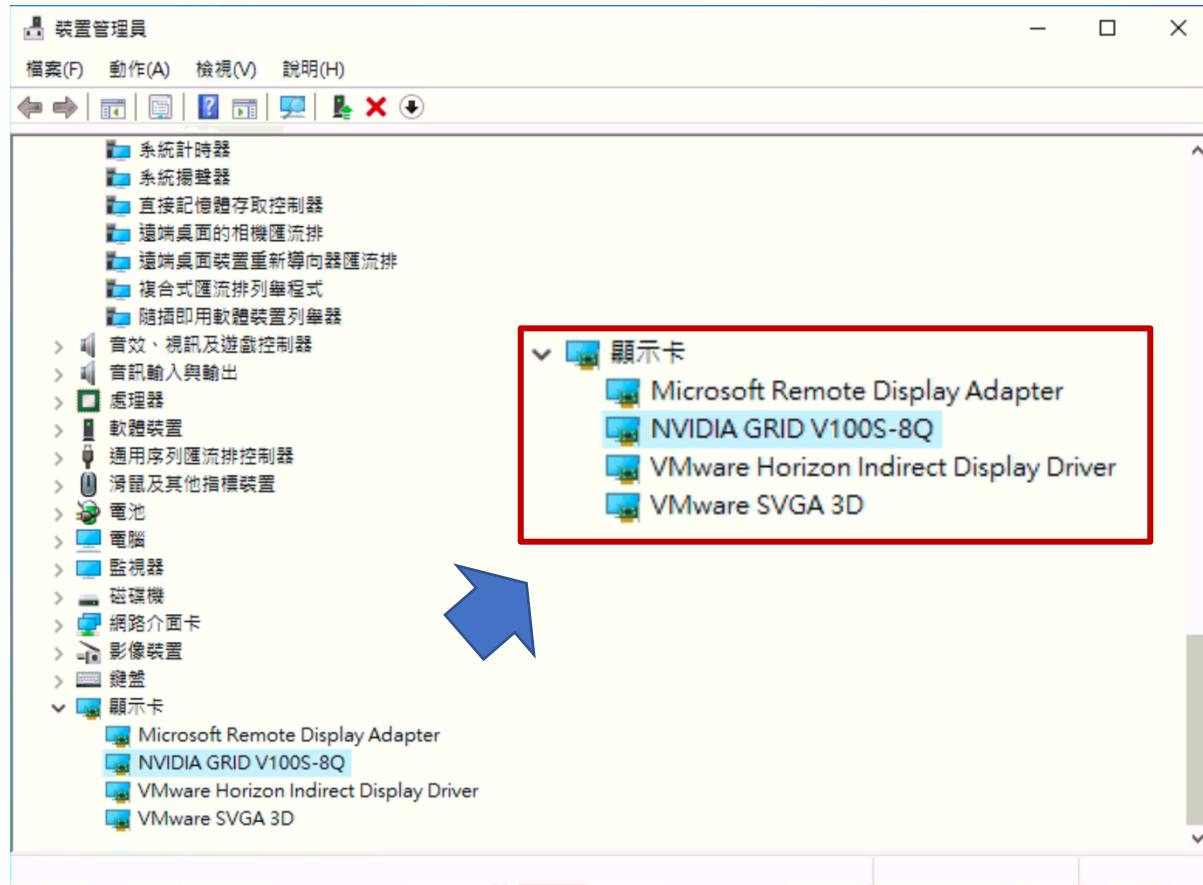


本文件為在 Windows 10 pro 上安裝 Visual Studio, NVIDIA CUDA Toolkit, NVIDIA cuDNN, Anaconda，並使用 Tensorflow 檢查 GPU 狀態

## 1. 檢查 GPU 相容及運算能力

開啟作業系統內的裝置管理員，查詢 GPU 型號



<https://developer.nvidia.com/cuda-gpus>

GPU 版本及運算能力、功能可在 WiKi, NVIDIA 的網站可參考

Architecture specifications	Compute capability (version)																										
	1.0	1.1	1.2	1.3	2.0	2.1	3.0	3.5	3.7	5.0	5.2	6.0	6.1, 6.2	7.0, 7.2	7.5	8.0											
Number of ALU lanes for integer and single-precision floating-point arithmetic operations	8 <sup>[36]</sup>		32	48	192			128		64	128	64															
Number of special function units for single-precision floating-point transcendental functions	2		4	8	32			16		32	16																
Number of texture filtering units for every texture address unit or <i>render output unit</i> (ROP)	2		4	8	16			8 <sup>[37]</sup>																			
Number of warp schedulers	1		2		4			2		4																	
Max number of instructions issued at once by a single scheduler	1			2 <sup>[38]</sup>			1																				
Number of tensor cores	N/A										8 <sup>[37]</sup>		4														
Size in KB of unified memory for data cache and shared memory per multi processor	t.b.d.										128		96 <sup>[39]</sup>	192													

使用 NVIDIA 程式來檢查驅動程式，如果在 AI 中心以外的電腦可能有其他的



GPU 核心與運算能力對照表，AI 中心使用的核心是 Volta

Table 2. Compute Capability Support

Hardware Generation	Compute Capability	Driver 384.111+	Driver 410.48+	Driver 418.40.04+	Driver 440.33.01+	Driver 450.36.06+
Ampere	8.0	No	No	No	No	Yes
Turing	7.5	No	Yes	Yes	Yes	Yes
Volta	7.x	Yes	Yes	Yes	Yes	Yes
Pascal	6.x	Yes	Yes	Yes	Yes	Yes
Maxwell	5.x	Yes	Yes	Yes	Yes	Yes
Kepler	3.x	Yes	Yes	Yes	Yes	Yes
Fermi	2.x	No	No	No	No	No

