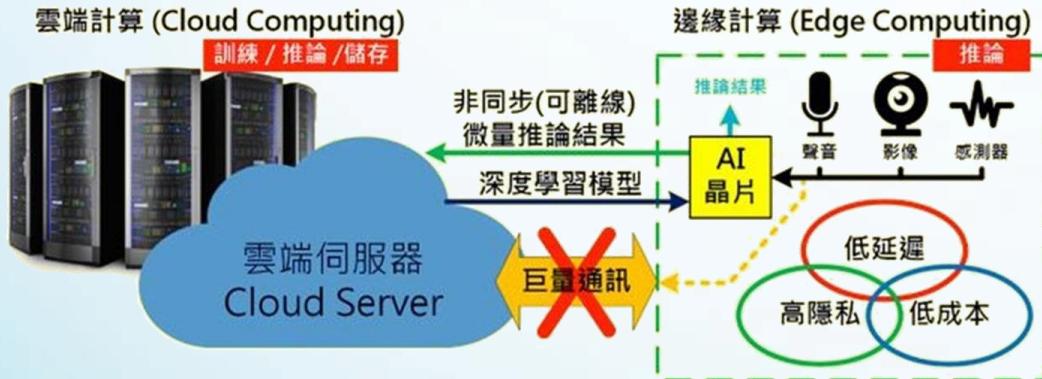


OmniXRI's Edge AI & TinyML 小學堂



歡迎加入
邊緣人俱樂部



【第14講】
實作案例 — 異常偵測



歐尼克斯實境互動工作室 (OmniXRI Studio)
許哲豪 (Jack Hsu)

簡報大綱

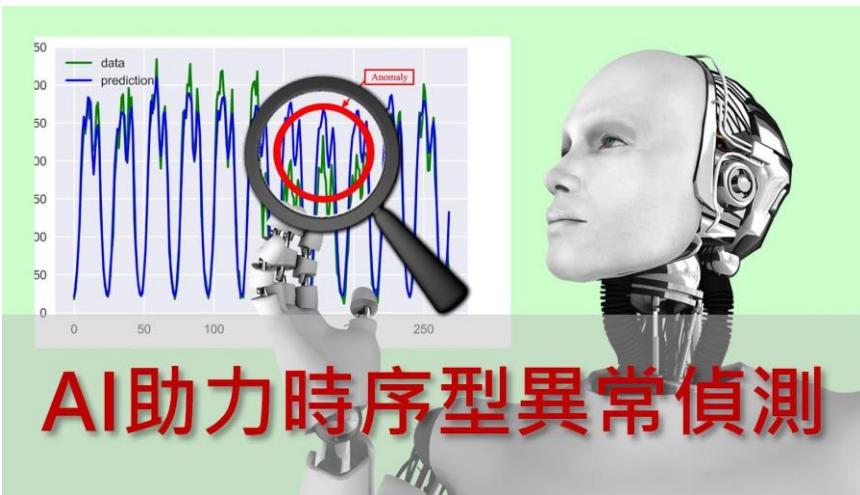


- 14.1. 異常偵測技術簡介
- 14.2. 異常偵測開源資源
- 14.3. 常見MCU AI視覺模組
- 14.4. 異常影像偵測案例

本課程完全免費，請勿移作商業用途！
歡迎留言、訂閱、點讚、轉發，讓更多需要的朋友也能一起學習。

完整課程大綱：<https://omnixri.blogspot.com/2024/02/omnixris-edge-ai-tinyml-0.html>
課程直播清單：<https://www.youtube.com/@omnixri1784streams>

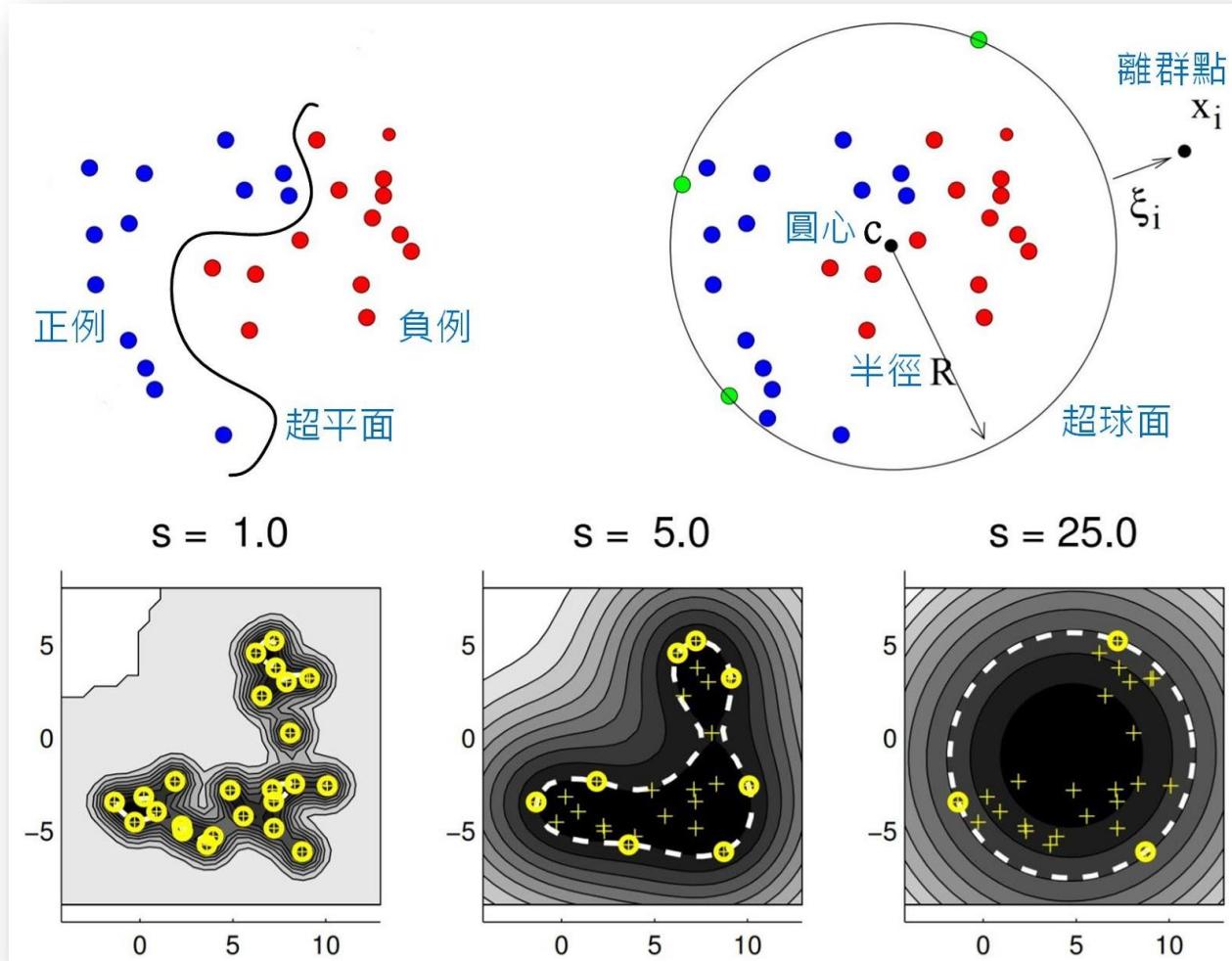
何謂異常偵測（離群偵測）



常見異常偵測作法

- 一元異常偵測
- 時序異常偵測
- 影像異常偵測（瑕疵檢測）
- 分類、物件、分割

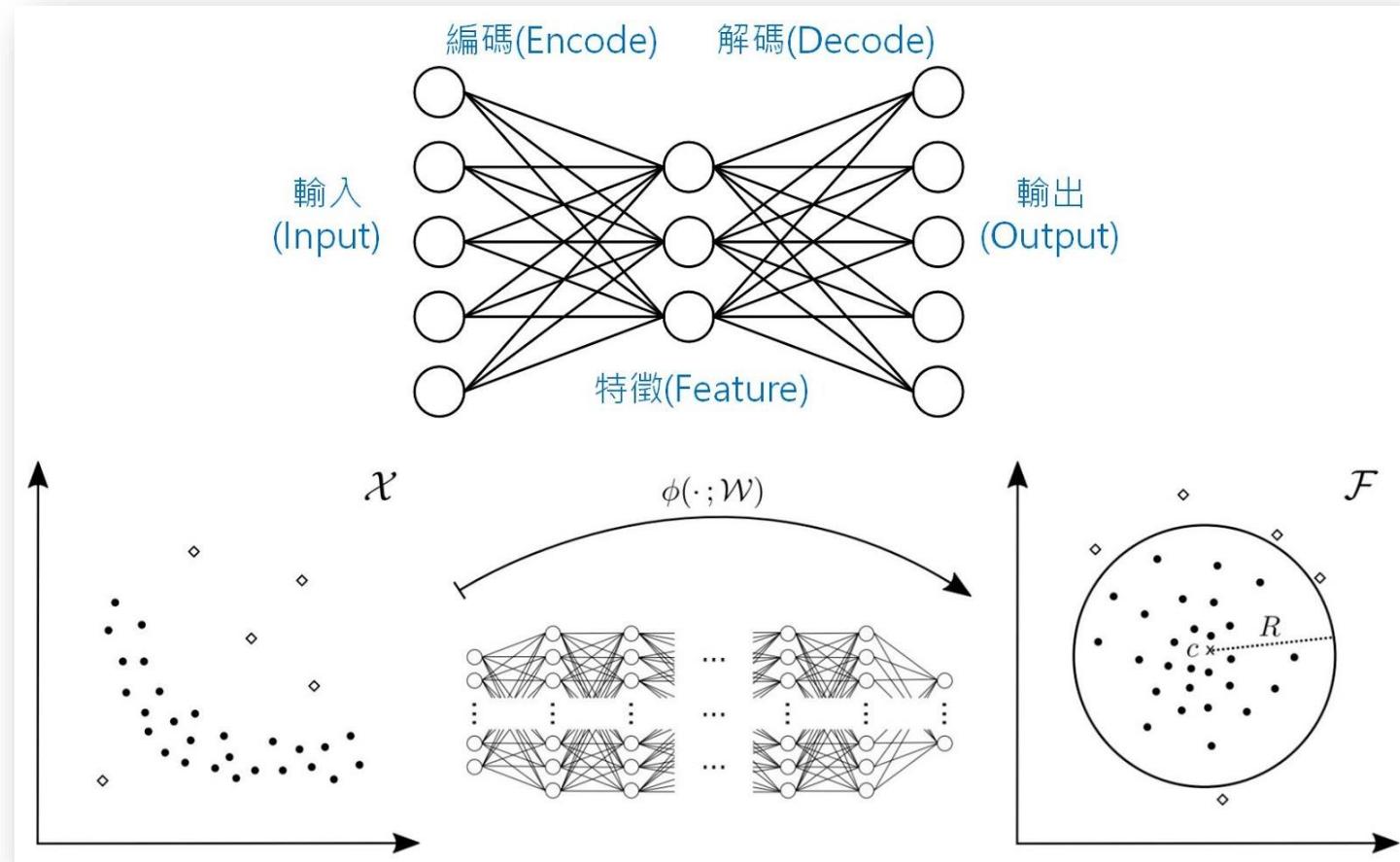
常見一元異常偵測 – 基於支持向量機式



資料來源：<https://omnixri.blogspot.com/2020/06/ai-hubai.html>

傳統機器學習領域的支持向量機 (Support Vector Machine, SVM) 常用於二分類，主要概念是找出資料中一個（多維）超平面(Hyper Plane)能完美分割二組（正例、負例）數據（如左上圖）。借鑑這條思路，可延伸變成找出一個（多維）超球體的中心c及半徑r來包圍所有已知數據（只有正常一類），而這種方法稱為支持向量數據描述(Support Vector Data Description, SVDD)（如右上圖）。

