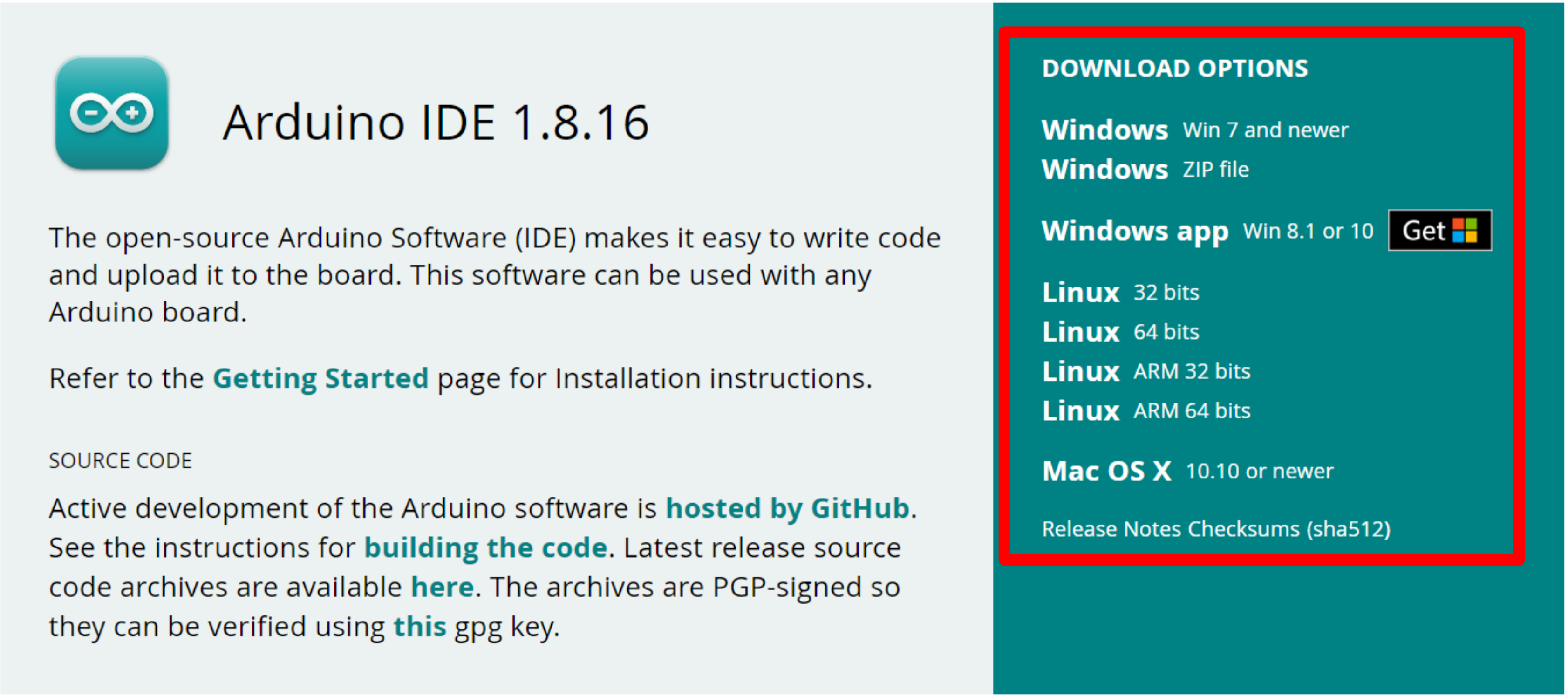


Arduino IDE

Before using Arduino

https://www.arduino.cc/en/software

Download Arduino IDE according to your OS



Arduino IDE 1.8.16

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

Refer to the **Getting Started** page for Installation instructions.

SOURCE CODE

Active development of the Arduino software is **hosted by GitHub**. See the instructions for **building the code**. Latest release source code archives are available **here**. The archives are PGP-signed so they can be verified using **this** gpg key.

DOWNLOAD OPTIONS

Windows Win 7 and newer
Windows ZIP file

Windows app Win 8.1 or 10 Get

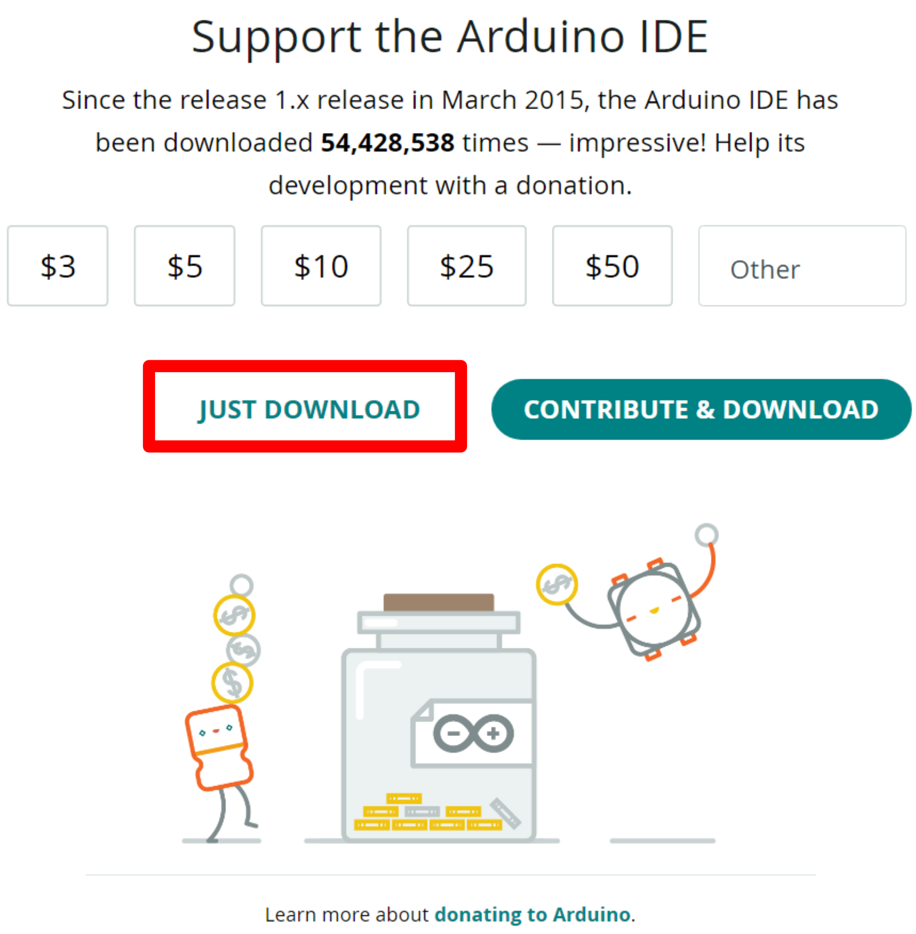
Linux 32 bits
Linux 64 bits
Linux ARM 32 bits
Linux ARM 64 bits

Mac OS X 10.10 or newer

Release Notes Checksums (sha512)

[Highly recommend] Bring your laptop to this class.

Download Arduino IDE



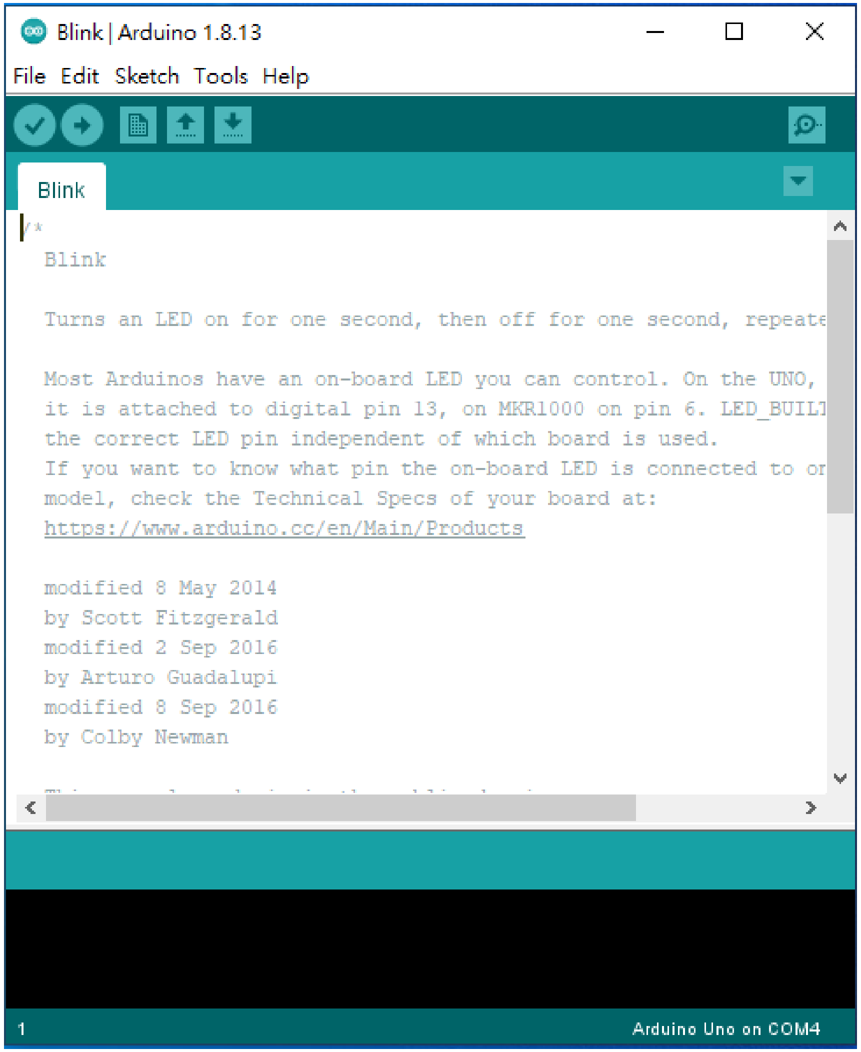
Support the Arduino IDE

Since the release 1.x release in March 2015, the Arduino IDE has been downloaded **54,428,538** times — impressive! Help its development with a donation.