本次操作的 LAB 所使用的 CUDA 為 10.2，需使用 440.33+ 以上的驅動程式，上方 GPU 驅動程式查詢結果為 441.66，高於最低要求

**Table 1. CUDA Toolkit and Compatible Driver Versions**

CUDA Toolkit	Linux x86_64 Driver Version
CUDA 11.0 (11.0.171)	>= 450.36.06
CUDA 10.2 (10.2.89)	>= 440.33
CUDA 10.1 (10.1.105)	>= 418.39
CUDA 10.0 (10.0.130)	>= 410.48
CUDA 9.2 (9.2.88)	>= 396.26
CUDA 9.1 (9.1.85)	>= 390.46
CUDA 9.0 (9.0.76)	>= 384.81
CUDA 8.0 (8.0.61 GA2)	>= 375.26
CUDA 8.0 (8.0.44)	>= 367.48
CUDA 7.5 (7.5.16)	>= 352.31
CUDA 7.0 (7.0.28)	>= 346.46

2. 下載及安裝 Microsoft Visual Studio 2019 Community

前往 <https://visualstudio.microsoft.com/zh-hant/vs/community/>

下載 Visual Studio 2019 Community

## Visual Studio Community

功能齊全且可擴充的免費 IDE，可用於建立 Android 版 Web 應用程式和雲端服務。

[下載 Visual Studio ↓](#)

下載完成之後啟動執行後繼續



執行時勾選“使用 C++ 的桌面開發”後啟動安裝

The screenshot shows the "Select Development Environment" step of the Visual Studio 2019 Community setup. It lists several development environments with checkboxes:

- ASP.NET 與網頁程式開發 (unchecked)
- Azure 開發 (unchecked)
- Python 開發 (unchecked)
- Node.js 開發 (unchecked)
- .NET 桌面開發 (unchecked)
- 使用 C++ 的桌面開發 (checked)

Below this, it says "完成 Visual Studio 2019 Community 安裝後，請關閉程式，以免影響 CUDA Toolkit 安裝" (After completing the Visual Studio 2019 Community installation, please close the program to avoid affecting CUDA Toolkit installation).

完成 Visual Studio 2019 Community 安裝後，請關閉程式，以免影響 CUDA Toolkit 安裝

### 3. 下載及安裝 NVIDIA CUDA Toolkit

前往 <https://developer.nvidia.com/cuda-toolkit-archive>

下載 NVIDIA CUDA Toolkit 10.2

## CUDA Toolkit 10.2 Download

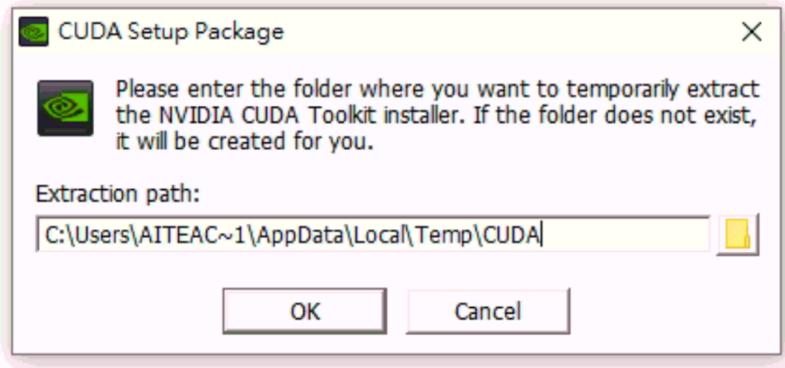
The screenshot shows the "Select Target Platform" section of the CUDA Toolkit 10.2 download page. It includes the following filters:

- Operating System: Windows (selected), Linux, Mac OSX
- Architecture: x86\_64 (selected)
- Version: 10, 8.1, 7, Server 2019 (selected), Server 2016, Server 2012 R2
- Installer Type: exe (network) (selected), exe (local)

