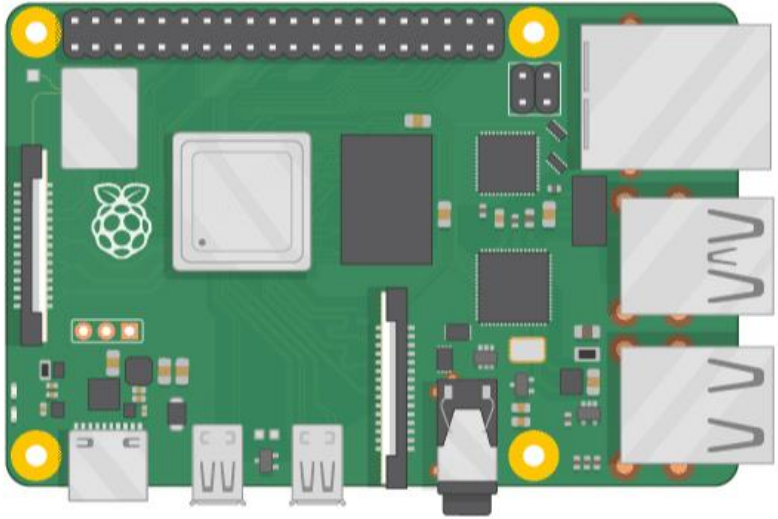
STEM Education Enriching Knowledge Series: Workshop on building an IOT People Counting Device with Single Board Computer

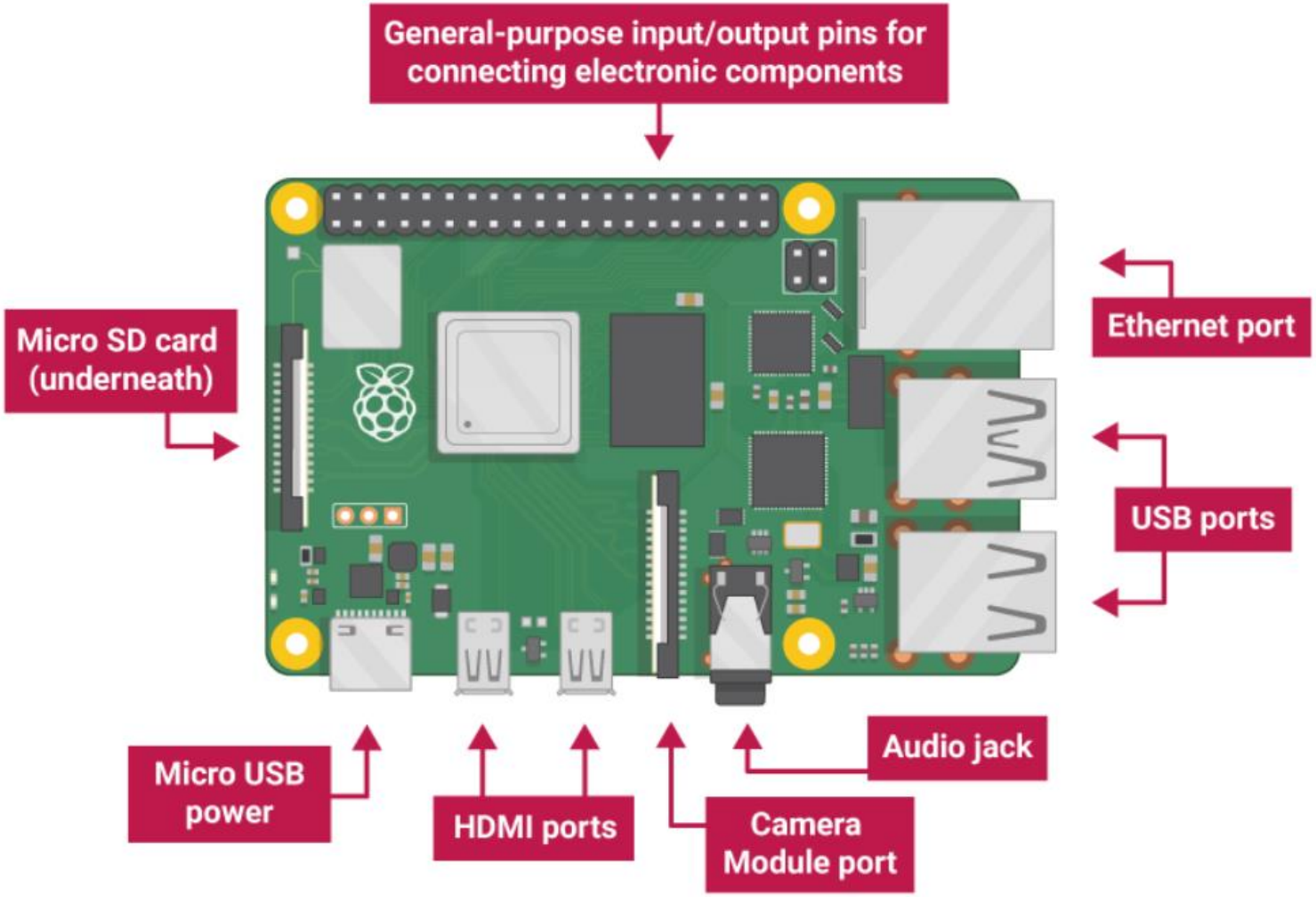
Content

1. What is raspberry pi?
2. A quick tour of raspberry pi
3. Basic Raspberry PI Command
4. Beginner Project
5. Using sensor with Raspberry Pi
6. Send data to Cloud - People counting project

1. What is raspberry pi?

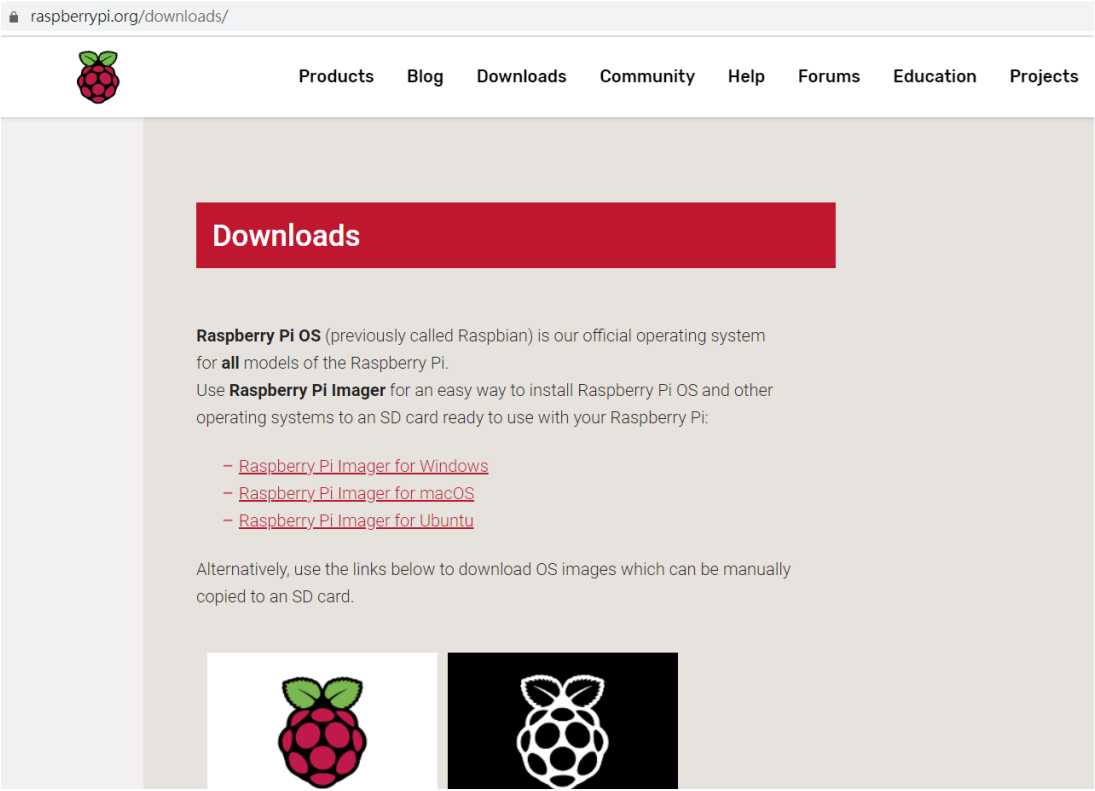
Introduction: https://projects.raspberrypi.org/en/projects/raspberry-pi-getting-started



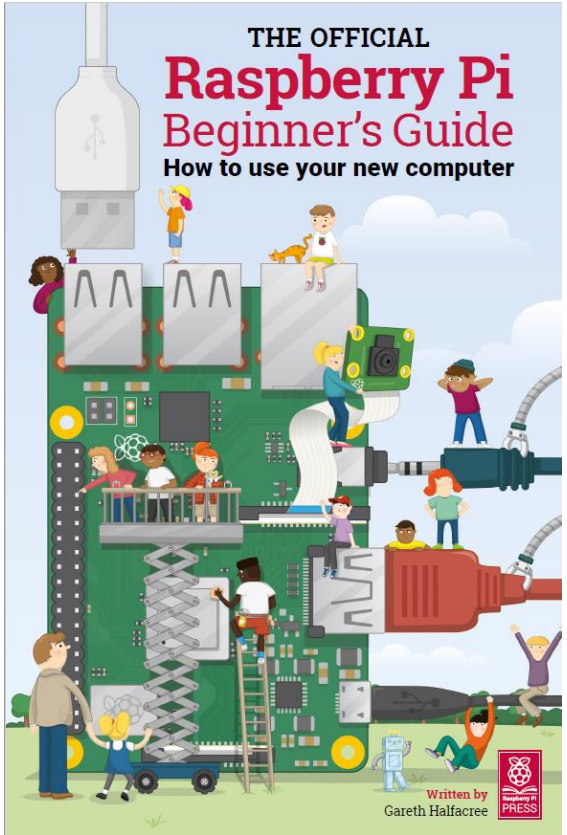

General-purpose input/output pins for connecting electronic components
Micro SD card (underneath)
Ethernet port
USB ports
Micro USB power
HDMI ports
Camera Module port
Audio jack

