

The Education University of Hong Kong

2023–2024 Quality Education Fund Thematic Network – Tertiary Institutes

Professional Development Program

Using Artificial Intelligence of Things (AIoT) Technologies
with Micro:bit to support innovative lesson design

人工智能物聯網 Artificial intelligence of things

(AIoT)

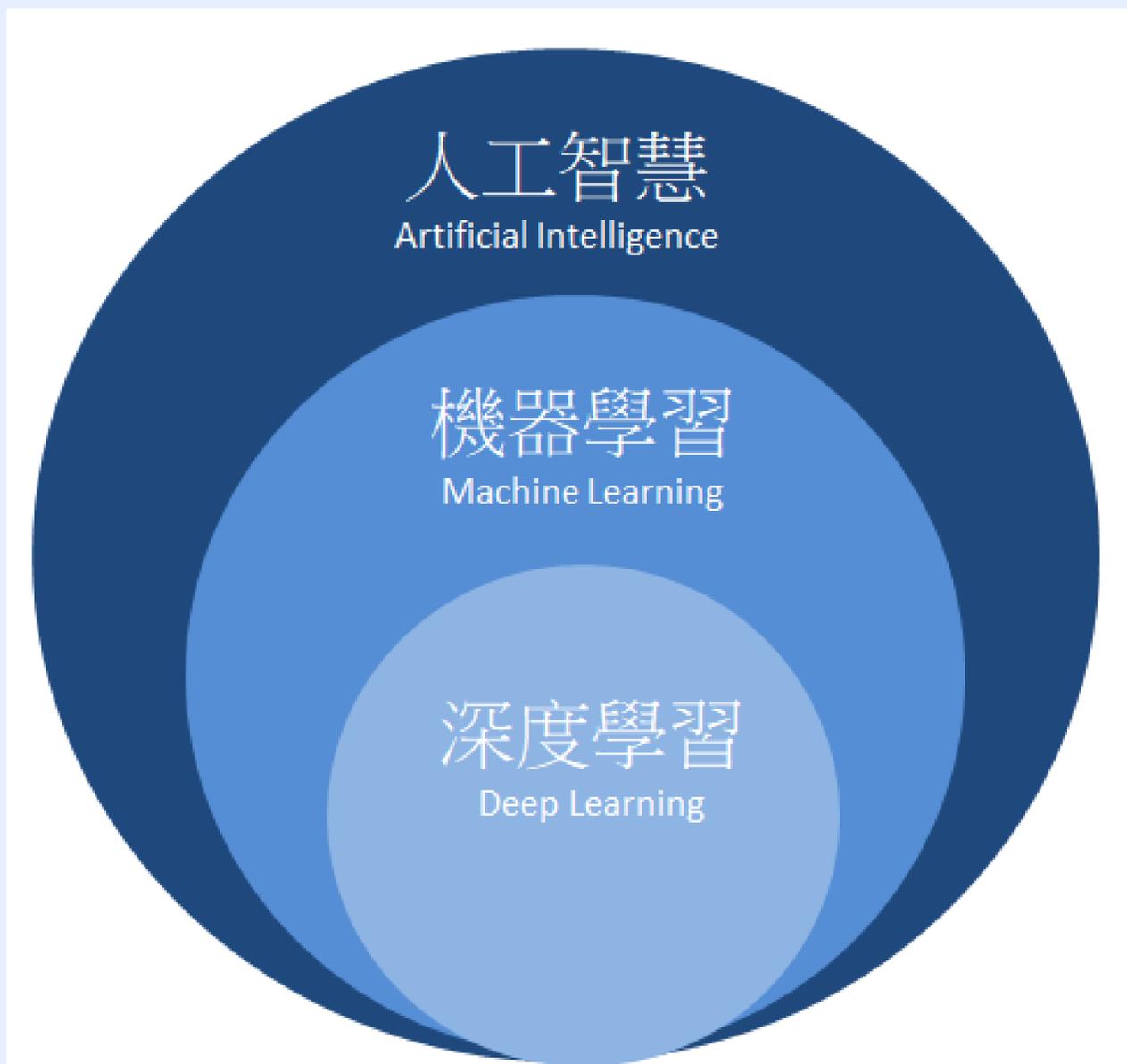
人工智能物聯網（**AIoT**）是人工智能（**AI**）技術與物聯網（**IoT**）基礎設施的結合，以實現更高效的物聯網運營、改善人機交互並增強數據管理和分析。



人工智能 Artificial intelligence (AI)

人工智能（AI）是指通過演算法模擬人類智能。人工智能的目標包括計算機增強學習、推理和感知。

- 弱人工智能(Weak AI)往往是簡單且面向單一任務的
- 強人工智能(Strong AI)則執行更複雜且類似於人類的任務。



Source: https://hackmd.io/@JimmyLiu0530/Hk6pW_3oD

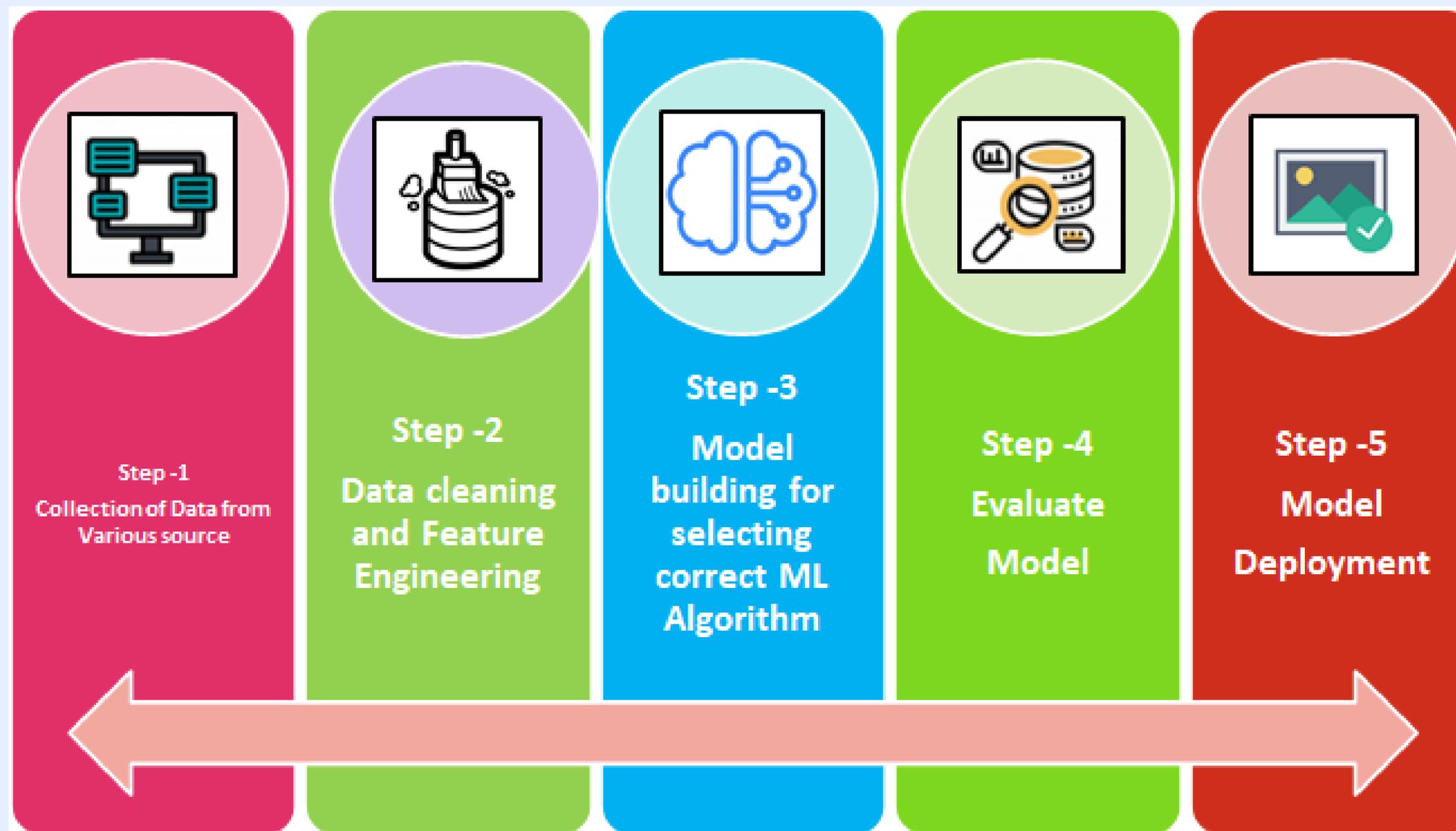
人工智能的一個子集是機器學習 (Machine Learning)，它指的是計算機程序可以自動學習並適應新數據而無需人類協助的概念。深度學習 (Deep Learning) 技術通過模擬人類大腦神經網絡 (Neural network) 來實現這種自動學習。

機器學習 Machine Learning (ML)

機器學習的類型：

- 1. Supervised Machine Learning (監督式學習)：**使用標記數據集來訓練對數據進行分類或準確預測結果的算法。
- 2. Unsupervised Machine Learning (非監督式學習)：**無需人工干預即可發現隱藏的模式或數據分組。
- 3. Reinforcement learning (強化學習)：**利用自身行為和經驗的反饋，通過反復試驗在交互式環境中進行學習。

機器學習的流程



機器學習模型評估指標

- 分類問題評估指標：
 - 準確率 - Accuracy
 - 精確率（差準率） - Precision
 - 召回率（查全率） - Recall
 - F1分數
 - ROC曲線
 - AUC曲線
- 迴歸問題評估指標：
 - MAE
 - MSE

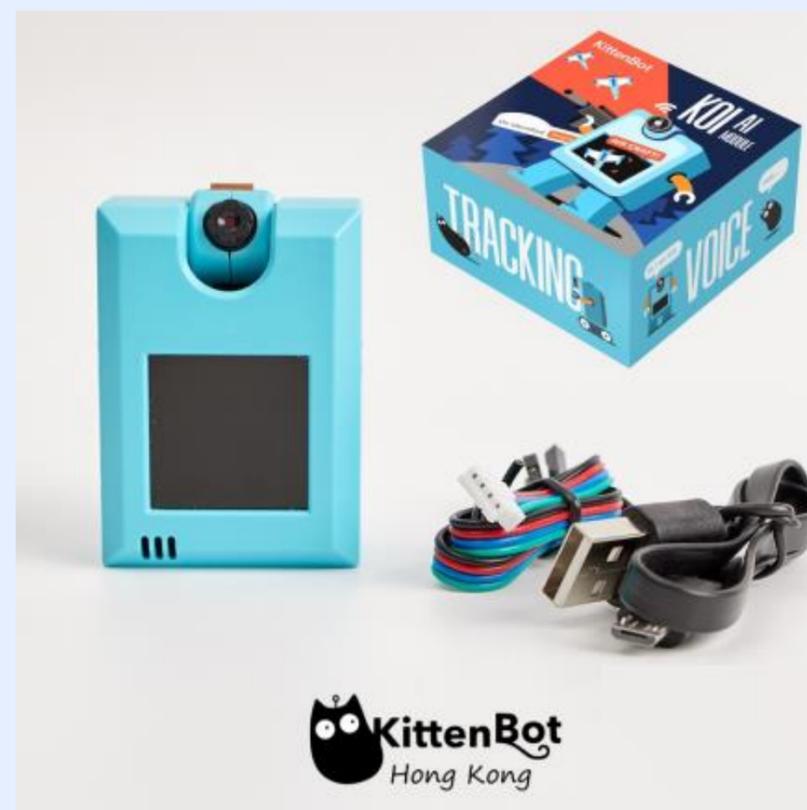
實作: 利用HuskyLens視覺傳感器作物體分類

工具:

1. HuskyLens視覺傳感器
2. Micro:bit V2 + Makecode

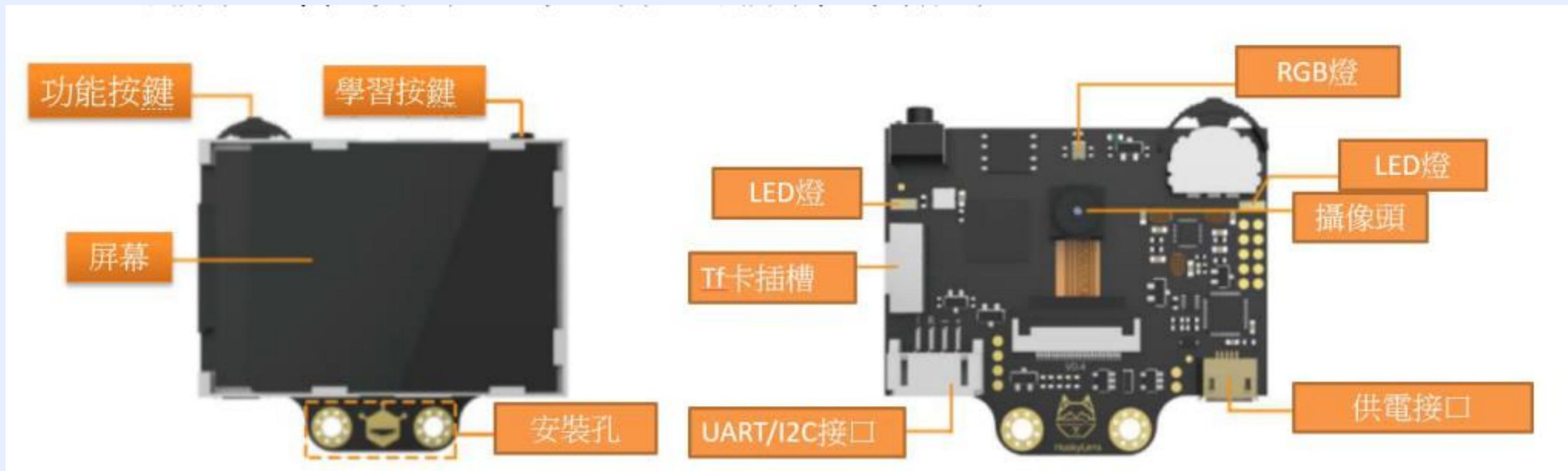
支援micro:bit的人工智能鏡頭:

- HuskyLens (由DFRobot 開發) - HKD 440
- KOI Artificial Intelligence Module (由KittenBot 開發) - HKD 670
- ELECFREAKS Smart AI Lens Kits (由ELECFREAKS開發) – HKD 400