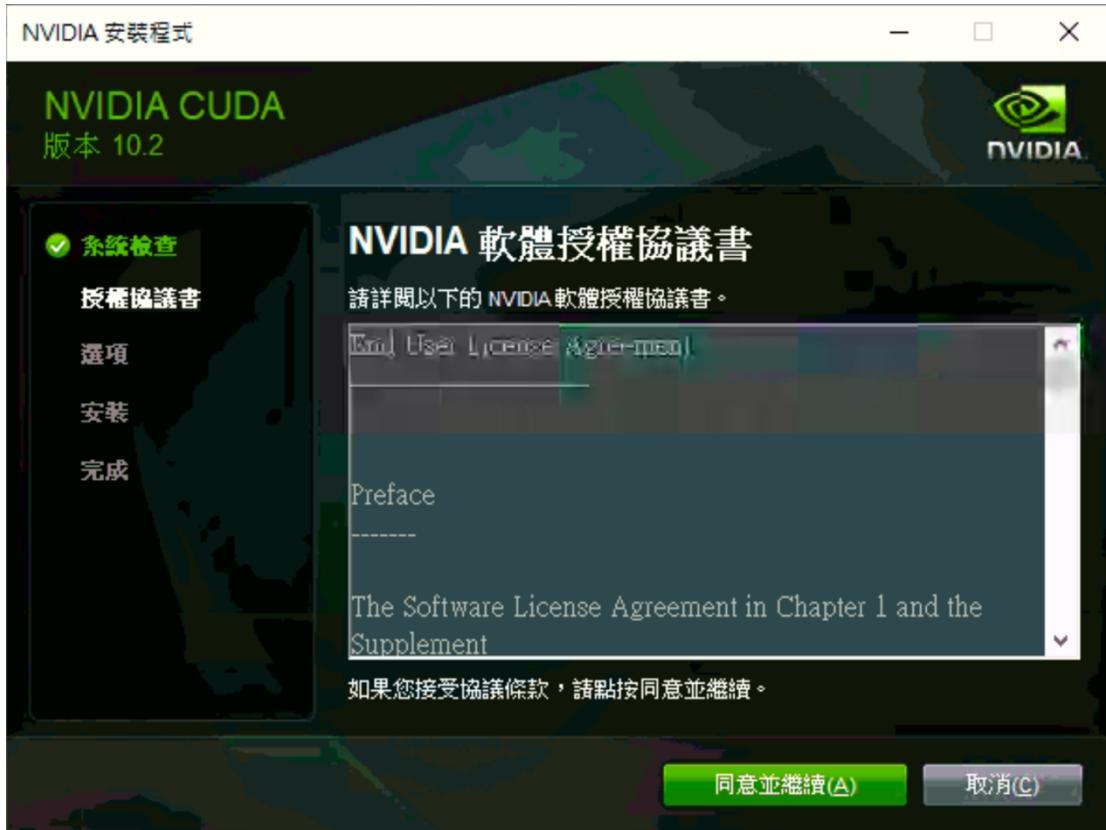
The screenshot shows the "Download Installer for Windows 10 x86\_64" section of the CUDA Toolkit 10.2 download page. It includes the following information:

- The base installer is available for download below.
- Base Installer**: A link to download the base installer (2.6 GB).
- Installation Instructions:
  - Double click cuda\_10.2.89\_441.22\_win10.exe
  - Follow on-screen prompts
- The checksums for the installer and patches can be found in [Installer Checksums](#).
- For further information, see the [Installation Guide for Microsoft Windows](#) and the [CUDA Quick Start Guide](#).

解壓縮安裝程式來執行 CUDA 10.2 Toolkit 安裝



同意 NVIDIA 軟體授權協議書後繼續



於安裝選項，選取“自訂（進階選項）”



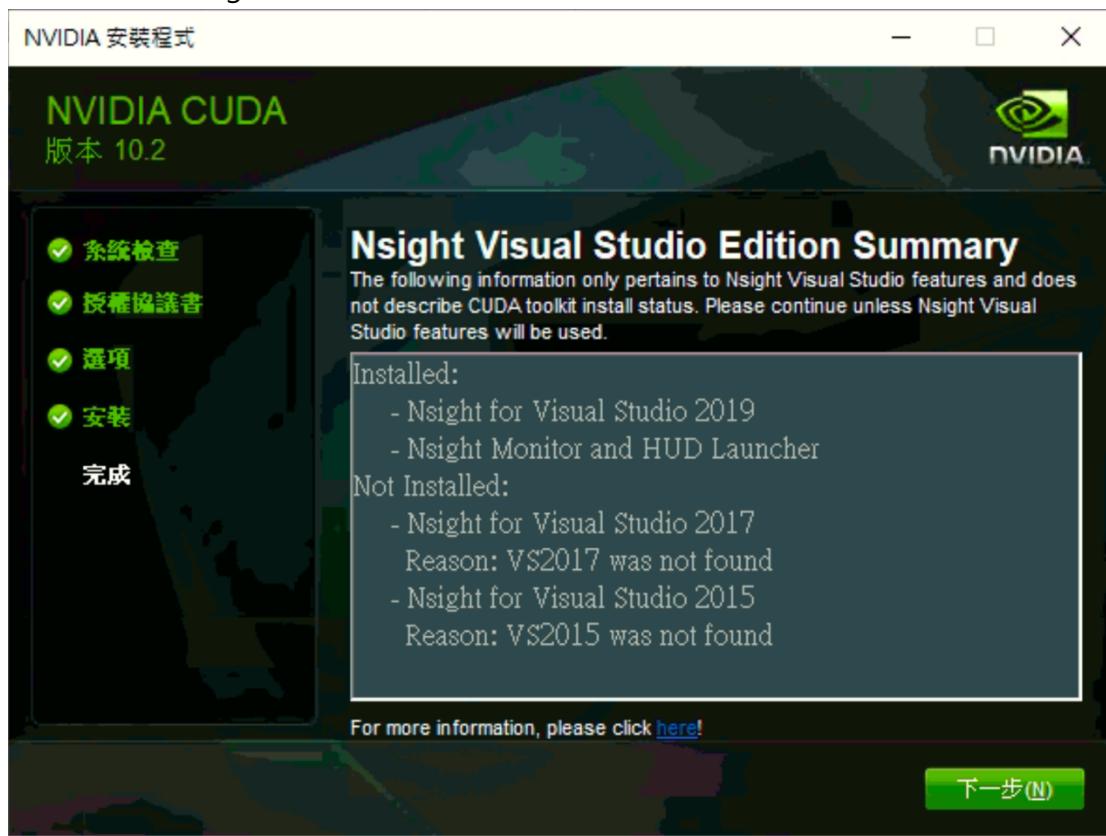
於“自訂安裝選項”取消選擇安裝驅動程式 ( AI 中心所使用的虛擬 GPU )