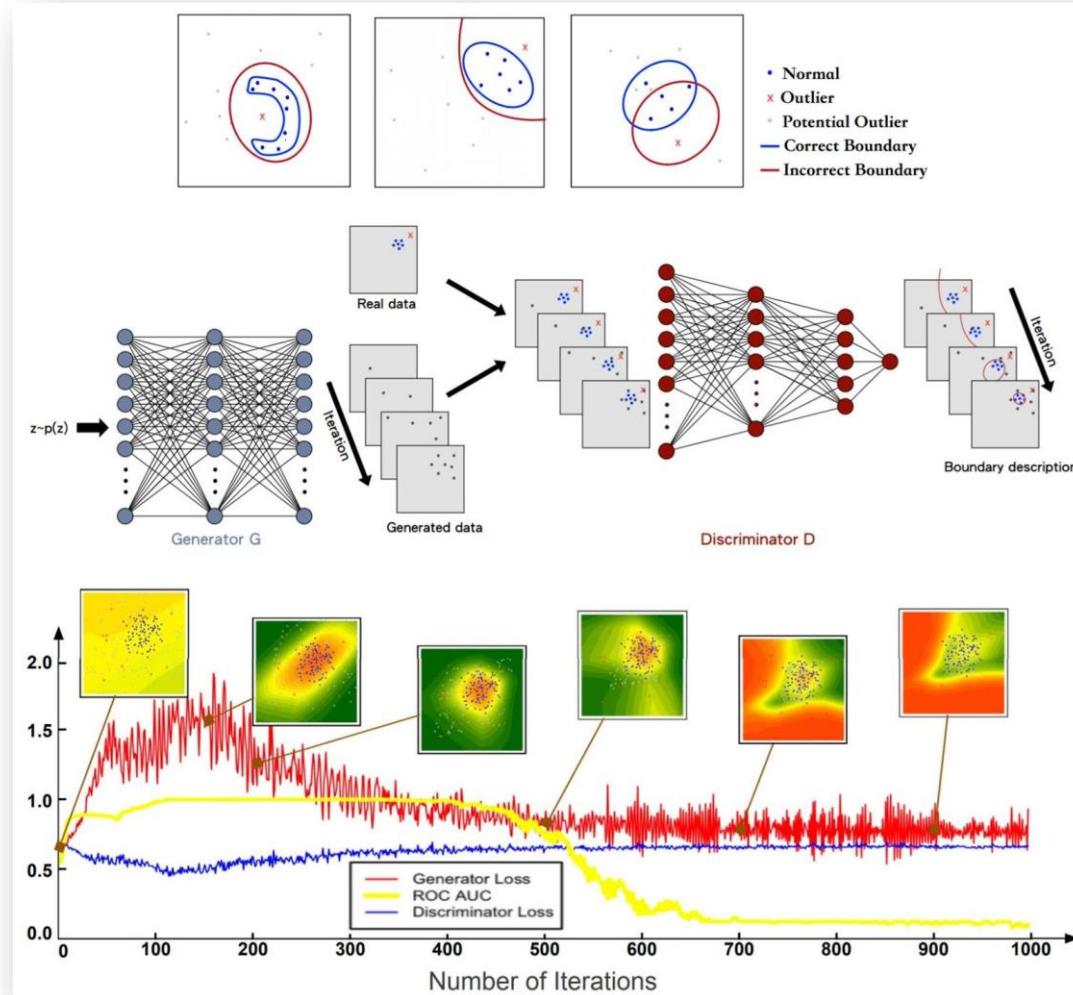
常見一元異常偵測 – 基於自動編碼器式



在深度學習中有一種非監督學習技術，稱為自動編碼器 (**Auto Encoder, AE**) (如上圖所示)。當資料分佈不均勻或維度過高時，利用SVDD常會找不到合適的超球面圓心及半徑，此時若先將資料使用深度自動編碼器 (Deep Auto Encoder, DAE) 方式提取出特徵 (或稱降維)，將資料分佈轉成低維度資料，如此就較容易使用SVDD找到新的超球面圓心、半徑，正確找出離群點，如下圖所示。

資料來源：<https://omnixri.blogspot.com/2020/06/ai-hubai.html>

常見一元異常偵測 — 基於生成對抗網路式

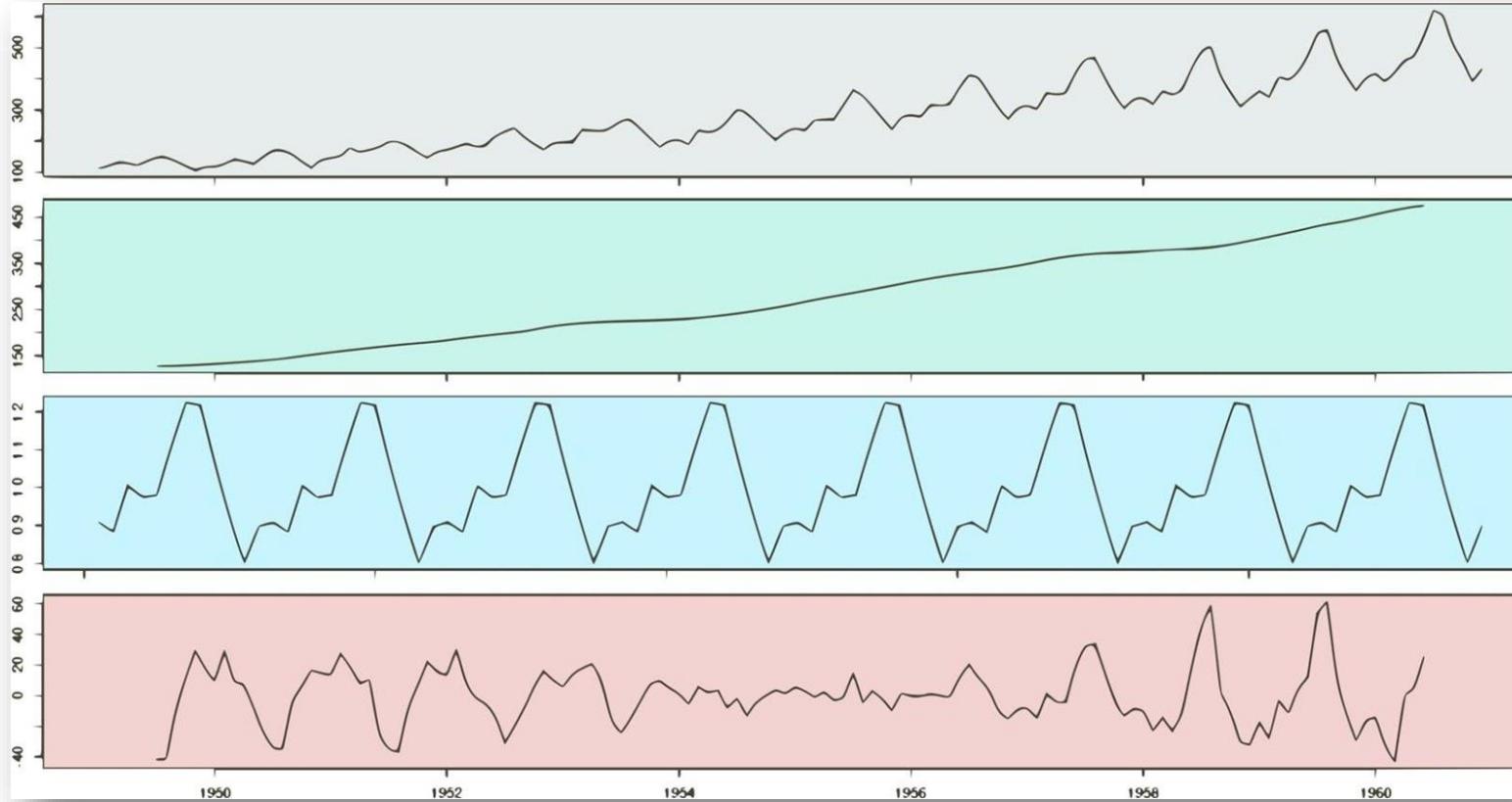


資料來源：<https://omnixri.blogspot.com/2020/06/ai-hubai.html>

生成對抗網路 (Generative Adversarial Network, GAN)常用來產生一些看似真實但其實不存在的資料，以滿足資料集不足或分佈不平均的問題。其主要思路有兩大元素生成網路(Generative Network)和判別網路(Discriminative Network)，生成網路負責產生虛假資料讓判別網路學習真偽，如此反覆訓練即可得到真偽難辨的資料集。這項技術可以從現有資料集中學習到資料集分佈特性，因此很適合用來協助找出非(高維)超球形分佈的資料集的邊界。

時序型資料分解

時間序列分解工具(**Time Series Decomposition Tools**)
STL分解法(Seasonal and Trend decomposition using Loess)



原始資料(Original)

趨勢(Trend)

季節性(Seasonality)

殘差(Residual)

資料來源：<https://omnixri.blogspot.com/2020/06/ai-hub.html>

常見時序異常偵測 – 傳統統計型

(a)自迴歸模型
(AR)

$$X_t = c + \sum_{i=1}^p \varphi_i X_{t-i} + \varepsilon_t$$

(b)向量自迴歸模型
(VAR)

$$\mathbf{y}_t = \mathbf{c} + A_1 \mathbf{y}_{t-1} + A_2 \mathbf{y}_{t-2} + \cdots + A_p \mathbf{y}_{t-p} + e_t$$

(c)移動平均模型
(MA)

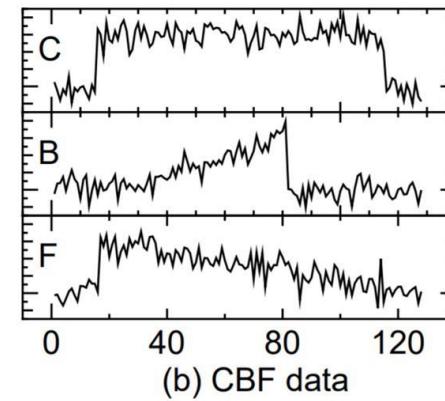
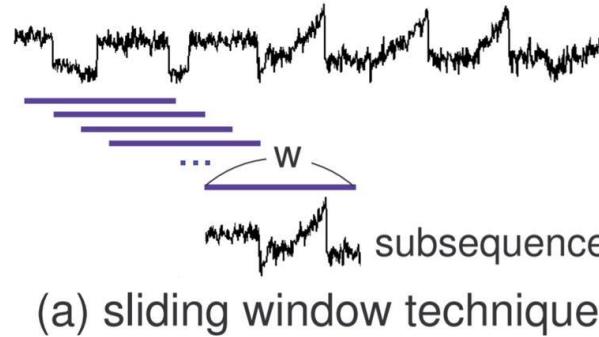
$$x_t = \mu + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - \cdots - \theta_q \varepsilon_{t-q}$$

(d)AR/MA混合模型
(ARIMA)

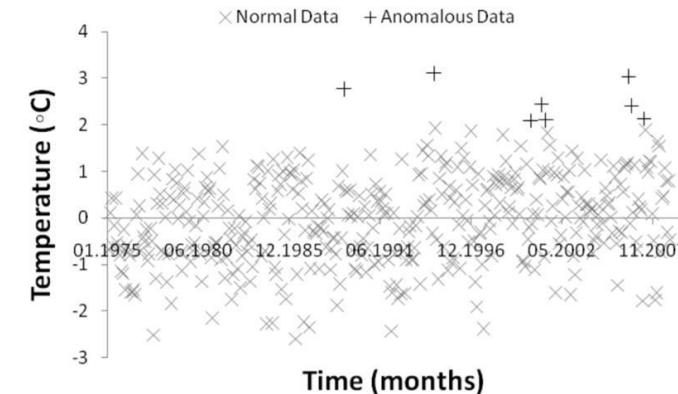
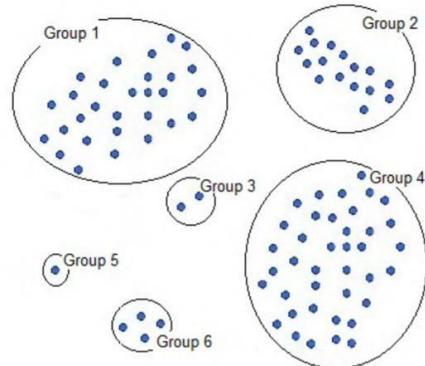
$$\left(1 - \sum_{i=1}^p \phi_i L^i \right) (1 - L)^d X_t = \left(1 + \sum_{i=1}^q \theta_i L^i \right) \varepsilon_t$$

資料來源：<https://omnixri.blogspot.com/2020/06/ai-hub.html>

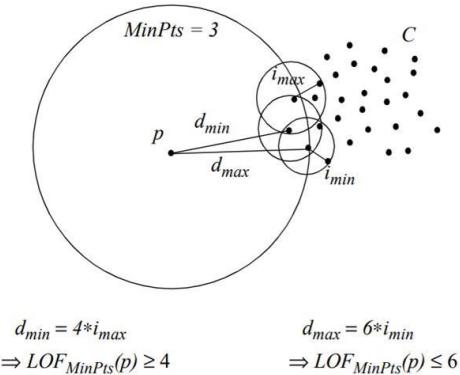
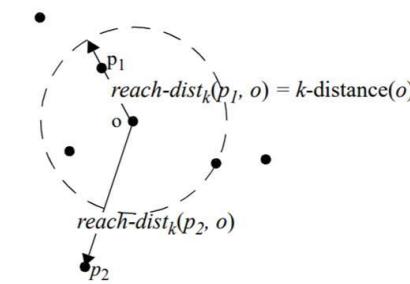
常見時序異常偵測 – 機器學習型



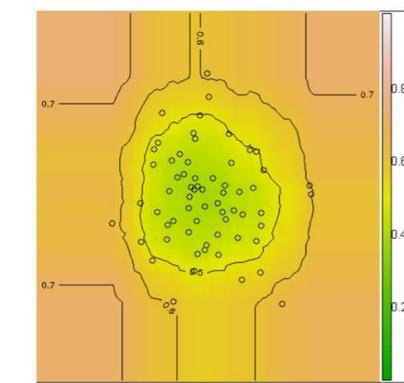
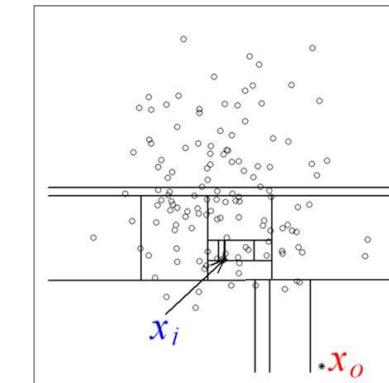
(a) K-Mean