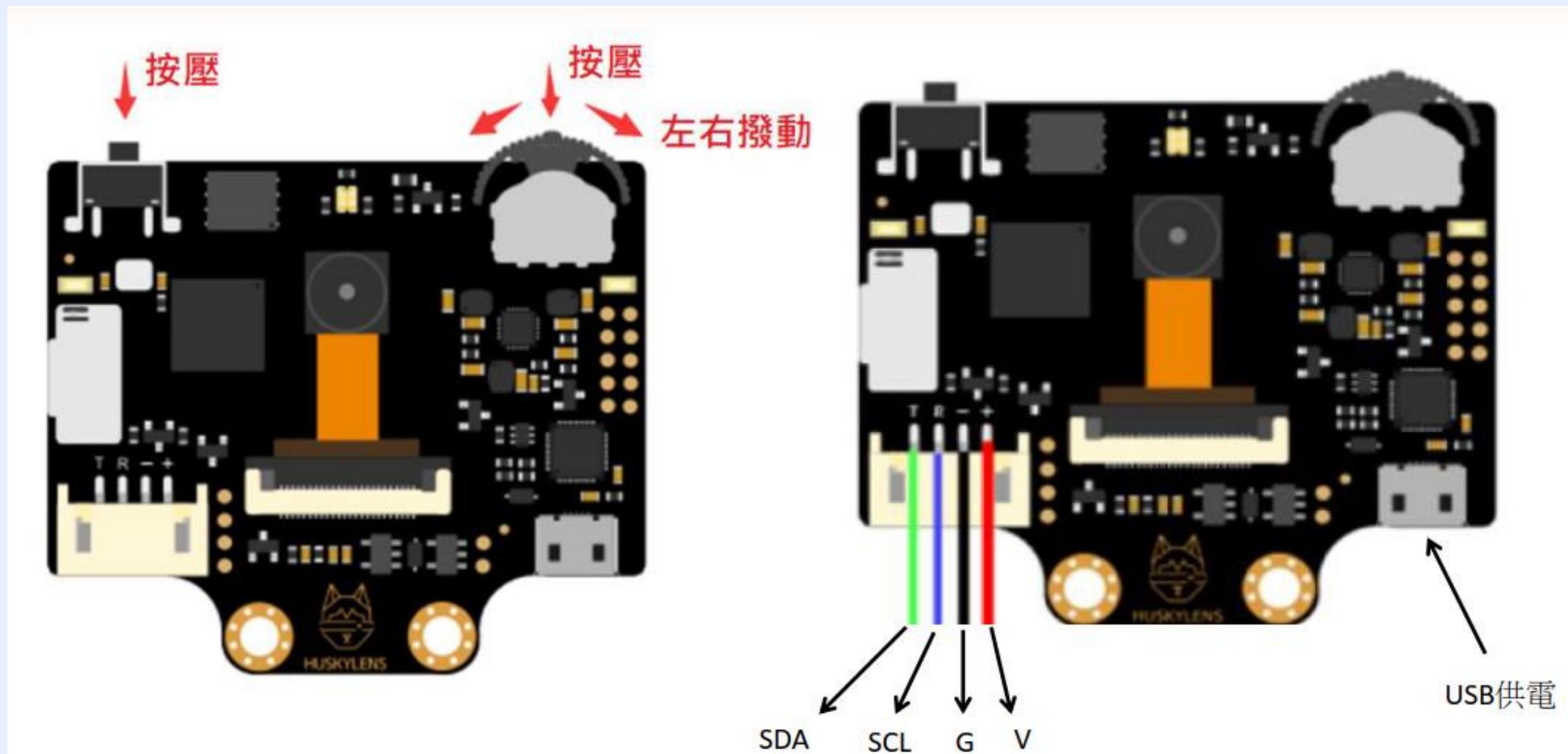


HuskyLens 視覺傳感器

- Huskylens 是一款簡單易用的人工智能相機 | 視覺傳感器。DFRobot Huskylens 配備了人臉識別、物體跟踪、物體識別、線路跟踪、顏色識別、標籤（二維碼）識別等多種功能。



HuskyLens 視覺傳感器

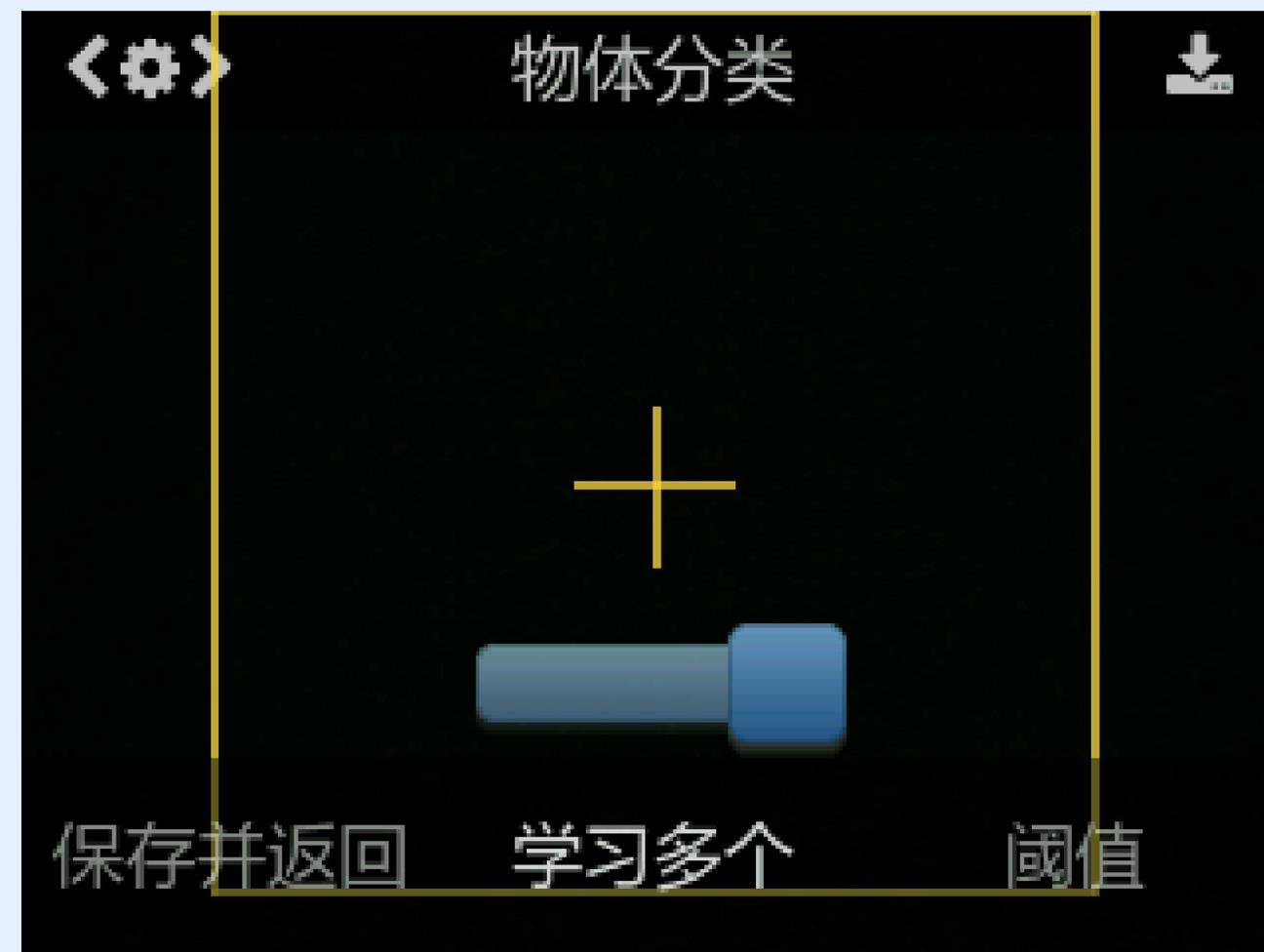


https://wiki.dfrobot.com/HUSKYLENS_V1.0_SKU_SEN0305_SEN0336

利用HuskyLens 視覺傳感器訓練模型 (物體分類)

操作設置

1. 向左或向右撥動“功能按鍵”，直至屏幕頂部顯示“物體分類”
2. 長按“功能按鍵”，進入物體分類功能的二級菜單參數設置界面
3. 向左或向右撥動“功能按鍵”，選中“學習多個”，查看該開關是否打開。如沒打開，則短按“功能按鍵”，接著向右撥動“功能按鍵”打開“學習多個”的開關，即：進度條顏色變藍，進度條上的方塊位於進度條的右邊。再短按“功能按鍵”，確認該參數
4. 向左撥動“功能按鍵”，選中“保存並返回“，短按”功能按鍵“，屏幕提示”是否保存參數？“，默認選擇”確認“，此時短按”功能按鍵“，即可保存參數，並自動返回到物體分類模式。



利用HuskyLens 視覺傳感器訓練模型 (物體分類)

學習與識別

1. 學習物體

將HuskyLens屏幕中央的橙黃色大框對準需要學習的物體(上圖中左邊帶安全帽的工人)，長按“學習按鍵”，從不同的角度和距離學習，完成第一個物體的學習之後，鬆開“學習按鍵”後，屏幕上會提示：“再按一次按鍵繼續！按其他按鍵結束”。如要繼續學習下一個物體，則在倒計時結束前按下“學習按鍵”，可以繼續學習下一個物體。如果不再需要學習其他物體了，則在倒計時結束前按下“功能按鍵”即可，或者不操作任何按鍵，等待倒計時結束。

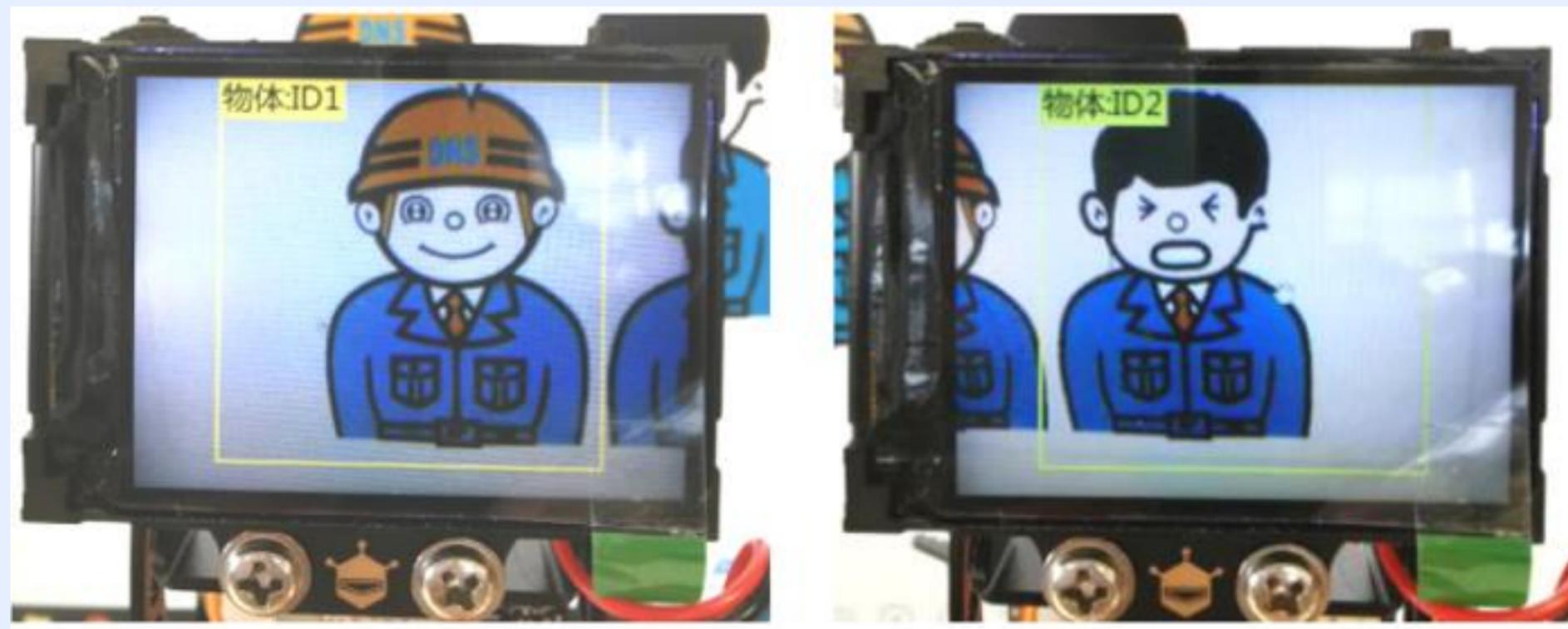


利用HuskyLens 視覺傳感器訓練模型 (物體分類)

學習與識別

2. 識別物體

HuskyLens再次遇到學習過的物體時，在屏幕上會顯示其ID號。如下圖，當HUSKYLENS識別到工人帶著安全帽，屏幕顯示ID1，沒帶安全帽顯示ID2。



更多關於物體分類的想法和項目：
<https://mc.dfrobot.com.cn/thread-304439-1-1.html>

利用HuskyLens 視覺傳感器訓練模型 (物體分類)

忘記學過的物件

如果屏幕中央沒有“+”字，說明HuskyLens在該功能下已經學習過了（已學習狀態）。如要讓HuskyLens學習新的物件，則需要刪除之前學習過的物件信息，也就是讓HuskyLens忘記已學的物件。

刪除已學東西的操作方法如下：

在當前功能下，短按“學習按鍵”，屏幕提示“再按一次遺忘！”。在倒計時結束前，再次短按“學習按鍵”，即可刪除上次學習的東西，屏幕中央顯示“+”字，說明HuskyLens已經準備好學習新東西了。如果不小心短按了“學習按鍵”，屏幕已經提示“再按一次遺忘！”，但又不想刪除已學習的東西，那麼在倒計時結束前，不要有任何操作即可。

利用HuskyLens 視覺傳感器訓練模型 (物體分類)

SD卡保存/加載模型

HuskyLens支持將同一個算法下學習的多個物體作為一個數據模型，通過SD卡能保存這個模型，即使刪除了當前算法的所有數據，也可以再從SD卡中重新加載模型，讓HuskyLens自動學習模型中的數據。

通過保存模型的方法，HuskyLens可以在一個算法中滿足多場景的使用，比如在物體分類算法中，學習剪刀石頭佈為1個模型，學習垃圾分類為1個模型，然後通過模型切換，就能快速實現所需功能，避免重複的讓HuskyLens學習。

使用此功能時，需要先插入一張SD卡，SD卡需要格式化為FAT32。HUSKYLENS的7大算法功能都支持SD卡保存和加載模型，每個算法功能可以保存5個模型。



利用HuskyLens 視覺傳感器訓練模型 (物體分類)

方式一：在各算法功能的二級菜單目錄下手動操作

此處在物體分類功能中為例進行演示，其他算法功能中的用法也是一樣的。

1. 學習新物體：讓HuskyLens學習完幾個新的物體。比如：在物體分類功能中，依次學習多個動物，有不同的ID號。
2. 導出模型：長按“功能按鍵”，進入物體分類功能的二級菜單參數設置界面，然後向右撥動“功能按鍵”，直至選擇“導出到SD卡”一項（即保存模型到SD卡），短按“功能按鍵”，左右撥動“功能按鍵”，選擇0~4任意一個即可（相當於選擇保存的位置，方便區分不同的模型），然後短按“功能按鍵”即可保存模型。