Raspberry Pi OS

https://www.raspberrypi.org/downloads/



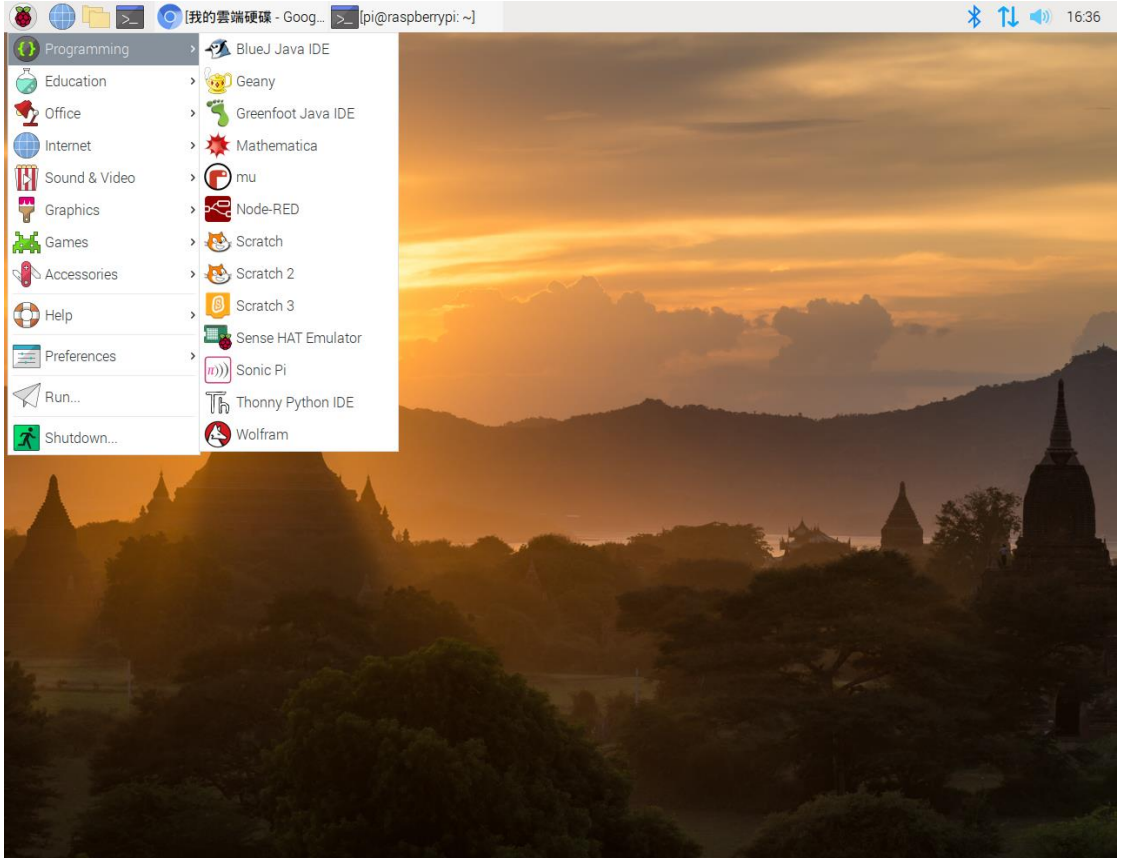
More about the Beginner's Guide



The most important resource

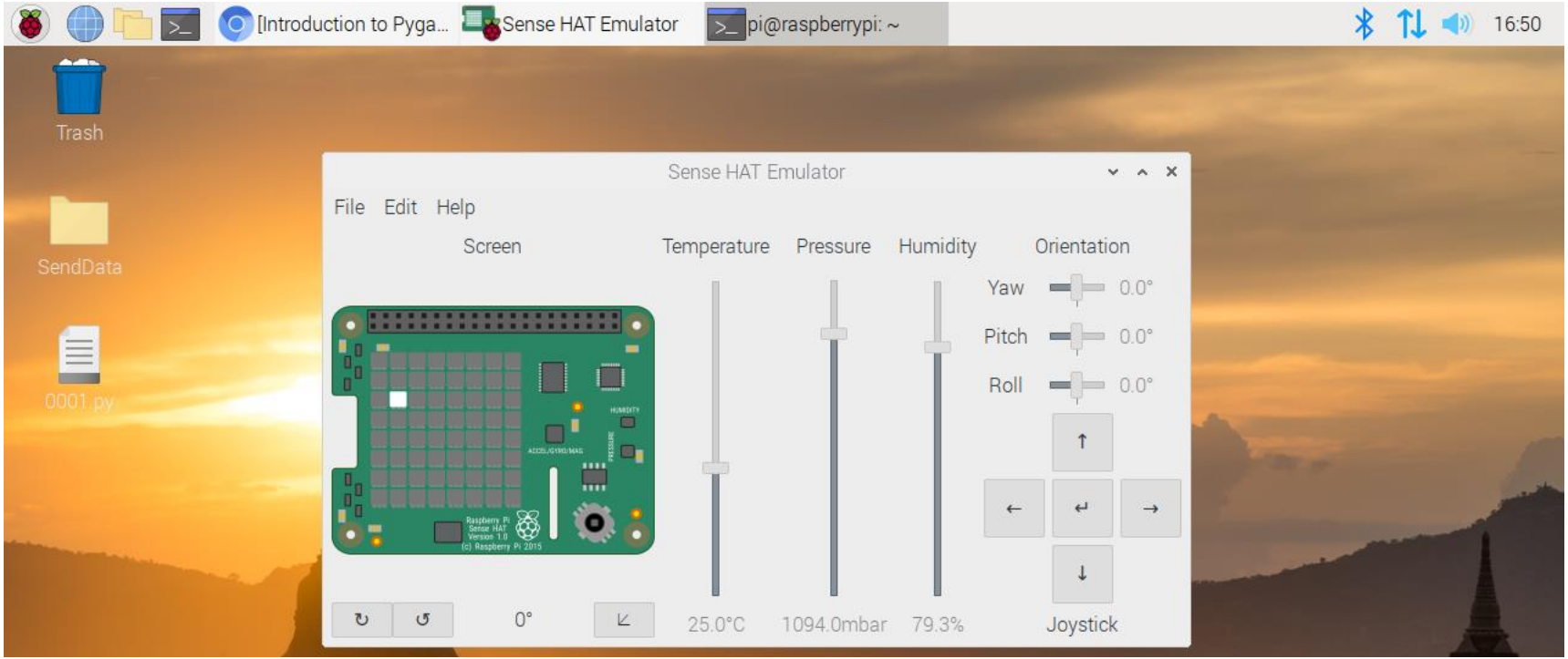
www.raspberrypi.org

2. A quick tour of Raspberry Pi



2. A quick tour of Raspberry Pi

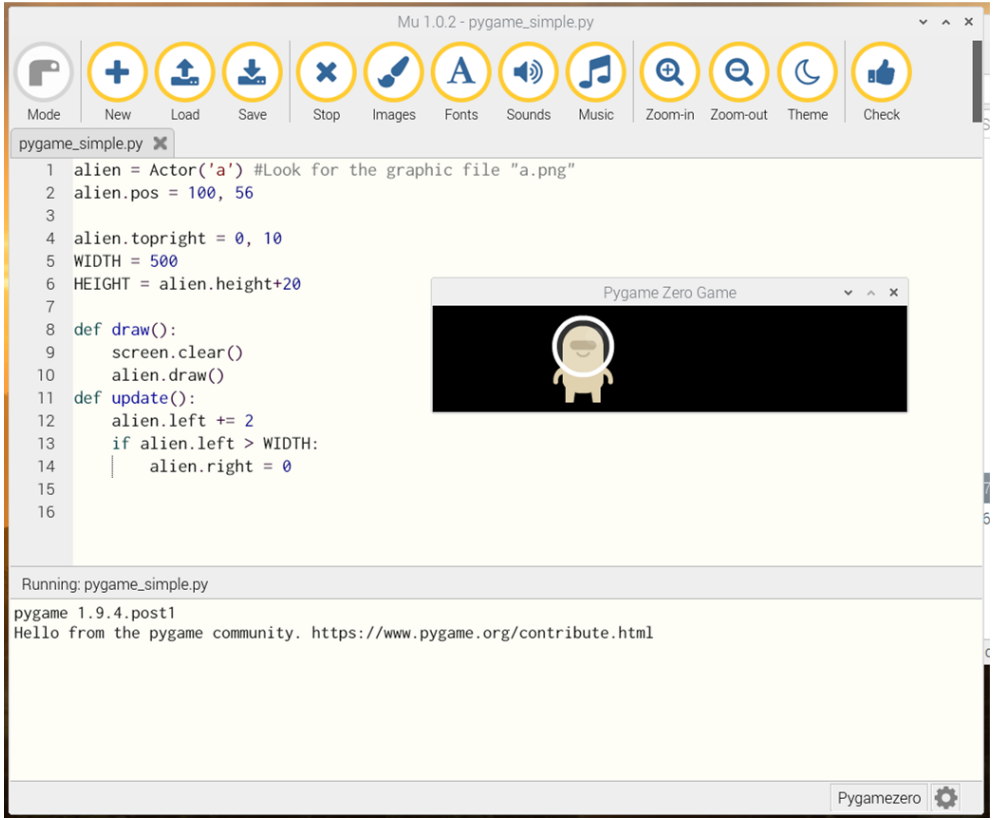
Sense HAT Emulator



2.1 A quick tour of Raspberry Pi

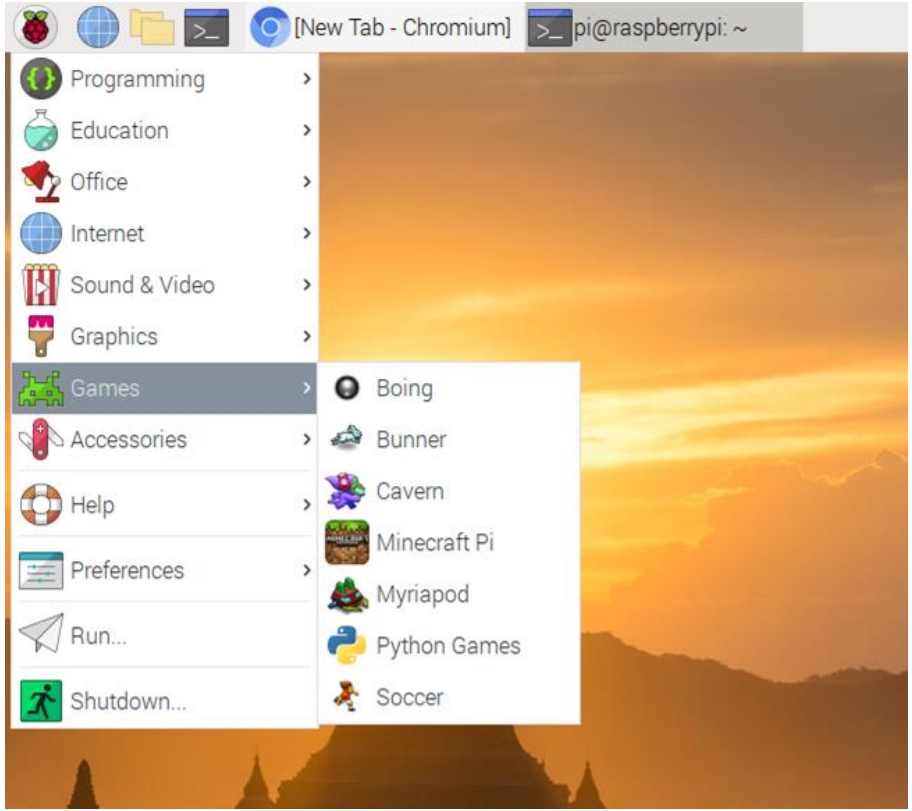
Mu - Pygame Zero

https://pygame-zero.readthedocs.io/en/stable/



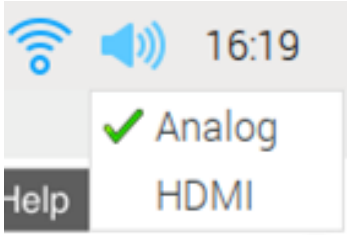
2.1 A quick tour of Raspberry Pi

And more game……



2.2 A quick tour of Raspberry Pi

Sonic Pi



Log

2.2 A quick tour of Raspberry Pi

Let’s code in Sonic Pi

Note	Octave										
	-2	-1	0	1	2	3	4	5	6	7	8
C	0	12	24	36	48	60	72	84	96	108	120
C#	1	13	25	37	49	61	73	85	97	109	121
D	2	14	26	38	50	62	74	86	98	110	122
D#	3	15	27	39	51	63	75	87	99	111	123
E	4	16	28	40	52	64	76	88	100	112	124
F	5	17	29	41	53	65	77	89	101	113	125
F#	6	18	30	42	54	66	78	90	102	114	126
G	7	19	31	43	55	67	79	91	103	115	127
G#	8	20	32	44	56	68	80	92	104	116	---
A	9	21	33	45	57	69	81	93	105	117	---
A#	10	22	34	46	58	70	82	94	106	118	---
B	11	23	35	47	59	71	83	95	107	119	---