Learn more about **donating to Arduino**.

Arduino IDE

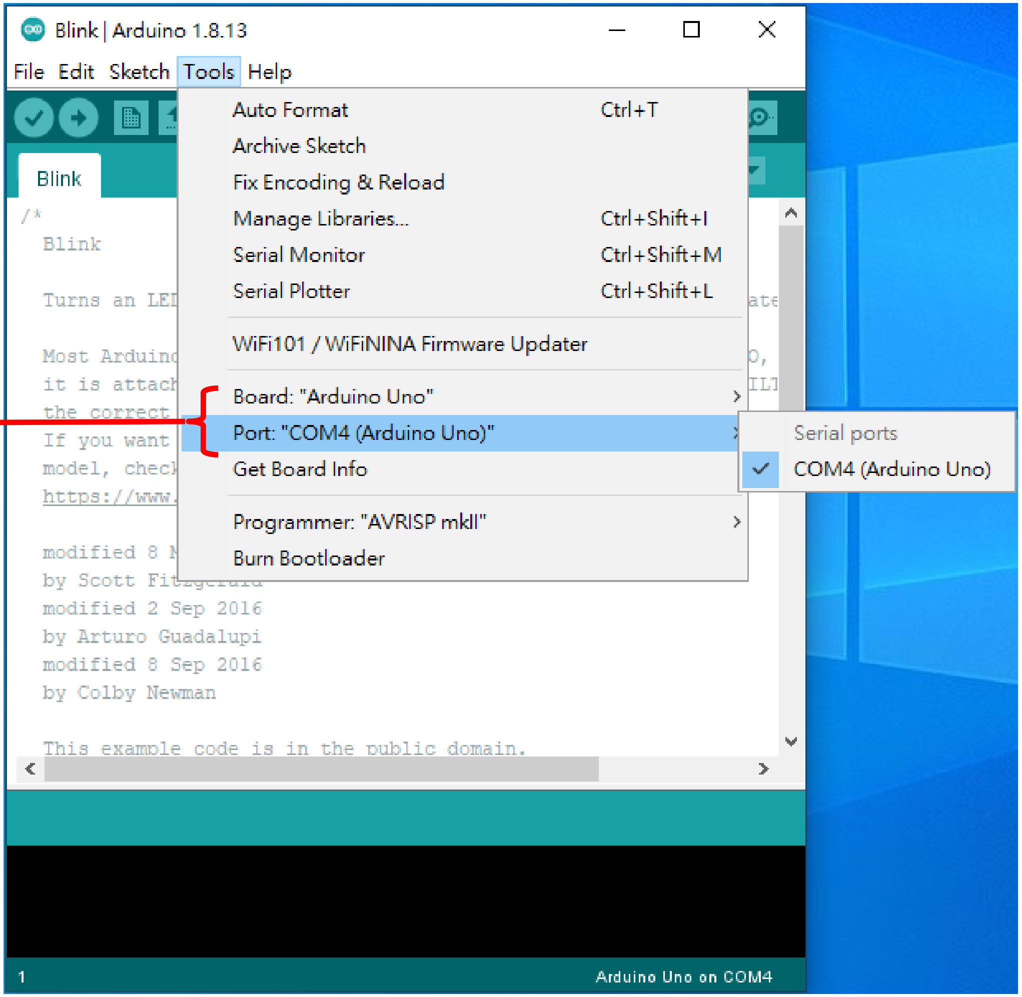
- □ Open Source
- □ Cross Platform
  - □ Windows
  - □ Mac OS X
  - □ Linux
- □ Simple UI
  (Easy to Use)



```
/*
  Blink

  Turns an LED on for one second, then off for one second, repeate

  Most Arduinos have an on-board LED you can control. On the UNO,
  it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILT
  the correct LED pin independent of which board is used.
  If you want to know what pin the on-board LED is connected to or
  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
```

Arduino IDE

Set “Arduino Uno”!!



Blink | Arduino 1.8.13

File Edit Sketch Tools Help

- Auto Format — Ctrl+T
- Archive Sketch
- Fix Encoding & Reload
- Manage Libraries... — Ctrl+Shift+I
- Serial Monitor — Ctrl+Shift+M
- Serial Plotter — Ctrl+Shift+L
- WiFi101 / WiFiNINA Firmware Updater
- Board: "Arduino Uno"
- Port: "COM4 (Arduino Uno)"
  - Serial ports
  - ✓ COM4 (Arduino Uno)
- Get Board Info
- Programmer: "AVRISP mkII"
- Burn Bootloader

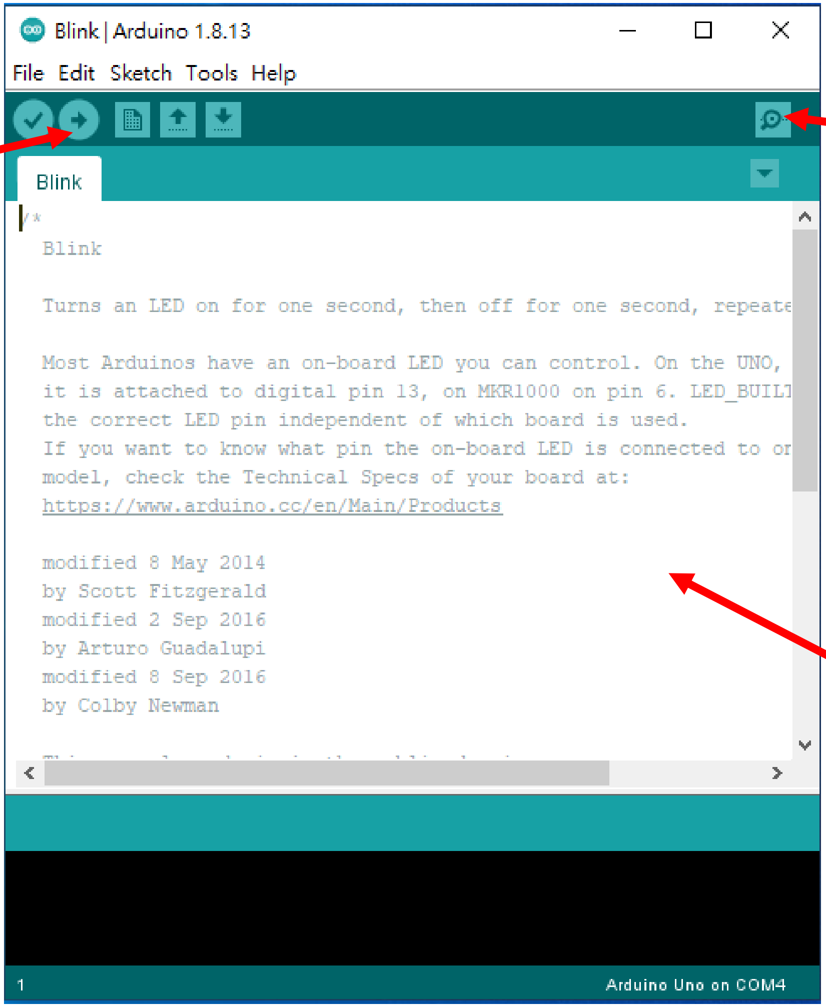
Blink

```
/*
  Blink

  Turns an LED                                                    ate

  Most Arduino                                                    O,
  it is attach                                                    ILT
  the correct
  If you want
  model, check
  https://www.

  modified 8 M
  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.
```

1 Arduino Uno on COM4

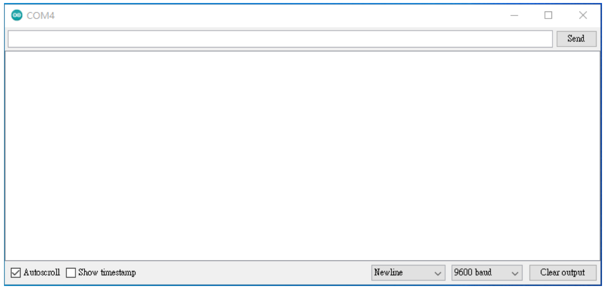
Arduino IDE

Upload code



```
/*
  Blink

  Turns an LED on for one second, then off for one second, repeate

  Most Arduinos have an on-board LED you can control. On the UNO,
  it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILT
  the correct LED pin independent of which board is used.
  If you want to know what pin the on-board LED is connected to or
  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
```

Open terminal
(Serial Monitor)



Write your code

Labs

□ After installing Arduino IDE (with Arduino board driver)

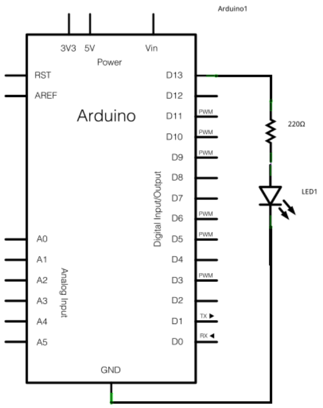
1. Blink: Turn an LED on and off.
2. DigitalReadSerial: Read a switch, print the state to serial monitor in Arduino IDE.
3. AnalogReadSerial: Read a potentiometer, print its state to the serial monitor.
4. ReadAnalogVoltage: Reads an analog input and prints the voltage to the serial monitor
5. Fade: Turn a analog pin on and off very quickly with different ratio between on and off

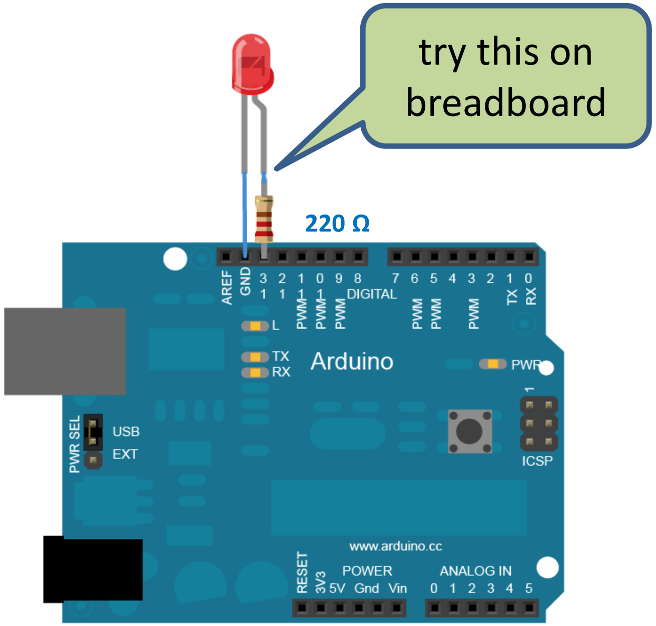
Lab1. Blink:

Turn an LED on and off.