(b) DBSCAN



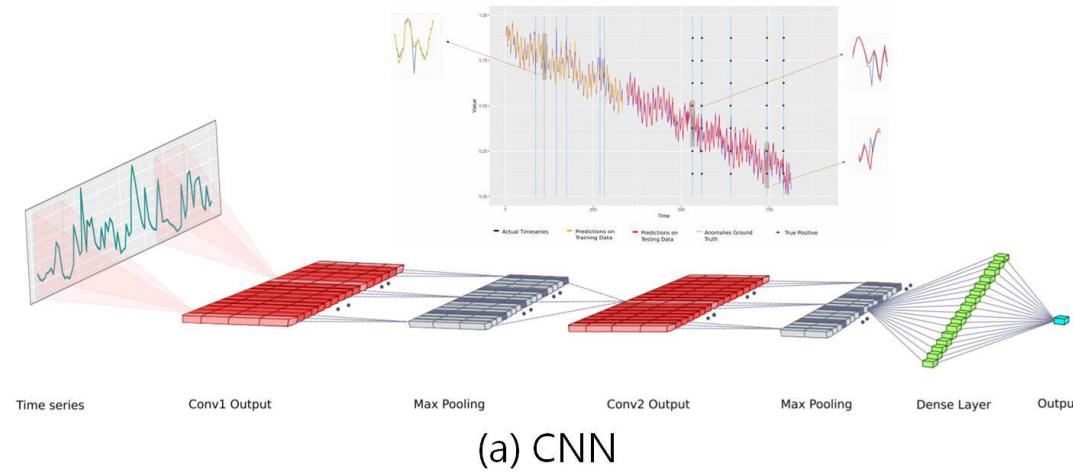
(c) LOF



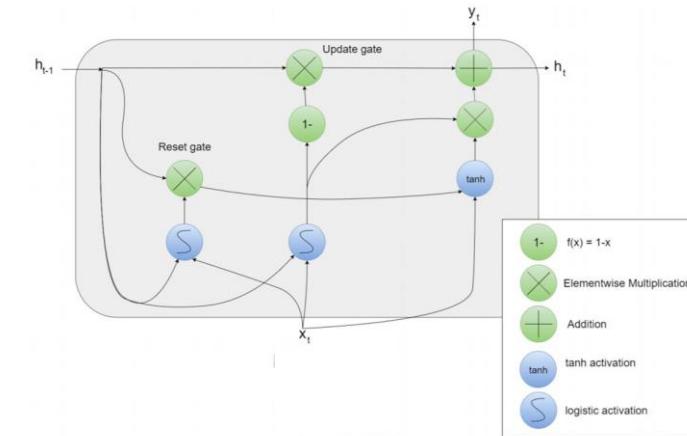
(d) IF

資料來源：<https://omnixri.blogspot.com/2020/06/ai-hub.html>

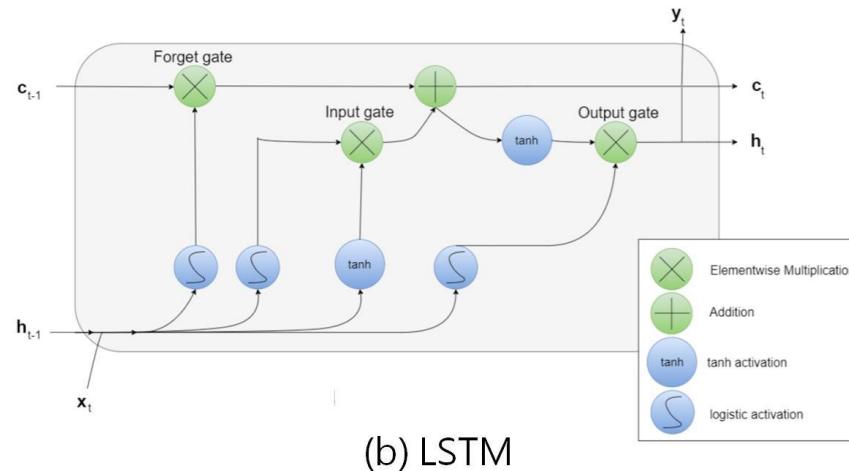
常見時序異常偵測 – 深度學習型



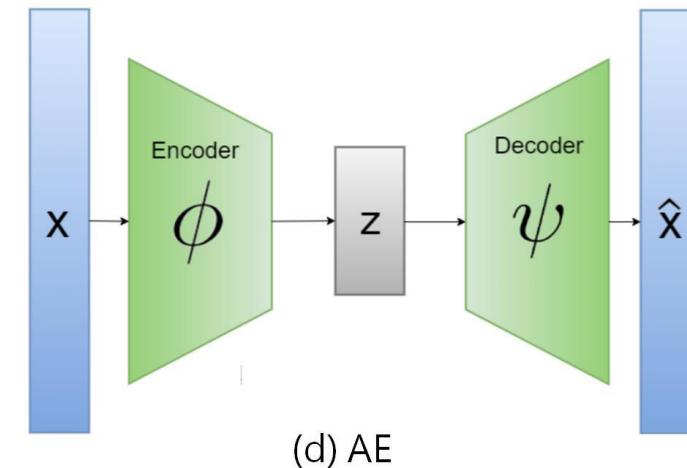
(a) CNN



(c) GRU



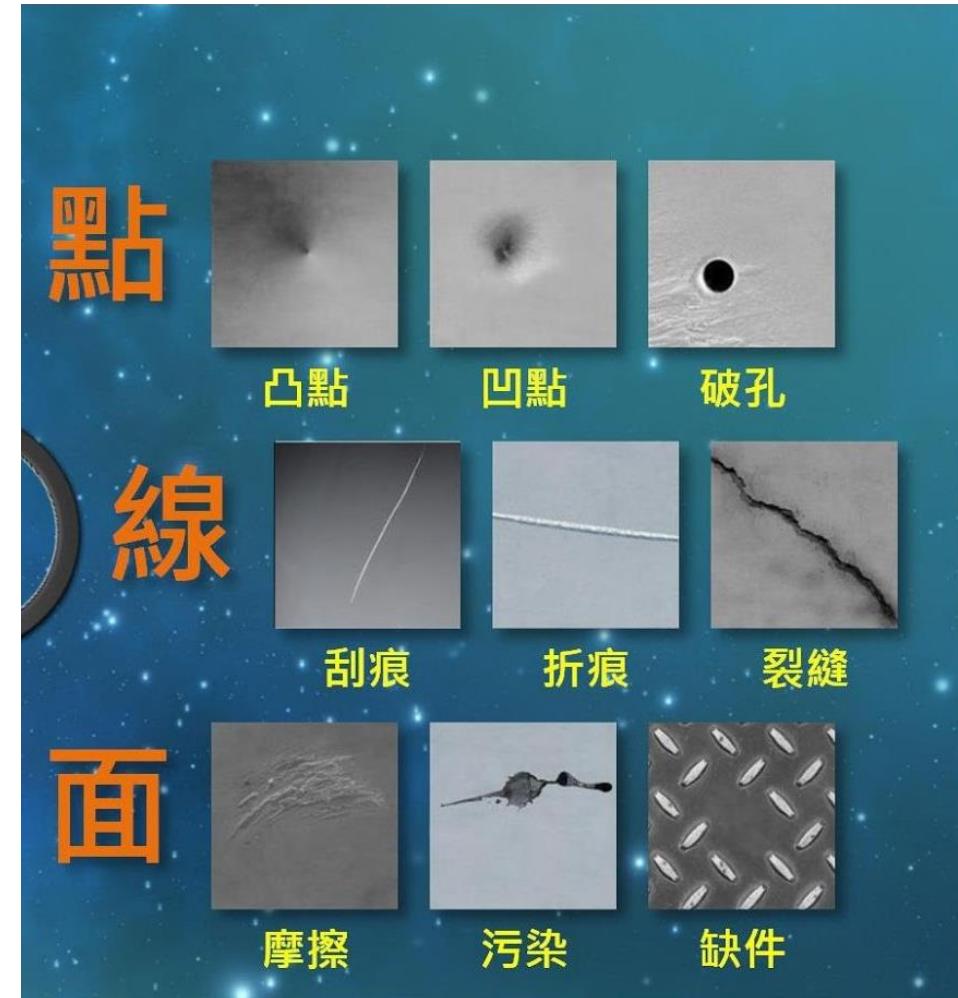
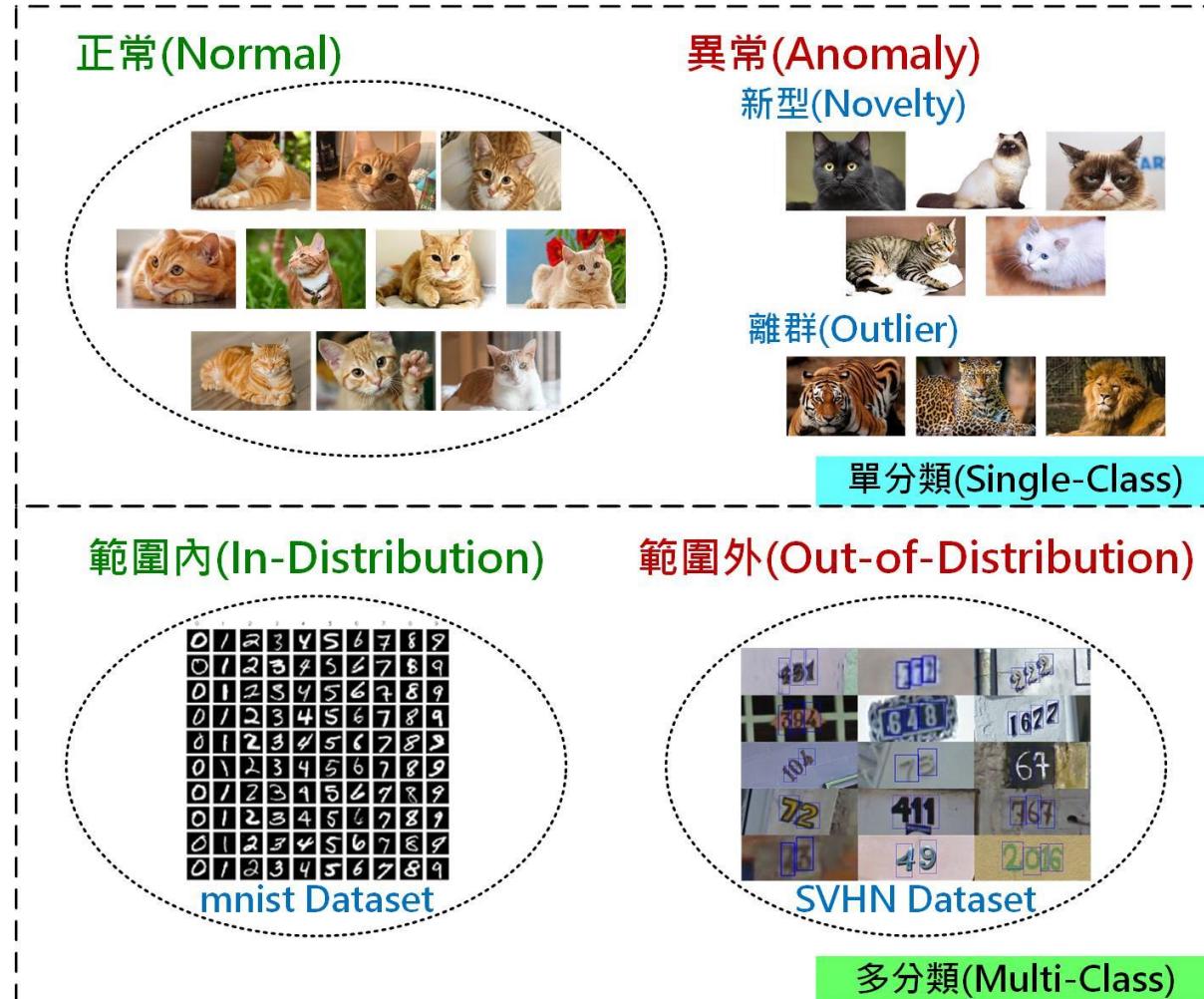
(b) LSTM