2.3 A quick tour of Raspberry Pi

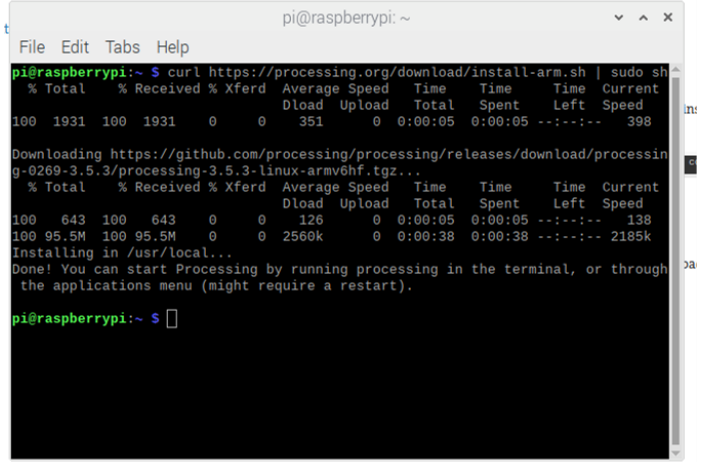
Processing: processing.org

2.3 A quick tour of Raspberry Pi

Install Processing onto existing installation

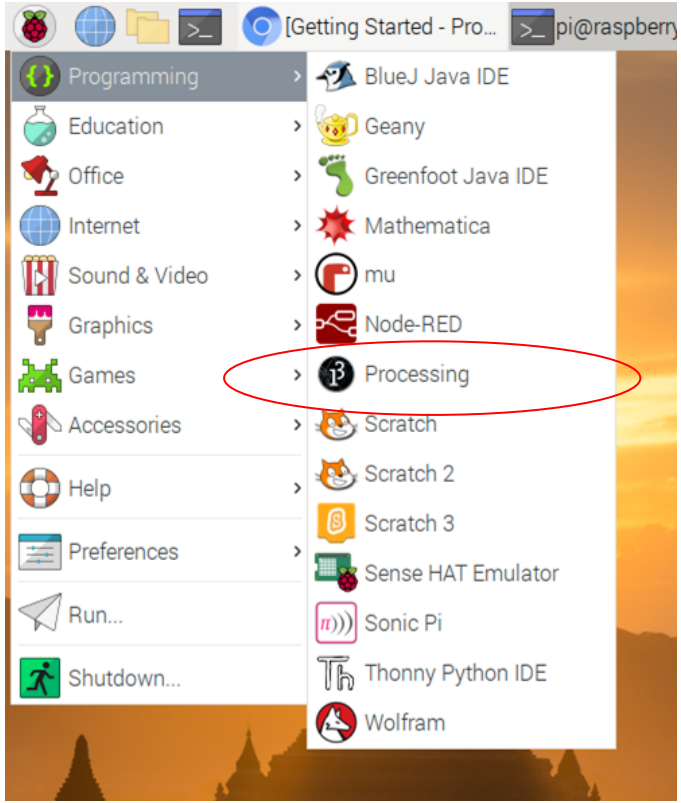
Type the following line at terminal:

curl https://processing.org/download/install-arm.sh | sudo sh



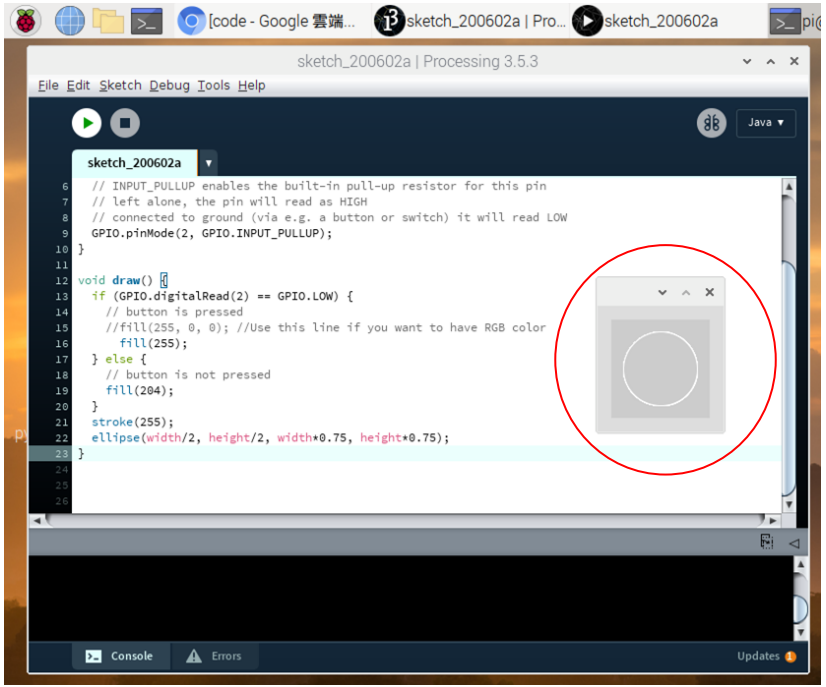
2.3 A quick tour of Raspberry Pi

Processing: processing.org



2.3 A quick tour of Raspberry Pi

Run the first Processing sketch



3. Basic Raspberry PI Command

Function	Command
Update OS	sudo apt update
Upgrade OS	sudo apt dist-upgrade
After upgrade OS	sudo apt clean
Reboot	sudo reboot
Check the version of Raspberry Pi	cat /etc/os-release
Pin diagram	pinout

3. Basic Raspberry PI Command

Function	Command
List out the directory files	ls
Go to directory or folder	cd
Move files or folders	mv
Copy files and folders	cp

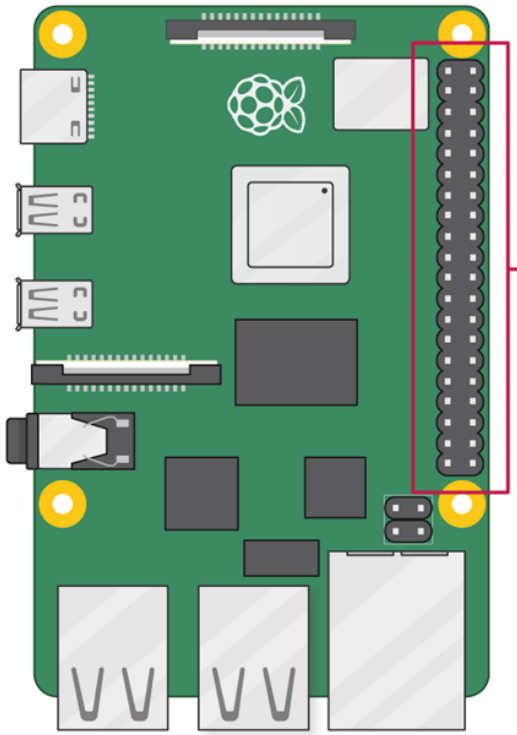
Enjoying the command line!

4. Beginner Project

https://projects.raspberrypi.org/en/projects/physical-computing

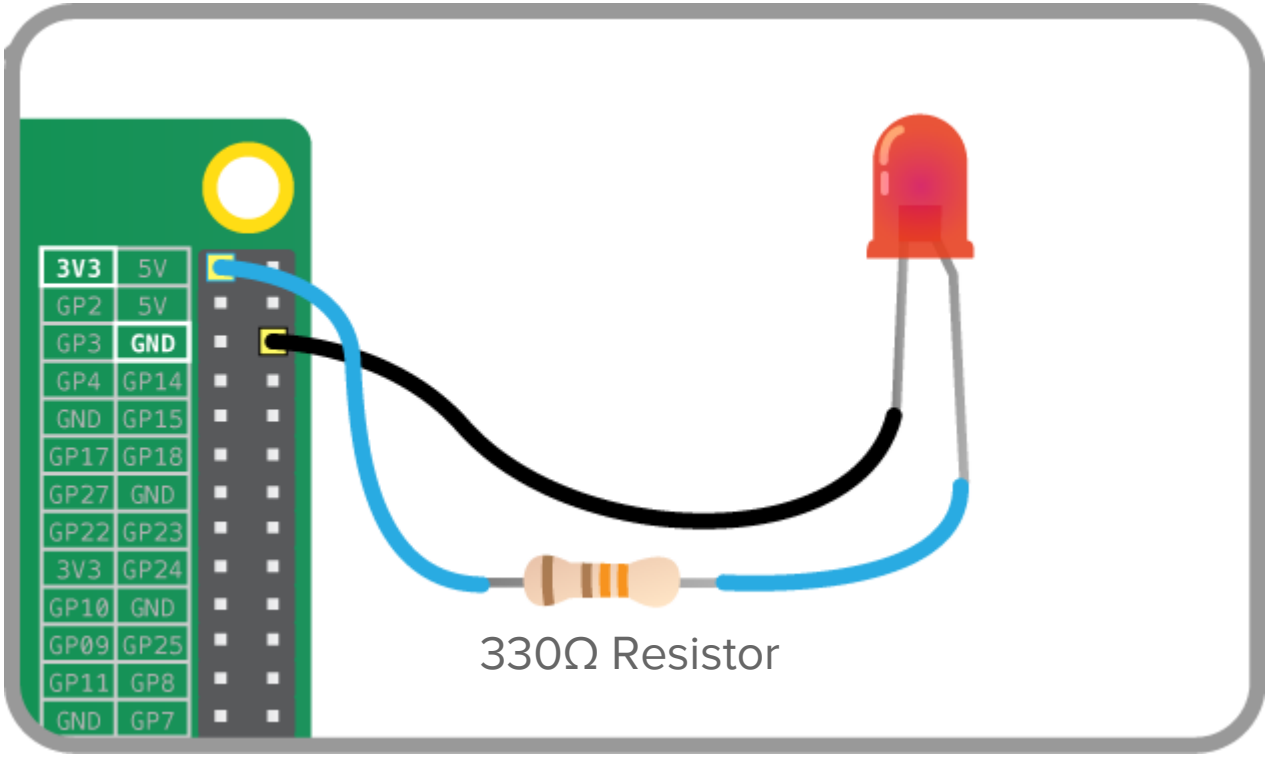
You need:

- 330Ω / 1kΩ / 2.2KΩ Resistor
- Led
- Jumper leads (Female-Male x 5)
- Button
- Solderless breadboard
- HC-SR04 Sensor

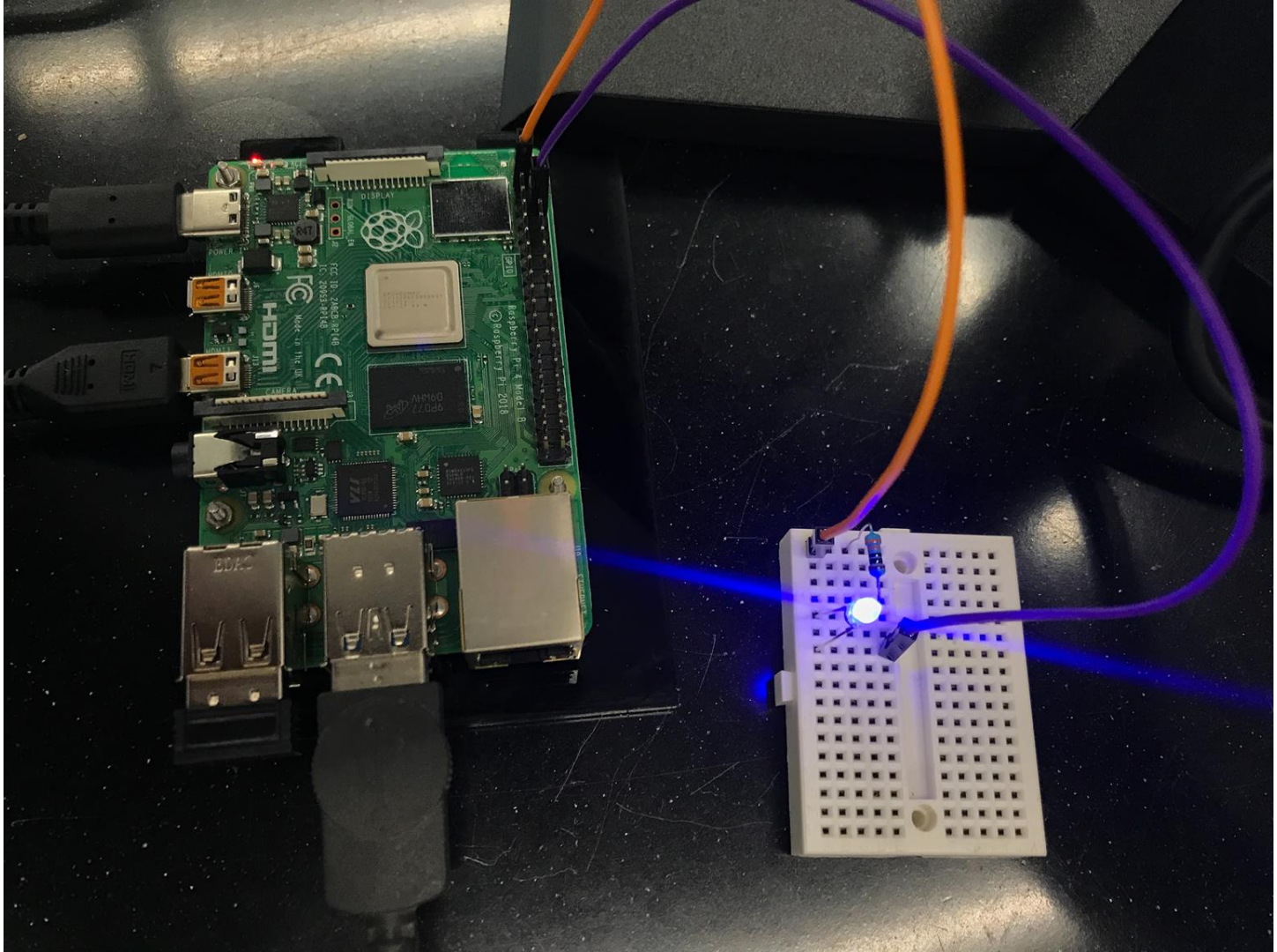


3V3 power	1	2	5V power
GPIO 2 (SDA)	3	4	5V power
GPIO 3 (SCL)	5	6	Ground
GPIO 4 (GPCLK0)	7	8	GPIO 14 (TXD)
Ground	9	10	GPIO 15 (RXD)
GPIO 17	11	12	GPIO 18 (PCM_CLK)
GPIO 27	13	14	Ground
GPIO 22	15	16	GPIO 23
3V3 power	17	18	GPIO 24
GPIO 10 (MOSI)	19	20	Ground
GPIO 9 (MISO)	21	22	GPIO 25
GPIO 11 (SCLK)	23	24	GPIO 8 (CE0)
Ground	25	26	GPIO 7 (CE1)
GPIO 0 (ID_SD)	27	28	GPIO 1 (ID_SC)
GPIO 5	29	30	Ground
GPIO 6	31	32	GPIO 12 (PWM0)
GPIO 13 (PWM1)	33	34	Ground
GPIO 19 (PCM_FS)	35	36	GPIO 16
GPIO 26	37	38	GPIO 20 (PCM_DIN)
Ground	39	40	GPIO 21 (PCM_DOUT)

Circuit 1

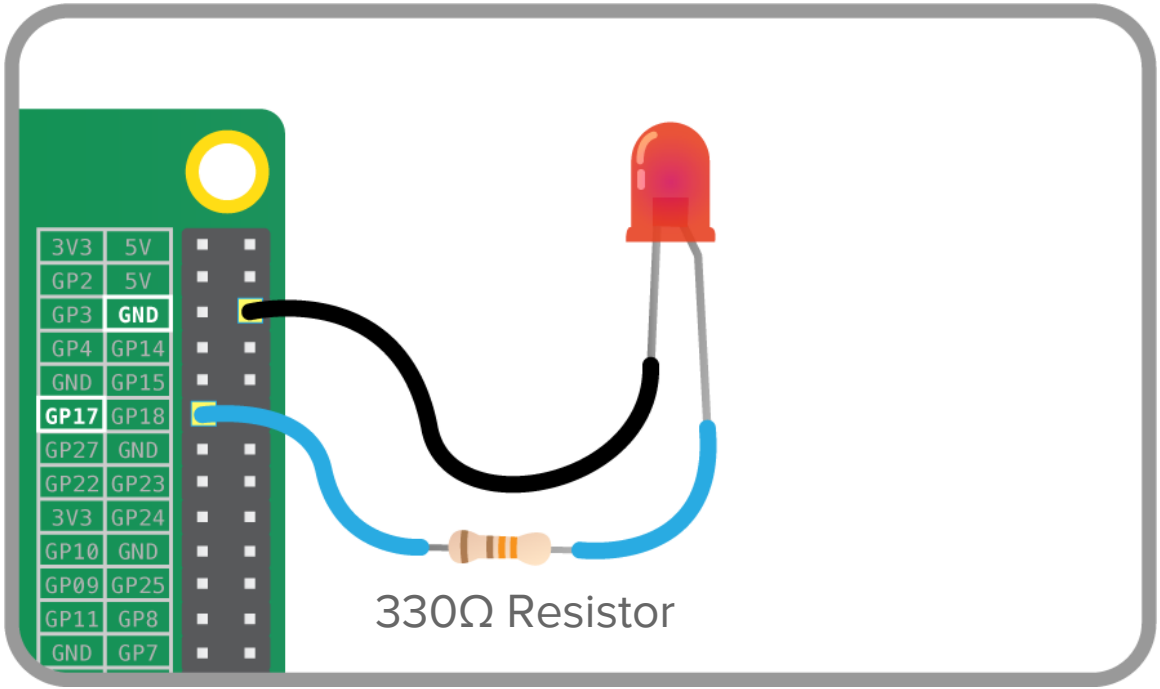


Connect the circuit, no need to write code


DISPLAY
POWER
CAMERA
Made in the UK
Raspberry Pi Model B
Raspberry Pi 2018

Circuit 2

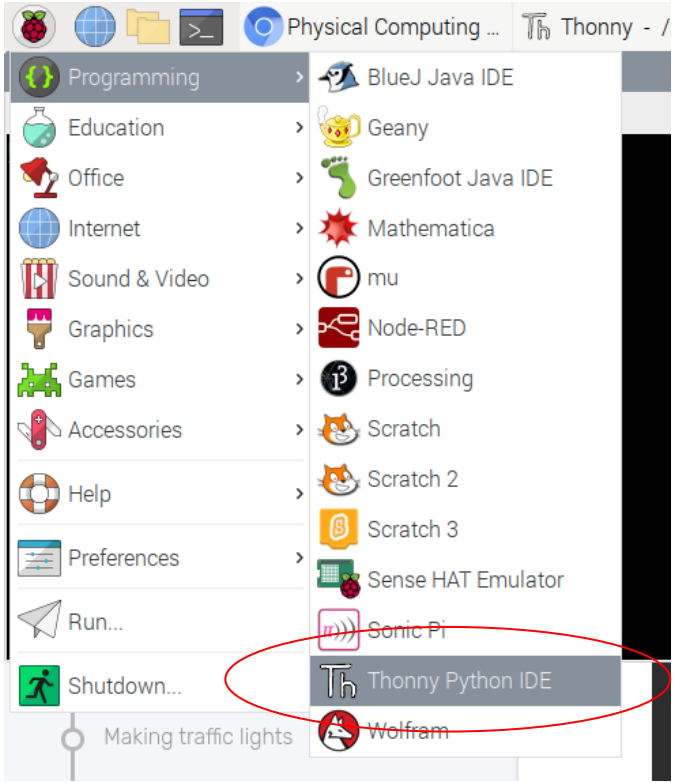
The LED should now turn off, but now it's on a GPIO pin, and can therefore be controlled by code.