Lab 1. Blink

- □ Goal: shows the simplest thing you can do with an Arduino to see physical output
- □ Output: it blinks an LED.
- □ Hardware Required:
  - □ Arduino Board
  - □ LED
  - □ a 220 ohm resistor



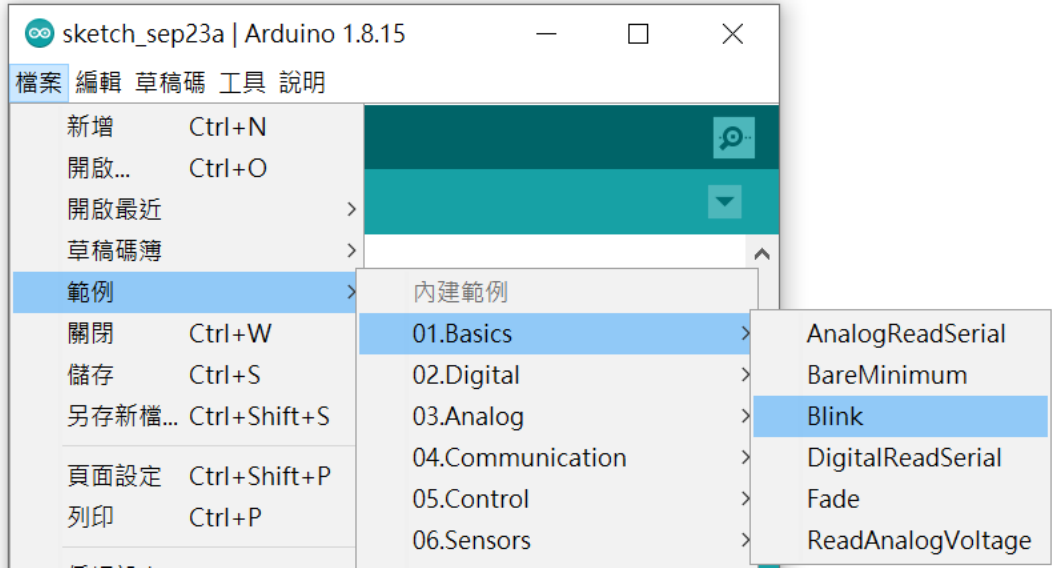

220 Ω
AREF GND 13 12 11 10 9 8 DIGITAL 7 6 5 4 3 2 1 0 TX RX
PWM
L
TX
RX
Arduino
PWR
ICSP
PWR SEL
USB
EXT
www.arduino.cc
RESET 3V3 5V Gnd Vin POWER
ANALOG IN 0 1 2 3 4 5

try this on breadboard

Lab 1. Blink

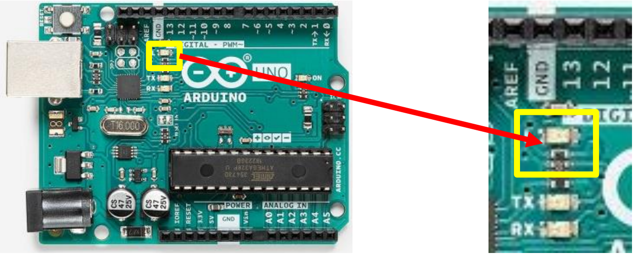
Arduino IDE

Open--->File--->Examples--->Basic--->Blink



Built-in Sample Code:

```
// 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
}
```



LED_BUILTIN: It is a pre-defined parameter that you can’t change it. (Usually, it is 13)

Modified Code

```
// give it a name:
int led = 12;            // change the digital output to pin 12

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin 12 as an output.
  pinMode(led, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite (led, HIGH);    // turn the LED on (HIGH is the voltage level)
  delay(1000);                 // wait for a second
  digitalWrite (led, LOW);     // turn the LED off by making the voltage LOW
  delay(1000);                 // wait for a second
}
```

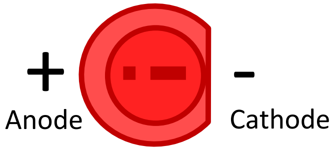
Lab 1. Syntax

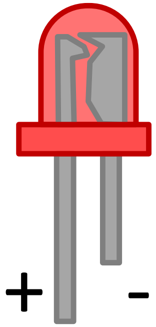
- Syntax
  - pinMode(pin, mode)
- Parameters
  - pin: the number of the pin whose mode you wish to set
  - mode: INPUT, OUTPUT, or INPUT_PULLUP
- Example
  - pinMode(13, OUTPUT);   // pin 13, OUTPUT mode

Lab 1. Syntax

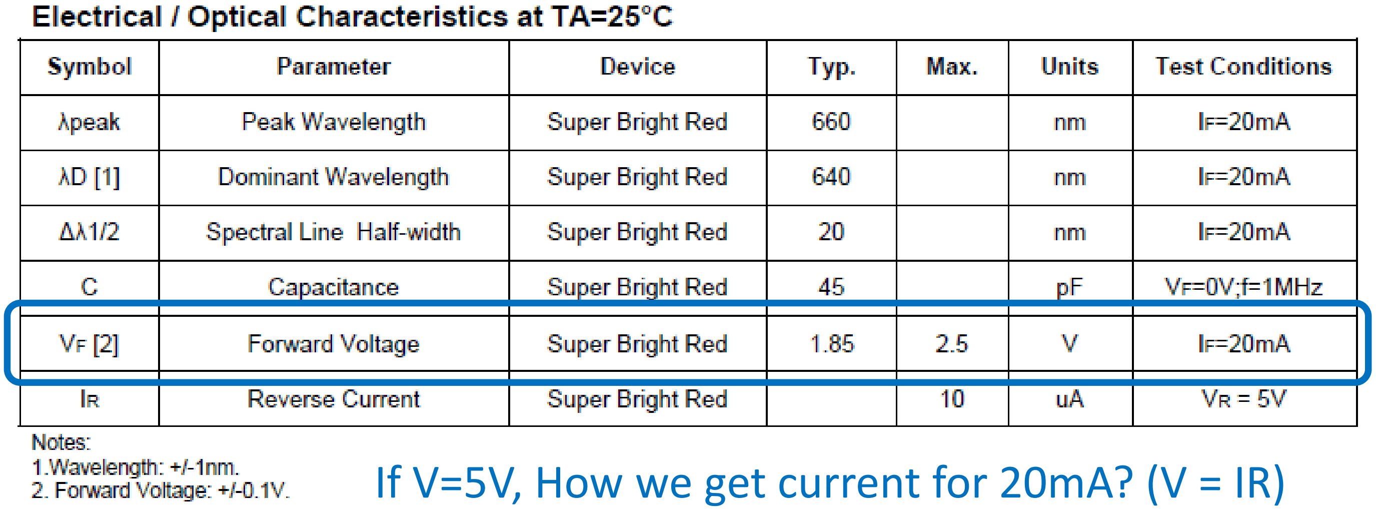
- Syntax
  - digitalWrite(pin, value)
    - Write a HIGH or a LOW value to a digital pin
- Parameters
  - pin: the pin number
  - value: HIGH or LOW
- Example
  - digitalWrite(13, HIGH);
  - digitalWrite(13, LOW);

LED intro





- The **LED** (**L**ight **E**mitting **D**iode) is a simple, digital **actuator**
- LEDs have a **short leg** (-) and a **long leg** (+) and it matters how they are oriented in a circuit
- To prevent damage, LEDs are used together with a **resistor**



Electrical / Optical Characteristics at TA=25°C

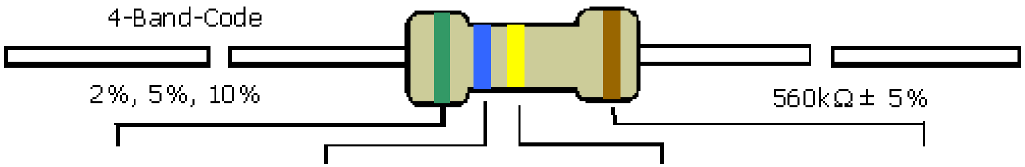
Symbol	Parameter	Device	Typ.	Max.	Units	Test Conditions
λpeak	Peak Wavelength	Super Bright Red	660		nm	IF=20mA
λD [1]	Dominant Wavelength	Super Bright Red	640		nm	IF=20mA
Δλ1/2	Spectral Line Half-width	Super Bright Red	20		nm	IF=20mA
C	Capacitance	Super Bright Red	45		pF	VF=0V;f=1MHz
VF [2]	Forward Voltage	Super Bright Red	1.85	2.5	V	IF=20mA
IR	Reverse Current	Super Bright Red		10	uA	VR = 5V

Notes:
1.Wavelength: +/-1nm.
2. Forward Voltage: +/-0.1V.