(d) AE

資料來源：<https://omnixri.blogspot.com/2020/06/ai-hub.html>

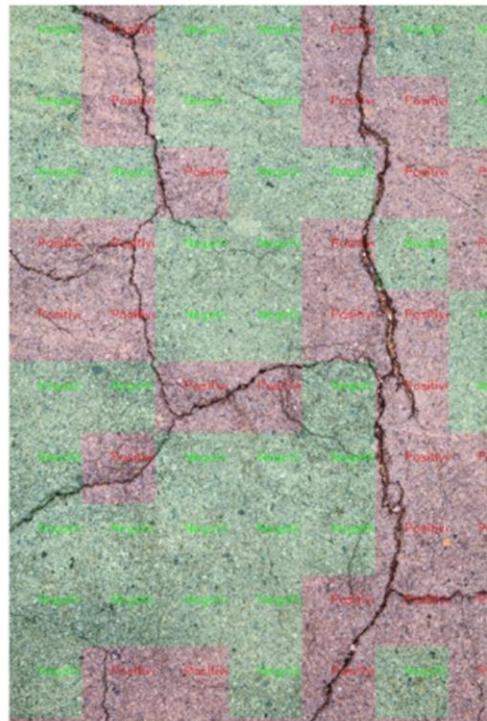
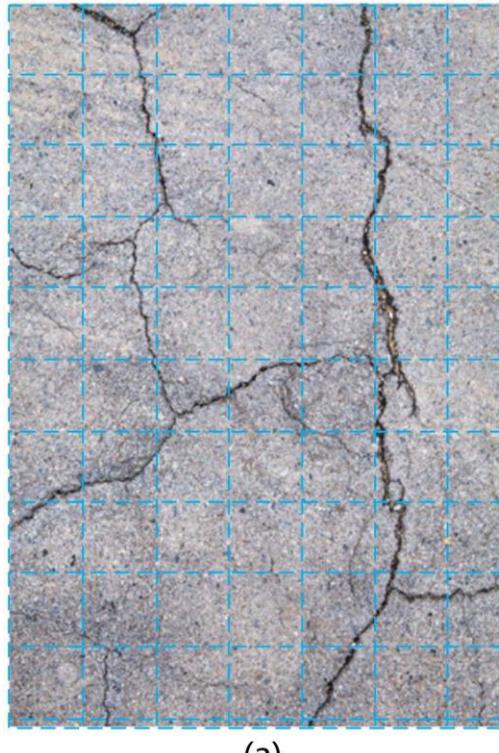
影像異常偵測（瑕疪檢測）



資料來源：<https://omnixri.blogspot.com/2020/07/ai-hubai.html>

影像異常偵測－深度學習式

影像分類（局部）

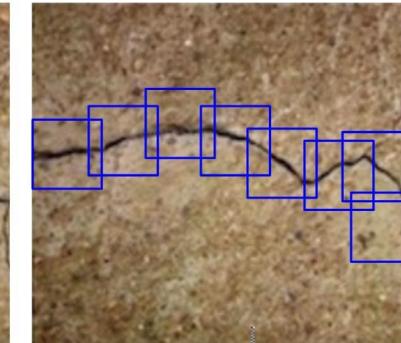


OmniXRI Nov. 2020 整理製作

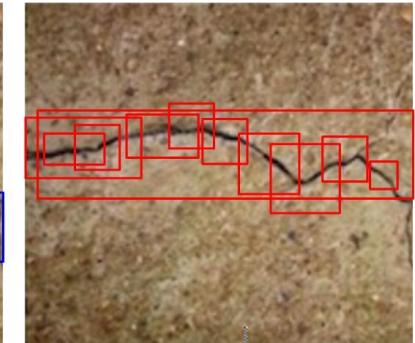
物件偵測



(a)



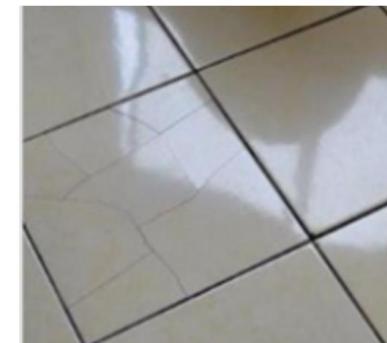
(b)



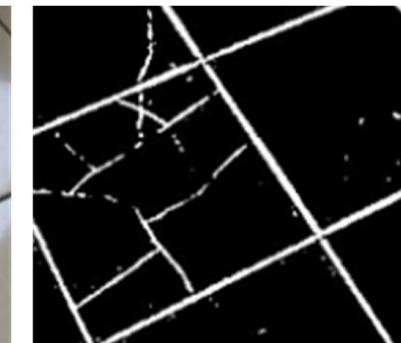
(c)

OmniXRI Nov. 2020 整理製作

影像分割（語義分割）



(a)



(b)



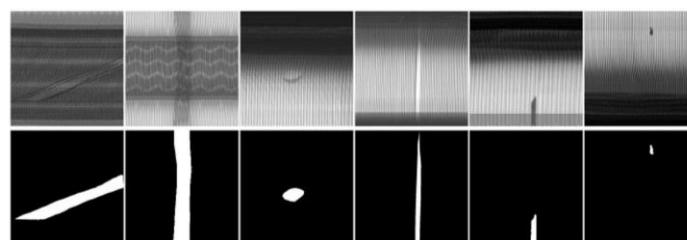
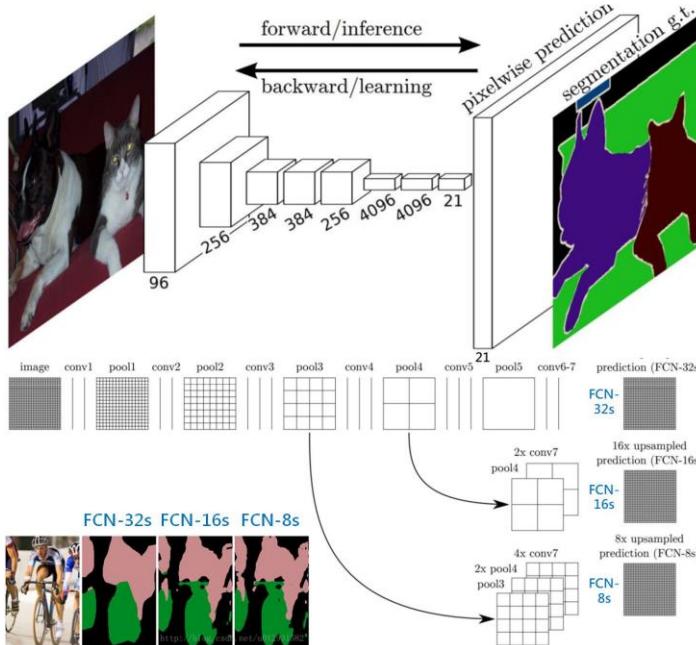
(c)

OmniXRI Nov. 2020 整理製作

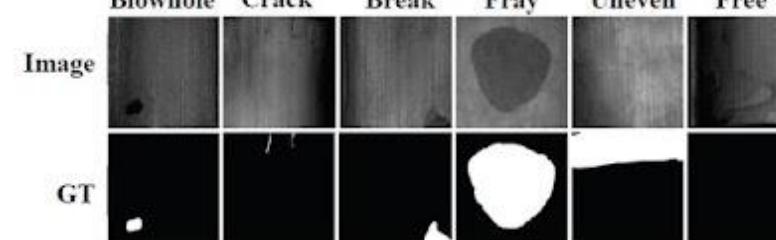
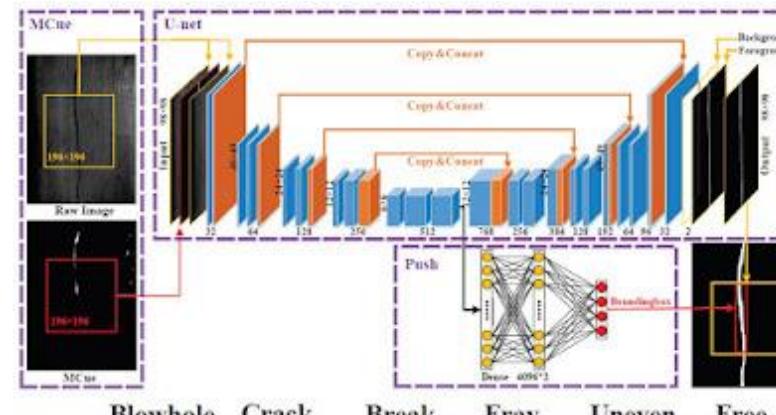
資料來源：https://omnixri.blogspot.com/2020/11/ai-hub_23.html

常見影像異常偵測－基於語義分割式

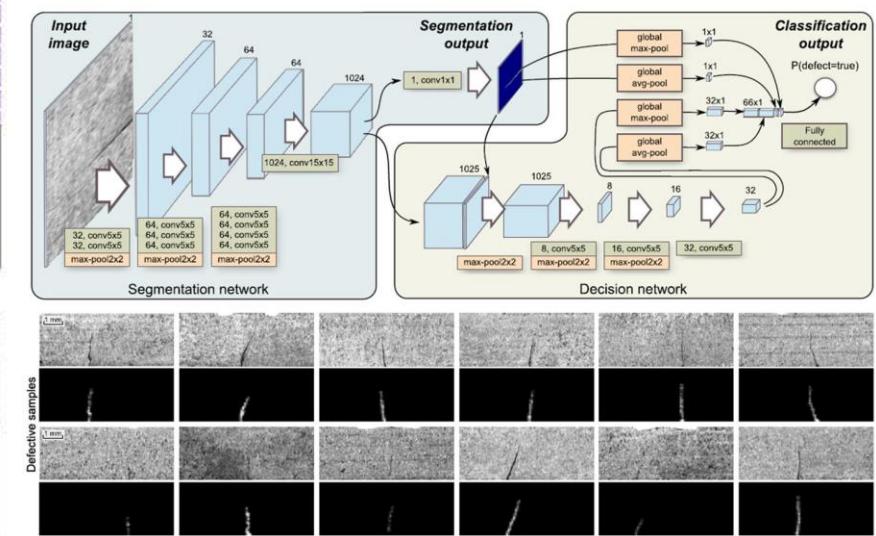
完全卷積網路



編碼/解碼網路

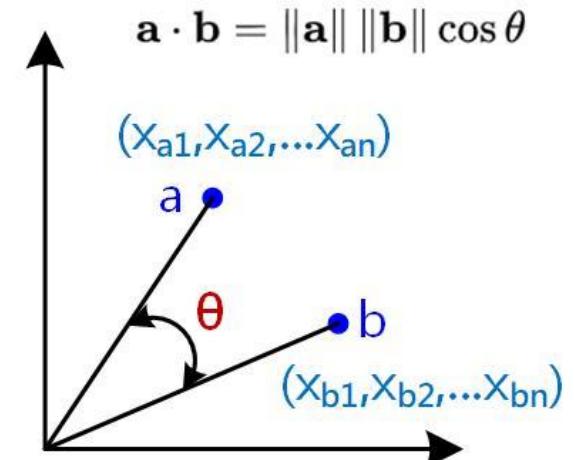
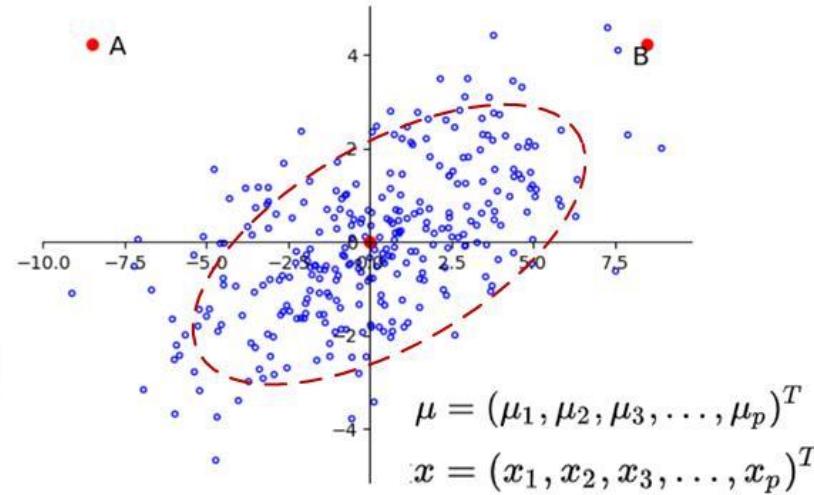
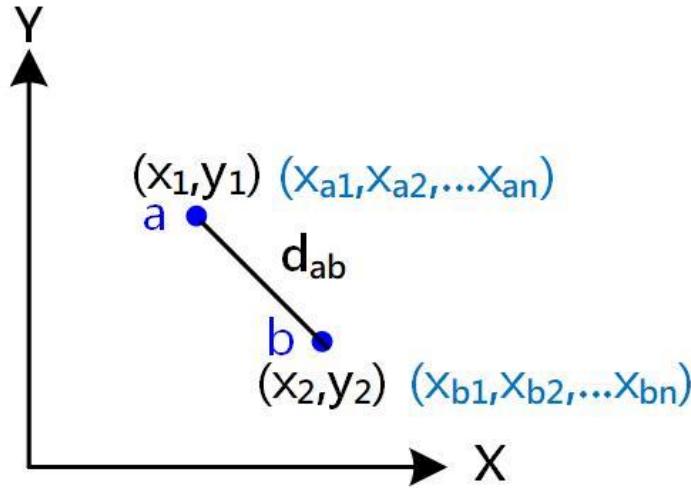


分割/決策網路



資料來源：<https://omnixri.blogspot.com/2020/07/ai-hubai.html>

常見資料距離量測



2維距離 : $d_{ab} = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$

n維距離 : $d_{ab} = \sqrt{\sum_{k=1}^n (x_{ak} - x_{bk})^2}$

單點距離 : $D_M(x) = \sqrt{(x - \mu)^T \Sigma^{-1} (x - \mu)}$

兩點距離 : $d(\vec{x}, \vec{y}) = \sqrt{(\vec{x} - \vec{y})^T \Sigma^{-1} (\vec{x} - \vec{y})}$

$$\cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\| \|\mathbf{B}\|} = \frac{\sum_{i=1}^n A_i \times B_i}{\sqrt{\sum_{i=1}^n (A_i)^2} \times \sqrt{\sum_{i=1}^n (B_i)^2}}$$

歐幾里德距離
(Euclidean Distance)

馬哈拉諾比斯距離
(Mahalanobis Distance)

餘弦距離
(Cosine Distance)

資料來源：<https://omnixri.blogspot.com/2020/12/ai-hub.html>

MLCommons Tiny - Anomaly Detection

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Server	queries to the SUT according to a Poisson distribution	270,336 queries and 60 seconds	1	Benchmark specific	99%	throughput parameter supported
Offline	LoadGen sends all queries to the SUT at start	1 query and 60 seconds	At least 24,576	None	N/A	Measured throughput

Benchmarks

Each benchmark is defined by a Dataset and Quality Target. The following table summarizes the benchmarks in this version of the suite (the rules remain the official source of truth):

All MLPerf Tiny benchmarks are single

Task	Dataset	Model	Mode	Quality	Latest Version Available
Keyword Spotting	Google Speech Commands	DS-CNN	Single-stream, Offline	90% (Top 1)	v1.1
Visual Wake Words	Visual Wake Words Dataset	MobileNetV1 0.25x	Single-stream	80% (Top 1)	v1.1
Image classification	CIFAR10	ResNet-8	Single-stream	85% (Top 1)	v1.1
Anomaly Detection	ToyADMOS	Deep AutoEncoder	Single-stream	0.85 (AUC)	v1.1

資料來源：<https://mlcommons.org/benchmarks/inference-tiny/>

異常偵測開源資源



<https://www.mvtect.com/company/research/datasets/mvtec-ad/>



<https://github.com/openvinotoolkit/anomalib>

Edge Impulse 異常偵測開源案例

Optimize a cloud-based Visual Anomaly Detection Model for Edge Deployments

Advanced ML workflow with available Jupyter Notebook using computer vision, AWS SageMaker and MLFlow to benchmark industry visual anomaly models.