以預設的安裝位置安裝 CUDA Toolkit



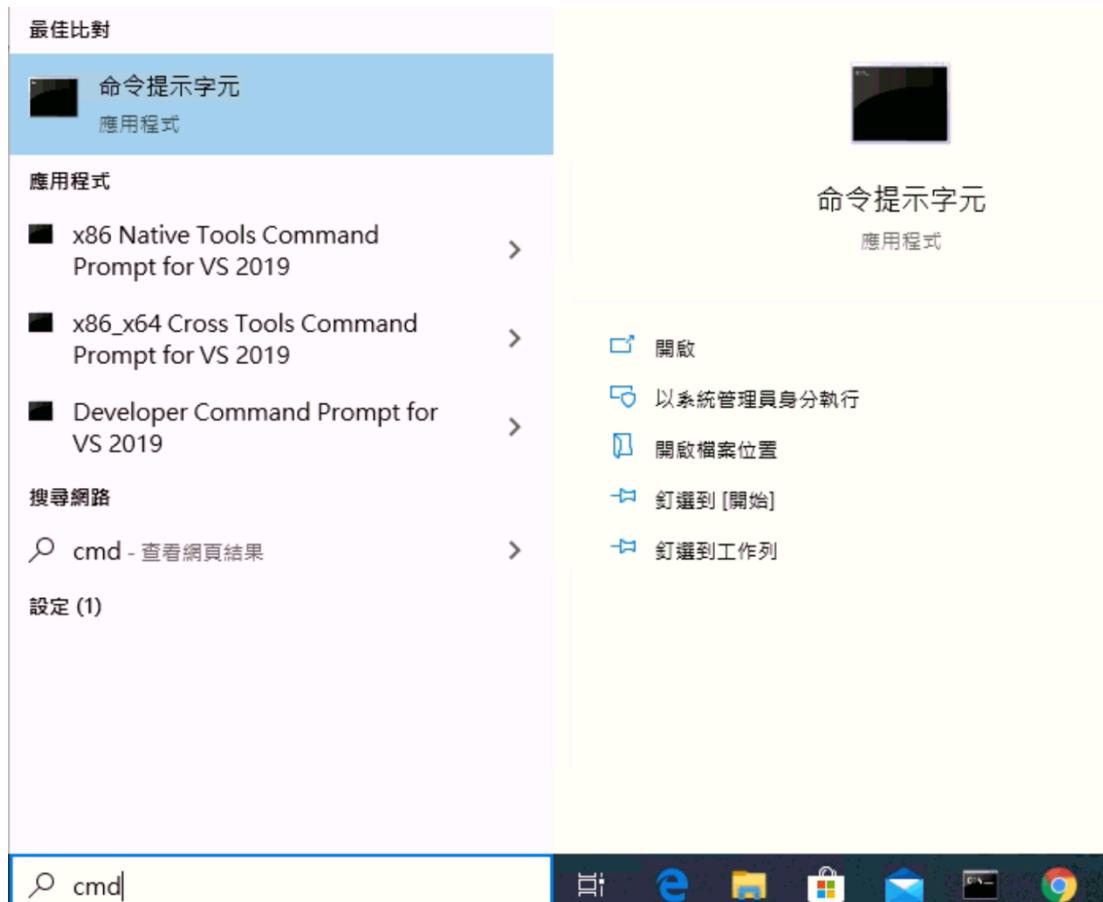
檢查所安裝的 Nsight for Visual Studio 及 Launcher



顯示 NVIDIA 安裝程式已完成



重新啟動後，使用命令提示字元來檢查



使用 nvcc -V 指令來檢查 CUDA 版本

```
C:\Users\aiteacher01>nvcc -V
nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2019 NVIDIA Corporation
Built on Wed_Oct_23_19:32:27_Pacific_Daylight_Time_2019
Cuda compilation tools, release 10.2, V10.2.89
```

於 "C:\Program Files\NVIDIA Corporation\NVSMI" 執行 "nvidia-smi" 指令來查詢 GPU 狀態

```
C:\Program Files\NVIDIA Corporation\NVSMI>nvidia-smi
Sun Jul 26 14:39:55 2020
+-----+
| NVIDIA-SMI 441.66      Driver Version: 441.66      CUDA Version: 10.2 |
+-----+
| GPU  Name      TCC/WDDM | Bus-Id      Disp.A  | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap| Memory-Usage | GPU-Util  Compute M. |
|-----+
| 0  GRID V100S-8Q      WDDM | 00000000:02:02.0  On | [ ] 0% | [ ] Default |
| N/A   N/A    P0    N/A / N/A | 923MiB / 8160MiB | [ ] 10% | [ ] Default |
+-----+
+-----+
Processes:
+-----+
| GPU  PID  Type  Process name          GPU Memory Usage |
| 0    1212  C+G   Insufficient Permissions [ ] N/A [ ] 1 |
| 0    1264  C+G   Insufficient Permissions [ ] N/A [ ] 1 |
| 0    1560  C+G   Insufficient Permissions [ ] N/A [ ] 1 |
| 0    1932  C+G   C:\Windows\explorer.exe [ ] N/A [ ] 1 |
| 0    2428  C+G   ...6)\Google\Chrome\Application\chrome.exe [ ] N/A [ ] 1 |
| 0    4372  C+G   Insufficient Permissions [ ] N/A [ ] 1 |
| 0    6564  C+G   ...oftEdge_8wekyb3d8bbwe\MicrosoftEdge.exe [ ] N/A [ ] 1 |
| 0    7204  C+G   ...2.97.0_x64_8wekyb3d8bbwe\YourPhone.exe [ ] N/A [ ] 1 |
| 0    7600  C+G   ...5n1h2txyewy\StartMenuExperienceHost.exe [ ] N/A [ ] 1 |
| 0    7884  C+G   ...dows.Cortana_cw5n1h2txyewy\SearchUI.exe [ ] N/A [ ] 1 |
+-----+
```

#### 4. 下載及安裝 NVIDIA cuDNN

前往 <https://developer.nvidia.com/cudnn>

註冊並登入 NVIDIA 開發者網站

## NVIDIA Developer Program Membership Required

The file or page you have requested requires membership in the NVIDIA Developer Program. Please either log in or join the program to view the benefits of the NVIDIA Developer Program here.