POWER IN
HDMI0
HDMI1
CAMERA
DISPLAY
Raspberry Pi 4 Model B
©Raspberry Pi 2018

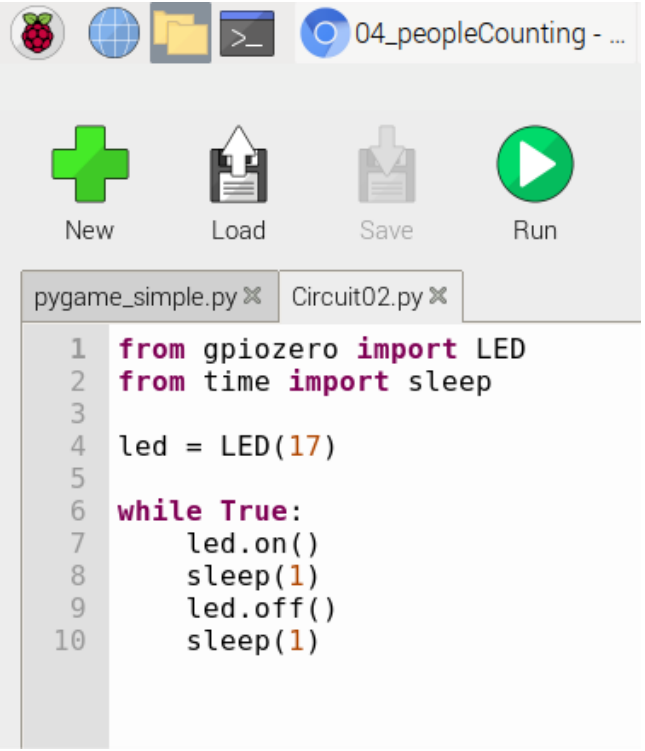
Circuit 2: Code the GPIO

Open the Thonny

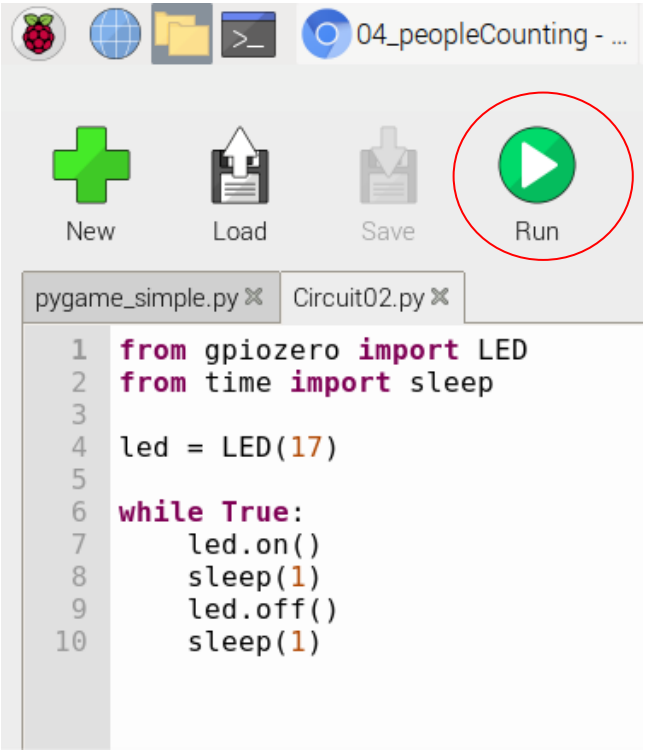


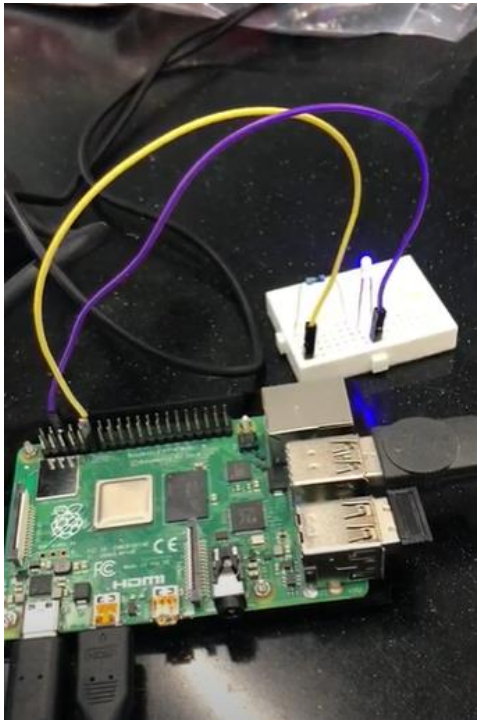
Circuit 2: Code the GPIO

```
from gpiozero import LED
from time import sleep

led = LED(17)

while True:
    led.on()
    sleep(1)
    led.off()
    sleep(1)
```



Circuit 2: Save and Run the program

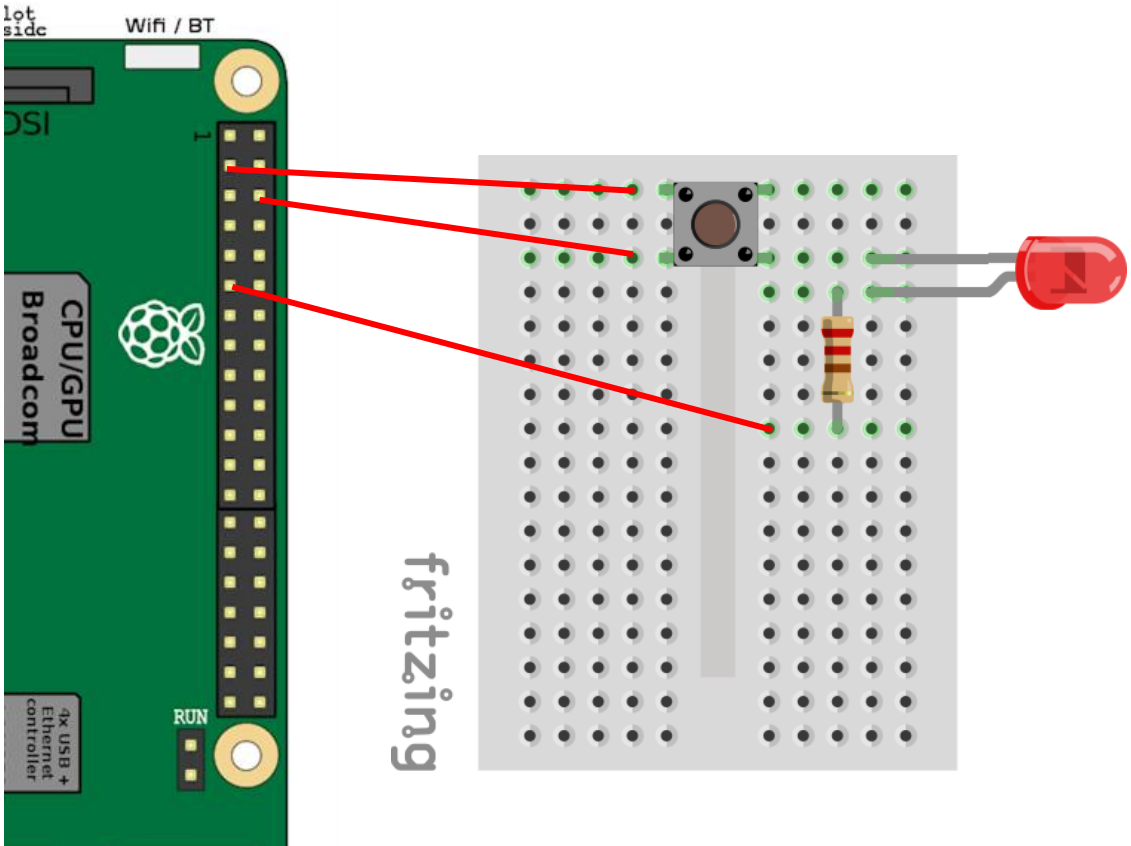




To exit the program click Stop.
Video: https://youtu.be/576h4Kd8mRw

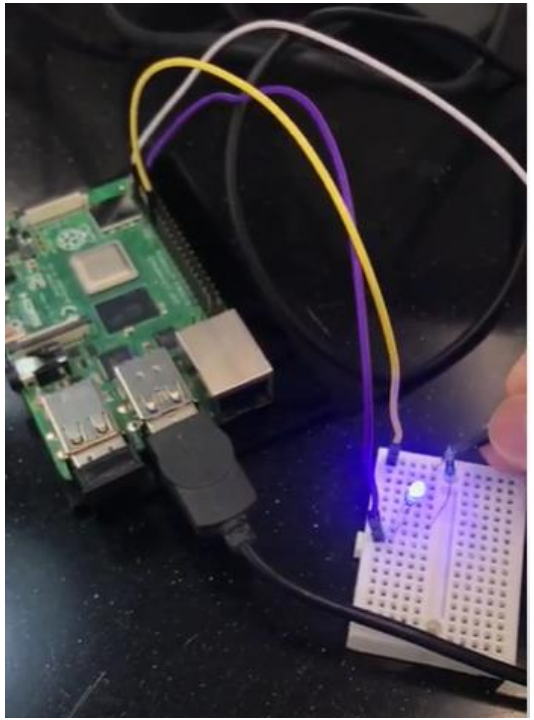
Circuit 3: Connect the GP2 to act as button

Connect the GP2 to act as button



Circuit 3: Connect the GP2 to act as button

```
from gpiozero import LED, Button
from time import sleep

led = LED(17)
button = Button(2)

while True:
    button.wait_for_press()
    led.on()
    sleep(0.5)
    led.off()
```



Video: https://youtu.be/L-qftlEUQZE

5. Using HC-SR04 with Raspberry Pi

Resource

https://www.instructables.com/id/Distance-Sensing-With-Raspberry-Pi-and-HC-SR04/

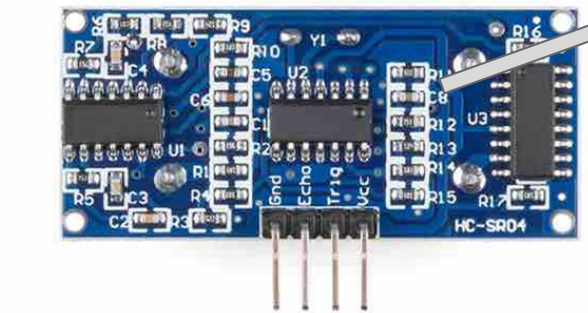
https://raspberrypi.stackexchange.com/questions/84012/how-to-wire-an-hc-sr04-without-a-breadboard

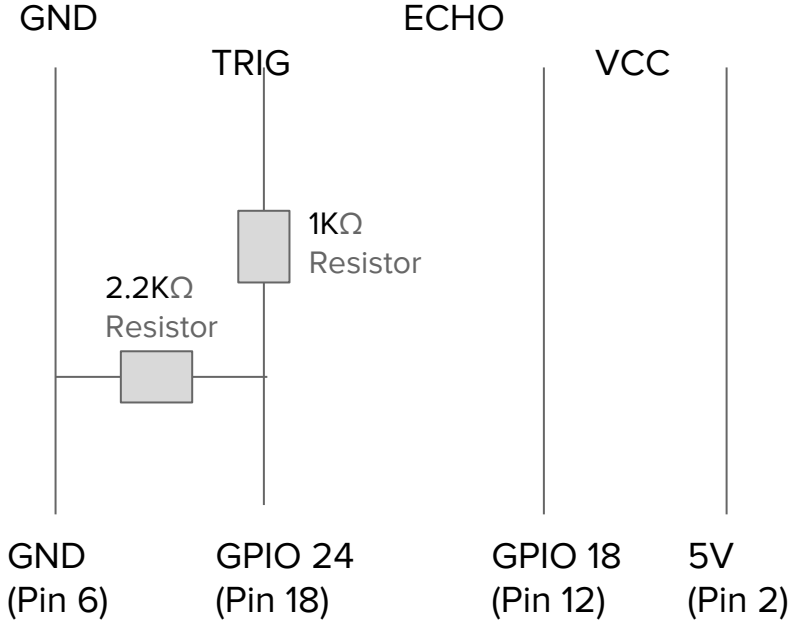
https://sites.google.com/site/rasberrypintust/shu-mei-pai-xiao-ji-qiao/8-hc-sr04-chao-yin-bo-gan-ce-qi