Created By: Mathieu Lescaudron

Public Project Link: <https://studio.edgeimpulse.com/public/376268>

GitHub Repo: <https://github.com/emergy-official/anomaly.parf.ai>

<https://docs.edgeimpulse.com/experts/featured-machine-learning-projects/fomo-ad-in-aws>

<https://docs.edgeimpulse.com/experts/predictive-maintenance-and-fault-classification/brushless-dc-motor-anomaly-detection>

<https://docs.edgeimpulse.com/experts/accelerometer-and-activity-projects/continuous-gait-monitor-nordic-thingy53>

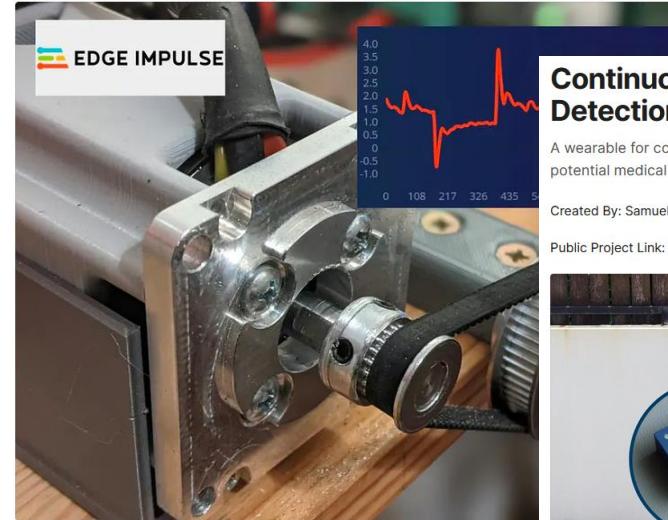
<https://docs.edgeimpulse.com/experts/predictive-maintenance-and-fault-classification/brickml-3d-printer-anomaly-detection>

Brushless DC Motor Anomaly Detection

Sample data from a BLDC motor controller and apply machine learning to receive predictive maintenance alerts.

Created By: Avi Brown

Public Project Link: <https://studio.edgeimpulse.com/public/102584/latest>



Continuous Gait Monitor (Anomaly Detection) - Nordic Thingy:53

A wearable for continuous gait analysis, aiming to detect gait abnormalities and potential medical conditions.

Created By: Samuel Alexander

Public Project Link: <https://studio.edgeimpulse.com/public/366723/live>

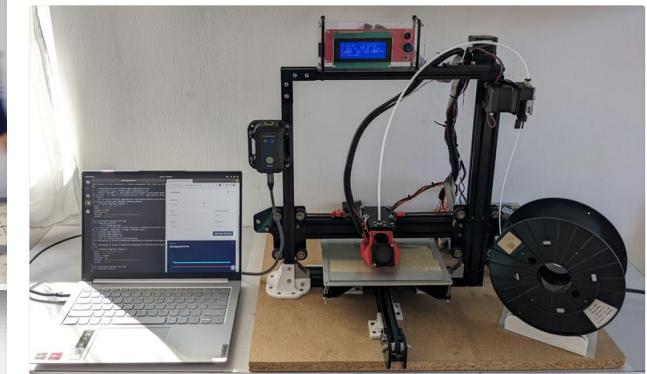


BrickML Demo Project - 3D Printer Anomaly Detection

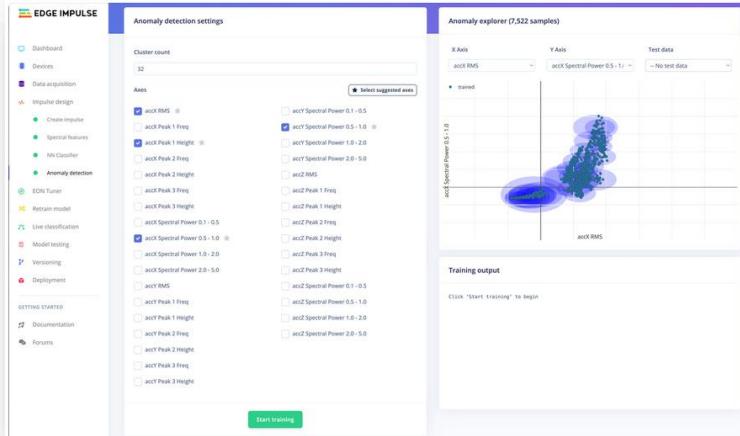
Use machine learning classification to monitor the operation of a 3D printer and look for anomalies in movement, with the Reloc / Edge Impulse BrickML device.

Created By: Attila Tokes

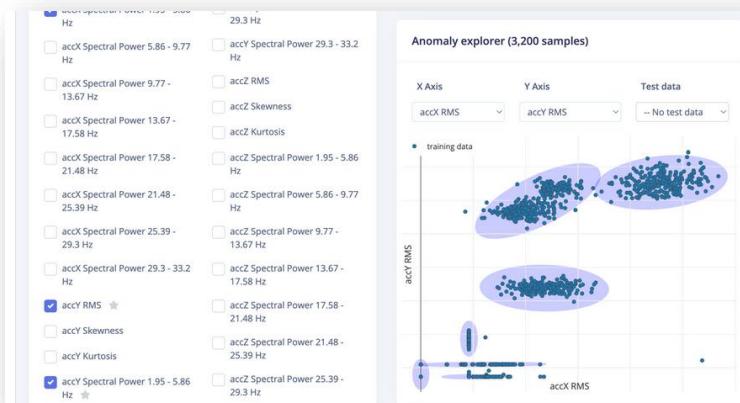
Public Project Link: <https://studio.edgeimpulse.com/public/283049/latest>



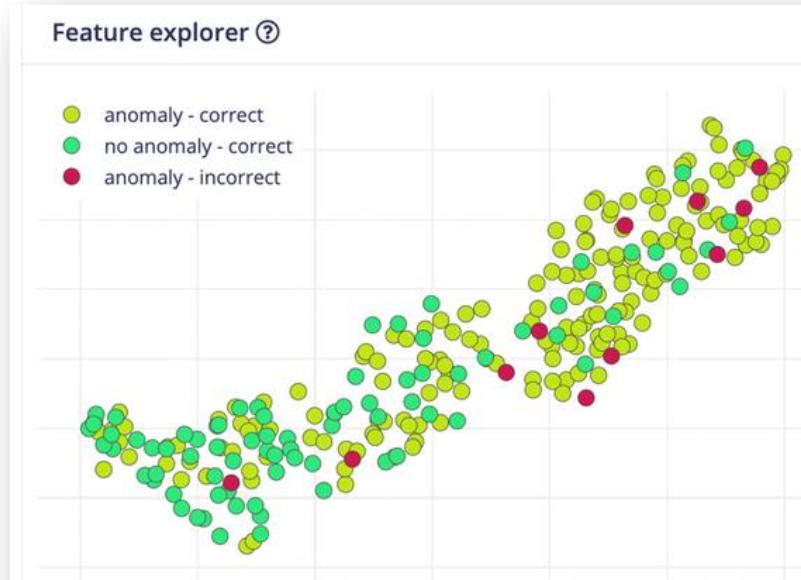
Edge Impulse Anomaly Detection Block



Anomaly Detection (K-means)



Anomaly Detection (GMM)



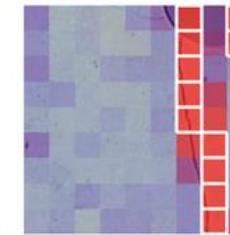
anomaly.cracked...

Label: anomaly

Predicted: anomaly

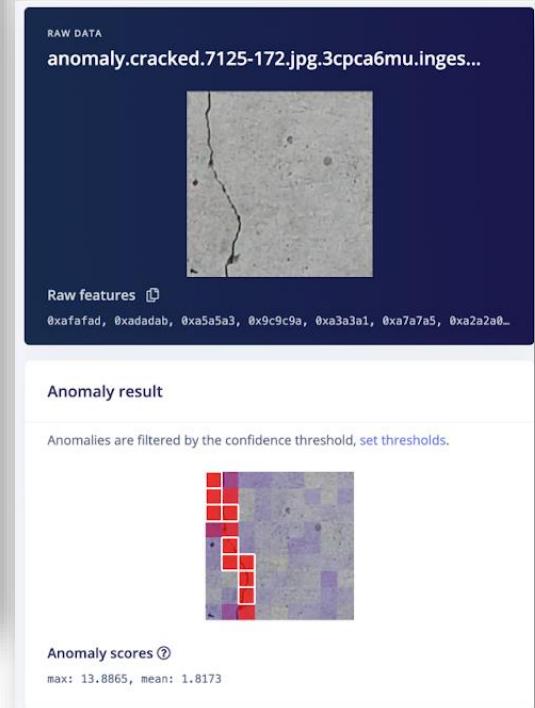
[View sample](#)

[View classification](#)

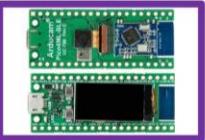
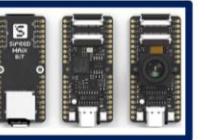
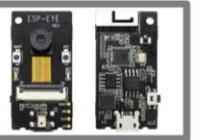
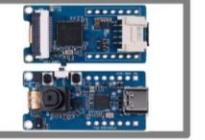


Visal Anomaly Detection (FOMO-AD with GMM)

資料來源：<https://docs.edgeimpulse.com/docs/edge-impulse-studio/learning-blocks>



常見MCU AI視覺模組 (2022)

							
Arducam Pico4ML-BLE	Arduino Nano 33 BLE Kit	Sony Spresense	Silicon Labs xG24 Dev Kit	Realtek AMB82-Mini	Sipeed Maix Bit	Espressif ESP-EYE (ESP32)	Lilygo T-Camera S3
Pi RP2040 MCU : (Cortex-M0+ @133MHz x2) Flash : 2MB SRAM : 264KB Camera : Himax M01B0 (320x240) Others : IMU, BLE, LCD	nRF52840 MCU : (Cortex-M4 @64MHz) Flash : 1MB SRAM : 256KB Camera : * IO OV7675 (640x480) Sensors : IMU, T&H, Mic, BP ...	CXD5602 MCU : (Cortex-M4F @156MHz x6) Flash : 8MB SRAM : 1.5MB Camera : CAM1(2608x1960) CAM2W(1280x960) Sensors : None	EFR32MG24 MCU : (Cortex-M33 @78MHz) Flash : 1536KB SRAM : 256KB Camera : *SPI Arducam Mini 2MP Plus (1632x1232) Mic, IMU, T&H, BP...	RTL8735B MCU : (Armv8-M @500MHz) NPU : 0.4 TOPS Flash : 768KB, 64MB(ext) RAM : DDR 128MB Camera : *?(1920x1080) Sensors : Mic	Kendryte K210 MCU : (RISC-V 64bit @400MHz) NPU : 1TOPS Flash : 16MB SRAM : 8MB Camera : OV2640 (1600x1200) Sensors : None	ESP32 MCU : (Xtensa LX7 x2 @240 MHz + ULP FSM) Flash : 448K, 4MB(ext) RAM : S:536KB, PS:8MB Camera : OV2640 (1600x1200) Others : Mic, WiFi, BLE	ESP32-S3 MCU : (Xtensa LX7 x2 @240MHz + ULP RISC-V+ ULP FSM) Flash : 384KB, 16MB(ext) RAM : S:512KB, PS:8MB Camera : OV2640 (1600x1200) Others : Mic, WiFi, BLE
							