[Login](#)

[Join now](#)

下載 cuDNN，本次安裝的 CUDA 版本 10.2，故下載相對的 7.6.5

## cuDNN Download

NVIDIA cuDNN is a GPU-accelerated library of primitives for deep neural networks.

**I Agree To the Terms of the cuDNN Software License Agreement**

Note: Please refer to the [Installation Guide](#) for release prerequisites, including supported GPU

For more information, refer to the cuDNN Developer Guide, [Installation Guide](#) and [Release Notes](#).

[Download cuDNN v8.0.1 RC2 \[June 26th, 2020\], for CUDA 11.0](#)

[Download cuDNN v8.0.1 RC2 \[June 26th, 2020\], for CUDA 10.2](#)

[Download cuDNN v7.6.5 \[November 18th, 2019\], for CUDA 10.2](#)

下載 for Windows 10 的版本

## Library for Windows, Mac, Linux, Ubuntu and

[cuDNN Library for Windows 7](#)

[cuDNN Library for Windows 10](#)

[cuDNN Library for Linux](#)

[cuDNN Runtime Library for Ubuntu18.04 \(Deb\)](#)

解壓縮所下載回來的檔案



將 cuDNN 目錄的三個資料夾檔案，個別複製到作業系統內相對應的資料夾中

名稱	修改日期
bin	2020/7/26 下午
include	2020/7/26 下午
lib	2020/7/26 下午
NVIDIA_SLA_cuDNN_Support	2020/7/26 下午

C:\Program Files\NVIDIA GPU Toolkit\CUDA\v10.2

名稱	修改日期	類型
bin	2020/7/26 下午 01:39	檔案資料夾
doc	2020/7/26 下午 01:39	檔案資料夾
extras	2020/7/26 下午 01:39	檔案資料夾
include	2020/7/26 下午 01:39	檔案資料夾
lib	2020/7/26 下午 01:39	檔案資料夾
libnvp	2020/7/26 下午 01:39	檔案資料夾
nvml	2020/7/26 下午 01:39	檔案資料夾
nvvm	2020/7/26 下午 01:39	檔案資料夾
nvvmx	2020/7/26 下午 01:39	檔案資料夾
src	2020/7/26 下午 01:39	檔案資料夾
tools	2020/7/26 下午 01:39	檔案資料夾
CUDA_Toolkit_Release_Notes	2019/10/24 下午 04:28	文字文件
EULA	2019/10/24 下午 04:28	文字文件
version	2019/10/24 下午 04:28	文字文件