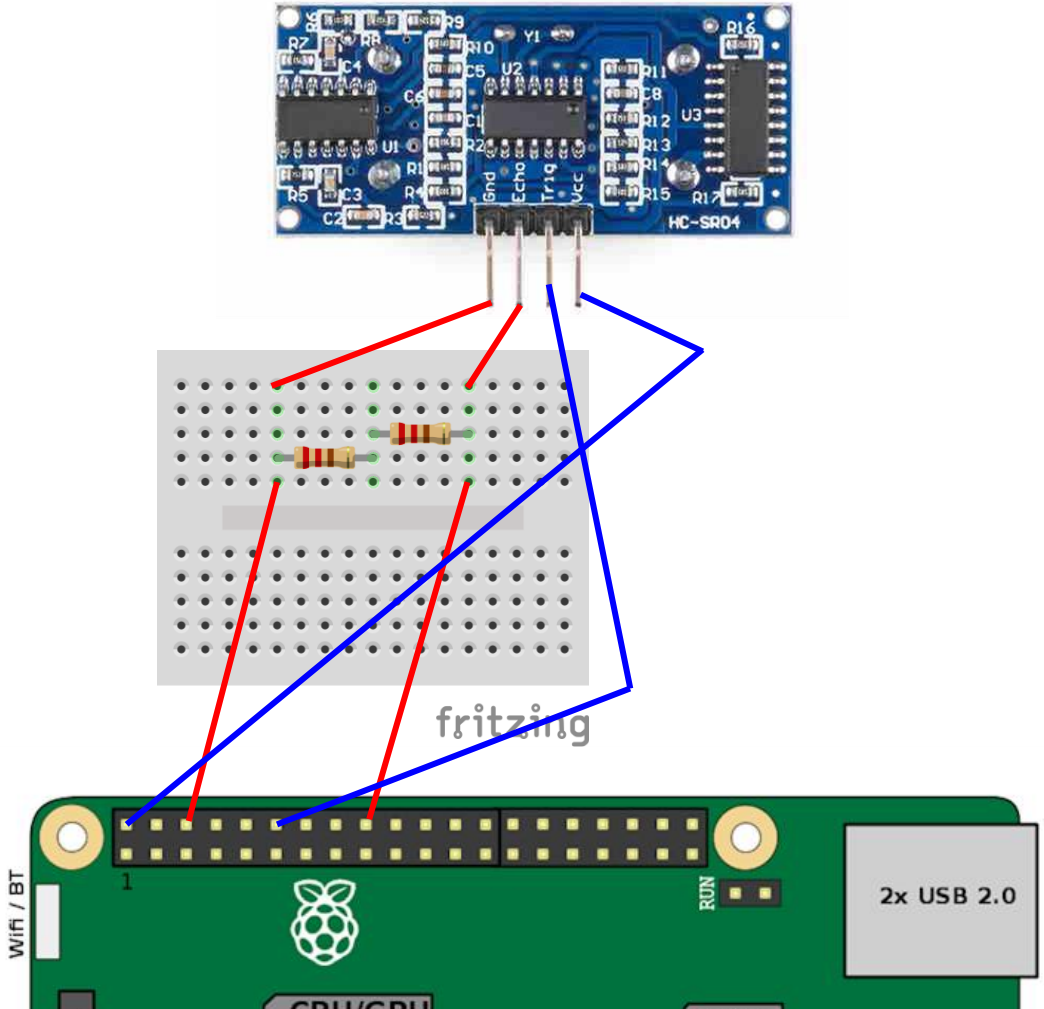
https://www.freva.com/2019/05/20/hc-sr04-ultrasonic-sensor-on-raspberry-pi/

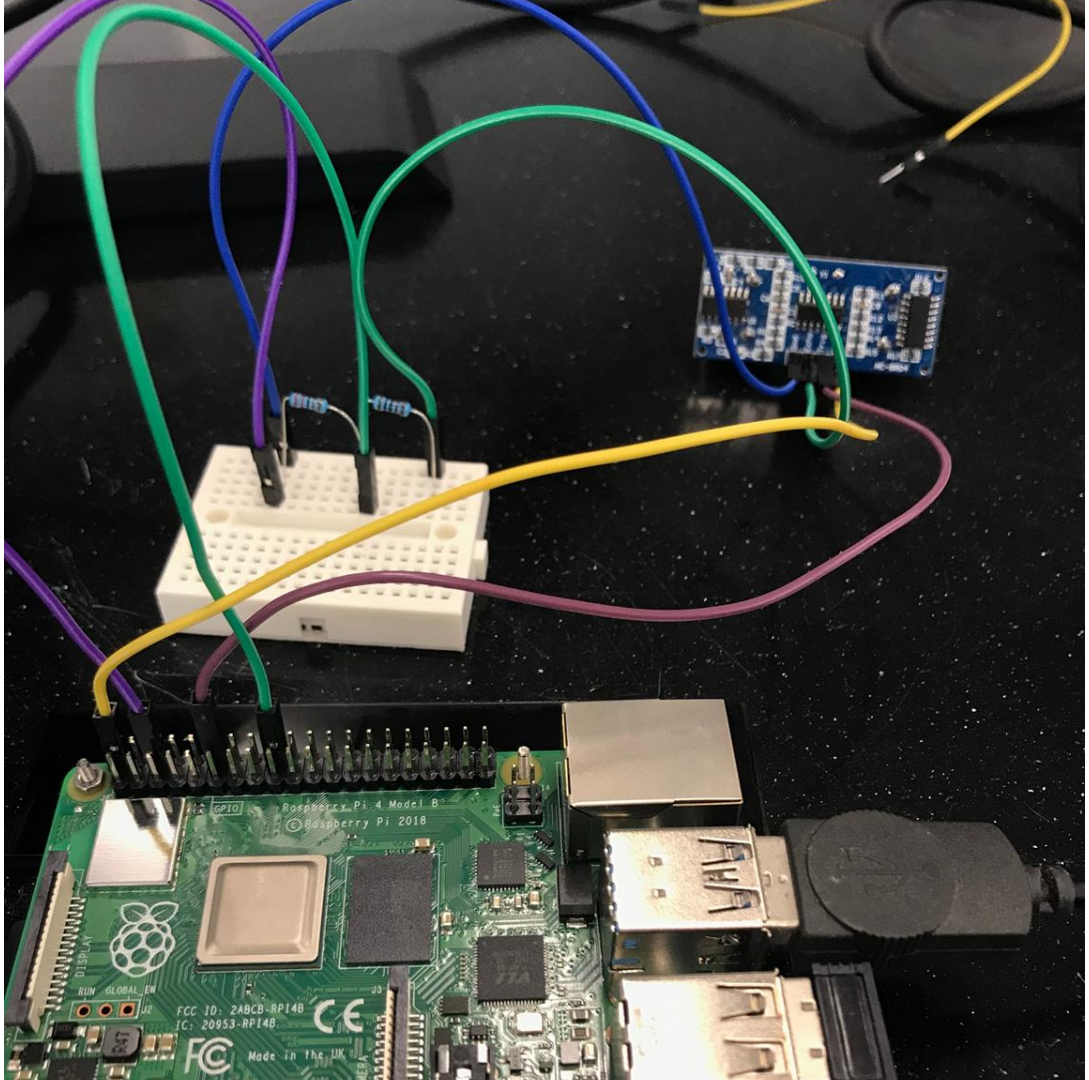
5. Using HC-SR04 with Raspberry Pi

Connect HC-SR04 to Raspberry Pi





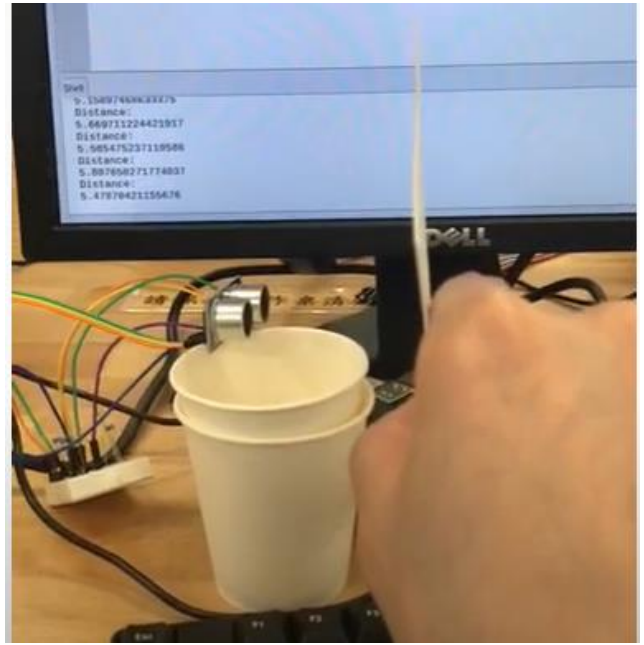

HC-SR04
Gnd
Echo
Trig
Vcc
fritzing
Wifi / BT
RUN
2x USB 2.0


GPIO
Raspberry Pi 4 Model B
©Raspberry Pi 2018
DISPLAY
RUN GLOBAL_EN
FCC ID: 2ABCB-RPI4B
IC: 20953-RPI4B
Made in the UK

5. Using HC-SR04 with Raspberry Pi (code: UltrasonicSensor_basic)

```
# Getting the libraries we need
from gpiozero import DistanceSensor
from time import sleep

# Initialize ultrasonic sensor
sensor = DistanceSensor(trigger=18, echo=24)

while True:
    # Wait 2 seconds
    sleep(2)

    # Get the distance in metres
    distance = sensor.distance

    # But we want it in centimetres
    distance = sensor.distance * 100

    # Print the information to the screen
    print("Distance:")
    print(distance)
```

5. Using HC-SR04 with Raspberry Pi (code: UltrasonicSensor_basic)

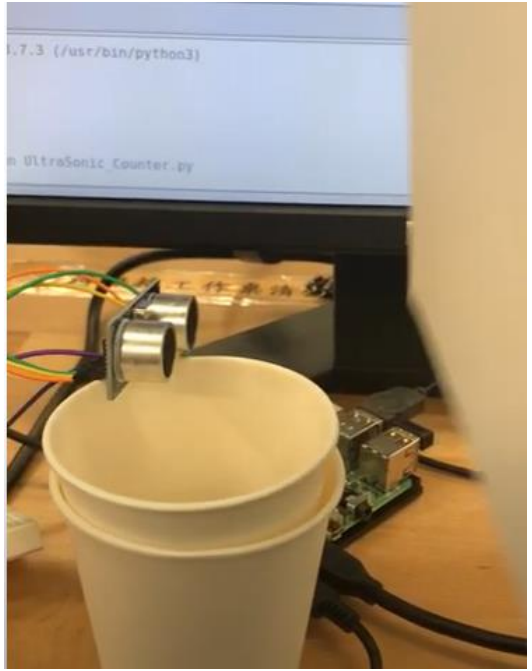


Video: https://youtu.be/d8pfgD6NN7g

5. Using HC-SR04 with Raspberry Pi (code: UltrasonicSensor_counter)

```
# Getting the libraries we need
from gpiozero import DistanceSensor
from time import sleep

# Initialize ultrasonic sensor
sensor = DistanceSensor(trigger=18, echo=24)
counter = 0

while True:
    # Wait 2 seconds
    sleep(0.5)

    # Get the distance in metres
    distance = sensor.distance

    # But we want it in centimetres
    distance = sensor.distance * 100

    # Print the information to the screen
    #print("Distance:"+ distance)

    print("Distance : %.1f" % distance)

    if distance < 10:
        counter = counter +1
        print("Counter : %.1f" % counter)
```