OpenMV Cam H7 Plus	Arduino Protenta H7+Vision	Arduino Nicla Vision	Alif Ensemble E7 DK	Eta Compute ECM3532-AVBK	Himax WE-I Plus EVB	Seeed Studio Grove- Vision AI	Useful Sensors Person Sensor
STM32H743II MCU : (Cortex-M7 @480MHz) Flash : 2MB, 32MB(ext) RAM : S:1MB, SD:32MB Camera : OV5640 (2592x1944) Sensors : None	STM32H747XI MCU : (CM7@480MHz+ CM4@240MHz) Flash : 2MB+16MB(ext) RAM : S:1MB+SD:8MB Camera : Himax HM-01B0 (320x240) Others : Mic, WiFi/BT, EtherNet	STM32H747AI6 MCU : (CM7@480MHz+ CM4@240MHz) Flash : 2MB+16MB(ext) SRAM : 1MB Camera : GC2145 (1616x1232) Sensors : IMU, Mic, ToF	Cortex-M55 x2 @160M / 400 MHz NPU : Ethos-U55 x2 128 / 256 MAC MPU : Cortex-A32 x2 @800 MHz MRAM : 5.5MB SRAM : 13.5MB Camera : * MIPI Interface Sensors : IMU, Mic, ALS	ECM3532 (Cortex-M3) DSP : CoolFlux DSP16 2MAC@100MHz Flash : 512KB, 8MB(ext) SRAM : 352KB Camera : Himax HM0360 (640x480) Sensors : IMU, Mic	HX6537-A MCU : (ARC EM9D DSP @400MHz) Flash : 2MB SRAM : 2MB Camera : Himax HM0360 (640x480) Sensors : IMU, Mic	HX6537-A MCU : (ARC EM9D DSP @400MHz) Flash : 2MB SRAM : 2MB Camera : OV2640 (1600x1200) Others : Mic, IMU, BLE	HX6537-A MCU : (ARC EM9D DSP @400MHz) Flash : 2MB SRAM : 2MB Camera : Himax HM0360 (640x480) Sensors : None

 Cortex-M0+
 Cortex-M3
 Cortex-M4
 Cortex-M7
 Cortex-M33/M35
 Cortex-M55
 RISC-V
 DSP

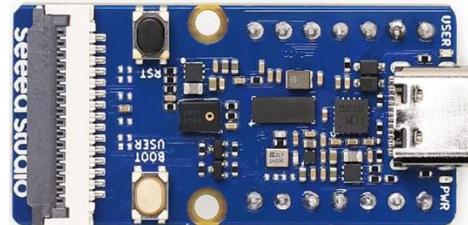
OmniXRI整理製作 · 2022/12/29

資料來源：<https://omnixri.blogspot.com/2022/12/tinymlmcu.html>

常見MCU AI視覺模組 (2024)



Telit & ALIF Vision AppKit
(ALIF E3, Arm Cortex-M55 *2
+ Ethos-U55 *2)



Seeed Grove Vision AI Module v2
(Himax HX6538, Arm Cortex-M55 *2
+ Ethos-U55)



OpenMV Cam RT1062
(NXP i.MX RT1062, Arm
Cortex-M7)



Seeed Xiao ESP32 Sense
(Xtensa DSP LX7 *2)



STM32N6
(Arm Cortex ?? + NPU ??)



Renesas EK-RA8D1
(Arm Cortex-M85)

常見MCU AI視覺模組(2024) 性能比較



資料來源：<https://www.hackster.io/lmengdu0117/2024-mcu-ai-vision-boards-performance-comparison-998505>

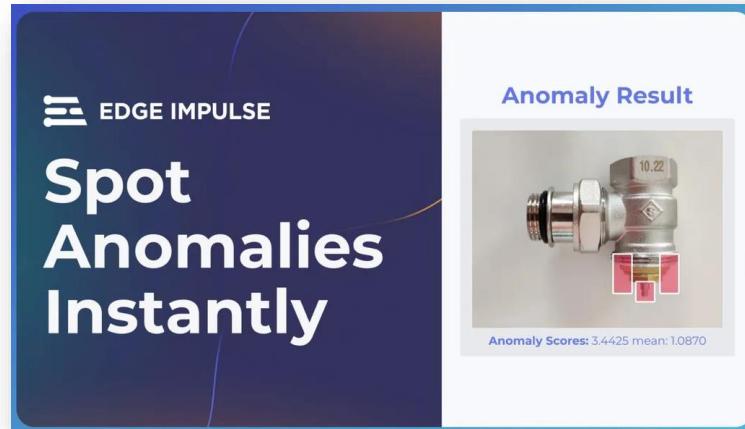
14.4. 異常影像偵測 案例



- Edge Impulse FOMO-AD
水五金異常偵測案例
- Seeed Vision AI Module V2 +
Seeed SenseCraft 應用例

Edge Impulse FOMO-AD 範例資源

水五金異常偵測案例



**FOMO + GMM
= FOMO-AD**

學習模組—Visual anomaly detection (FOMO-AD) :

<https://docs.edgeimpulse.com/docs/edge-impulse-studio/learning-blocks/visual-anomaly-detection>

說明文章：

<https://www.edgeimpulse.com/blog/announcing-visual-anomaly-detection/>

公開範例：

<https://studio.edgeimpulse.com/public/377568/live>

將案例複製到個人帳號中再執行

Edge Impulse FOMO-AD – Data Acquisition

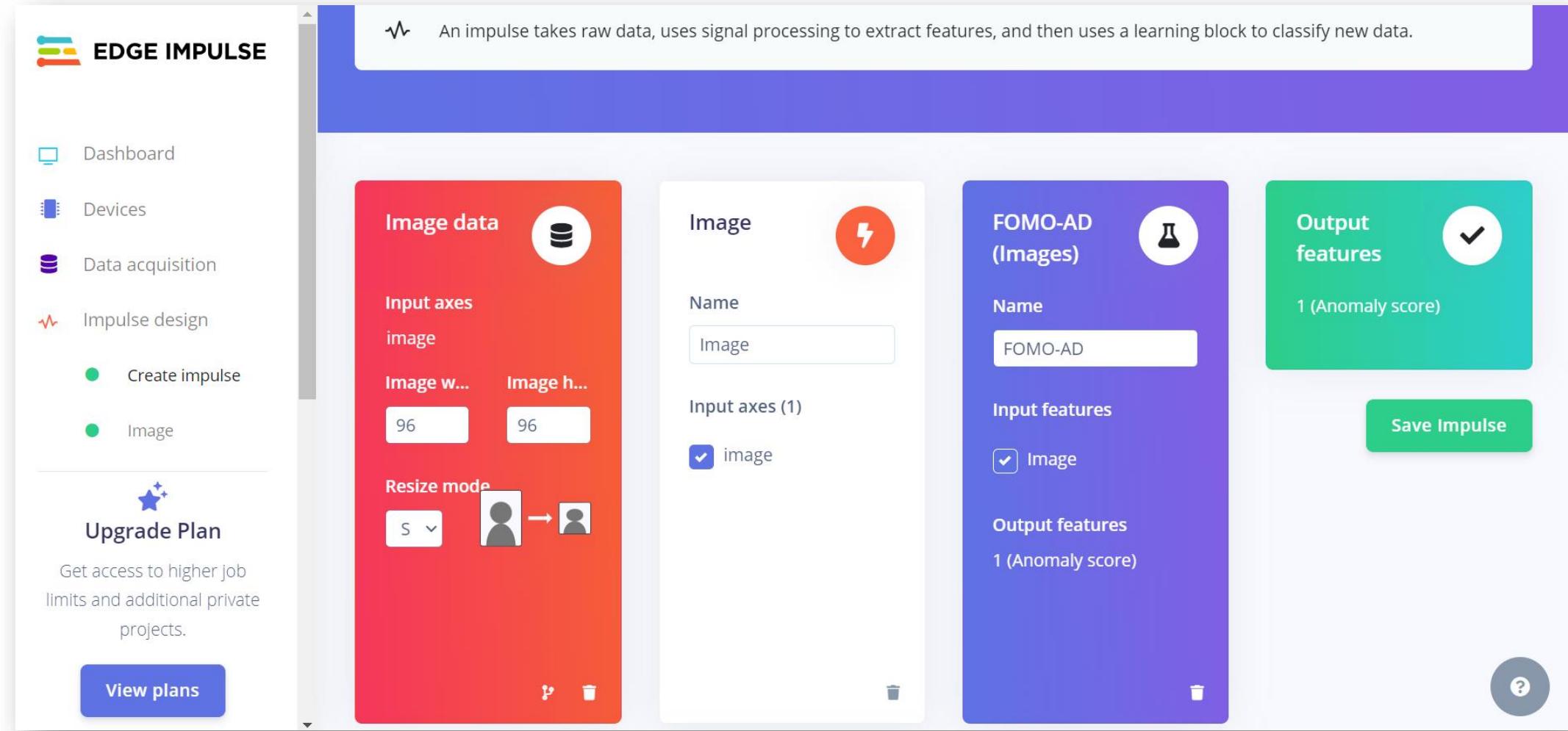


no anomaly



anomaly

Edge Impulse FOMO-AD – Impulse Design



An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.

EDGE IMPULSE

- Dashboard
- Devices
- Data acquisition
- Impulse design
- Create impulse
- Image

Upgrade Plan
Get access to higher job limits and additional private projects.

View plans

Image data

Input axes
image

Image w... Image h...
96 96

Resize mode
S ↗

Image

Name Image

Input axes (1)
 image

FOMO-AD (Images)

Name FOMO-AD

Input features
 Image

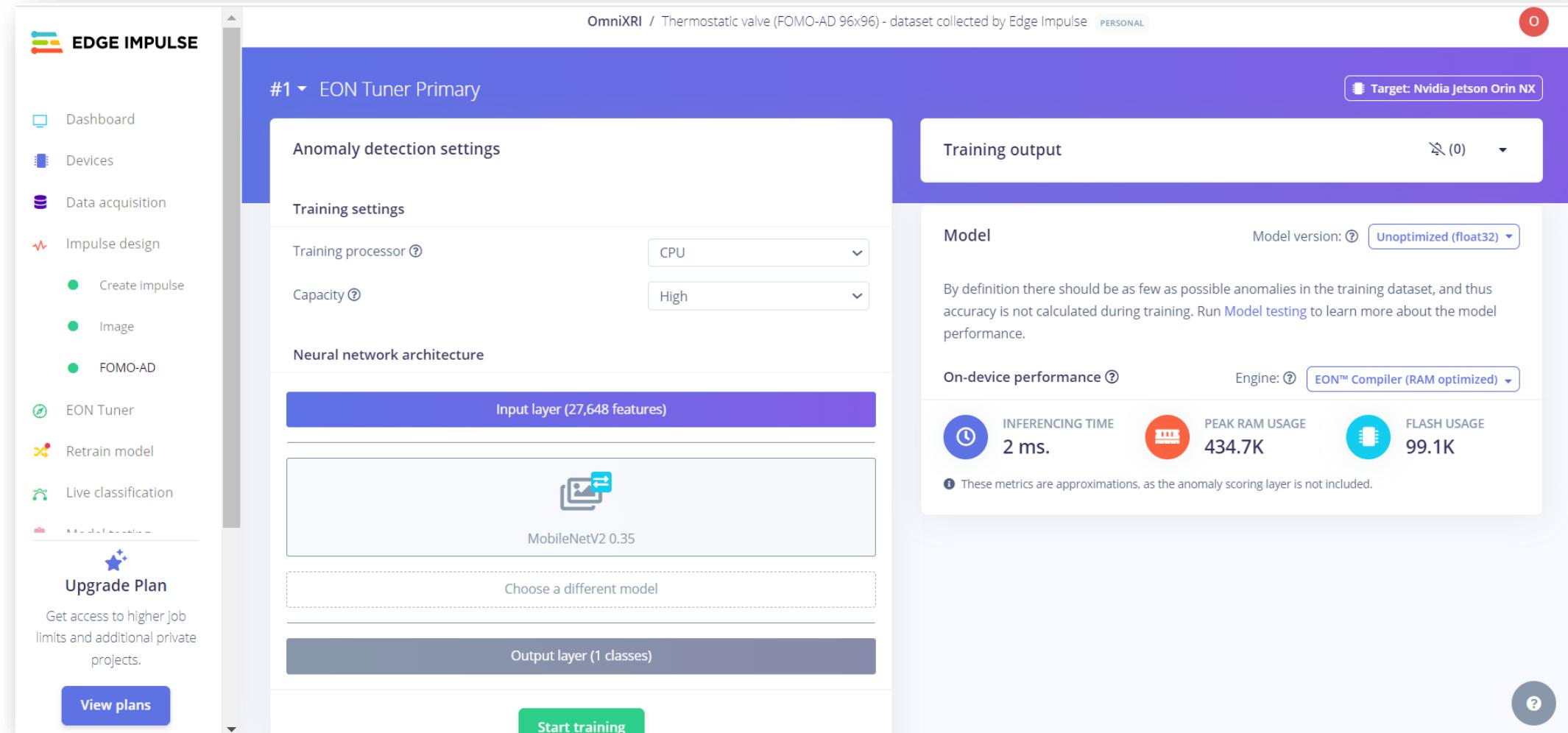
Output features
1 (Anomaly score)

Output features

1 (Anomaly score)

Save Impulse

Edge Impulse FOMO-AD – Model Training



The screenshot shows the Edge Impulse web interface for training a model named "#1 EON Tuner Primary".