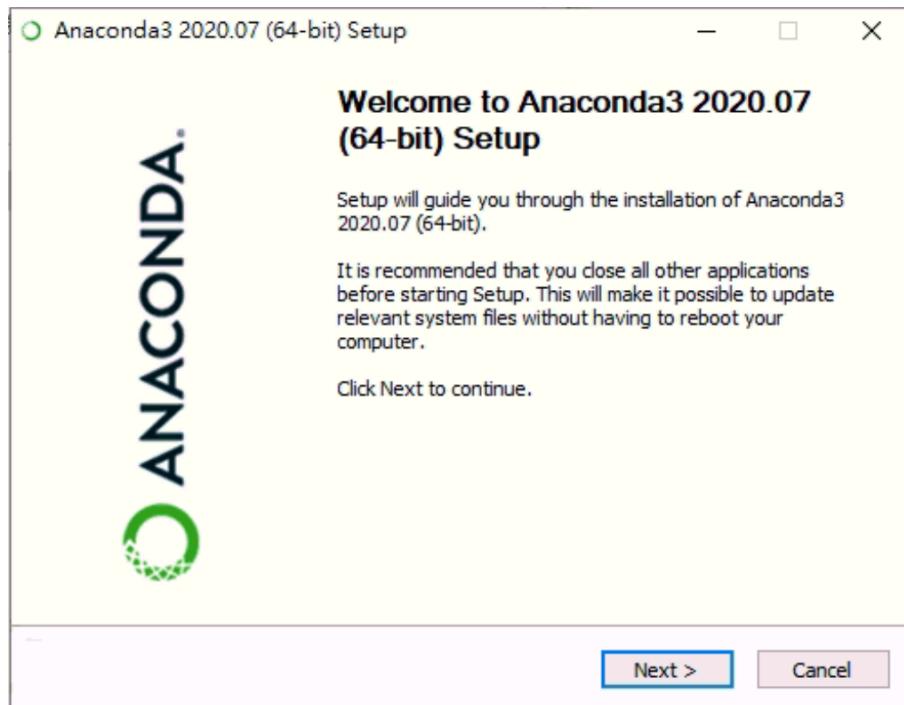
## 5. 下載及安裝 Anaconda

前往 <https://www.anaconda.com/products/individual>

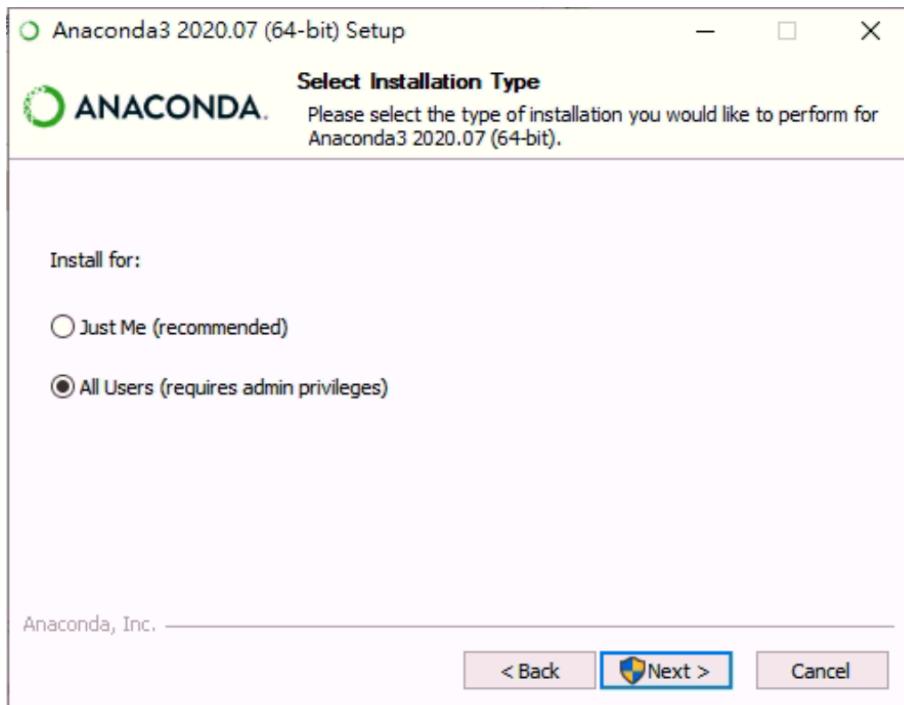
下載 Windows 64bit 版本的 Anaconda Individual Edition 安裝檔