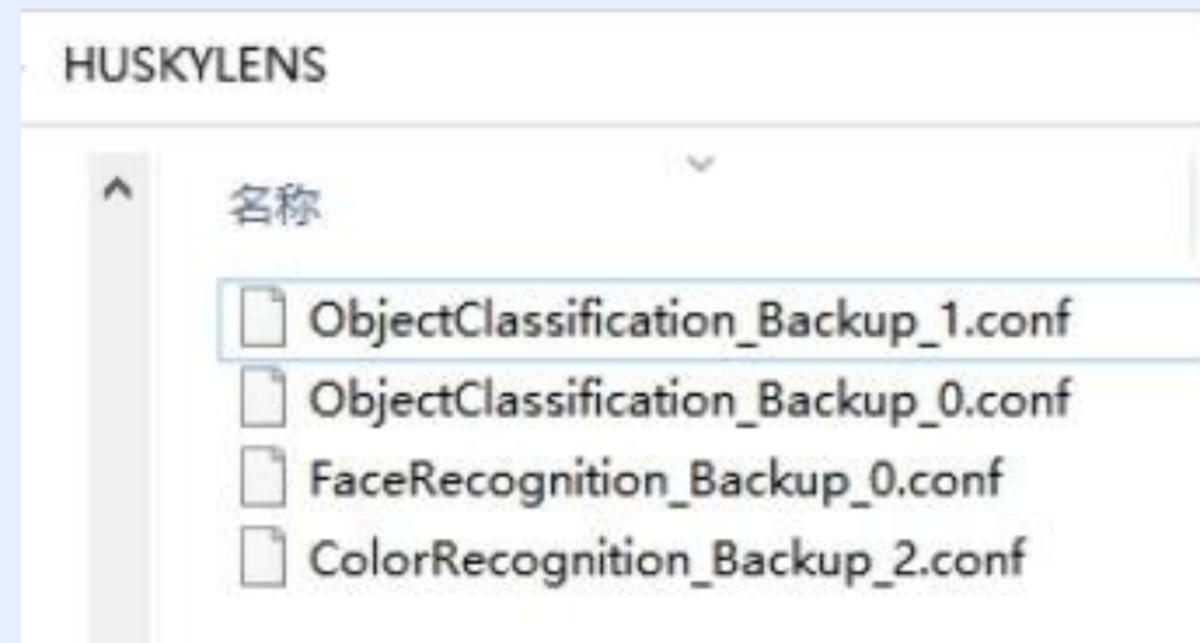


利用HuskyLens 視覺傳感器訓練模型 (物體分類)

方式一：在各算法功能的二級菜單目錄下手動操作

3. 模型導出到SD卡後，用電腦讀取該SD卡，在“HUSKYLENS”文件夾下即可看到後綴為.conf的模型數據文件，不同算法保存的文件名稱不同。

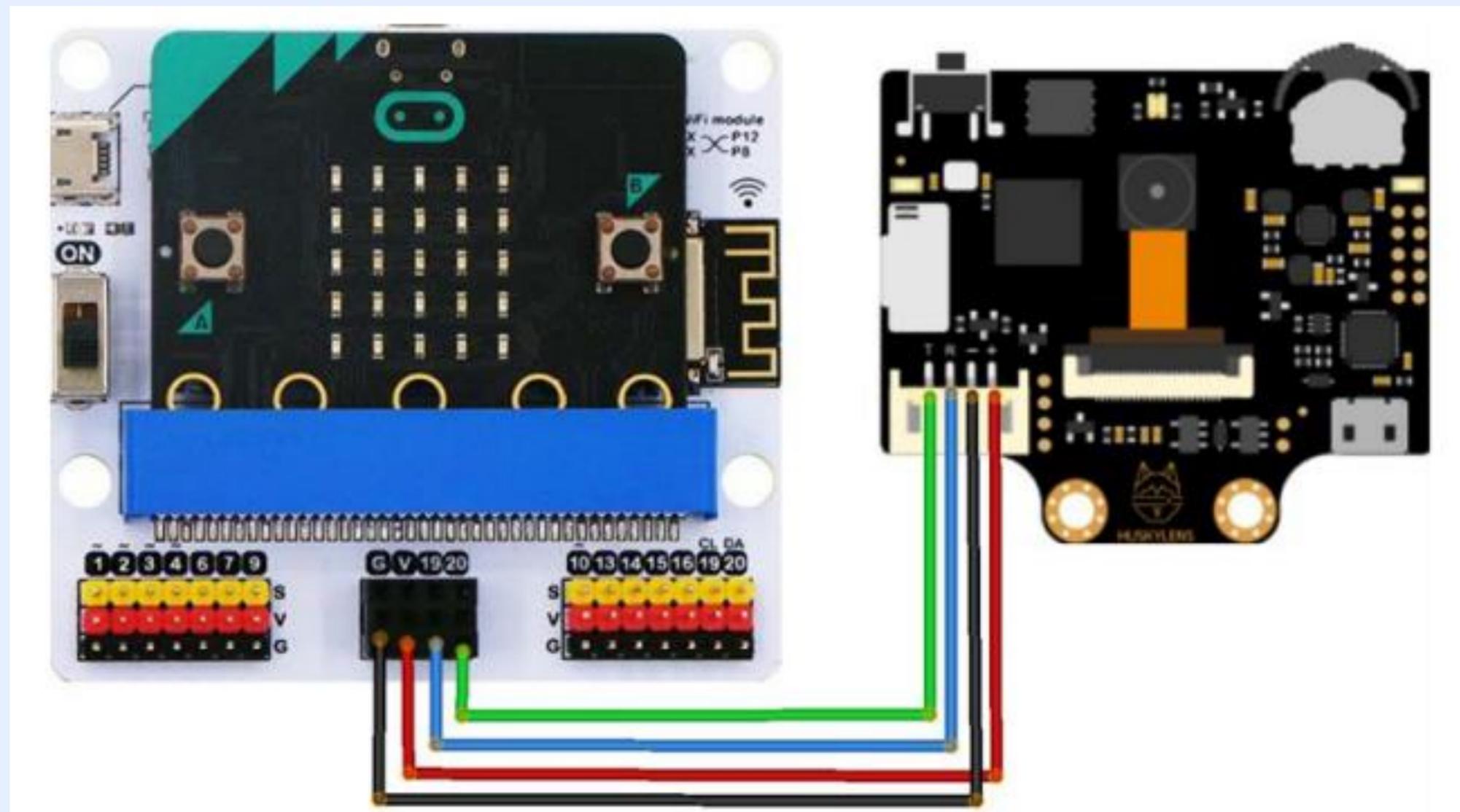
4. 導入模型：當SD卡中已經有模型數據文件時，可以把模型直接導入給HuskyLens。比如：在物體分類功能中，SD卡中已經有物體分類的模型數據文件了，那麼在物體分類功能的二級菜單參數設置界面中，選擇“從SD卡導入”一項，選擇0~4其中一個，即可把SD卡的模型加載到HuskyLens中。導入模型後，HuskyLens就可以使用當前模型進行識別了。



利用HuskyLens 視覺傳感器訓練模型 (物體分類)

方式二：程序觸發學習功能

1. 使用micro:bit、IoT:bit擴展板和HuskyLens建構電路



利用HuskyLens 視覺傳感器訓練模型 (物體分類)

方式二：程序觸發學習功能

2. 在MakeCode網頁版中新建一個項目，然後，點擊右上方的“更多”按鈕（齒輪圖標），在其下拉菜單中選擇“擴展”，打開擴展界面。

3. 在搜索框中輸入"huskylens"，然後點擊搜索按鈕（搜索框右邊的放大鏡按鈕），就能看到HuskyLens插件(如下圖，左邊第一個)，然後點擊它，就能把HuskyLens的插件加載進來了。



利用HuskyLens 視覺傳感器訓練模型 (物體分類)

方式二：程序觸發學習功能

4. Makecode示例程序

```
当开机时
  HuskyLens通过I2C初始化直到成功
  HuskyLens切换到 物体分类 算法直到成功

无限循环
  如果为 当按钮 A 被按下时 则
    HuskyLens自动学习一次ID 1
```

利用HuskyLens 視覺傳感器訓練模型 (物體分類)

利用學習模型控制 micro:bit

編寫一個程序，透過經過學習的HuskyLens來識別動物圖像，並將動物的名字顯示在micro:bit的LED面板上。

當啟動時

- HuskyLens通過I2C初始化直到成功
- HuskyLens切換到 物體分類 算法直到成功

重複無限次

- HuskyLens請求一次數據存入結果
- 變數 animal 設為 HuskyLens從結果中獲取第 1 個方框 ID 參數
- 如果 animal = 1 那麼
 - 顯示文字 "Chicken"
- 否則如果 animal = 2 那麼
 - 顯示文字 "Duck"
- 否則如果 animal = 3 那麼
 - 顯示文字 "Owl"

可自行設計 MICROBIT 根據 AI 模型的預測，作出不同的反應，例如開動不同的裝置

利用HuskyLens 視覺傳感器訓練模型 (物體分類)

常見問題

物體分類算法可以得出物體在HUSKYLENS屏幕上的相對位置嗎？

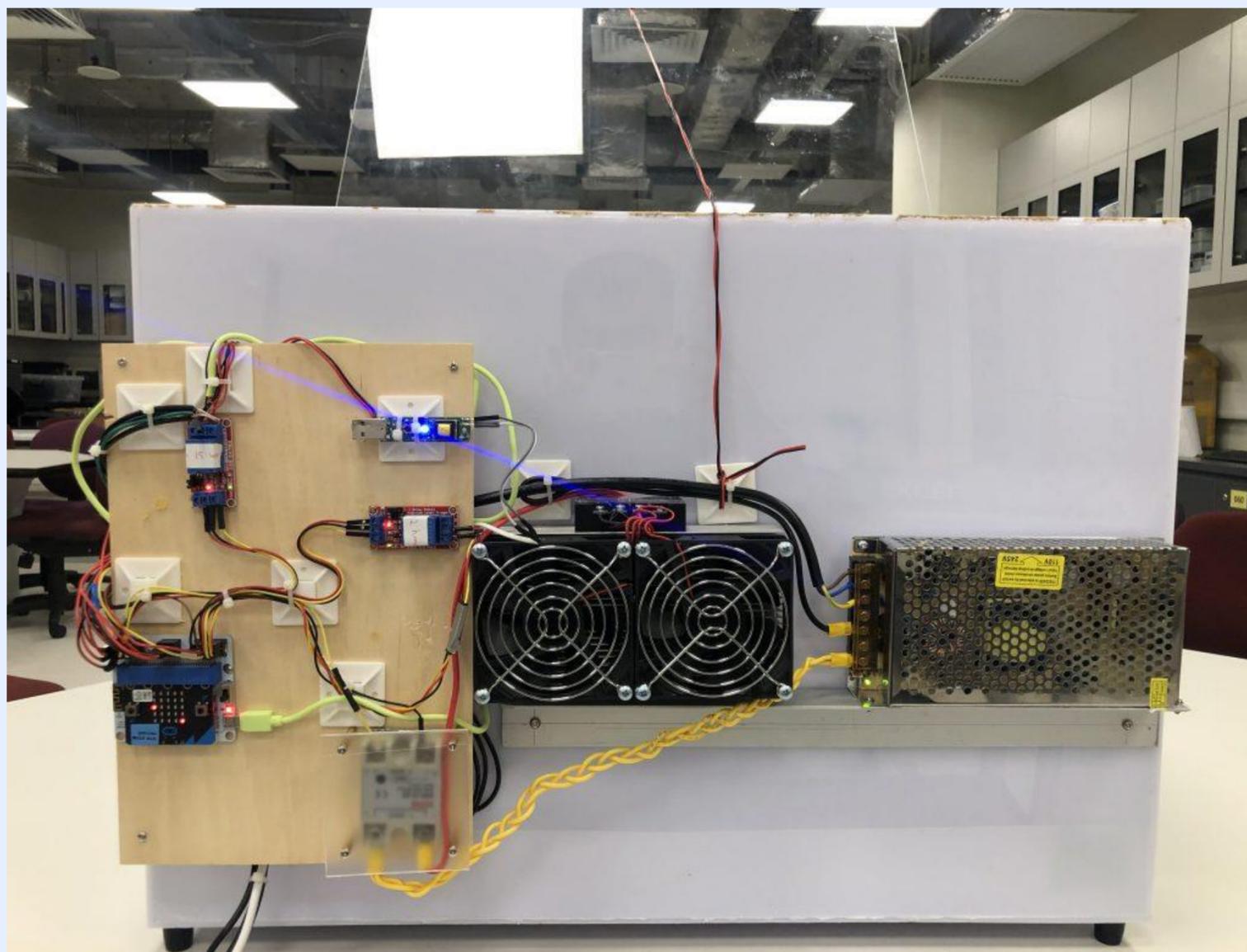
答: 不能。物體分類算法下，輸出方框的位置固定，其在屏幕上的x、y中心坐標保持不變，所以HUSKYLENS無法得出物體在屏幕上的相對位置。但是可以通過學習物體的不同位置作為不同的ID，通過ID來判斷位置，比如無人車中，分別學習道路左側、中間、右側為ID1、2、3，通過判斷ID就可以知道無人車相對於馬路的位置

物體分類算法下，怎麼提高識別的精準度？

答：長按“學習按鍵”不鬆開，可以從多個角度和距離錄入目標圖片，提高識別精準度

物聯網(IoT)技術與STEAM教育應用

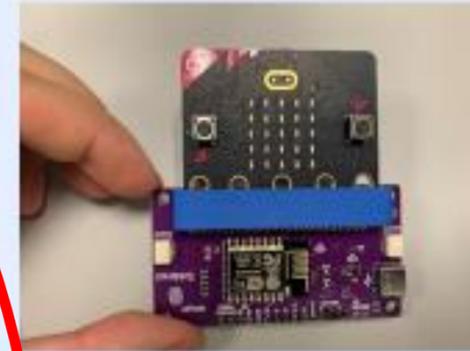
STEAM 教育範例 (物聯網溫室)



Micro:bit-driven Greenhouse
Hydroponic Device with IoT

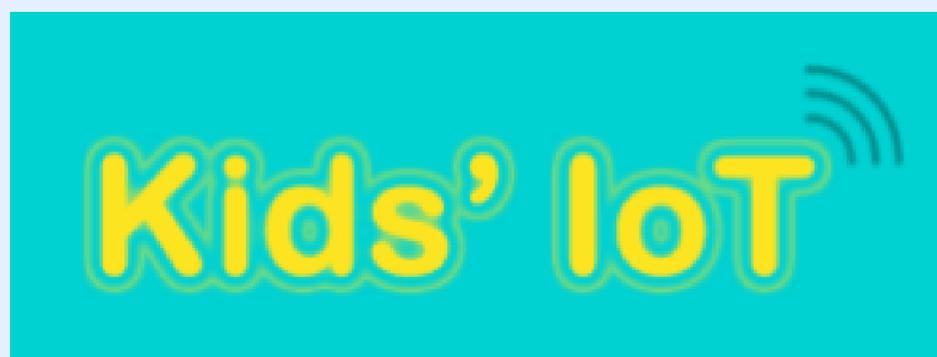
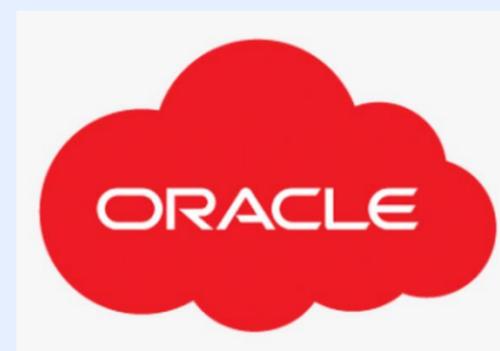