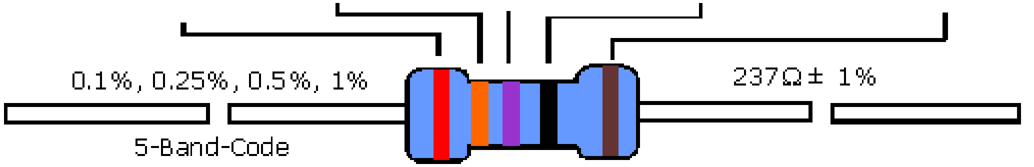
If V=5V, How we get current for 20mA? (V = IR)

LED 串聯電阻計算器: https://www.digikey.tw/zh/resources/conversion-calculators/conversion-calculator-led-series-resistor

Resistor



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

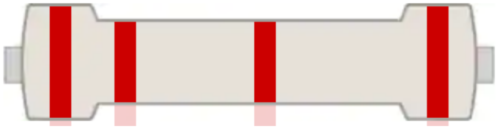


Ex: 20KΩ = Red, Black, Orange = 20*1000 (4-band)
= Red, Black, Black, Red = 200*100 (5-band)

Discussion 1

- □ Why do usually we put a resistor with LED?
  If we do not put the resistor, what will happen?

- □ For a 4-band resistor with all red, what is the resistor value?



Lab2. DigitalReadSerial:

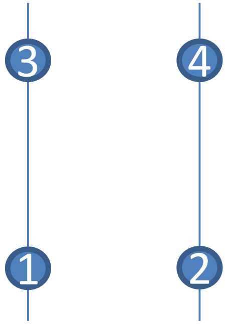
Read a switch, print the state to serial monitor in Arduino IDE.

Lab 2. Digital Read Serial

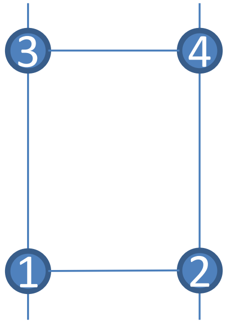
- Goal: how to monitor the state of a button by establishing serial communication between your Arduino and your computer over USB.
- Hardware Required
  - Arduino Board
  - A momentary switch, button, or toggle switch
  - 10k ohm resistor
  - breadboard
  - hook-up wire

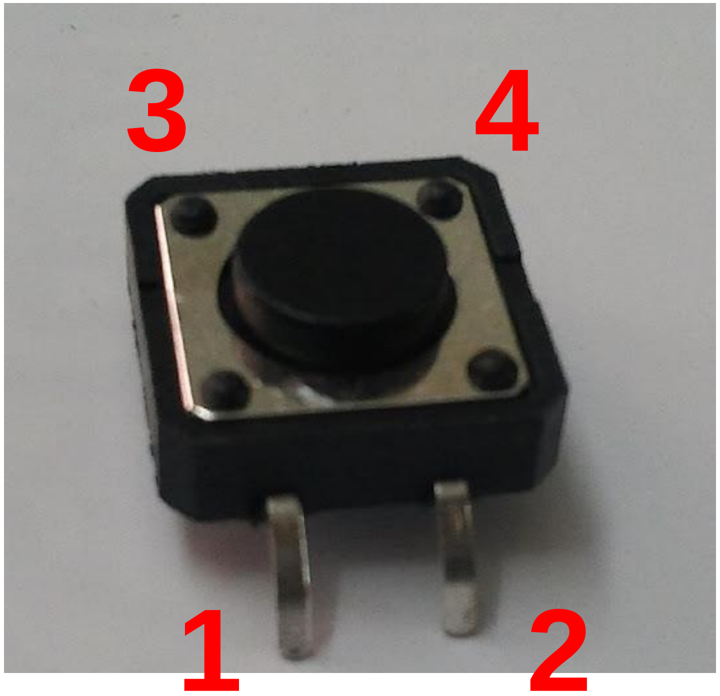
Lab 2. Digital Read Serial

- There are 4 pins in a button.
- What is the relationship between these pins?
  - Before press

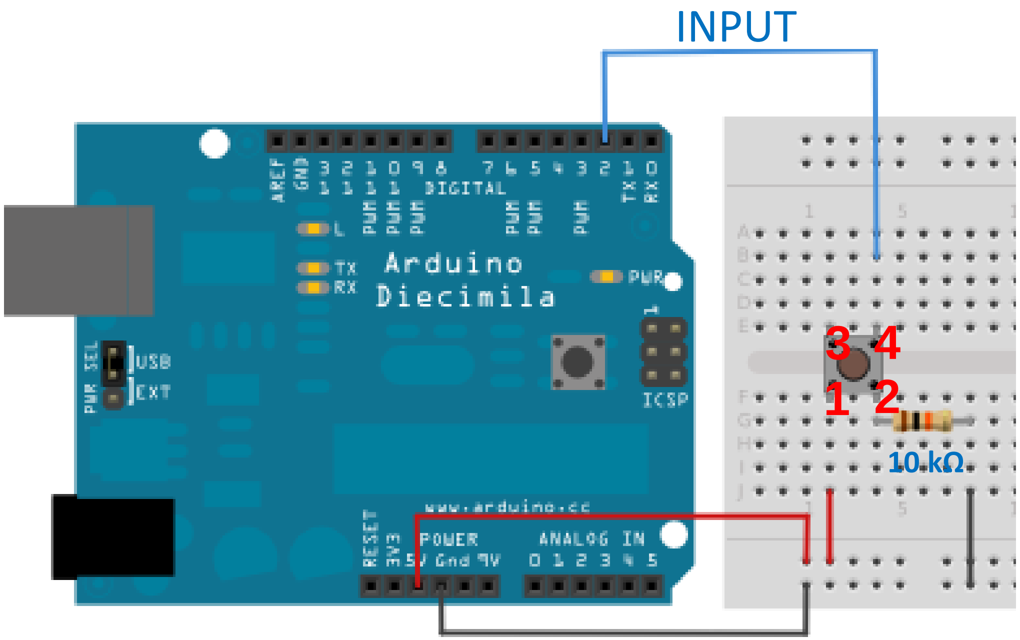


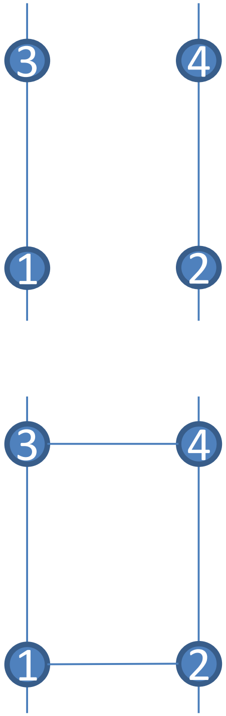
  - After press





Lab 2. Digital Read Serial

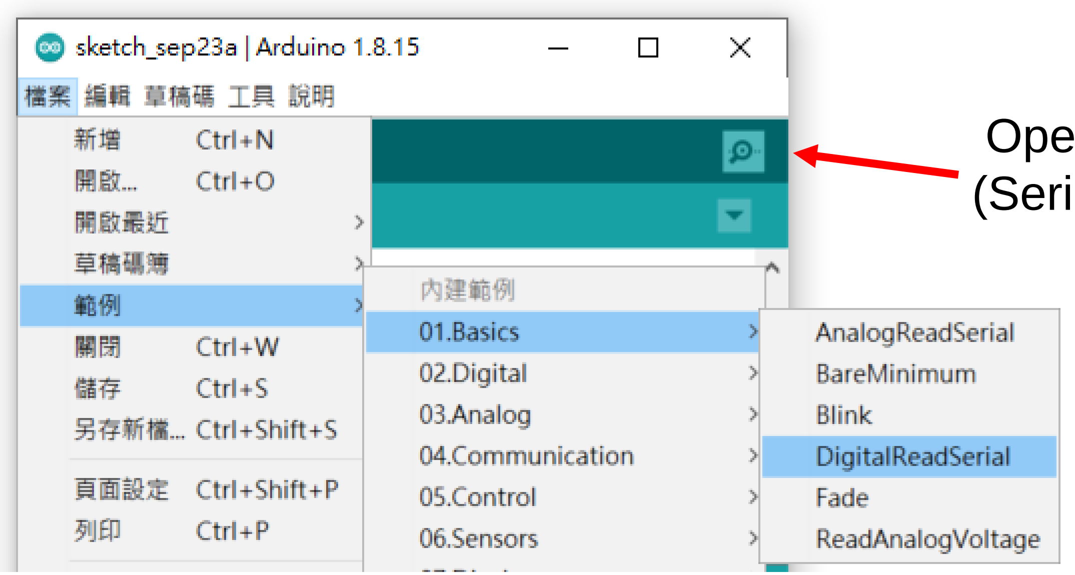




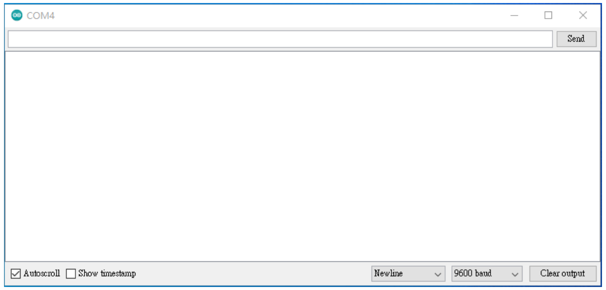
Lab 2. Digital Read Serial

Arduino IDE

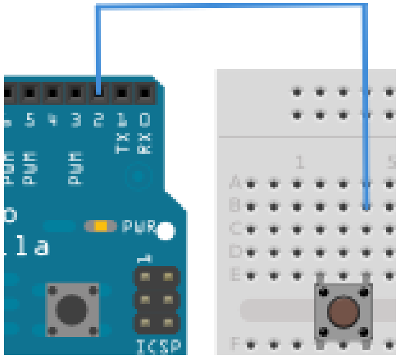
Open--->File--->Examples--->Basic---> DigitalReadSerial



Open terminal (Serial Monitor)



Built-in Sample Code:



```
// digital pin 2 has a pushbutton attached to it. Give it a name:
int pushButton = 2;
```

```
void setup() {
 Serial.begin(9600);     // initialize serial communication at 9600 bits/s
 pinMode(pushButton, INPUT);    // make the pushbutton's pin an input
}

void loop() {
 int buttonState = digitalRead(pushButton);    // read the input pin
 Serial.println(buttonState);     // print out the state of the button:
 delay(1);        // delay in between reads for stability
}
```