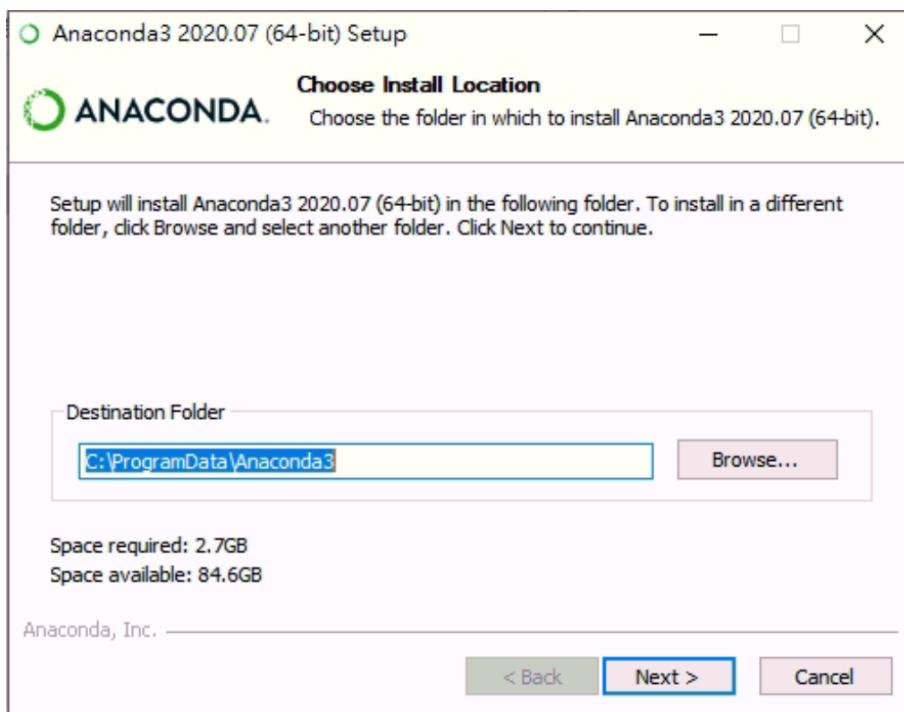
啟動 Anaconda Individual 安裝程式



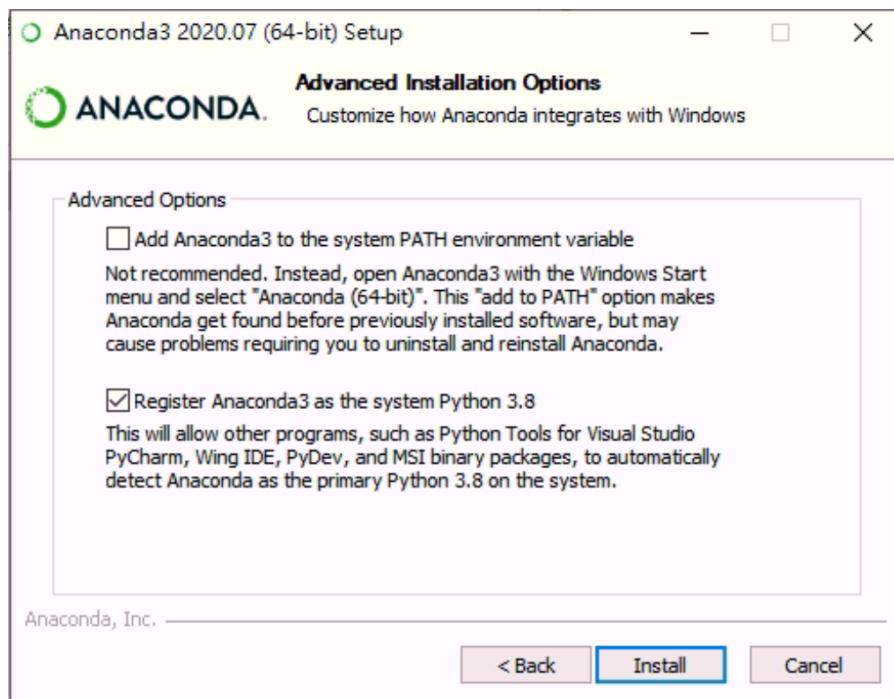
在 AI 中心所使用的安裝，建議使用 All Users 來安裝



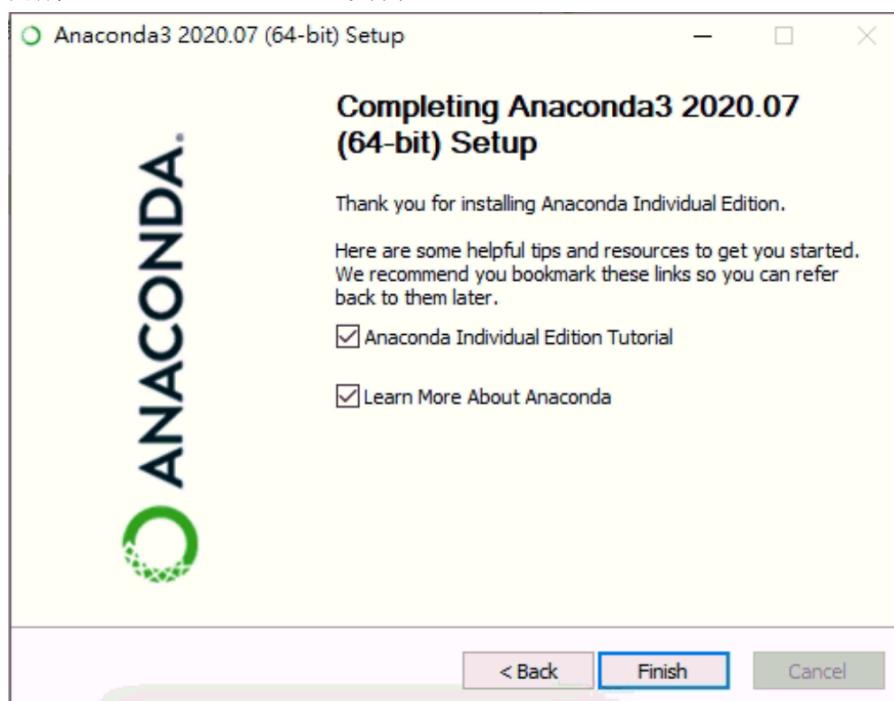
使用預設的安裝路徑



## 使用預設的安裝參數

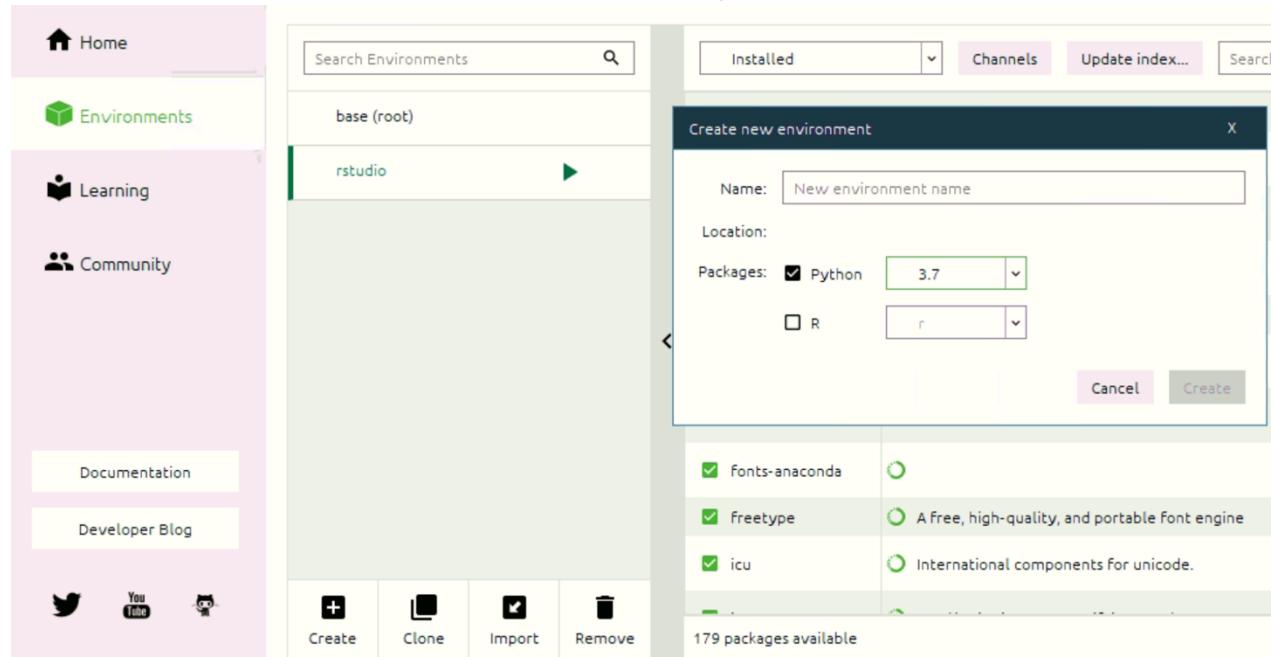