Micro:bit IoT Board Comparison



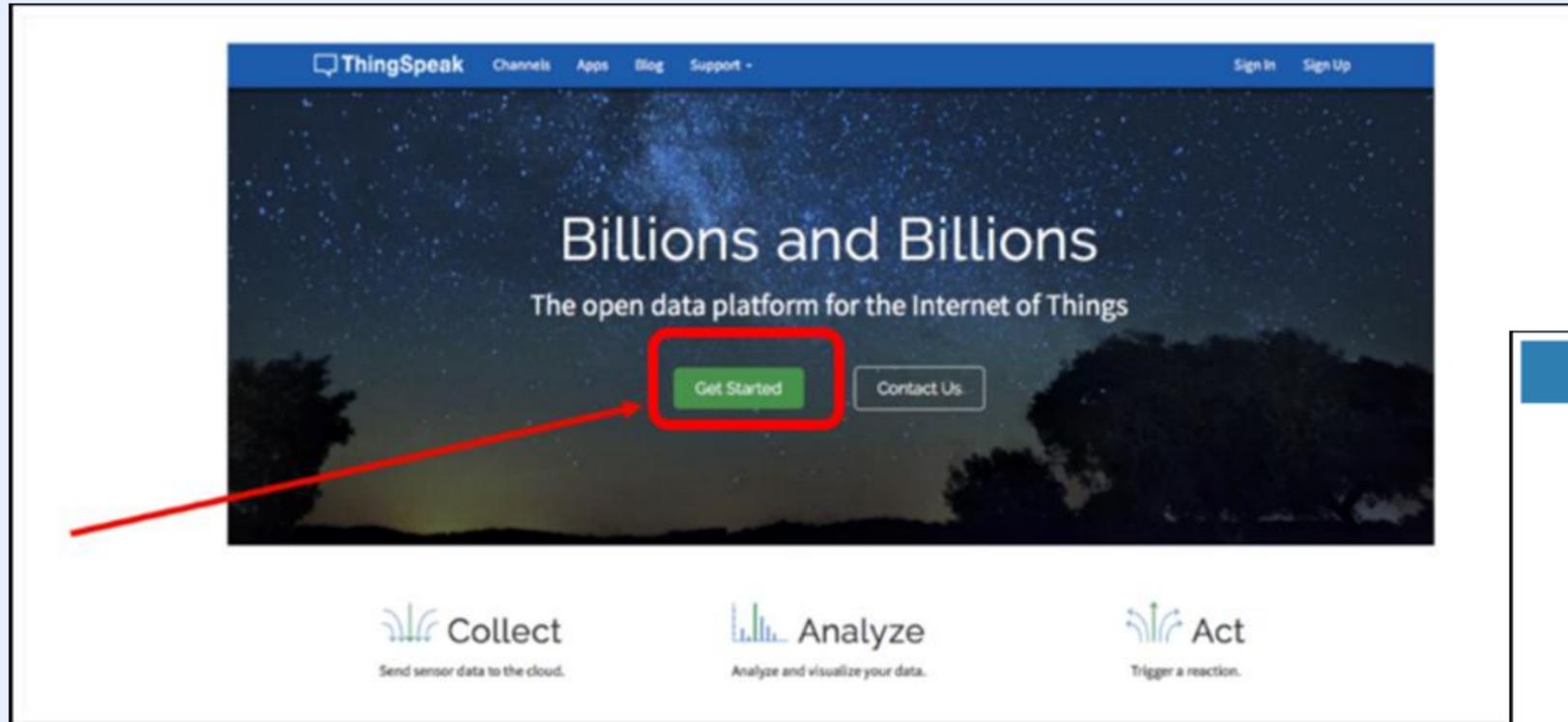
	Esp-01 Wifi module	iot:bit	WiFi:bit	MuseLab
Price (HKD)	6	130	159	646
Difficulty	Advance	Medium	Medium	Easy
Coding platform	Makecode	Makecode	Makecode	Makecode + Scratch + Snap!
IoT Platform Support	ThingSpeak	ThingSpeak, IFTTT, MQTT, Kidslot	ThingSpeak	Cisco, Amazon Alexa, Google Home, IFTTT, ThingSpeak
Source	Esp-01: Taobao or any local STEM material vendors	ELECFREAKS	ETC Educational Technology Connection (HK) Ltd	華輝無線電行有限公司 -門市

Different IoT platforms

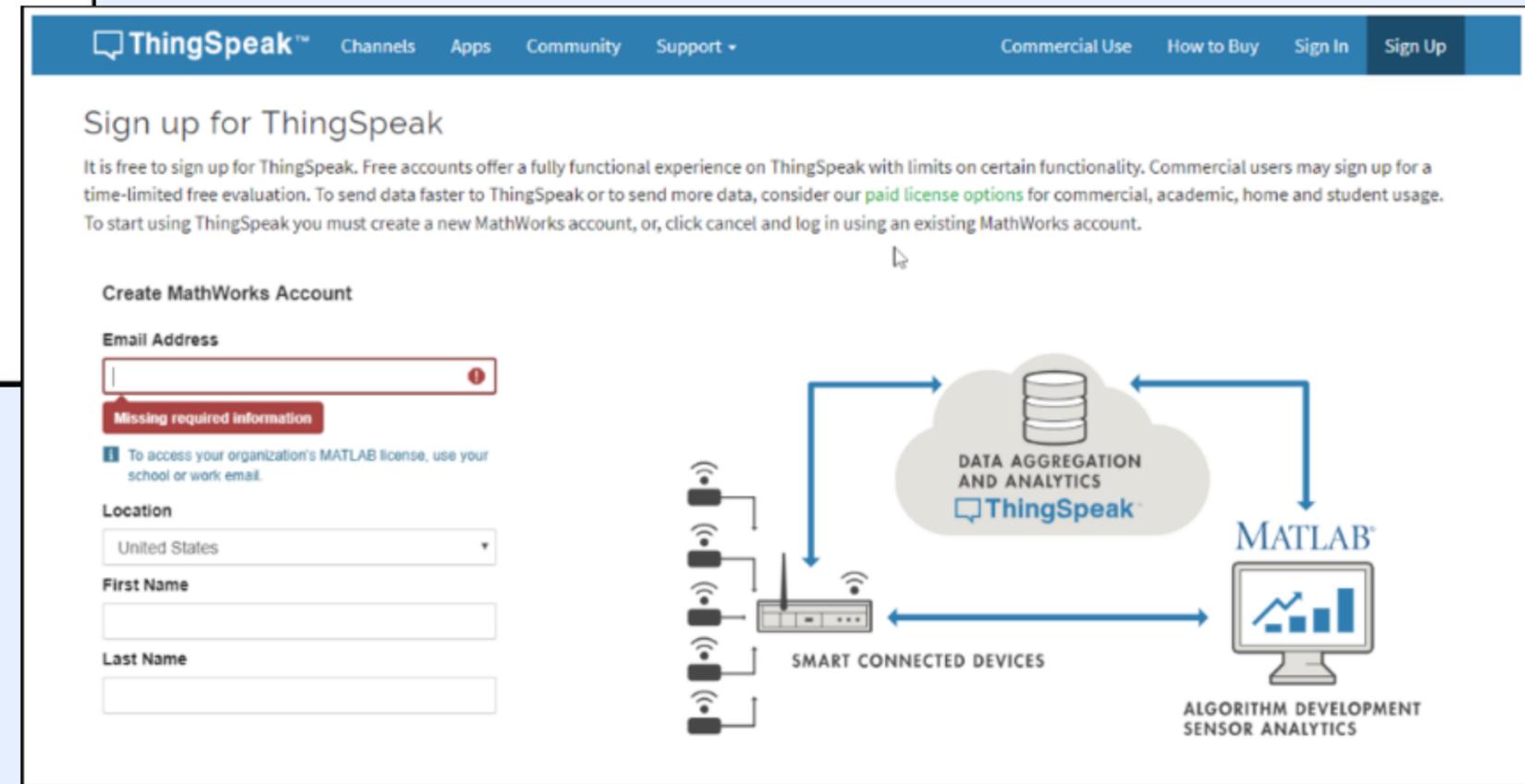


實作: ThingSpeak & IFTTT IoT 應用

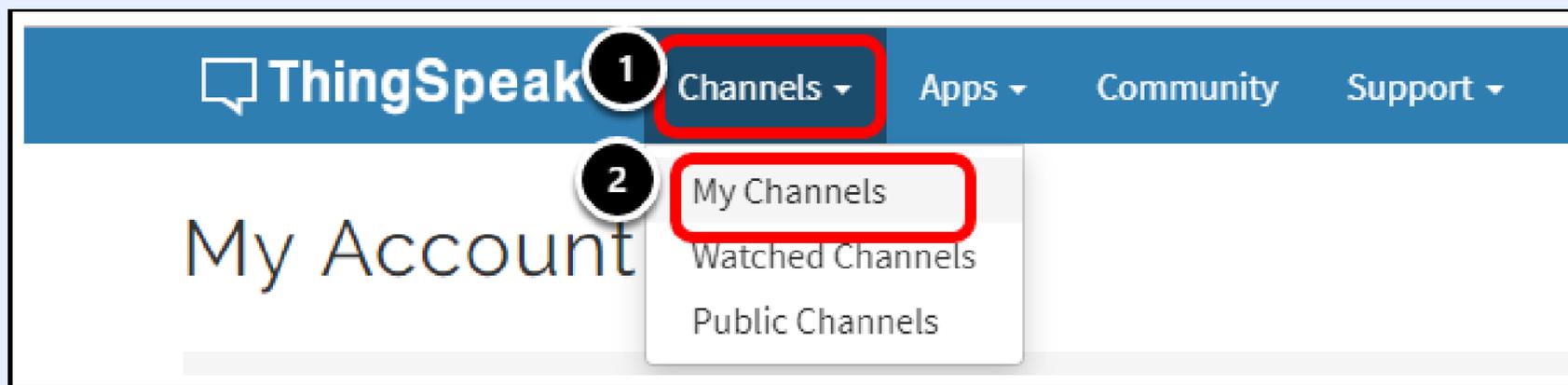
ThingSpeak Set Up (1)



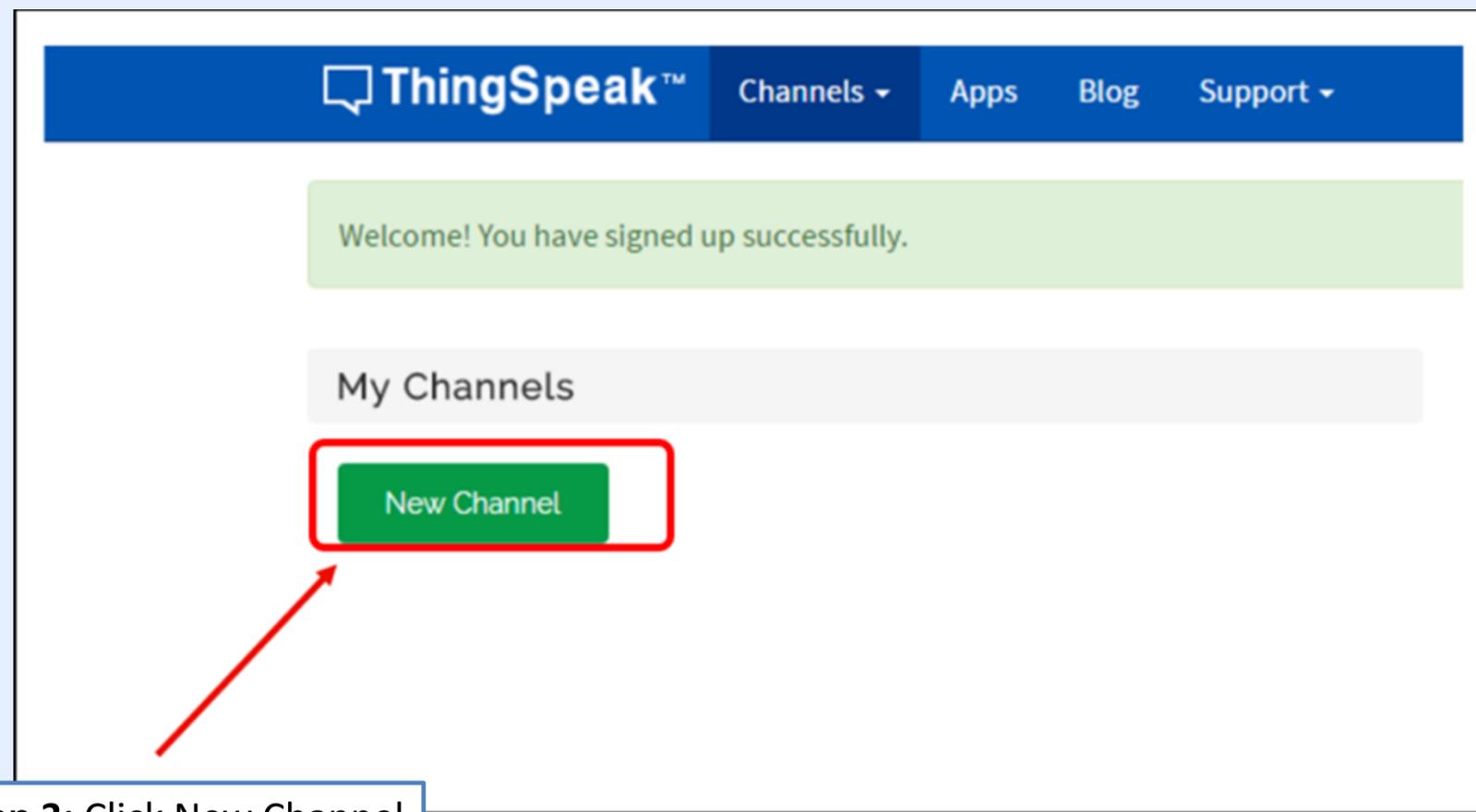
Step 1: Sign up in
<https://thingspeak.com>



ThingSpeak Set Up (2)



Step 2: After login 'ThingSpeak', click 'Channels' and choose 'My Channels'



Step 3: Click New Channel

ThingSpeak Set Up (3)

New Channel

Name "IOT TESTING" (for example)

Description

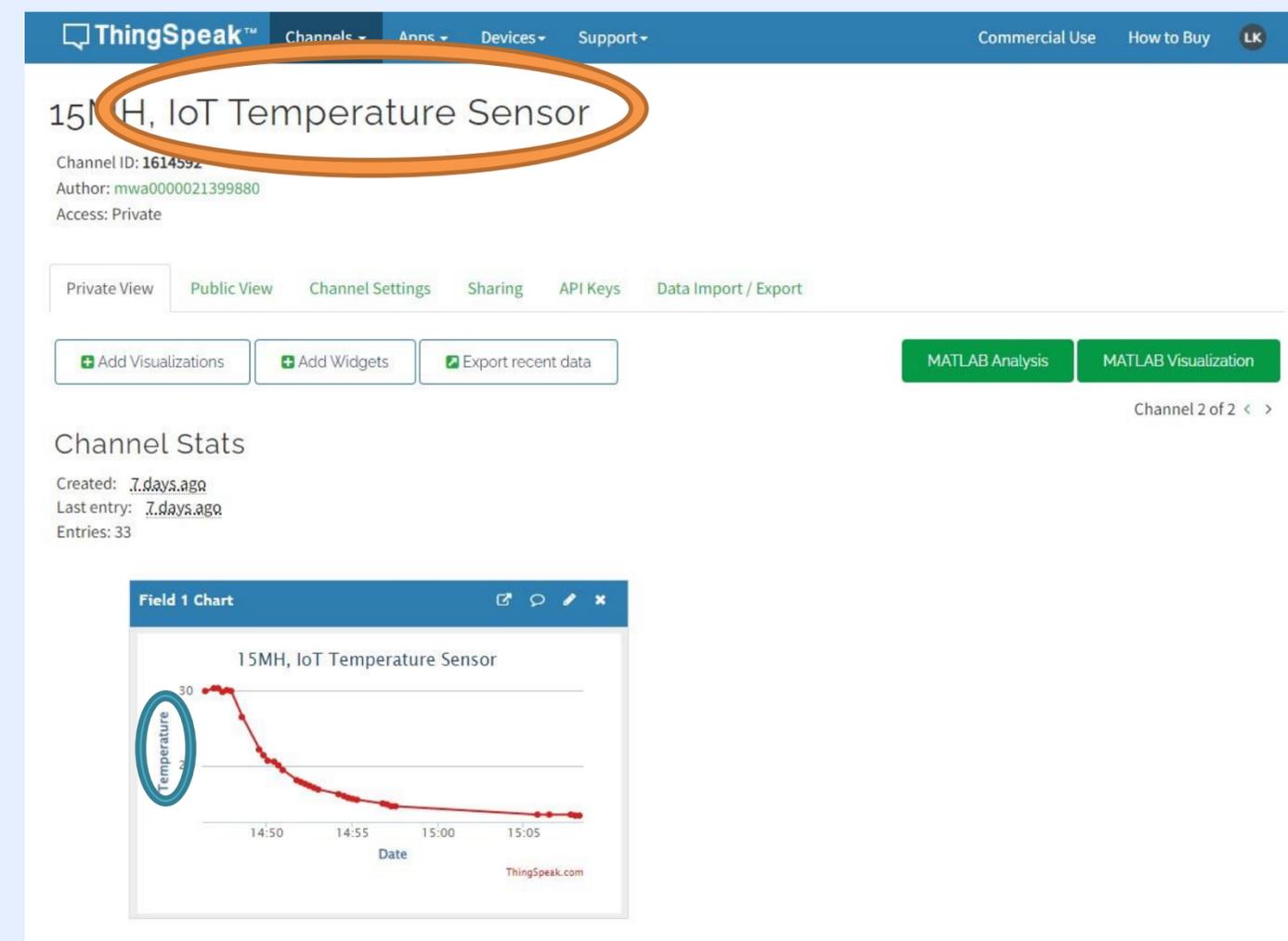
Field 1 "Temperature"

Field 2

Field 3

Field 4

Step 4: Enter the name of the Channel and add a name in 'Field' to record the data.