Lab 2. Syntax

- Syntax
  - digitalRead(pin)
- Parameters
  - pin: the number of the digital pin you want to read (int)
  - Returns value: HIGH or LOW
- Example
  - val = digitalRead(13);

Discussion 2

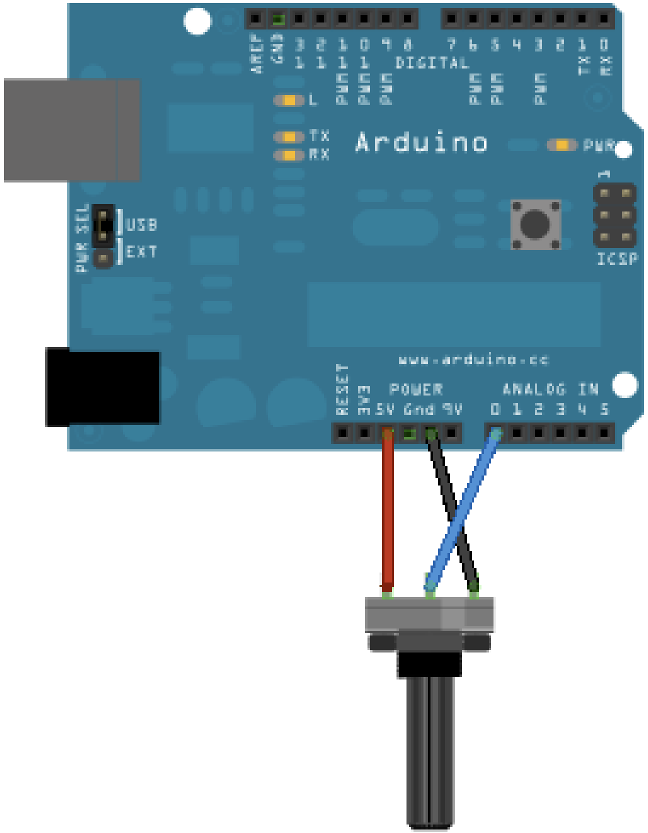
- Please draw a line chart to show the button state (before/after press button).

Lab3. AnalogReadSerial:

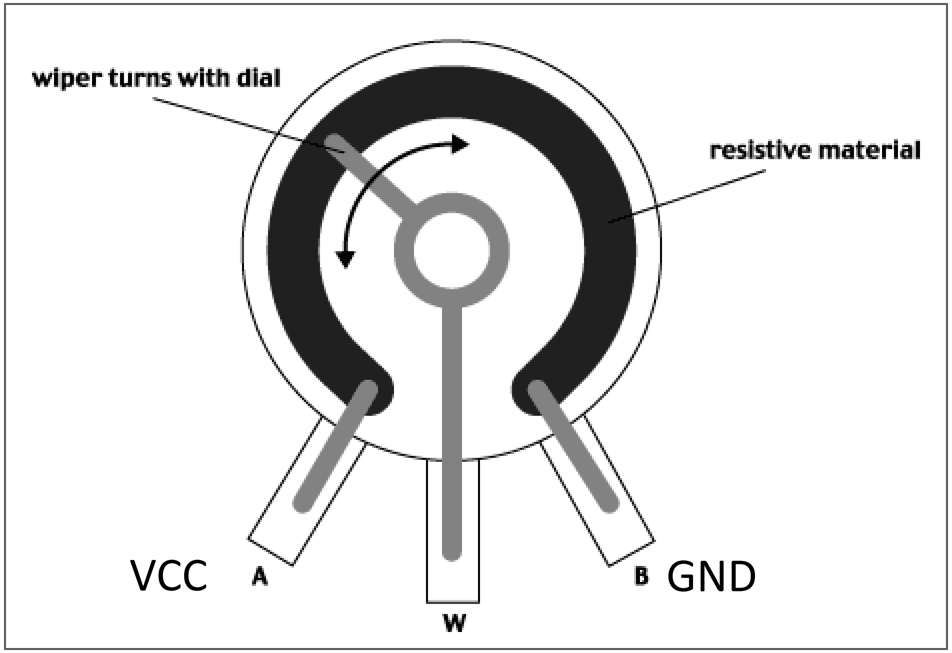
Read a potentiometer, print its state to the serial monitor.

Lab 3. AnalogReadSerial

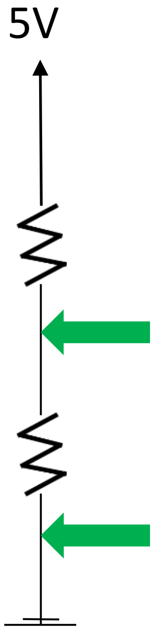
- Goal: shows you how to read analog input from the physical world using a potentiometer.
- Hardware Required
  - Arduino Board
  - 10-kilohm Potentiometer



Lab 3. AnalogReadSerial



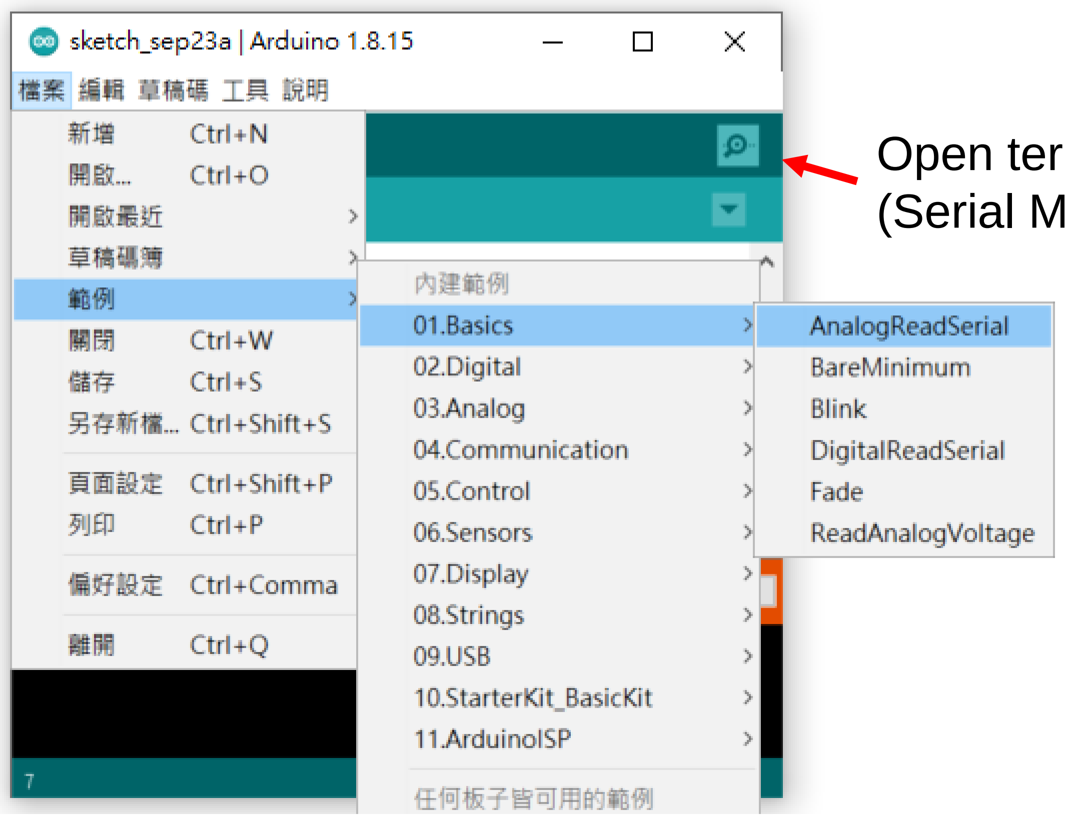
Read potential value



Lab 3. AnalogReadSerial

Arduino IDE

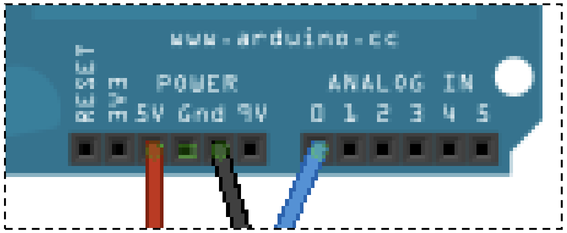
Open--->File--->Examples--->Basic---> AnalogReadSerial

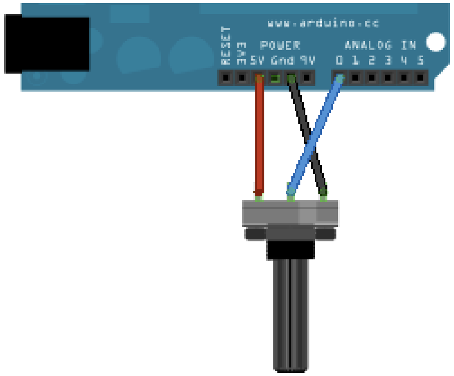


Open terminal
(Serial Monitor)

Built-in Sample Code:

```
// the setup routine runs once when you press reset:
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

// the loop routine runs over and over again forever:
void loop() {
  // read the input on analog pin 0:
  int sensorValue = analogRead(A0);

  // print out the value you read:
  Serial.println(sensorValue);
  delay(1);        // delay in between reads for stability
}
```





Lab 3. Syntax

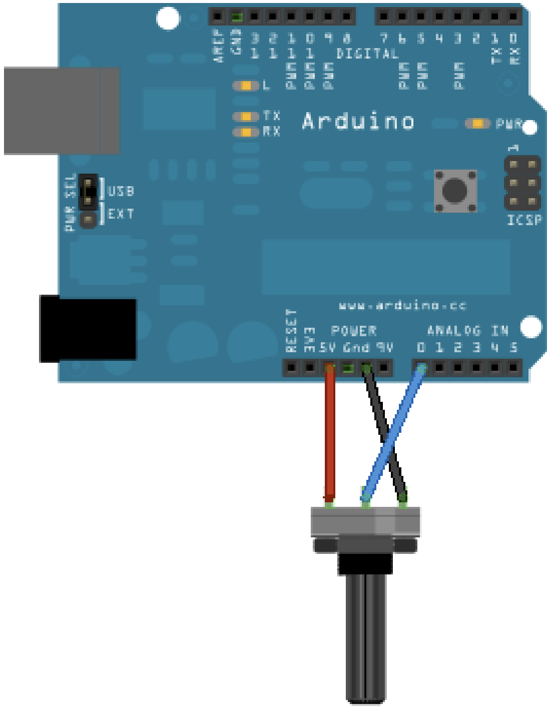
- Syntax
  - analogRead(pin)
- Description
  - 10-bit analog to digital converter.
  - Map input voltages 0~5 volts ---> 0~1023.
  - Resolution: 5 volts / 1024 or, 0.0049 volts per unit.
- Returns
  - int (0 to 1023)
- Example
  - value = analogRead(3);

Lab4. ReadAnalogVoltage:

Reads an analog input and prints the voltage to the serial monitor.