- Left Sidebar:**
 - EDGE IMPULSE
 - Dashboard
 - Devices
 - Data acquisition
 - Impulse design
 - Create impulse
 - Image
 - FOMO-AD
 - EON Tuner
 - Retrain model
 - Live classification
 - Upgrade Plan
- Center Content:**
 - Anomaly detection settings**
 - Training settings**
 - Training processor: CPU
 - Capacity: High
 - Neural network architecture**
 - Input layer (27,648 features)**
 - MobileNetV2 0.35
 - Choose a different model
 - Output layer (1 classes)**
 - Training output**: (0)
 - Model**: Model version: Unoptimized (float32)
 - By definition there should be as few as possible anomalies in the training dataset, and thus accuracy is not calculated during training. Run [Model testing](#) to learn more about the model performance.
 - On-device performance**: Engine: EON™ Compiler (RAM optimized)
 - INFERENCING TIME**: 2 ms.
 - PEAK RAM USAGE**: 434.7K
 - FLASH USAGE**: 99.1K

These metrics are approximations, as the anomaly scoring layer is not included.
- Bottom Buttons:**
 - Start training
 - View plans
 - ?

Edge Impulse FOMO-AD - Live Test

The screenshot displays the Edge Impulse Classification result interface. On the left, a sidebar lists various project management and development tools: Dashboard, Devices, Data acquisition, Impulse design, Create impulse, Image, FOMO-AD, EON Tuner, Retrain model, Live classification, and Upgrade Plan. The Upgrade Plan section includes a callout for higher job limits and private projects, with a 'View plans' button.

The main area shows two classification results for a metal fitting:

- Classification Result 1:** Raw data file: `no anomaly.4r0tpev5`. The image shows a metal fitting with a blue cap. The summary table shows:

CATEGORY	COUNT
anomaly	0
no anomaly	1

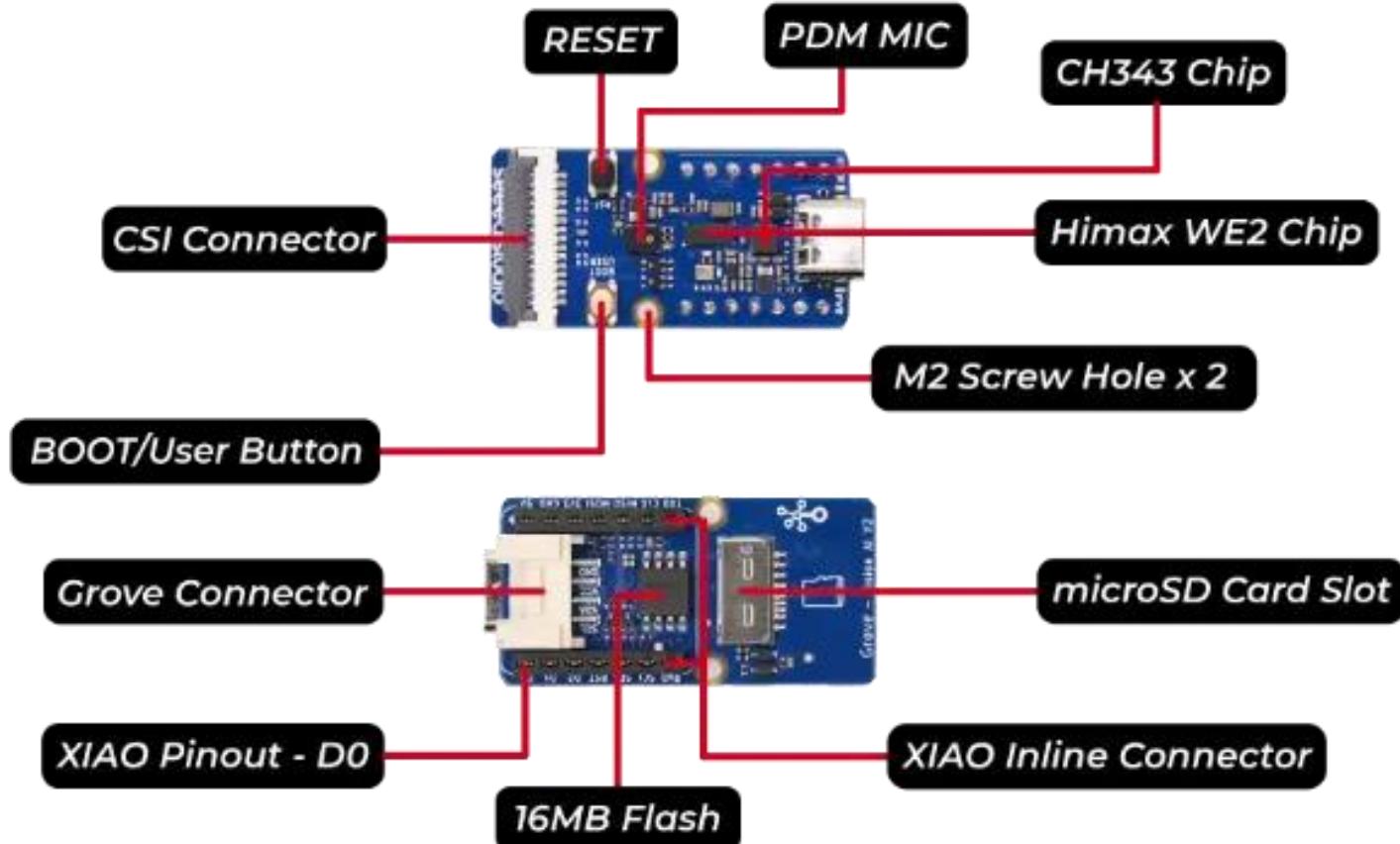
Raw features: `0xc7c3bb, 0xc6c3b9, 0xc7c3bb, 0xc7c3bb, 0xc7c3ba, 0xc7c3ba, 0xc9c2ba, 0xc9c2ba, 0xc7c2bc, 0xc...`
- Classification Result 2:** Raw data file: `anomaly.4r2ob38f`. The image shows a similar metal fitting. The summary table shows:

CATEGORY	COUNT
ANOMALY	1
no anomaly	0

Raw features: `0xcdcbff, 0xcdcbff, 0xcdcbc0, 0xcecbc2, 0xcdcac1, 0xcecac1, 0xcdcac1, 0xcdcac0, 0xcecabf, 0xc...`

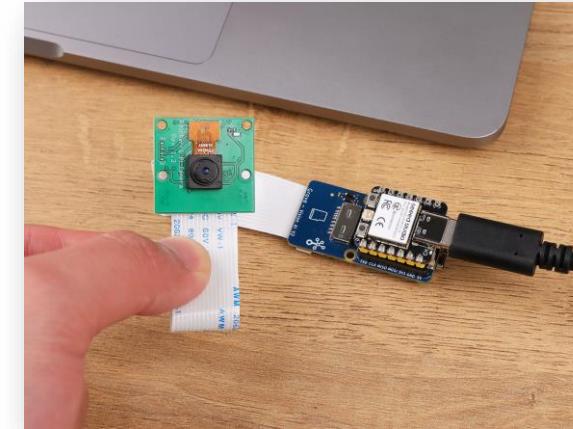
Detailed results for both show a confidence score of 2.27 for the first and 2.35 for the second, with a mean of 1.1169 for the first and 0.9007 for the second.

實驗器材 – Seeed Vision AI Module V2



資料來源：https://wiki.seeedstudio.com/grove_vision_ai_v2/

<https://www.himax.com.tw/products/wiseeye-ai-sensing/wiseeye2-ai-processor/>



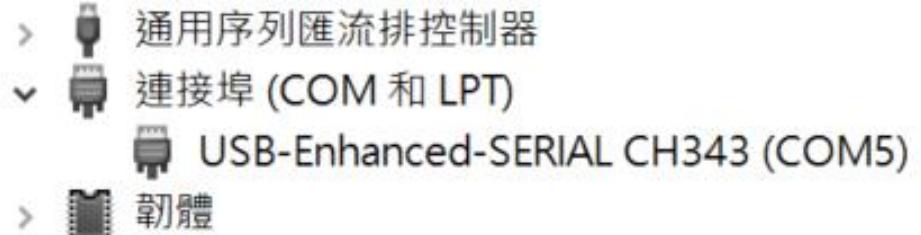
Himax (奇景) WiseEye2
 (Arm Cortex-M55 *2 @400MHz / 160MHz + Micro NPU Ethos-U55 400MHz)
 SRAM: 2432KB
 Boot ROM: 64KB
 Sensor: PDM
 SD Card Slot
 Camera: **Pi OV5647-62 (Option)**

安裝序列埠驅動程式

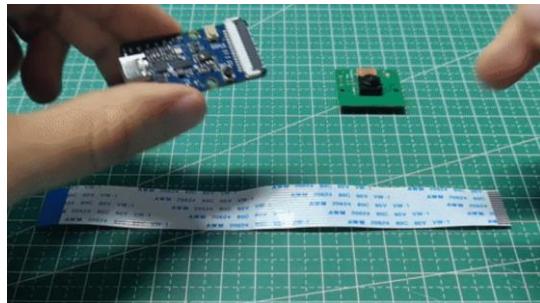
Driver

If you find that the Grove Vision AI V2 is not recognised after connecting it to your computer. Then you may need to install the CH343 driver on your computer. Here are some links to download and install the CH343 driver.

- Windows Vendor VCP Driver One-Click Installer: [CH343SER.EXE](#)
- Windows Vendor VCP Driver: [CH343SER.ZIP](#)
- Windows CDC driver one-click installer: [CH343CDC.EXE](#)
- Windows CDC driver: [CH343CDC.ZIP](#)
- macOS Vendor VCP Driver: [CH34xSER_MAC.ZIP](#)

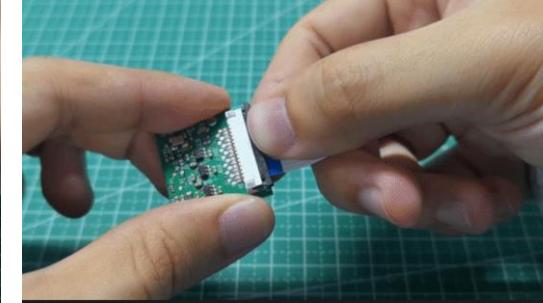


選擇對應作業系統驅動程式並安裝



開發板、攝影機、軟排線

軟排插入開發板



軟排插入攝影機



USB插入開發板後
USB另一端插入電腦

資料來源：https://wiki.seeedstudio.com/grove_vision_ai_v2/

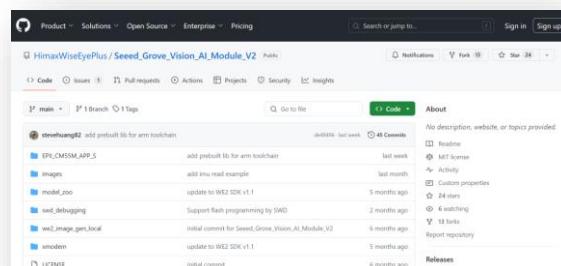
Seeed Vision AI Module V2 開發資源



矽遞科技 WIKI 文檔平台 – Grove – Vision AI V2 模塊人工智能
 (英文版) https://wiki.seeedstudio.com/grove_vision_ai_v2/
 (簡中版) https://wiki.seeedstudio.com/cn/grove_vision_ai_v2/

This screenshot shows the SenseCraft AI platform interface. The top navigation bar includes "Home", "AI Models", and "Device Workspace". The main content area is titled "Welcome to SenseCraft AI" and features sections for "Explore AI Solution", "Public AI Models", "Share your own AI Model", "My Own Models", "Real-time Inference", and "Device Workspace". To the right, there is a section titled "Popular AI Models" featuring four cards: "General Object Detection", "Pose estimation", "Emotion Classification", and "Face detection". Each card includes a thumbnail image and a brief description.