ThingSpeak Guideline (1)

1. Share

2. Edit (clear data)

3. API Key (Coding)

4. Download data (Excel)

ThingSpeak Channel: 15MH, IoT Temperature Sensor

Channel ID: 1614591
Author: mwa00000280
Access: Private

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

+ Add Visualizations | + Add Widgets | Export recent data

MATLAB Analysis | MATLAB Visualization

Channel 2 of 2 < >

Channel Stats

Created: 7 days ago
Last entry: 7 days ago
Entries: 33

Field 1 Chart

15MH, IoT Temperature Sensor

Date	Temperature
14:50	30
14:51	30
14:52	28
14:53	26
14:54	25
14:55	24
14:56	23
14:57	22
14:58	21
14:59	20
15:00	19
15:01	18
15:02	17
15:03	16
15:04	15
15:05	14

ThingSpeak Guideline (2)

1.Share

ThingSpeak™ Channels - Apps - Support - Commercial Use How to Buy

Color Test 3.0

Channel ID: 1295560
Author: mwa0000021225182
Access: Private

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

This channel is not public.
To make this channel public, navigate to [Sharing](#)

Blog | Documentation | Tutorials | Terms | Privacy Policy © 2021 The MathWorks, Inc.

2. Edit(clear data)

ThingSpeak™ Channels - Apps - Support - Commercial Use How to Buy

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

Channel Settings

Percentage complete: 30%

Channel ID: 1295560
Name: Color Test 3.0
Description:
Field 1: Temperature
Field 2: Temperature
Field 3: Temperature
Field 4: Temperature
Field 5: Temperature
Field 6: Temperature
Field 7: Temperature
Field 8: Temperature
Metadata:
Tags:
Link to External Site:
Link to GitHub:
Elevation:
Show Channel Location:
Latitude:
Longitude:
Show Video:
Video URL:
Show Status:
[Save Channel](#)

Want to clear all feed data from this Channel?
[Clear Channel](#)

Help

Channels store all the data that a ThingSpeak application collects. Each channel includes eight fields that can hold any type of data, plus three fields for location data and one for status data. Once you collect data in a channel, you can use ThingSpeak apps to analyze and visualize it.

Channel Settings

- Percentage complete: Calculated based on data entered into the various fields of a channel. Enter the name, description, location, URL, video, and tags to complete your channel.
- Channel Name: Enter a unique name for the ThingSpeak channel.
- Description: Enter a description of the ThingSpeak channel.
- Fields: Check the box to enable the field, and enter a field name. Each ThingSpeak channel can have up to 8 fields.
- Metadata: Enter information about channel data, including JSON, XML, or CSV data.
- Tags: Enter keywords that identify the channel. Separate tags with commas.
- Link to External Site: If you have a website that contains information about your ThingSpeak channel, specify the URL.
- Show Channel Location:
 - Latitude: Specify the latitude position in decimal degrees. For example, the latitude of the city of London is 51.5072.
 - Longitude: Specify the longitude position in decimal degrees. For example, the longitude of the city of London is -0.1278.
 - Elevation: Specify the elevation position meters. For example, the elevation of the city of London is 38.000.
- Video URL: If you have a YouTube™ or Vimeo® video that displays your channel information, specify the full path of the video URL.
- Link to GitHub: If you store your ThingSpeak code on GitHub®, specify the GitHub repository URL.

Using the Channel

You can get data into a channel from a device, website, or another ThingSpeak channel. You can then visualize data and transform it using ThingSpeak Apps.

See [Get Started with ThingSpeak™](#) for an example of measuring data from a weather station that acquires data from an Arduino® device.

[Learn More](#)

Clear Channel

ThingSpeak Guideline (3)

3. API Key (Coding)

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

Write API Key

Key:

[Generate New Write API Key](#)

Read API Keys

Key:

Note:

API Requests

[Write a Channel Feed](#)

```
https://api.thingspeak.com/update?api_key=GVU4MXNZ2MS5U6VR&field1=0
```

4. Download data(Excel)

ThingSpeak Channels Apps Support Commercial Use How to Buy

Color Test 3.0

Channel ID: 1295560
Author: mwa0000021225182
Access: Public

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

Import

Upload a CSV file to import data into this channel.

File: No file chosen

Time Zone:

[Upload](#)

Export

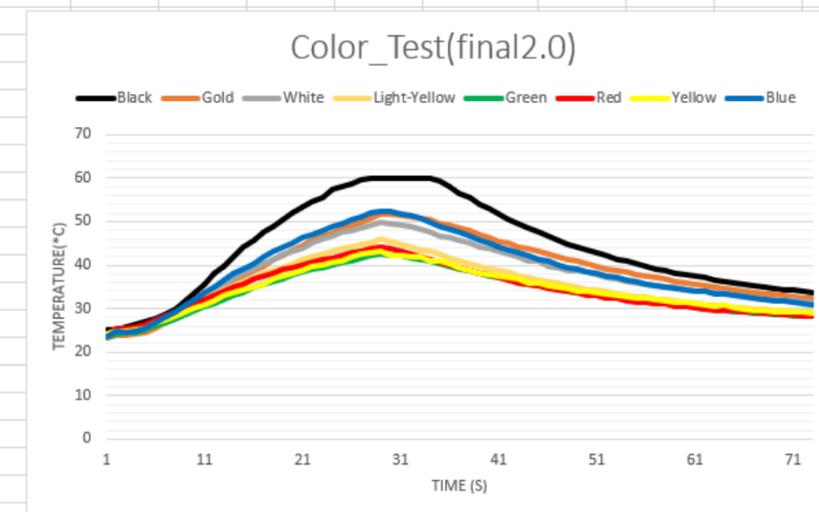
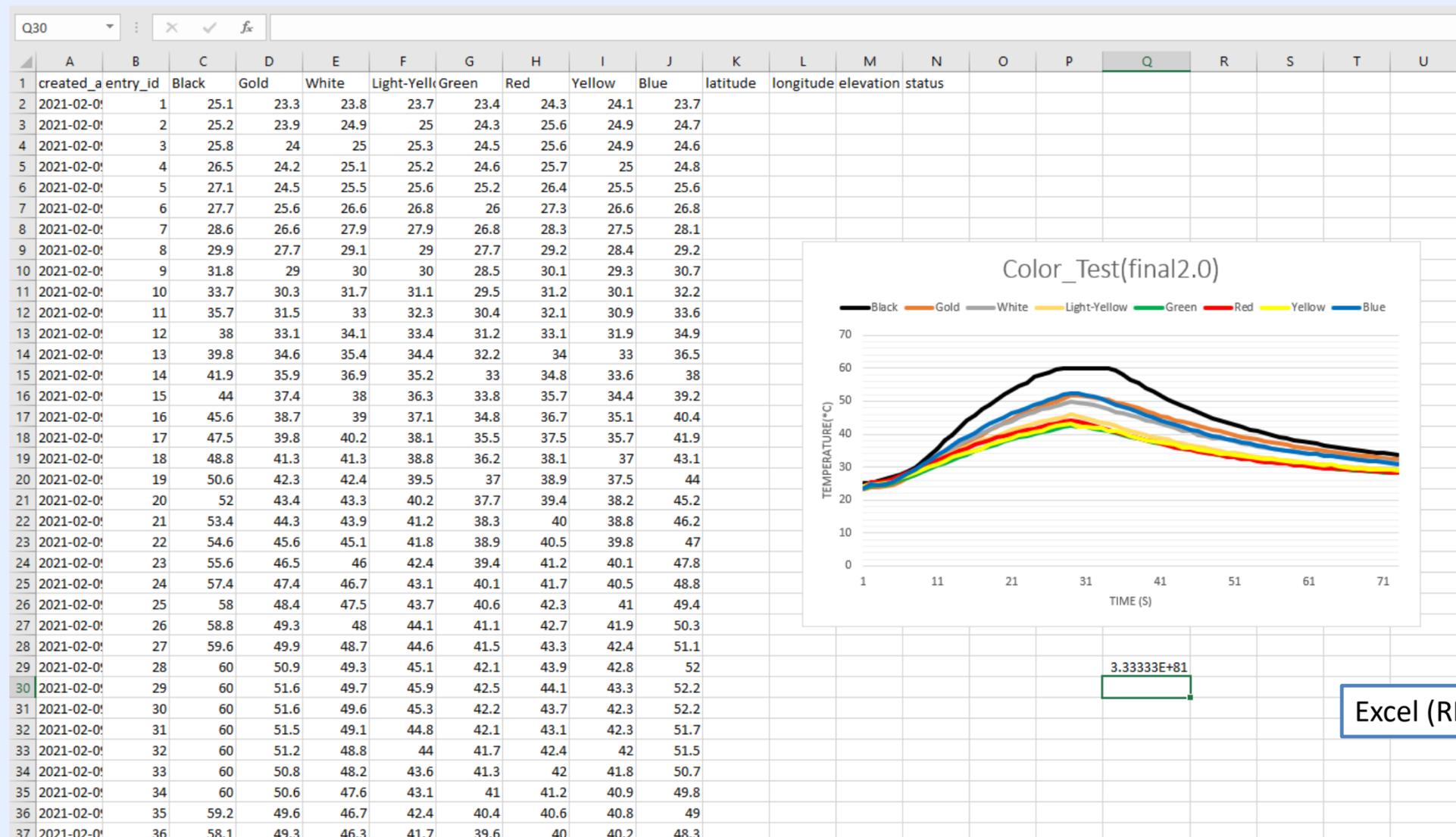
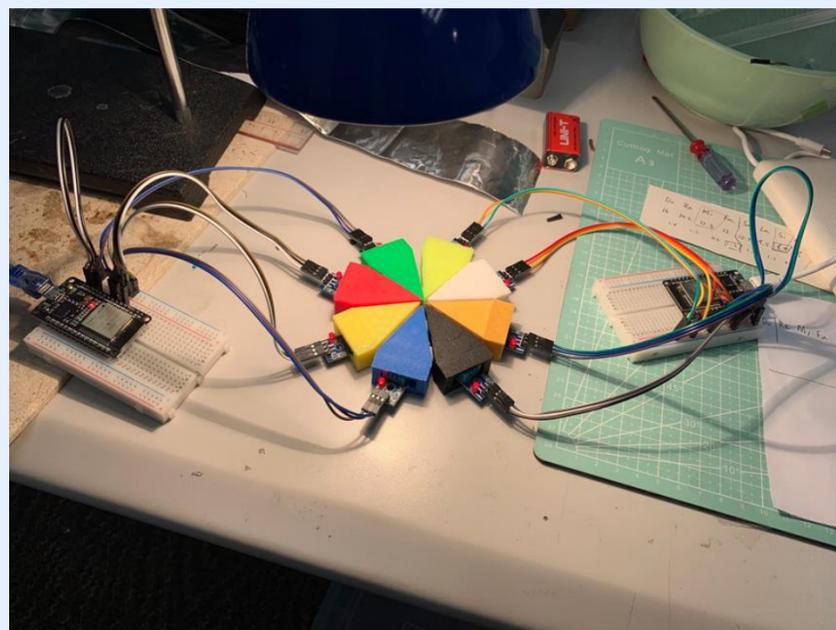
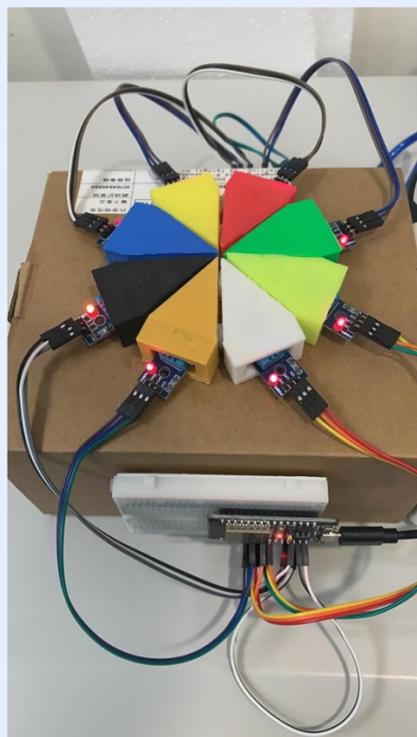
Download all of this Channel's feeds in CSV format.