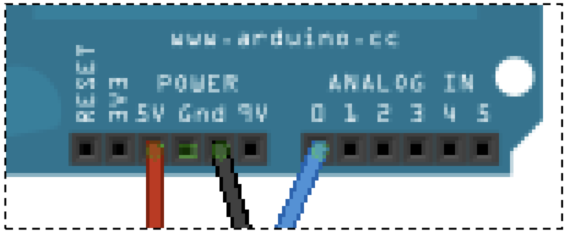
Lab 4. Analog Read Voltage

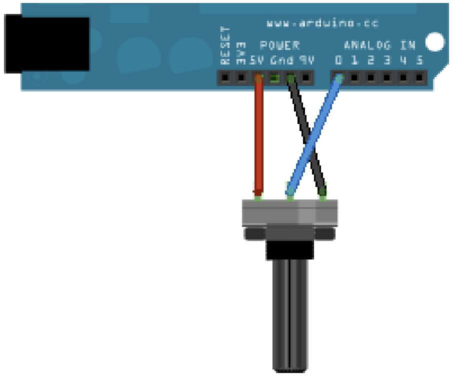
- Goal: shows you how to read an analog input on Pin 0, convert the values from analogRead() into voltage, and print it out to the serial monitor.
- Hardware Required
  - Arduino Board
  - Potentiometer



Built-in Sample Code:

```
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
}

void loop() {
  // read the input on analog pin 0
  int sensorValue = analogRead(A0);

  // Convert the analog reading (which goes from 0 - 1023)
  // to a voltage (0 - 5V)
  float voltage = sensorValue * (5.0 / 1023.0);

  Serial.println(voltage);   // print out the value you read:
}
```





Discussion 3

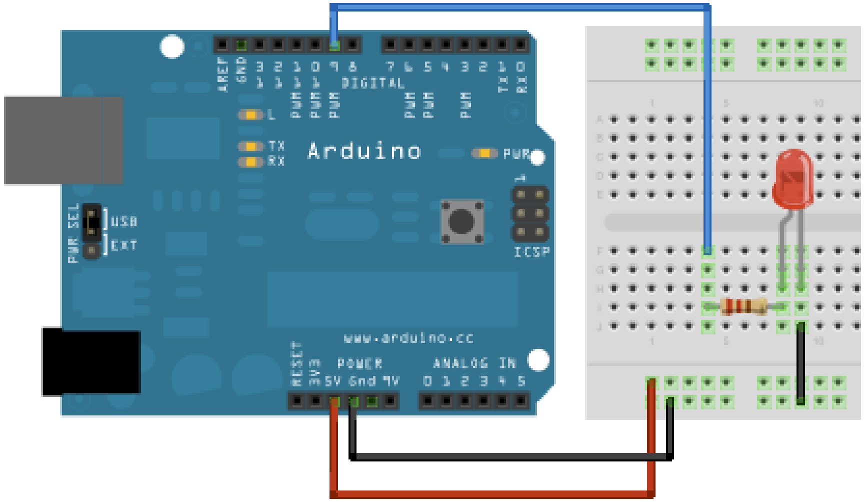
- Can we map the input voltage into finer range?
  - Current: Map input voltages 0~5 volts ---> 0~1023

Lab5. Fade :

Turn a analog pin on and off very quickly with different ratio between on and off

Lab 5. Fade

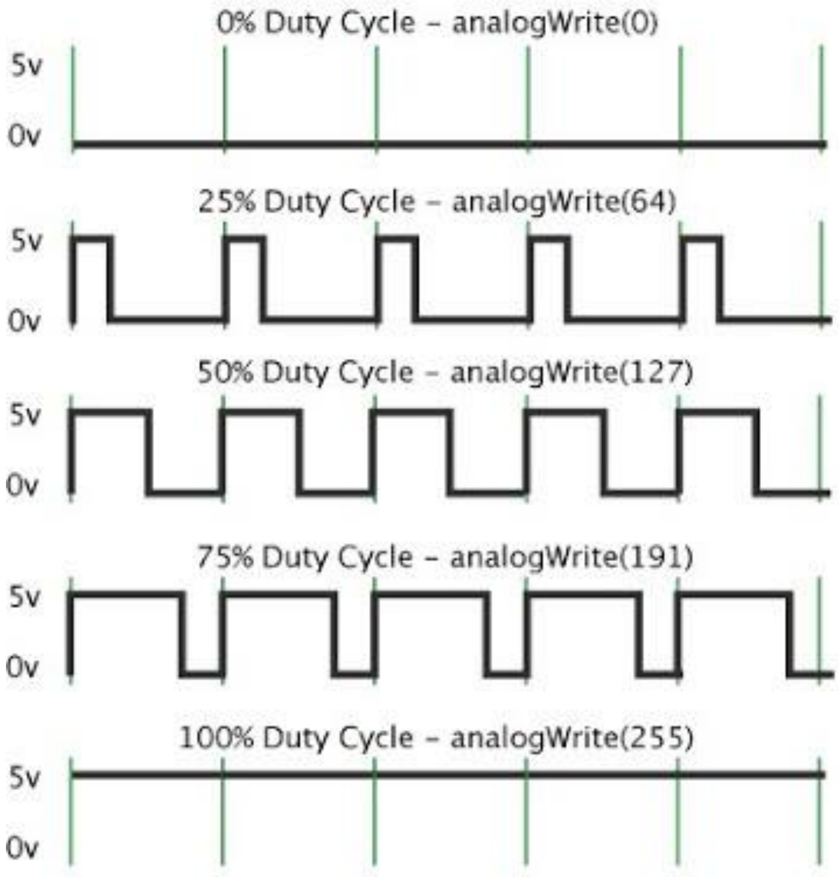
- Goal: Demonstrates the use of the analogWrite() function in fading an LED off and on. AnalogWrite uses pulse width modulation (PWM~), turning a analog pin on and off very quickly, to create a fading effect.
- Hardware Required
  - Arduino board
  - Breadboard
  - a LED
  - a 220 ohm resistor



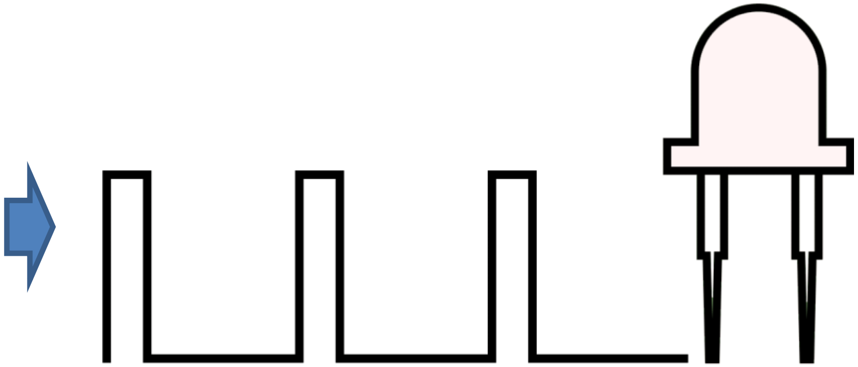
(you can skip 5V here)

Lab 5. Fade

PWM: Pulse Width Modulation



Darkness



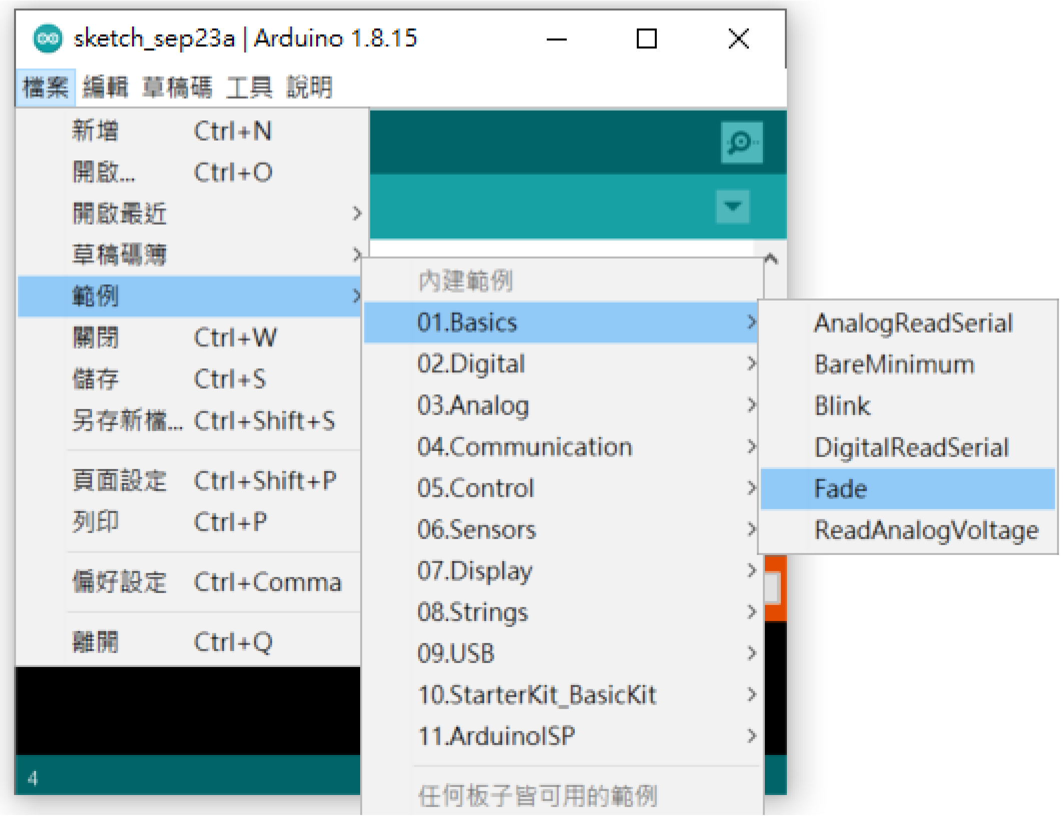
Brightness

http://yehnan.blogspot.tw/2012/02/arduino_16.html
http://www.electronicwings.com/pic/pic18f4550-pwm