5. Using HC-SR04 with Raspberry Pi (code: UltrasonicSensor_counter)



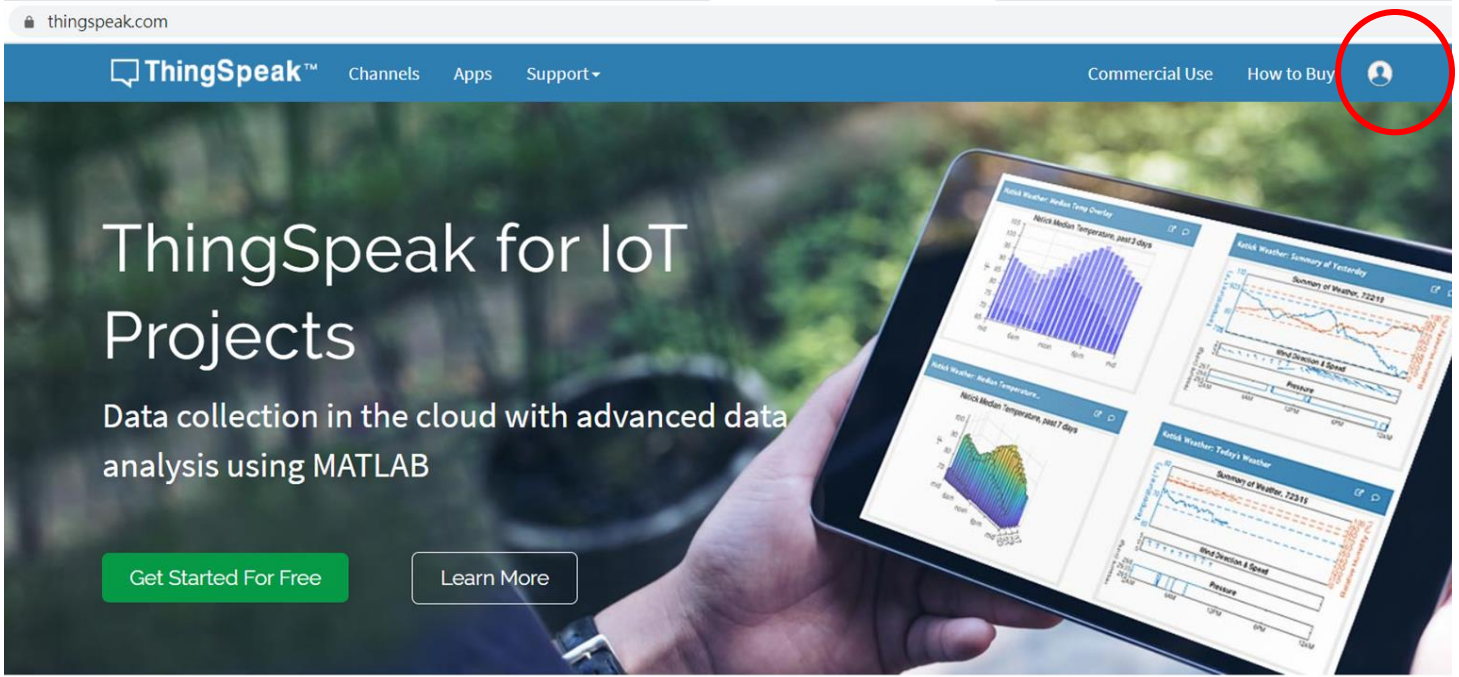
Video: https://youtu.be/GnGU1OOW5VA

6. Send data to Cloud - People counting project

Ready to IOT?

ThingSpeak

Go to "thingspeak.com", then click this icon.



ThingSpeak™ Channels Apps Support

To use ThingSpeak, you must sign in with your existing MathWorks acc

Non-commercial users may use ThingSpeak for free. Free accounts offe
get full access to the MATLAB analysis features on ThingSeak, log in to T

To send data faster to ThingSpeak or to send more data from more devi

Create a new account

MathWorks

Email

No account? Create one!

By signing in you agree to our privacy policy.

Next

Create MathWorks Account

Email Address

chw@atec.edu.hk

To access your organization's MATLAB license, use your school or work email.

Location

Hong Kong

First Name

chw

Last Name

chw

Continue

Cancel

Verify Your MathWorks Account

To finish creating your account, complete the following steps:

1. Go to your inbox for **chw@atec.edu.hk**.
2. Click the link in the email we sent you.
3. Click **Continue**.

Didn't receive the email?

- Check your spam folder.
- Send me the email again.
- If you still have not received the email, Contact Customer Support

Continue

Cancel

Verify Email Address 收件匣 ×

service@account.mathworks.com 取消訂閱 下午2:47 (2 分鐘前)
寄給 我

英文 > 中文（繁體） 翻譯郵件 關閉下列語言的翻譯功能：英文 ×

To ensure our e-mails reach your inbox, add the domain @mathworks.com
to your safe sender list.

MathWorks

Thank you for registering with MathWorks!

Next, please verify this email address for your MathWorks Account.

Verify your email

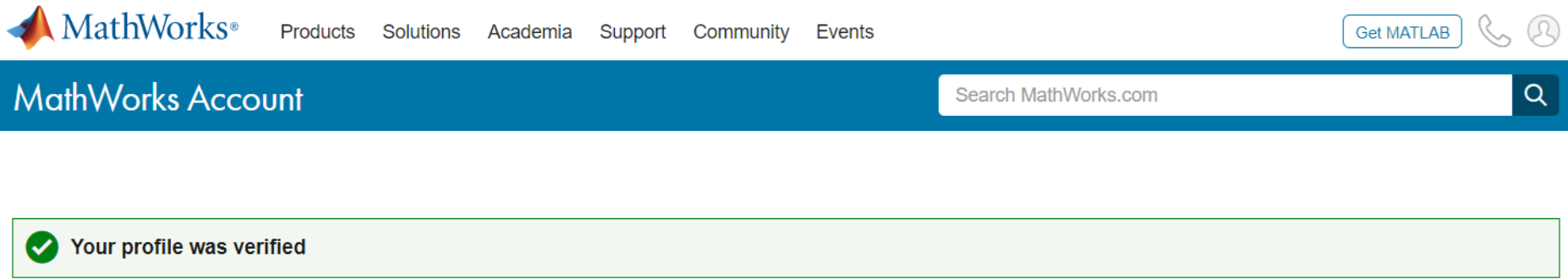
Alternatively, copy and paste the following link into your browser:

https://www.mathworks.com/mwaccount/widgets/embedded/register/verify/9ea2005c-a89f-4063-9f45-ecf94b7a2292

MathWorks Customer Service Team

The MathWorks, Inc. 3 Apple Hill Drive, Natick, MA 01760 - 508-647-7000
© 2020 The MathWorks, Inc. MATLAB and Simulink are registered trademarks of The MathWorks, Inc.
Trademarks | Privacy Policy

Finished verified your e-mail!



Verify Your MathWorks Account

To finish creating your account, complete the following steps:

1. Go to your inbox for **chw@atec.edu.hk**.
2. Click the link in the email we sent you.
3. Click **Continue**.

Didn't receive the email?

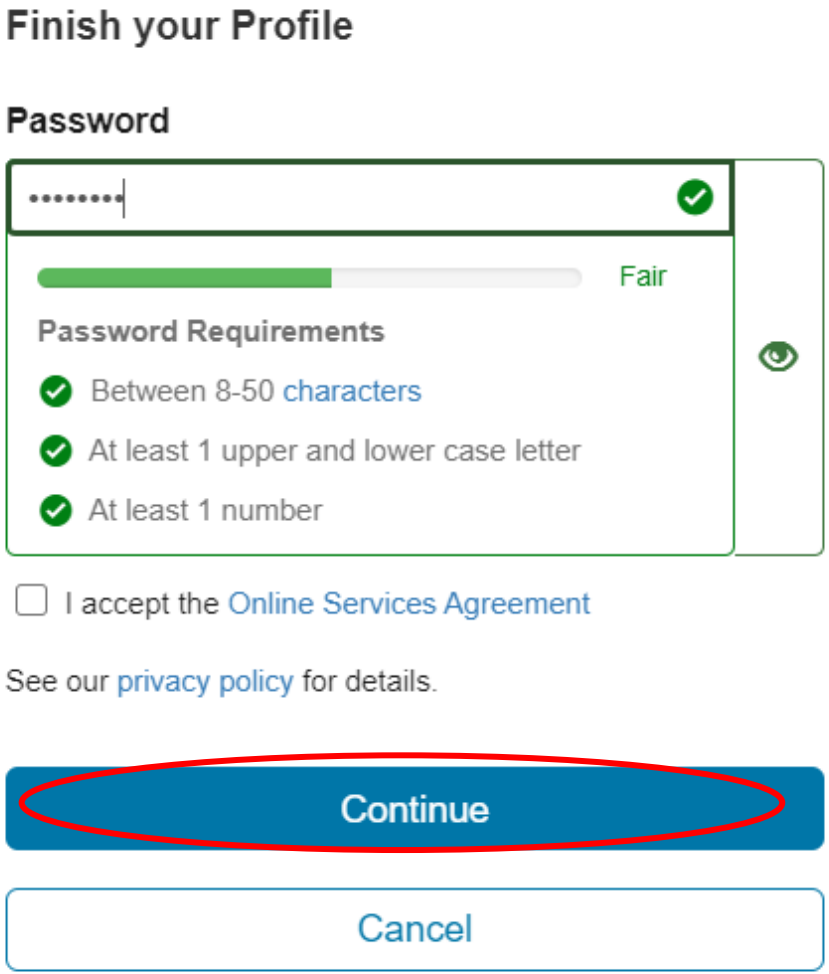
- Check your spam folder.
- Send me the email again.
- If you still have not received the email, Contact Customer Support

Continue

Cancel

Set your password

Tick this box



Finish create your account

ThingSpeak™ Channels Apps Support Commercial Use How to Buy CC

Signed in successfully. X

Sign-up successful

Congratulations, you have successfully linked your MathWorks account to ThingSpeak. Use the following email ID and its associated MathWorks account password on all subsequent logins to ThingSpeak.

Email ID: **chw@atec.edu.hk**

Welcome to ThingSpeak!

OK

ThingSpeak™ Channels Apps Support Commercial Use How to Buy CC

My Channels

New Channel

Search by tag

The first look in your TS account

Help

Collect data in a ThingSpeak channel from a device, from another channel, or from the web.

Click **New Channel** to create a new ThingSpeak channel.

Click on the column headers of the table to sort by the entries in that column or click on a tag to show channels with that tag.

Learn to create channels, explore and transform data.

Learn more about ThingSpeak Channels.

Examples

- Arduino
- Arduino MKR1000
- ESP8266
- Raspberry Pi
- Netduino Plus

Upgrade

Need to send more data faster?

Need to use ThingSpeak for a commercial project?

Upgrade

ThingSpeak™ Channels Apps Support Commercial Use How to Buy CC

My Channels

New Channel

Search by tag

Click “New Channel” to create a new channel

Help

Collect data in a ThingSpeak channel from a device, from another channel, or from the web.