Time Zone:

[Download](#)

***GMT+8:00 - Hong Kong**

ThingSpeak & Excel Reference



3.33333E+81

Excel (REFERENCE)

ThingSpeak Public View Sharing

testing

Channel ID: 1281894

Author: mwa0000020852618

Access: Public

Private View

Public View

Channel Settings

Sharing

API Keys

Data Import / Export

Channel Sharing Settings

- Keep channel view private
- Share channel view with everyone
- Share channel view only with the following users:

Email
Address

Enter email here

Add User

Help

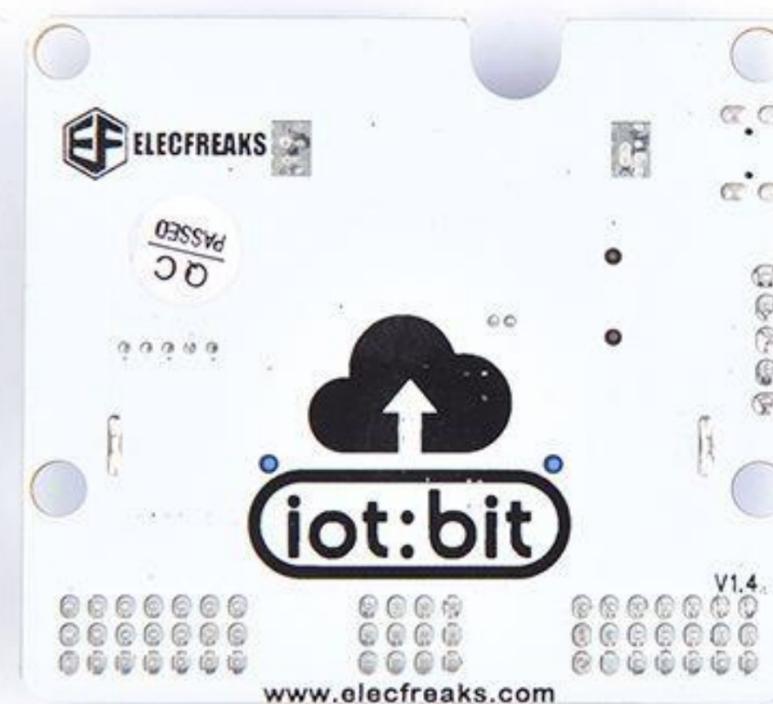
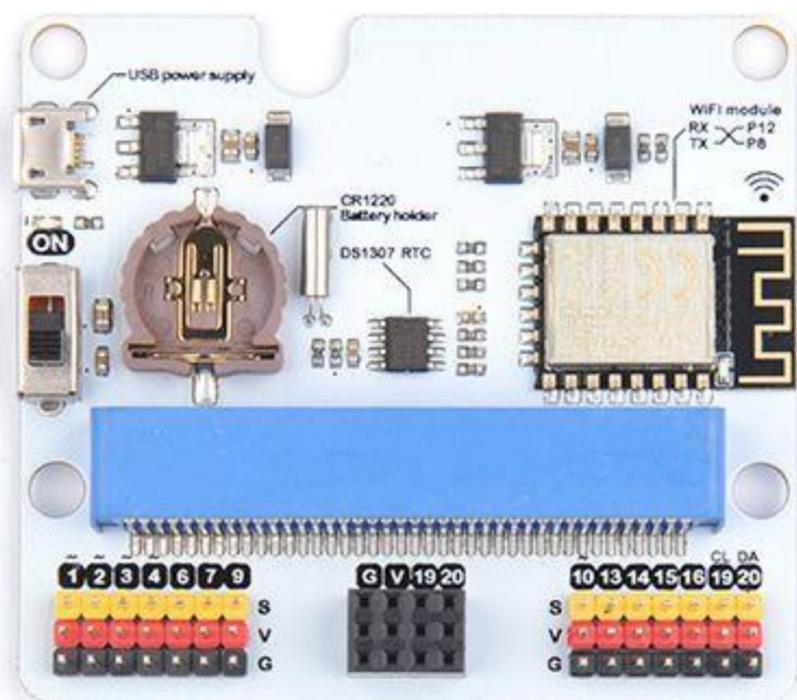
ThingSpeak allows you to control who can view the data in your channel. Irrespective of the settings on this tab, reading data from or writing data to the fields of a channel requires the appropriate API key for the channel.

Channel Sharing Settings

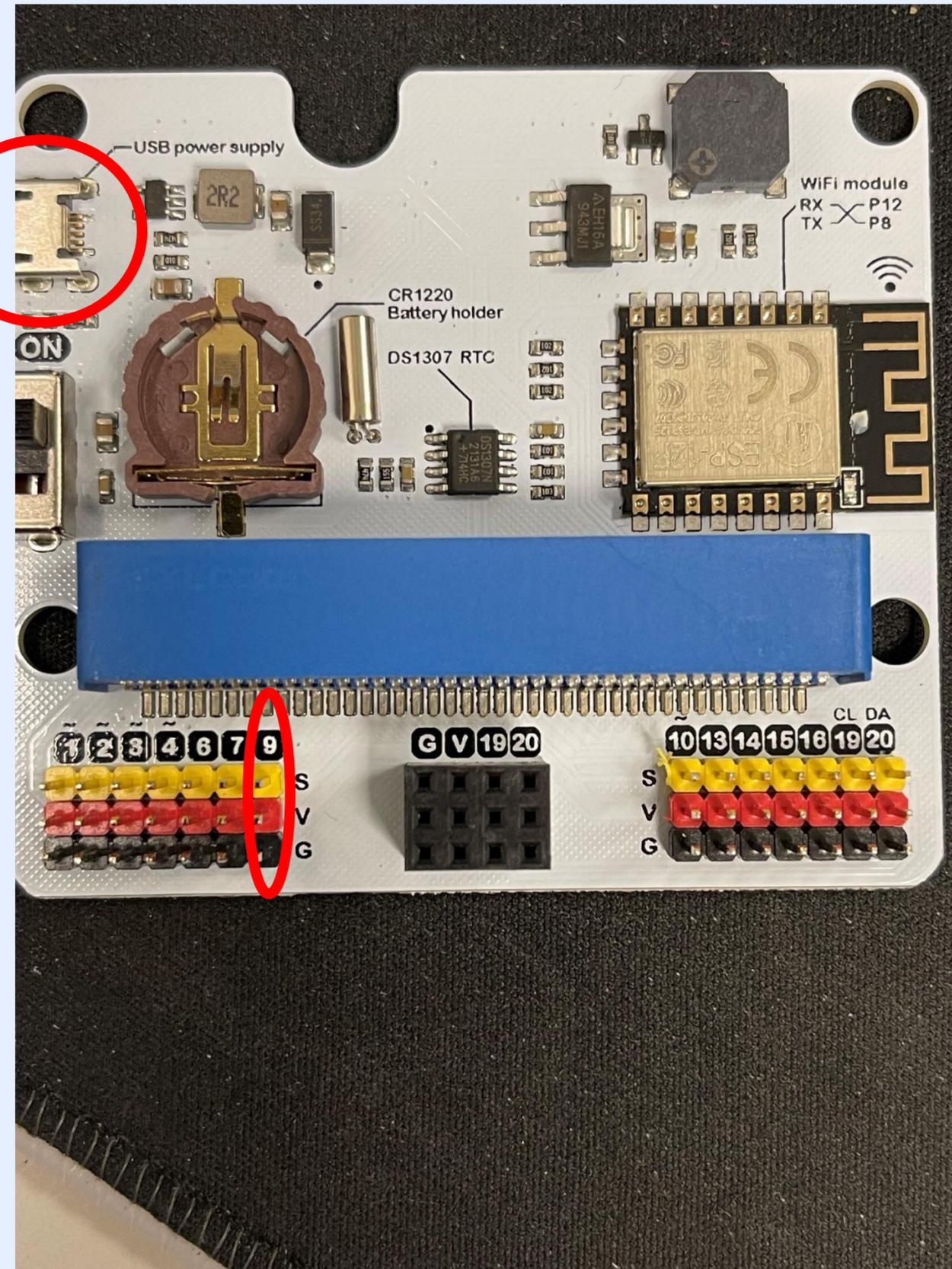
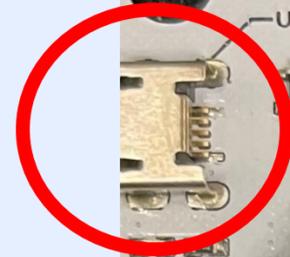
- **Keep channel view private:** Selecting this option keeps your channel private. Only you will be able to see the channel view.
- **Share channel view with everyone:** Selecting this option makes the public view of your channel viewable by anyone browsing the ThingSpeak website.
- **Share channel view only with the following users:** Selecting this option shares the private view of your channel only with specific ThingSpeak users.

iot:bit

Works with
micro:bit | V1 & V2

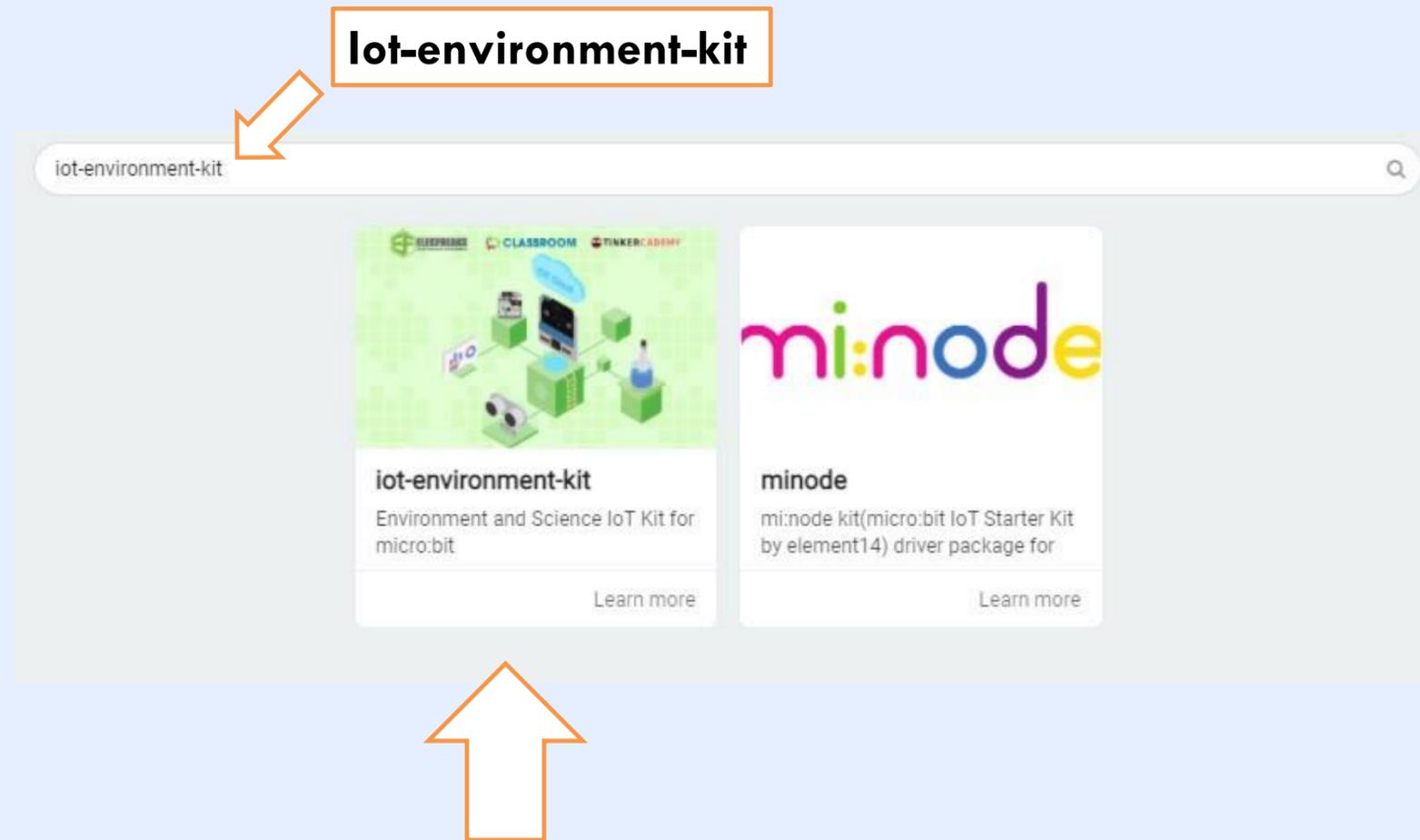


Power supply for
iot:bit



S = Data pin
V = 3.3v power
G = GND

MakeCode extensions



Coding (ThingSpeak)

```
on start
  set ESP8266 RX P8 TX P12 Baud rate 115200
  connect Wifi SSID = "IoT" KEY = "eduhk+IoT+2018"
```

Drag in these blocks.
Then enter the Wi-Fi name and
the password.

```
every 5000 ms
  if Wifi connected true then
    show icon [grid icon]
  if ThingSpeak connected true then
    show icon [grid icon]
```

```
forever
  show number temperature (°C)
  connect thingspeak
  set data to send ThingSpeak
  Write API key = "SUPTXHTON7TWLW0J"
  Field 1 = temperature (°C)
  Upload data to ThingSpeak
  pause (ms) 2000
```

Change the API key (Copy the API
key from your ThingSpeak account)

https://makecode.microbit.org/_Ty7MEfY7pLv6



IFTTT (If This Then That)