Lab 5. Fade

Arduino IDE

Open--->File--->Examples--->Basic--->Fade

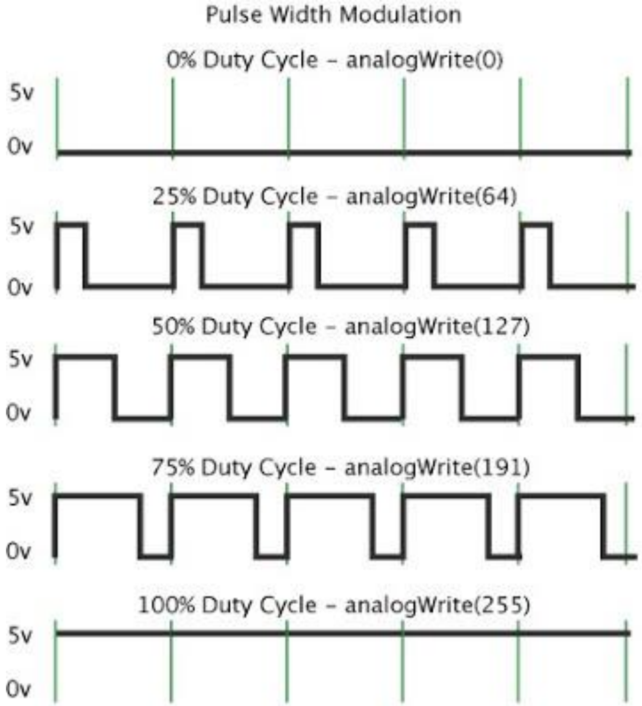


Built-in Sample Code:

```
int led = 9;          // the pin that the LED is attached to
int brightness = 0;    // how bright the LED is
int fadeAmount = 5;    // how many points to fade the LED by

void setup()  {
 pinMode(led, OUTPUT);   // declare pin 9 to be an output
 }

void loop()  {
 analogWrite(led, brightness);    // set the brightness of pin 9

 // change the brightness for next time through the loop:
 brightness = brightness + fadeAmount;

 // reverse the direction of the fading at the ends of the fade:
 if (brightness <= 0 || brightness >= 255) {
  fadeAmount = -fadeAmount ;            // If it's -5, then it's set to 5.
  }
 delay(30);       // wait for 30 milliseconds to see the dimming effect
}
```

Lab 5. Syntax

- Syntax
  - analogWrite(pin, value)
- Parameters
  - pin: the pin number
  - value: the duty cycle: between 0 (always off) and 255 (always on)
- Example
  - analogWrite(3, 255)


Pulse Width Modulation
0% Duty Cycle - analogWrite(0)
5v
0v
25% Duty Cycle - analogWrite(64)
5v
0v
50% Duty Cycle - analogWrite(127)
5v
0v
75% Duty Cycle - analogWrite(191)
5v
0v
100% Duty Cycle - analogWrite(255)
5v
0v

Discussion 4

- Is it possible to watch the fade effect by our eyes? If yes, how to watch?

線上demo

Discord

Discord

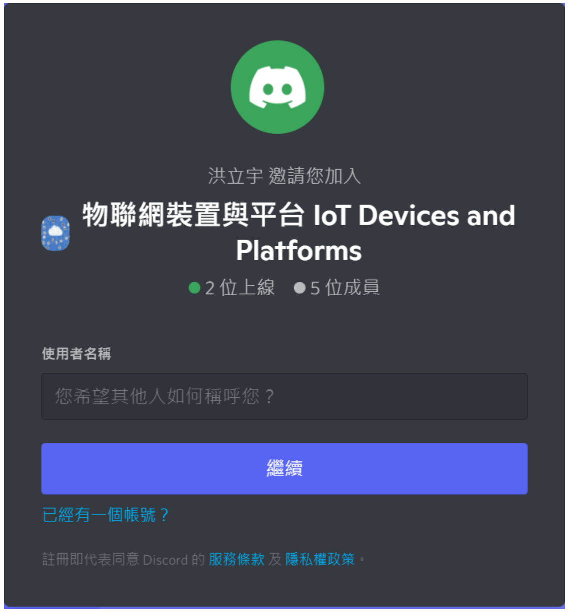
- □ Download: https://discord.com/download
- □ Server Link: https://discord.gg/sXX9pVNh

任何裝置都能取得
DISCORD

冒險正等著您。在我們的電腦版上與好友混在一起，並在手機上繼續對話。

Tutorial

- □ Create an user name: ID/Name
- □ ex: 30955xxxx/OOO



洪立宇 邀請您加入

物聯網裝置與平台 IoT Devices and Platforms

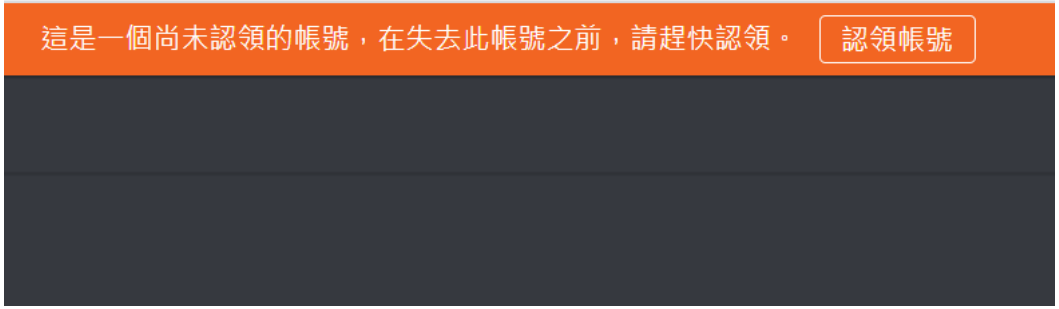
●2 位上線 ●5 位成員

使用者名稱

您希望其他人如何稱呼您？

已經有一個帳號？

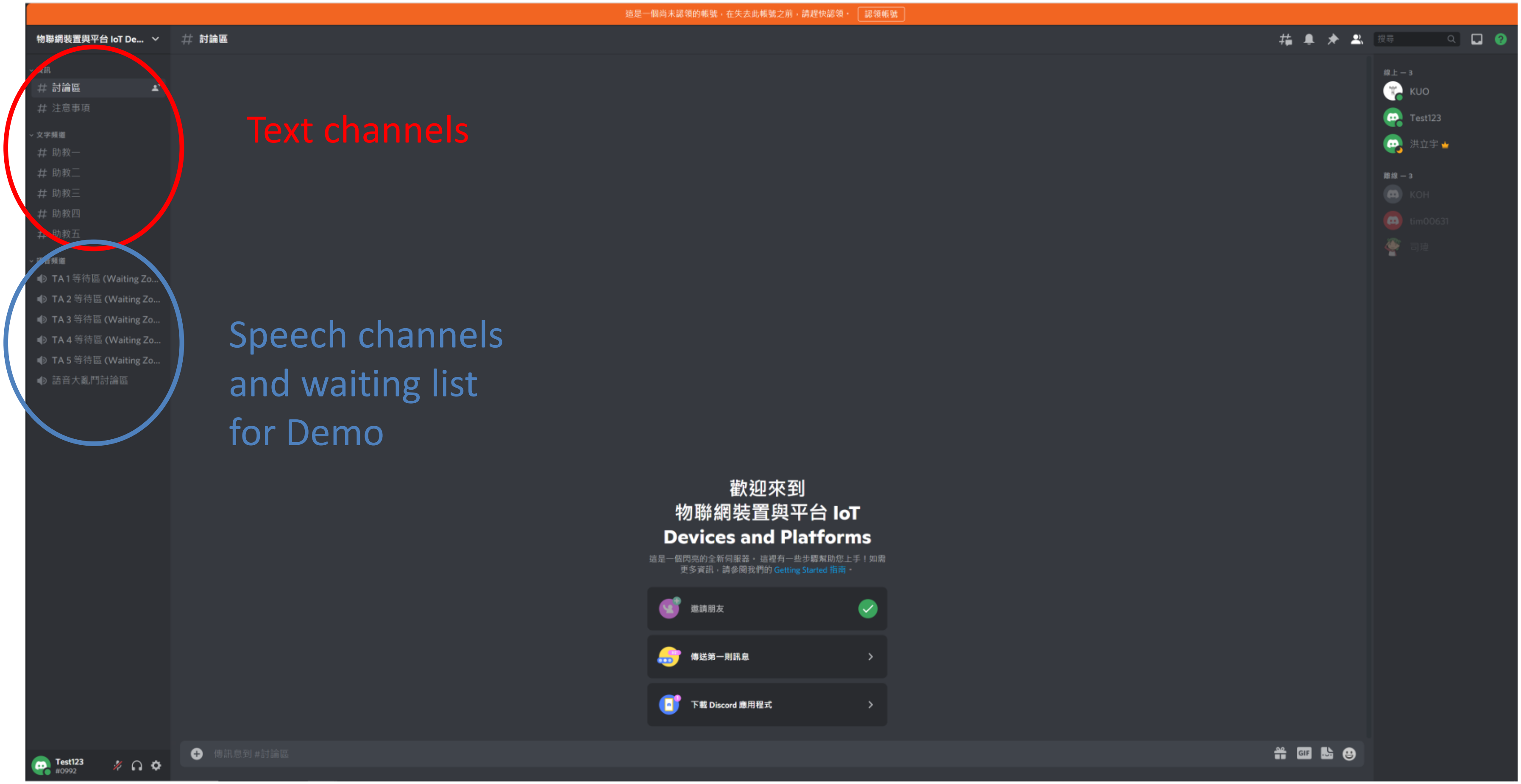
註冊即代表同意 Discord 的 服務條款 及 隱私權政策。



這是一個尚未認領的帳號，在失去此帳號之前，請趕快認領。

Tutorial

□ Enter the server



這是一個尚未認領的帳號，在失去此帳號之前，請趕快認領。 認領帳號

物聯網裝置與平台 IoT De...