Click **New Channel** to create a new ThingSpeak channel.

Click on the column headers of the table to sort by the entries in that column or click on a tag to show channels with that tag.

Learn to create channels, explore and transform data.

Learn more about ThingSpeak Channels.

Examples

- Arduino
- Arduino MKR1000
- ESP8266
- Raspberry Pi
- Netduino Plus

Upgrade

Need to send more data faster?

Need to use ThingSpeak for a commercial project?

Upgrade

ThingSpeak™ Channels Apps Support

New Channel

Name: Demo

Description:

Field 1	Field Label 1	☑
Field 2		☐
Field 3		☐
Field 4		☐
Field 5		☐
Field 6		☐
Field 7		☐
Field 8		☐

Input the Name of the Channel.
Just leave the other blank.

Tick this one for one channel

Link to External Site

http://

Link to GitHub

https://github.com/

Elevation

Show Channel Location

Latitude

0.0

Longitude

0.0

Show Video

YouTube

Vimeo

Video URL

http://

Show Status

Save Channel

Demo

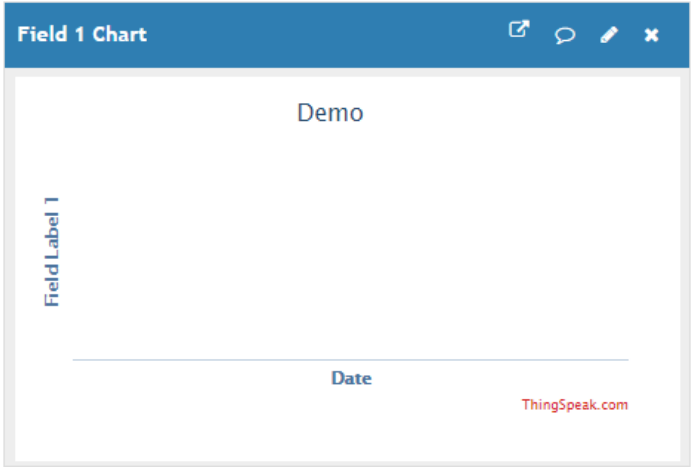
Channel ID: **1077276**
Author: mwa0000018718853
Access: Private

Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

Add Visualizations | Add Widgets | Export recent data

Channel Stats

Created: 2 minutes ago
Entries: 0



ThingSpeak™ Channels Apps Support Commercial Use How to Buy

Demo

Channel ID: **1077276**
Author: mwa0000018718853
Access: Private

Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

Write API Key

Key [redacted]

Generate New Write API Key

Read API Keys

Key [redacted]

Note

Save Note | Delete API Key

Help

API keys enable you to write data to a channel or read data from a private channel. API keys are auto-generated when you create a new channel.

API Keys Settings

- **Write API Key:** Use this key to write data to a channel. If you feel your key has been compromised, click **Generate New Write API Key.**
- **Read API Keys:** Use this key to allow other people to view your private channel feeds and charts. Click **Generate New Read API Key** to generate an additional read key for the channel.
- **Note:** Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel.

API Requests

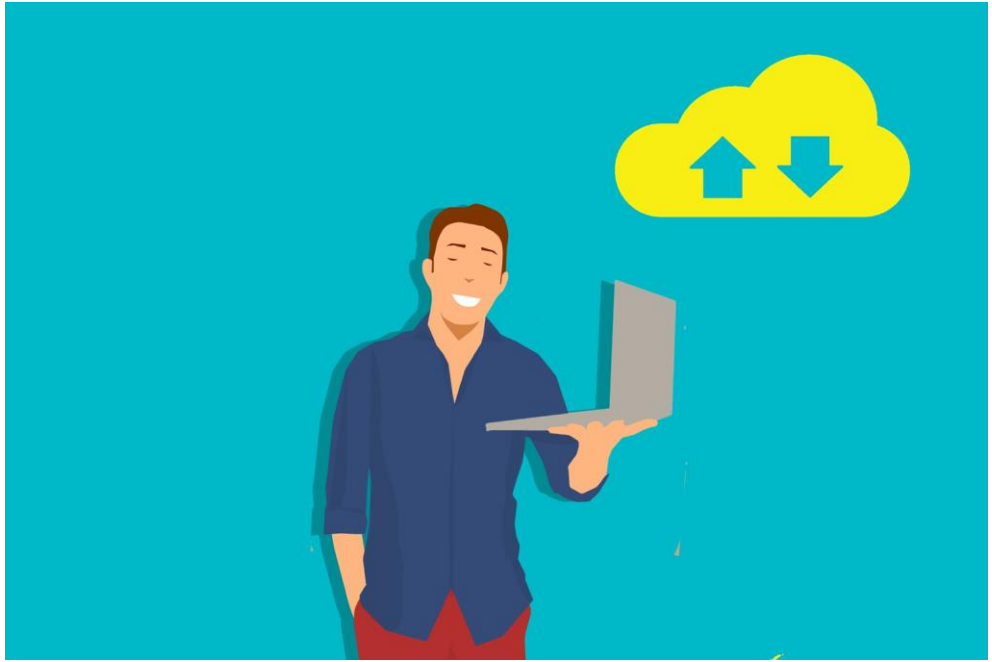
Write a Channel Feed

```
GET https://api.thingspeak.com/update?api_key=30823AK65O30ZFVA&field
```

Read a Channel Feed

```
GET https://api.thingspeak.com/channels/1077276/feeds.json?api_key=
```

We are ready to send data to ThingSpeak



Code: Send_Data_Every16s

```
from time import sleep

import time   # Import libraries
import urllib.request

x = 0      #Variable to send to ThingSpeak
counter = 0
print ('Program Started')

while True:
    x=x+1
    print(x)
    counter = counter +1
    sleep(1)
    if counter == 16:
        baseURL = 'https://api.thingspeak.com/update?api_key=[redacted]'
        f = urllib.request.urlopen(baseURL + "&field1=%s" % (x))
        f.close()
        print ("The data is sent to Thingspeak")
        counter = 0
```

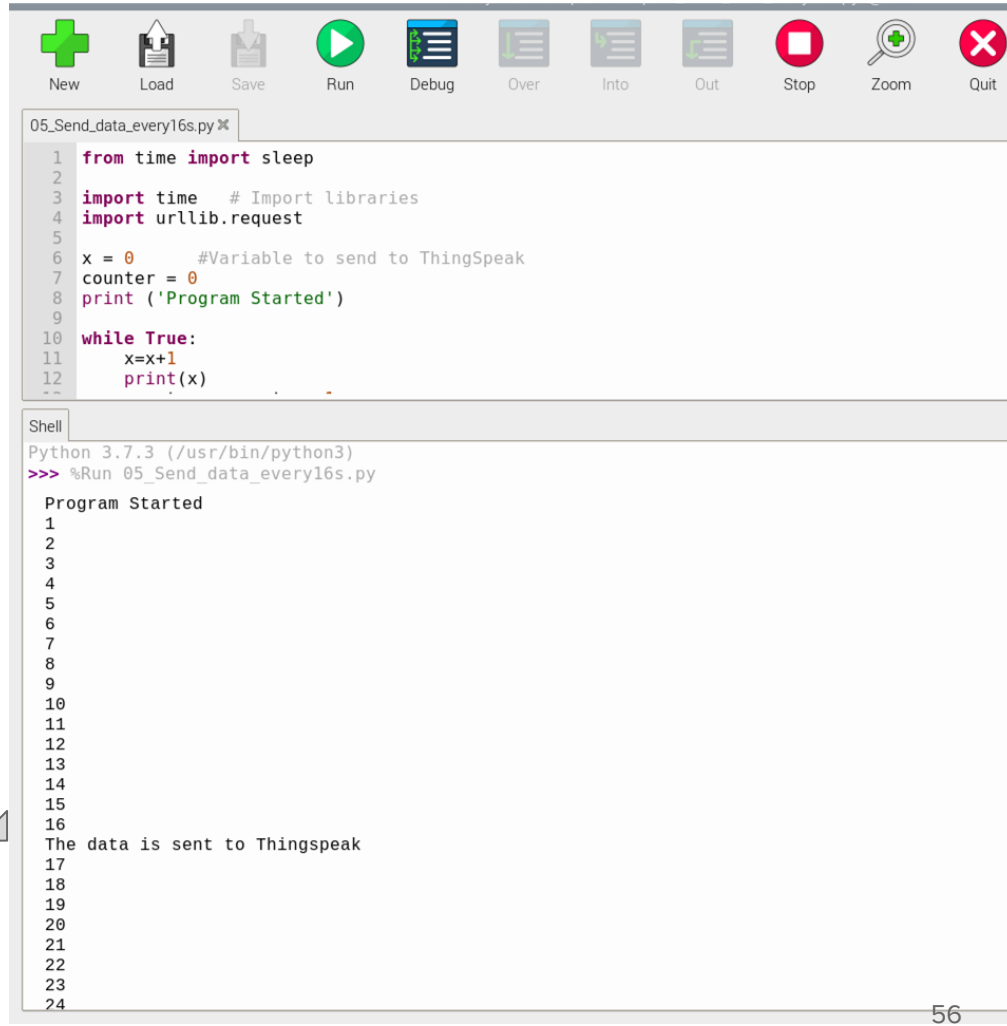
You can send data every 15 seconds to ThingSpeak

Change to your Write API

Specified the field number of the channel

When the program is running, the variable showed in the shell.

What happen at this moment?



ThingSpeak™ Channels Apps Support

Demo

Channel ID: **1077276**
Author: mwa0000018718853
Access: Private

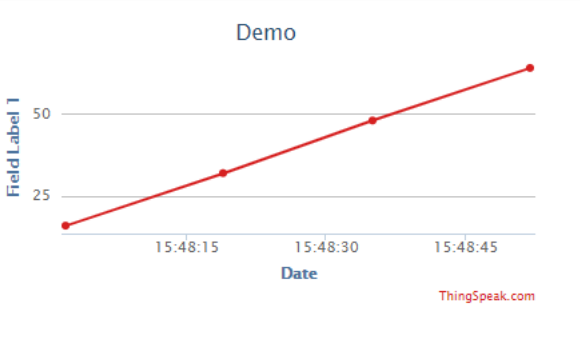
Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

Add Visualizations | Add Widgets | Export recent data

Channel Stats

Created: about an hour ago
Entries: 4

Field 1 Chart



Location

Latitude 0.0

Longitude 0.0

Show Video

YouTube

Vimeo

Video URL http://

Show Status

Save Channel

You can clear the channel, or delete it.

Want to clear all feed data from this Channel?

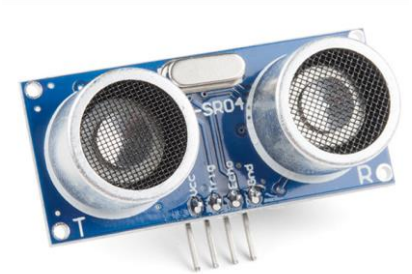
Clear Channel

Want to delete this Channel?

Delete Channel

Combine the program

Try combining the "UltransonicSensor_counter" and "Send_Data_Every15s” to complete the project.



ThingSpeak™