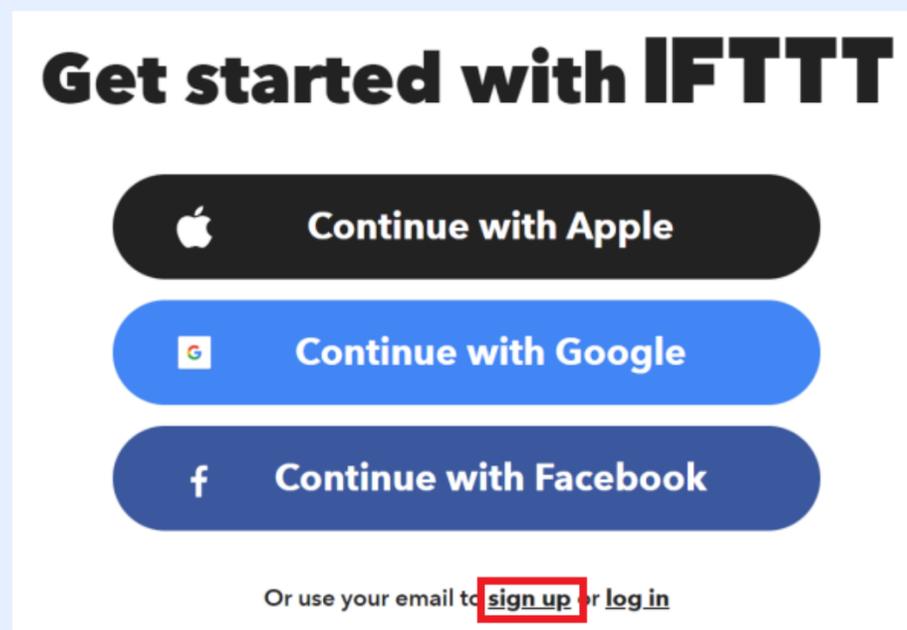
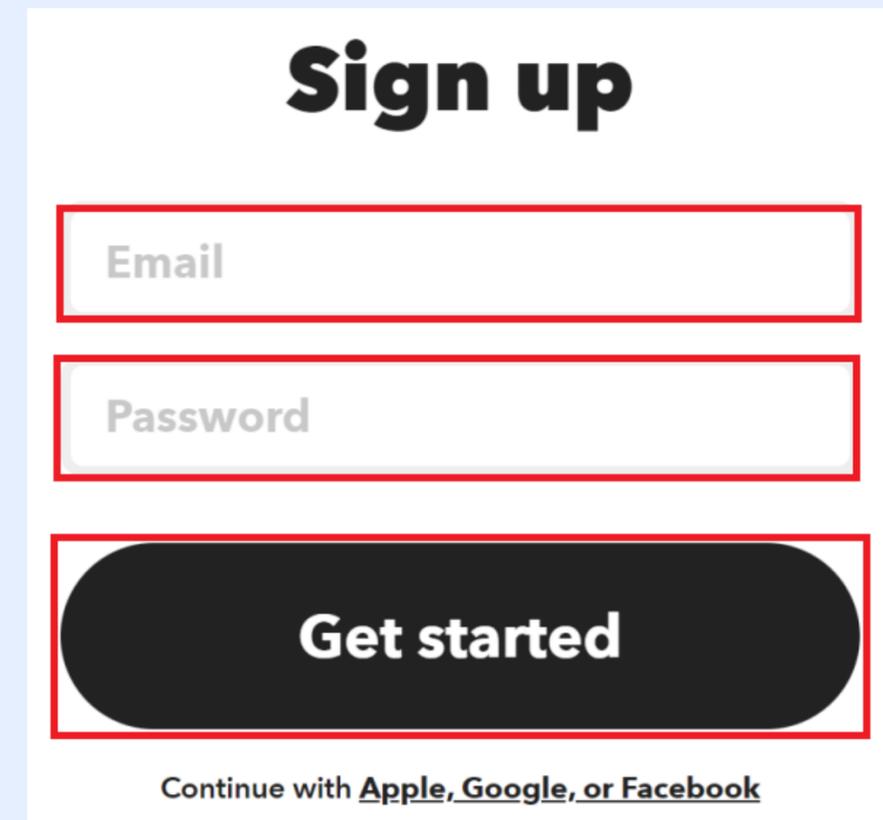
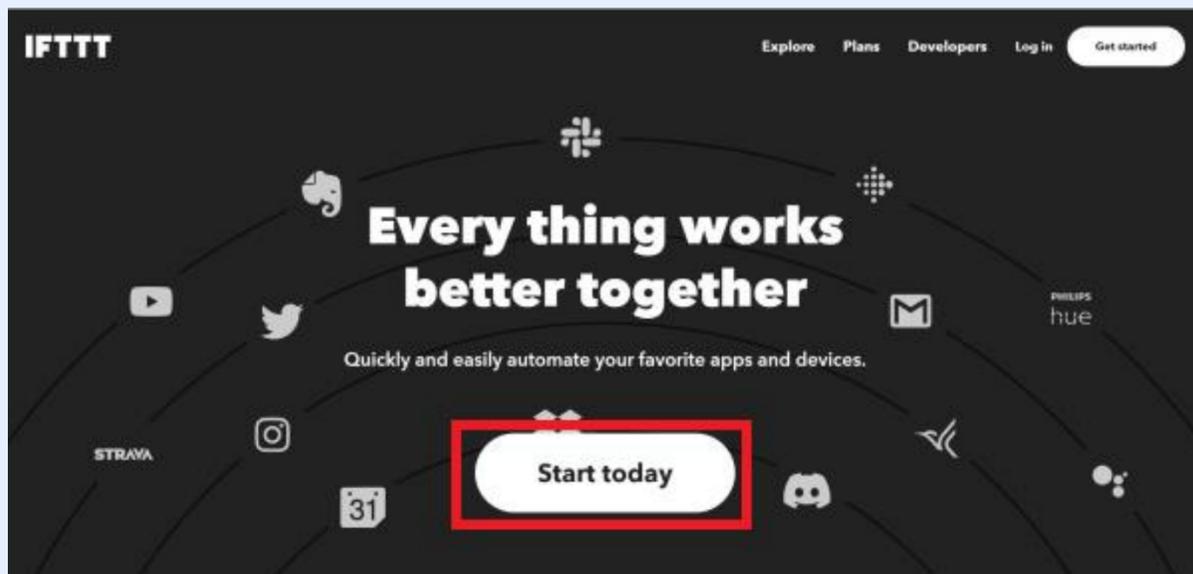
IFTTT通過流程將各種信息連接起來，然後將您想要的信息集中呈現給您，解決了信息雜亂的問題，接收或關注重要信息。

“這個(This)”的操作被稱為“觸發器(Trigger)”，也就是說你在某個網站上的行為；而“那個(That)”則執行指令。在IFTTT中稱為“通道(Channel)”。整個“如果這個那麼那個”動作被定義為任務(Task)。

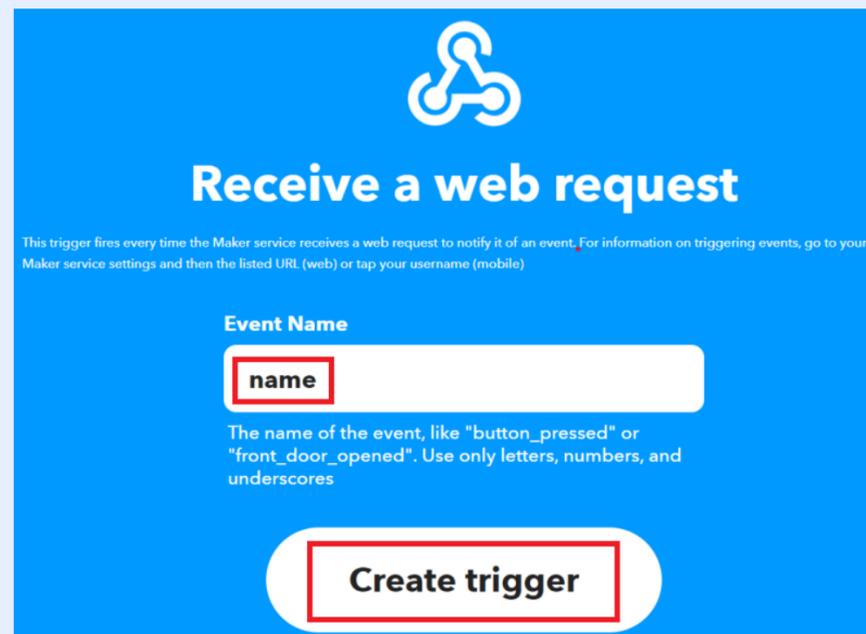
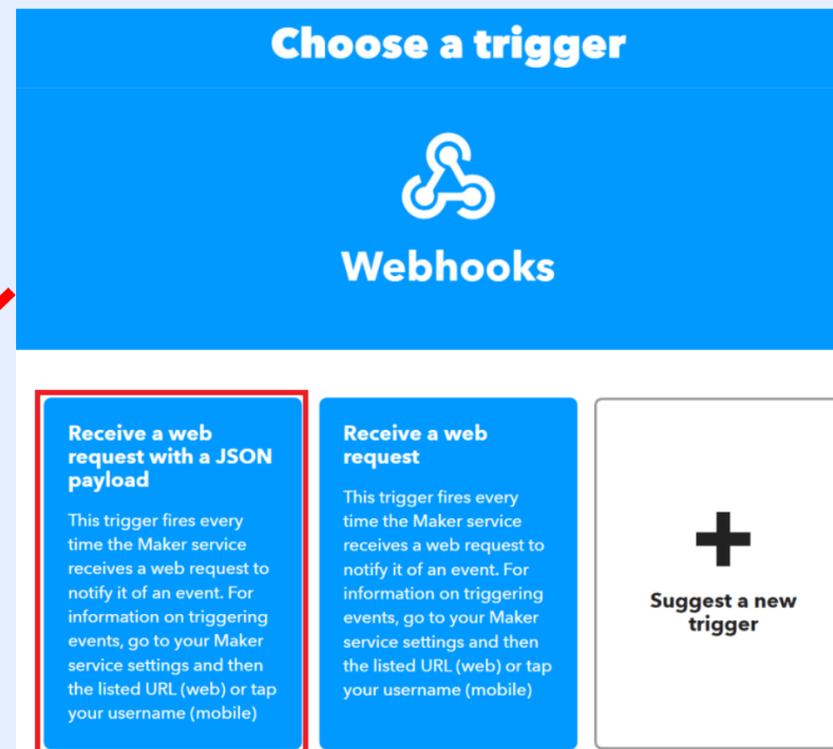
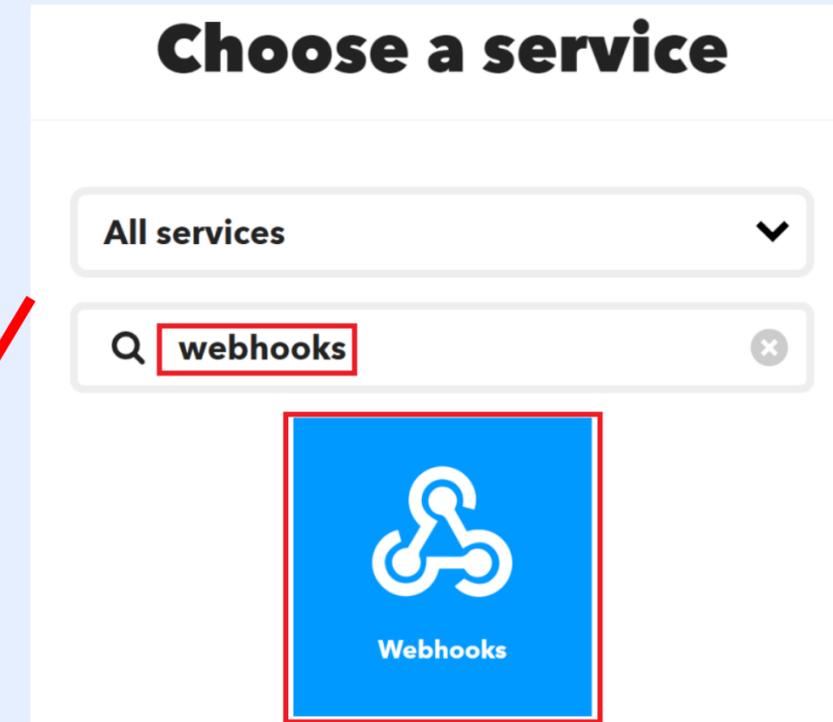
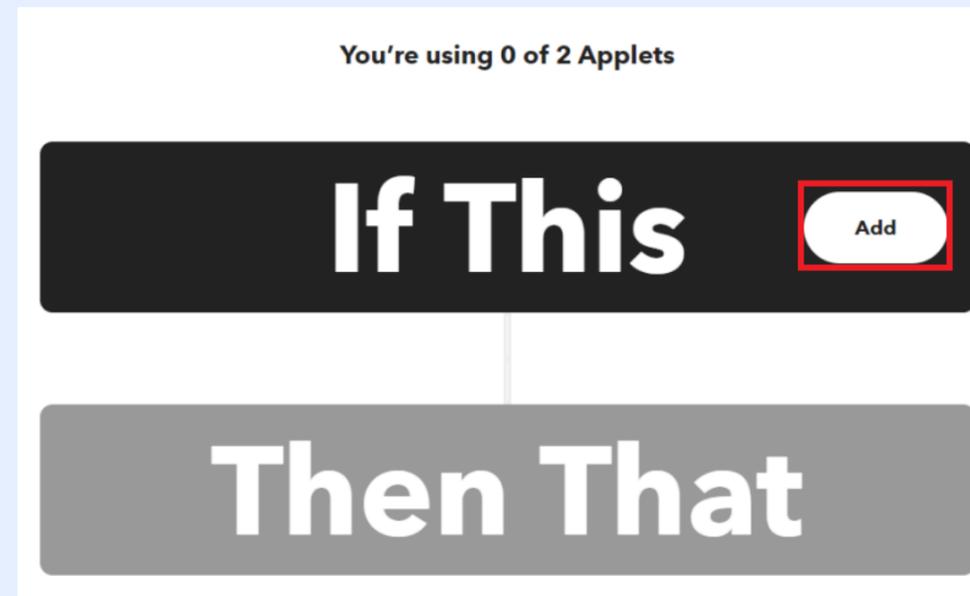


IFTTT

1. 註冊 IFTTT 帳戶 (<https://ifttt.com/>)



2. IFTTT Webhook 設置



3. 接收 IFTTT EMAIL 設置

You're using 0 of 2 Applets

If Receive a web request Edit Delete

Then That Add

Choose a service

All services

Q **email**

Email Email Digest

Choose an action

Email

Send me an email
This Action will send you an HTML based email. Images and links are supported.

Suggest a new action

Applet Title

If Maker Event "name", then Send me an email at wangzhenping1994@gmail.com

by wangzhenping1994 74/140

Finish

Complete action fields

Step 5 of 6

Send me an email
This Action will send you an HTML based email. Images and links are supported.

Subject
The event named "**EventName**" occurred on the Maker Webhooks service Add ingredient