Seeed - SenseCraft AI
<https://sensecraft.seeed.cc/ai/#/home>



Github, Himax WiseEye Plus – Seeed_Grove_Vision_AI_Module_V2
https://github.com/HimaxWiseEyePlus/Seeed_Grove_Vision_AI_Module_V2

Seeed SenseCraft AI 選擇裝置及模型

SenseCraft | SenseCraft AI

Home **AI Models** Device Workspace ▾

Grove - Vision AI V2 ×

Task

- Detection
- Classification
- Segmentation
- Pose
- Generation

Gesture Detection
The model is a Swift-YOLO model trained on the gesture detection...
Detection Grove - Vision AI V2

Face Detection
The model is a Swift-YOLO model trained on the face detection dataset.
Detection Grove - Vision AI V2

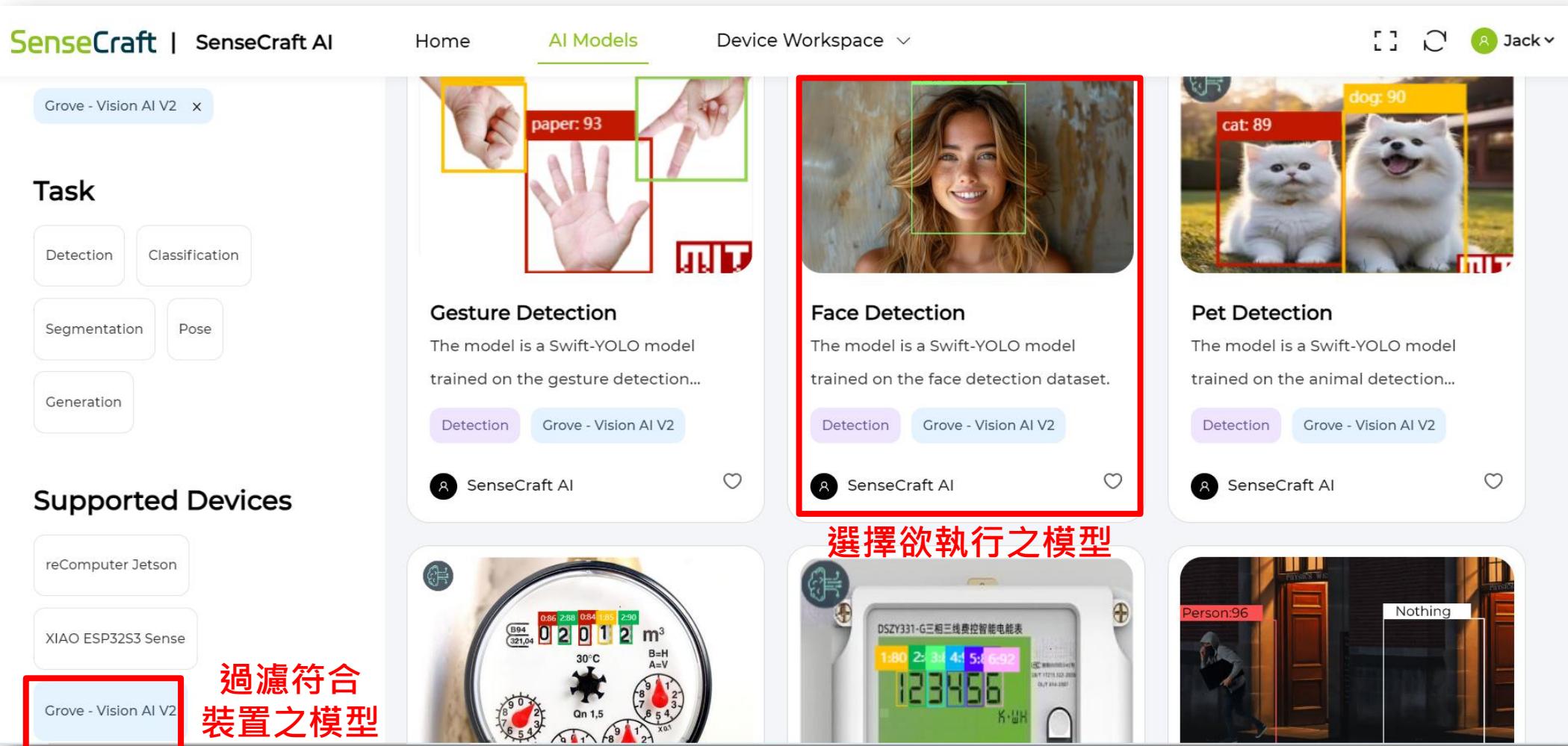
Pet Detection
The model is a Swift-YOLO model trained on the animal detection...
Detection Grove - Vision AI V2

Supported Devices

- reComputer Jetson
- XIAO ESP32S3 Sense
- Grove - Vision AI V2

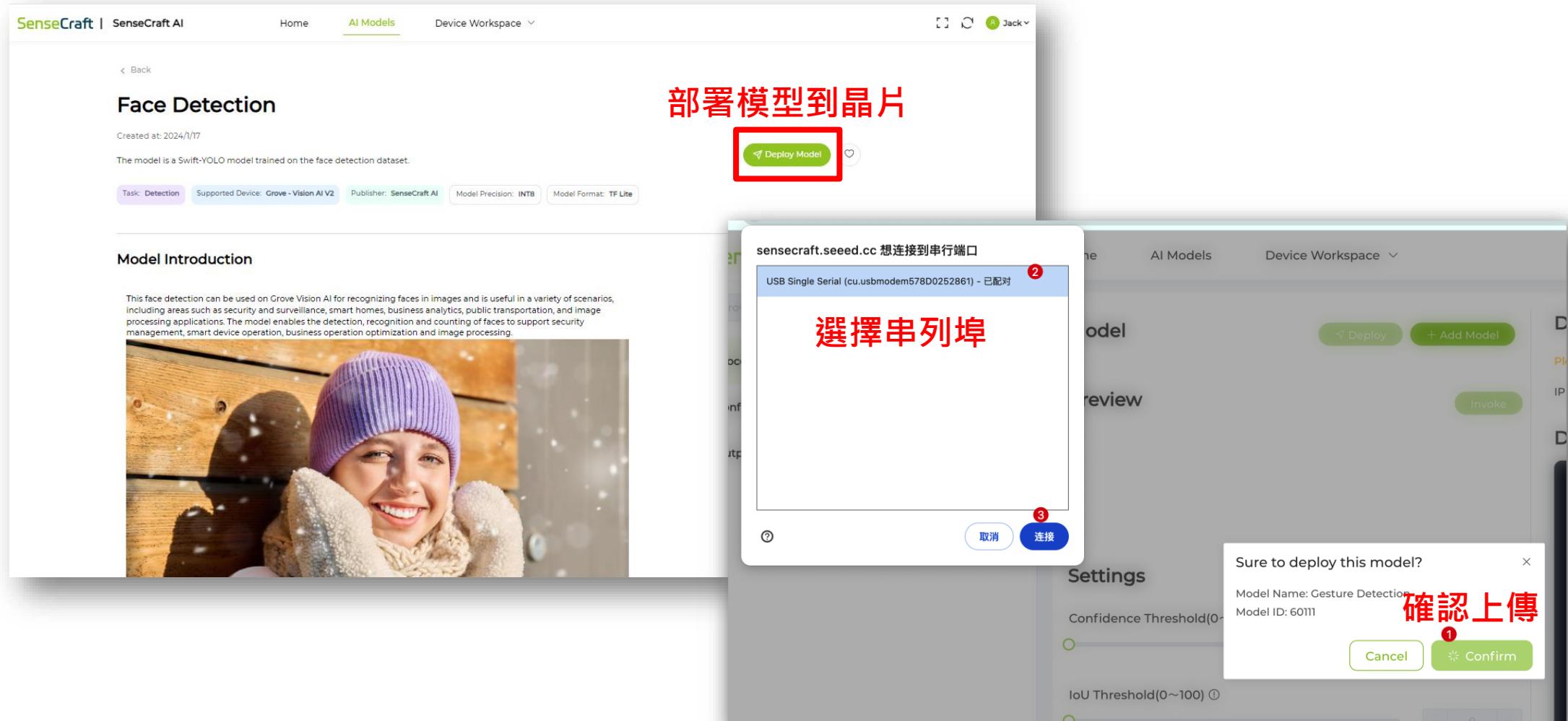
選擇欲執行之模型

過濾符合裝置之模型



資料來源：<https://sensecraft.seeed.cc/ai/#/model>

Seeed SenseCraft AI 模型部署



The image shows a multi-step process for deploying an AI model to a Grove Vision AI V2 device:

- Step 1: Model Selection** - The main SenseCraft AI interface shows a "Face Detection" model card. A red box highlights the "Deploy Model" button.
- Step 2: Port Selection** - A modal window titled "選擇串列埠" (Select Serial Port) lists "USB Single Serial (cu.usbmodem578D0252861) - 已配對" (USB Single Serial (cu.usbmodem578D0252861) - Paired). A red box highlights the "連接" (Connect) button.
- Step 3: Confirmation** - A confirmation dialog box asks "Sure to deploy this model?" with "Cancel" and "Confirm" buttons. A red box highlights the "Confirm" button.

資料來源：<https://sensecraft.seeed.cc/ai/#/model>

Seeed SenseCraft AI 連接、上傳、測試

選擇裝置並連線

SenseCraft | SenseCraft AI

Home AI Models Device Workspace ▾

Grove Vision AI(V2) ▾

Disconnect

Process Configuration Output

Model Deploy Add Model

Model Name: Face Detection
Model Version: 1.0.0

Preview Invoke

啟動 / 停止 檢測

Device

Device ID: 330e0c07
Device Name: Grove Vision AI (V2)
Device Version: 2024.05.22
IP Address: - Configure wifi now
Service Status: MQTT not initialized or not connected

Settings

Confidence Threshold(0 ~ 100) ①
IoU Threshold(0 ~ 100) ①

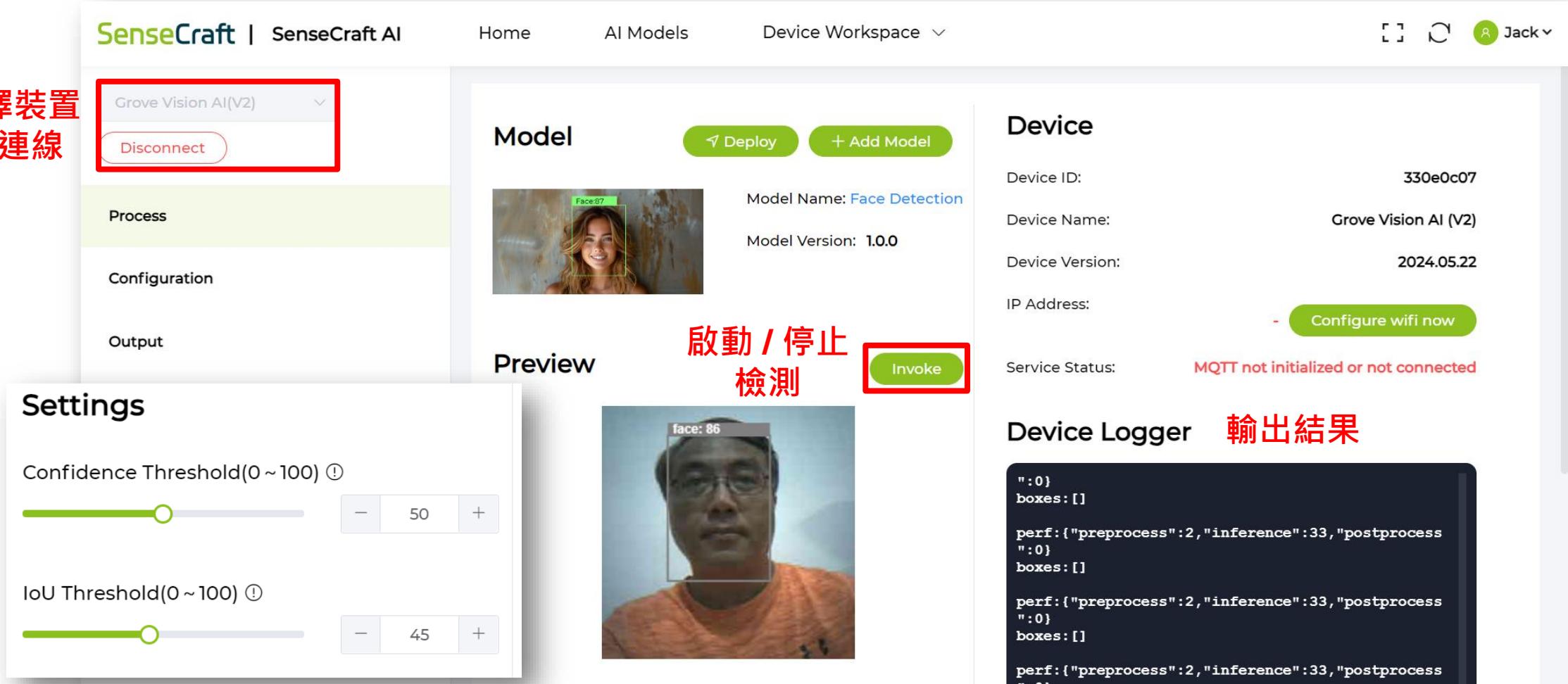
Device Logger 輸出結果

```
":0}
boxes:[]

perf:{"preprocess":2,"inference":33,"postprocess":0}
boxes:[]

perf:{"preprocess":2,"inference":33,"postprocess":0}
boxes:[]

perf:{"preprocess":2,"inference":33,"postprocess":0}
```



資料來源：<https://sensecraft.seeed.cc/ai/#/model>

參考文獻

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<https://omnixri.blogspot.com/p/ntust-edge-ai.html>
- 許哲豪，有了TinyML加持MCU也能開始玩電腦視覺了
<https://omnixri.blogspot.com/2022/12/tinymilmcu.html>
- Himax, WiseEye2 AI Processor (WE2) (HX6538)
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https://wiki.seeedstudio.com/cn/grove_vision_ai_v2/
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<https://sensecraft.seeed.cc/ai/#/home>
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延伸閱讀

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https://omnixri.blogspot.com/2020/11/ai-hub_23.html
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<https://omnixri.blogspot.com/2020/12/ai-hub.html>

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只有更邊



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邊緣人俱樂部



YOUTUBE 直播 : <https://www.youtube.com/@omnixri1784streams>



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[部落格 : https://omnidxri.blogspot.tw](#)

[開 源 : https://github.com/OmniXRI](#)