資訊

# 討論區

# 注意事項

文字頻道

# 助教一

# 助教二

# 助教三

# 助教四

# 助教五

語音頻道

TA 1 等待區 (Waiting Zo...

TA 2 等待區 (Waiting Zo...

TA 3 等待區 (Waiting Zo...

TA 4 等待區 (Waiting Zo...

TA 5 等待區 (Waiting Zo...

語音大亂鬥討論區

Test123
#0992

# 討論區

搜尋

線上 — 3

KUO

Test123

洪立宇

離線 — 3

KOH

tim00631

司瑋

歡迎來到
物聯網裝置與平台 IoT
Devices and Platforms

這是一個閃亮的全新伺服器。 這裡有一些步驟幫助您上手！如需更多資訊，請參閱我們的 Getting Started 指南。

邀請朋友 ✓

傳送第一則訊息 >

下載 Discord 應用程式 >

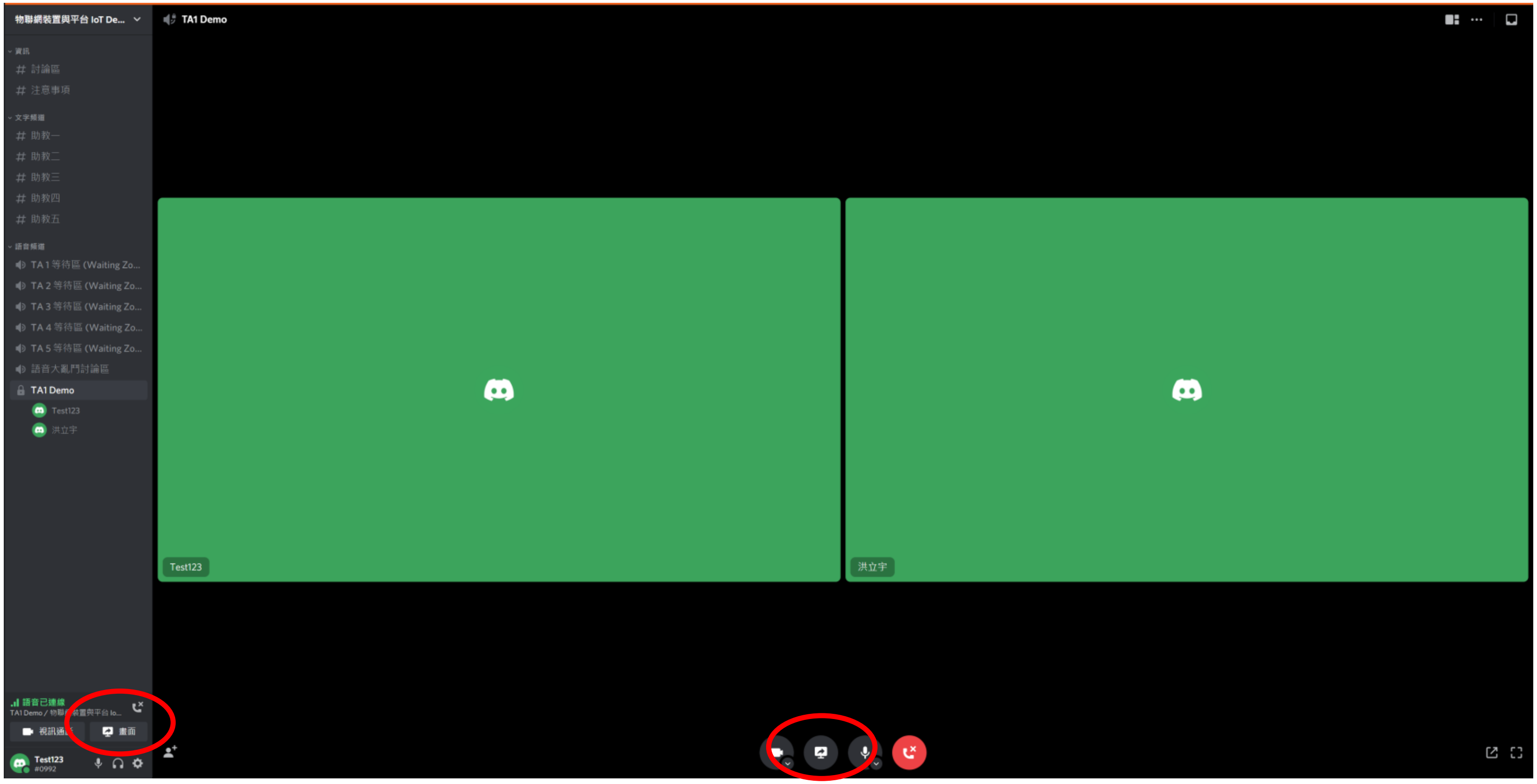
傳訊息到 #討論區

Text channels

Speech channels and waiting list for Demo

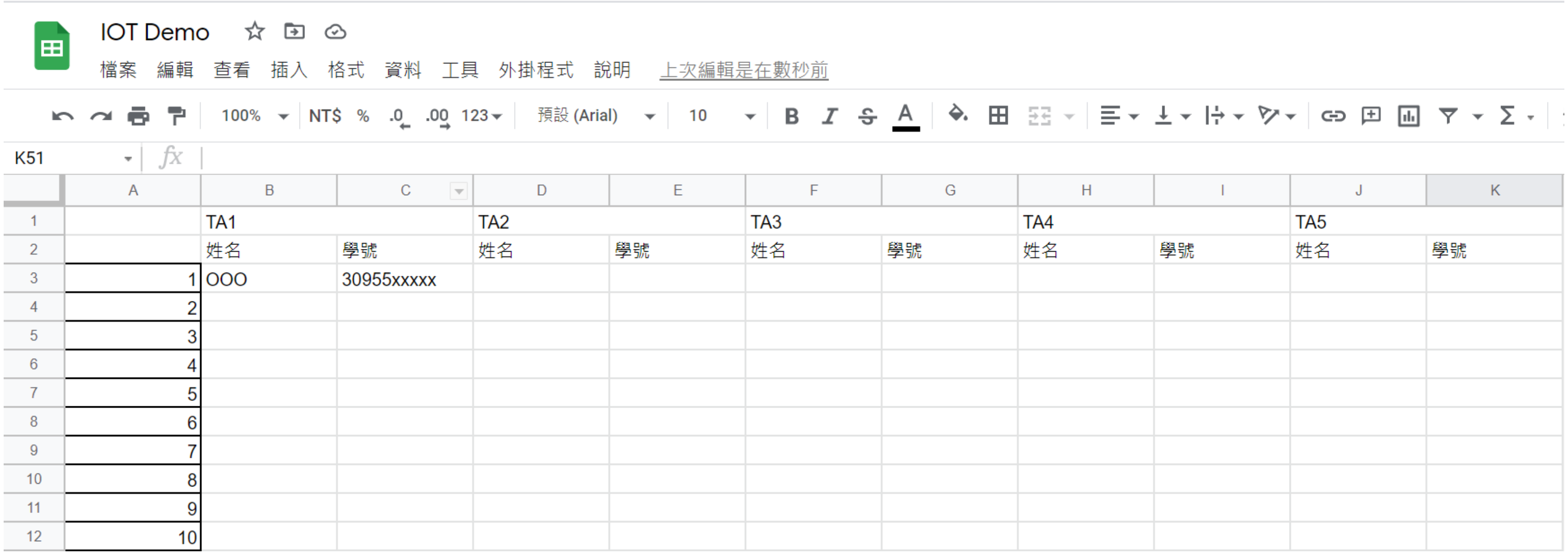
Tutorial

- □ Pull to private demo channel by TAs
- □ Share screen and Demo


物聯網裝置與平台 IoT De...
TA1 Demo
資訊
# 討論區
# 注意事項
文字頻道
# 助教一
# 助教二
# 助教三
# 助教四
# 助教五
語音頻道
TA 1 等待區 (Waiting Zo...
TA 2 等待區 (Waiting Zo...
TA 3 等待區 (Waiting Zo...
TA 4 等待區 (Waiting Zo...
TA 5 等待區 (Waiting Zo...
語音大亂鬥討論區
TA1 Demo
Test123
洪立宇
語音已連線
TA1 Demo / 物聯網裝置與平台 Io...
視訊通話
畫面
Test123
#0992
Test123
洪立宇

Demo

- □ Separated to groups for each TA
- □ Demo time: until 3:20
- □ 補demo will be at the same time



	A	B	C	D	E	F	G	H	I	J	K
1		TA1		TA2		TA3		TA4		TA5	
2		姓名	學號	姓名	學號	姓名	學號	姓名	學號	姓名	學號
3	1	OOO	30955xxxxx								
4	2										
5	3										
6	4										
7	5										
8	6										
9	7										
10	8										
11	9										
12	10										

Summary

Summary

- Write Answers for Discussion 1 to 4
  - Upload to e3 before next class

- Quiz: Talk/Chat to TA by Discord
  - Finish this task in the class