Body
What: **EventName**

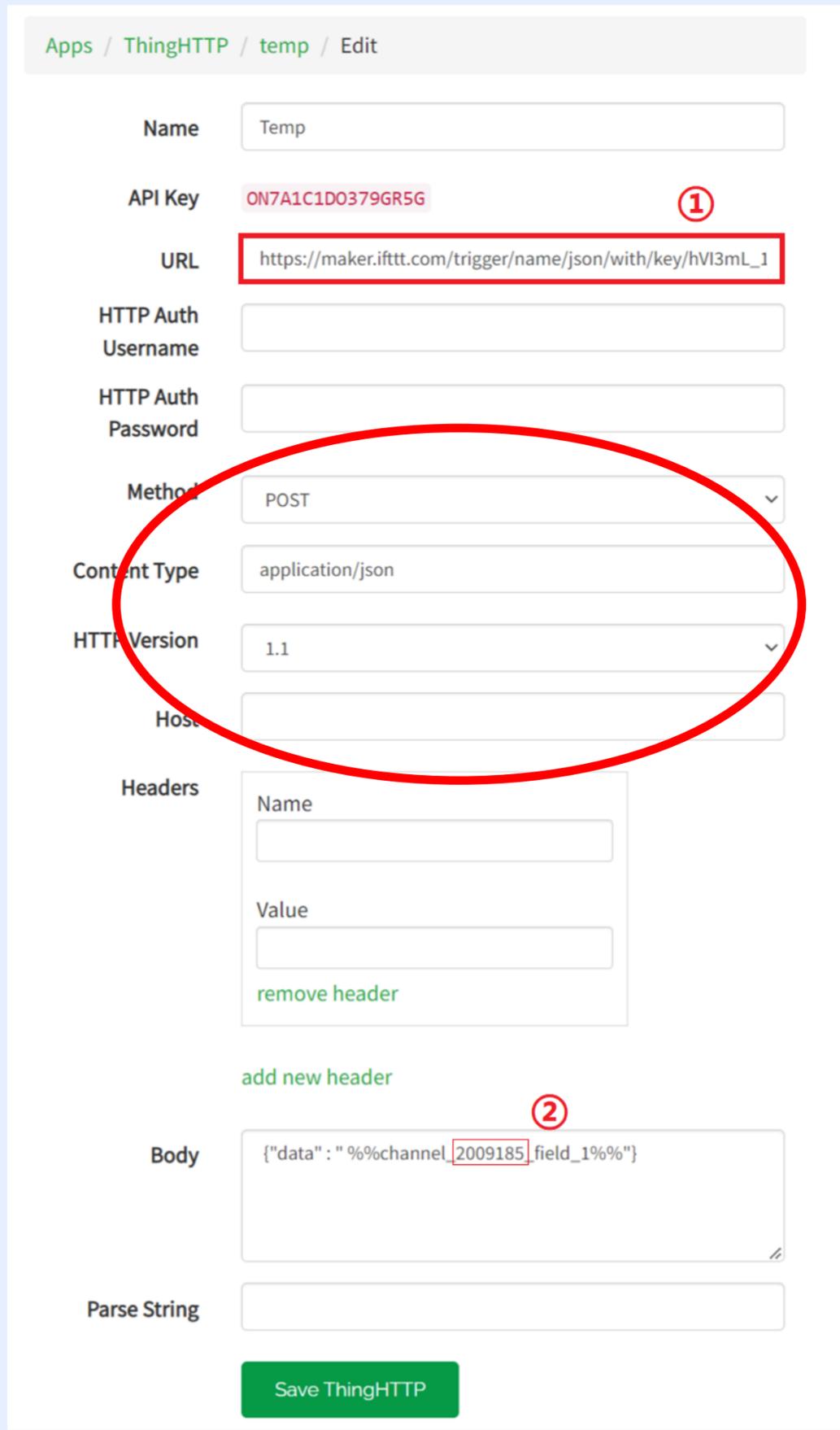
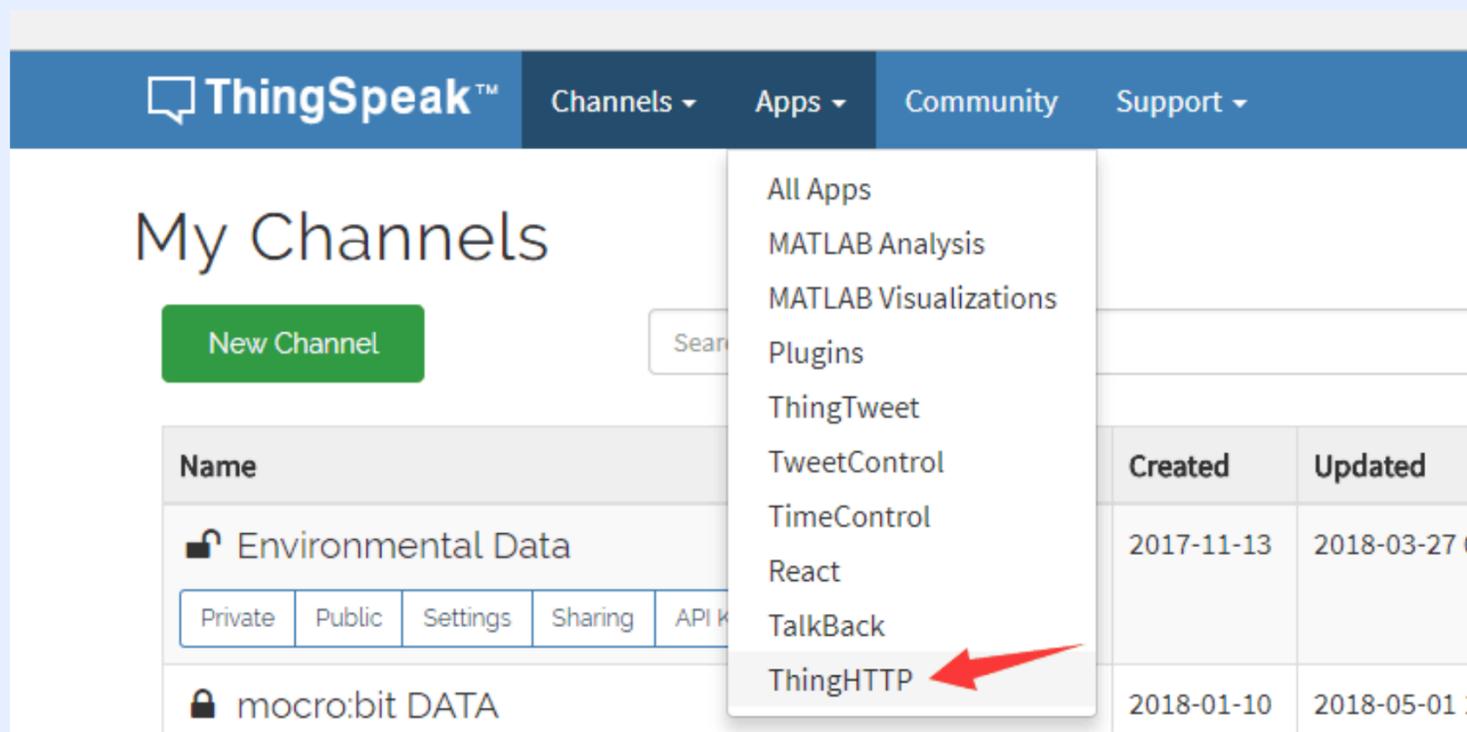
When: **OccurredAt**

Microbit Temperature Data: **Value1** Add ingredient

Create action

Email 內容修改

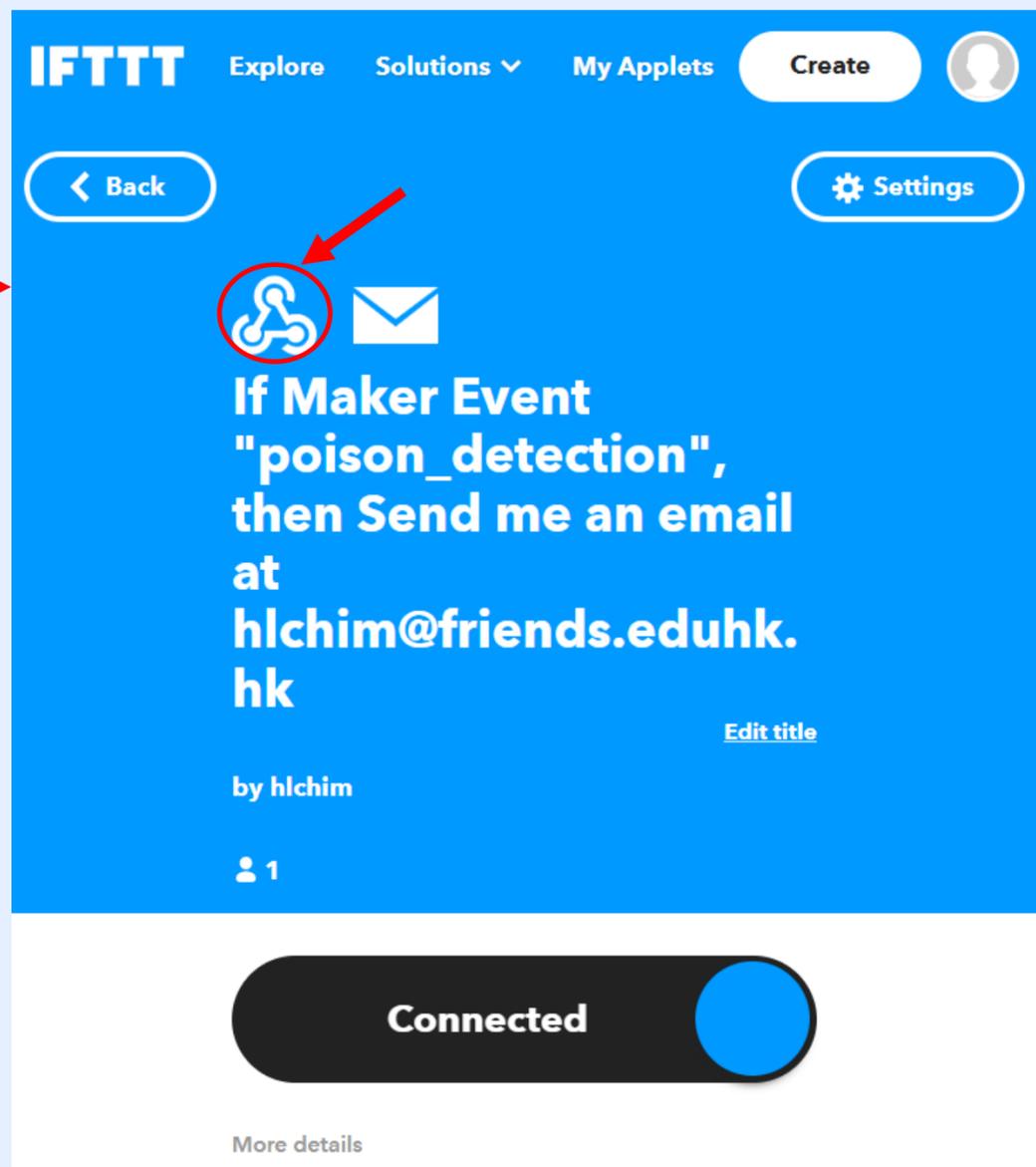
4. Thingspeak 設置



在Body中，您可以調用Channel中的任何數據。這是將發送到IFTTT的數據

格式如下：{"data": "%% channel_2009185_field_1 %%"}

其中②處數字ID是你已經建立好的 Channel ID



IFTTT Explore Solutions My Applets Create

Back Settings

If Maker Event "poison_detection", then Send me an email at hlchim@friends.eduhk.hk

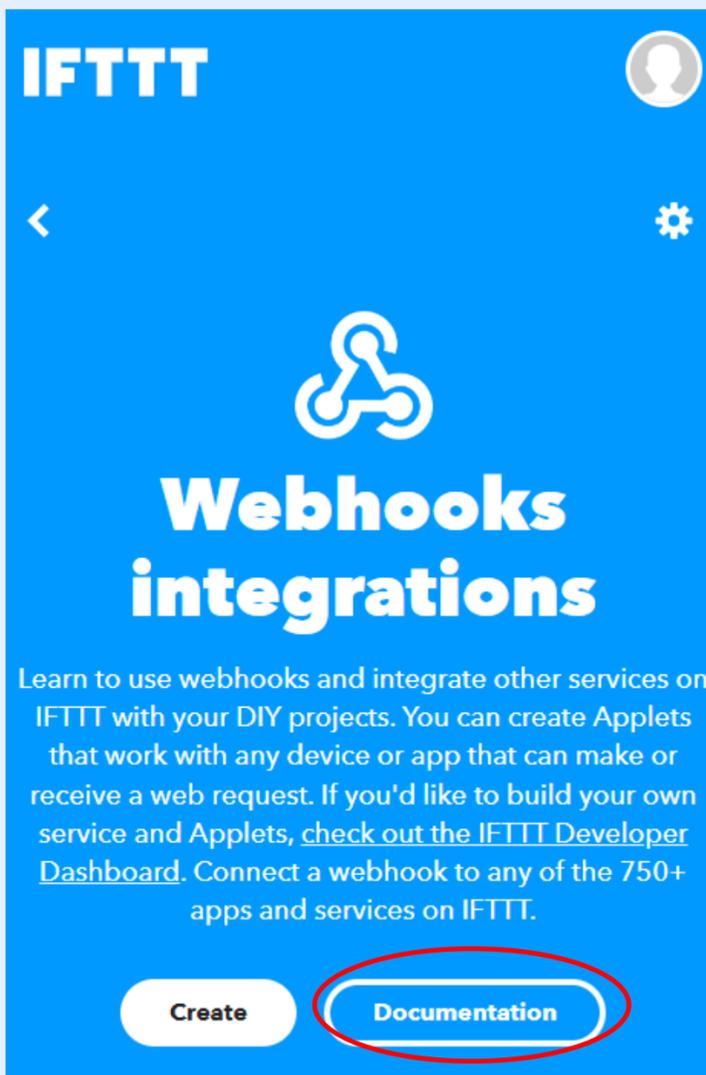
[Edit title](#)

by hlchim

1

Connected

More details

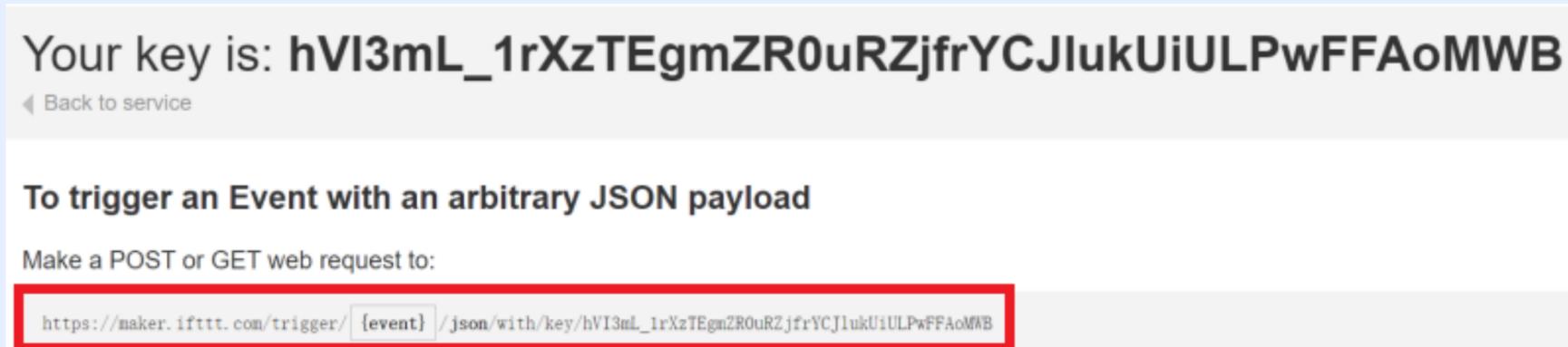


IFTTT

Webhooks integrations

Learn to use webhooks and integrate other services on IFTTT with your DIY projects. You can create Applets that work with any device or app that can make or receive a web request. If you'd like to build your own service and Applets, [check out the IFTTT Developer Dashboard](#). Connect a webhook to any of the 750+ apps and services on IFTTT.

Create Documentation



Your key is: **hVI3mL_1rXzTEgmZR0uRZjfrYcJlUkUiULPwFFAoMWB**

[Back to service](#)

To trigger an Event with an arbitrary JSON payload

Make a POST or GET web request to:

`https://maker.ifttt.com/trigger/{event}/json/with/key/hVI3mL_1rXzTEgmZR0uRZjfrYcJlUkUiULPwFFAoMWB`

將鏈接中的{event}改為觸發事件名稱，在本案例中使用的是“name”，將改好的鏈接複製到ThinkSpeak的①處。

ThingSpeak™ Channels Apps Devices Support

IOT_DATA

Channel ID: **2009185**
Author: [tianxiajianye](#)
Access: Private

My Channels
My Image Channels
Watched Channels
Public Channels

显示温度数据

ThingSpeak™ Channels Apps Devices Support

Apps / React

New React

Name	Created
<input checked="" type="checkbox"/> temp_react	2023-01-17

View Edit

All Apps
MATLAB Analysis
MATLAB Visualizations
Plugins
ThingTweet
TimeControl
React
TalkBack
ThingHTTP

Apps / React / temp_react / Edit

React Name: temp_react

Condition Type: Numeric

Test Frequency: On Data Insertion

Condition: If channel
IOT_DATA (2009185)

field: 1 (temp_data)

is greater than

30

Action: ThingHTTP

then perform ThingHTTP: Temp

Options:
 Run action only the first time the condition is met
 Run action each time condition is met

Save React

AIoT 範例

```
on start
  HuskyLens initialize I2C until success
  HuskyLens switch algorithm to Object Classification
  set ESP8266 RX P8 TX P12 Baud rate 115200
  connect Wifi SSID = "IoT" KEY = "eduhk+IoT+2018"

every 5000 ms
  if ThingSpeak connected true then
    show icon
  if Wifi connected true then
    show icon
```

```
forever
  HuskyLens request data once and save into the result
  set mushrooms to HuskyLens get ID of the No. 1 frame from the result
  if mushrooms = 1 then
    show icon
  else if mushrooms = 2 then
    show icon
  connect thingspeak
  set data to send ThingSpeak
  Write API key = "H7Q4XPW6Y0SX7GFM"
  Field 1 = mushrooms
  Upload data to ThingSpeak
```



https://makecode.microbit.org/_M7T231a4YWkW

學與教資源

創新科技教育

- 高小增潤編程教育課程單元
- 初中人工智能課程單元

<https://www.edb.gov.hk/tc/curriculum-development/kla/technology-edu/resources/innovationandtechnologyeducation/resources.html>