## 完成 Anaconda Individual 安裝

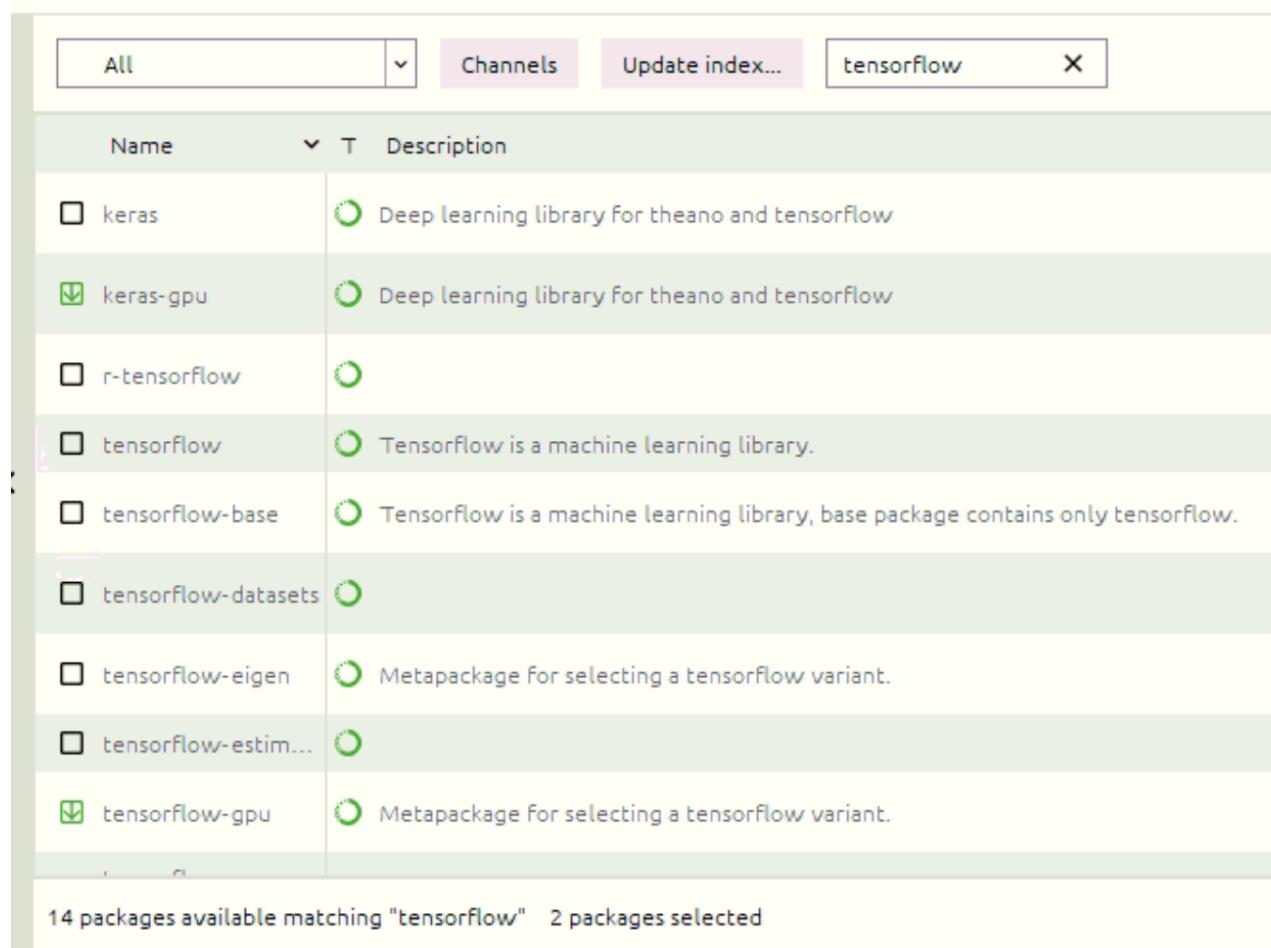


## 6. 建立一個可以執行 Tensorflow 的環境

開啟 Anaconda, 在 Environments 新增一個環境，使用 Python 3.7



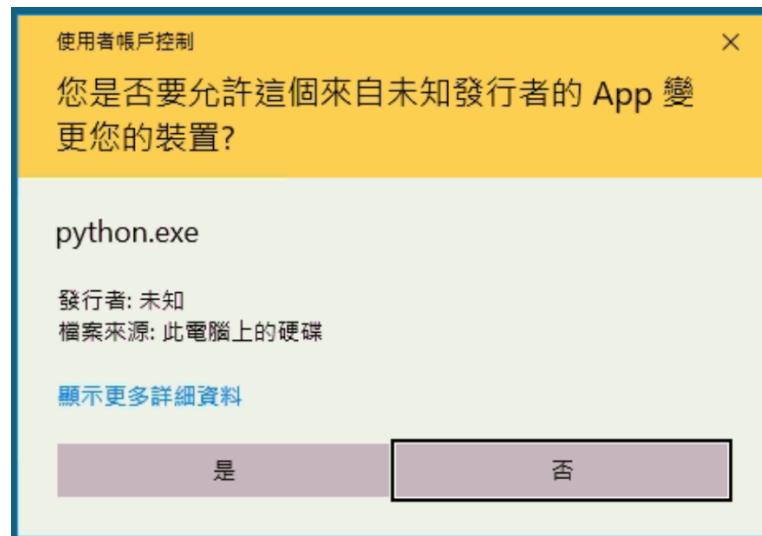
以安裝功能來安裝 Keras-GPU, Tensorflow-GPU



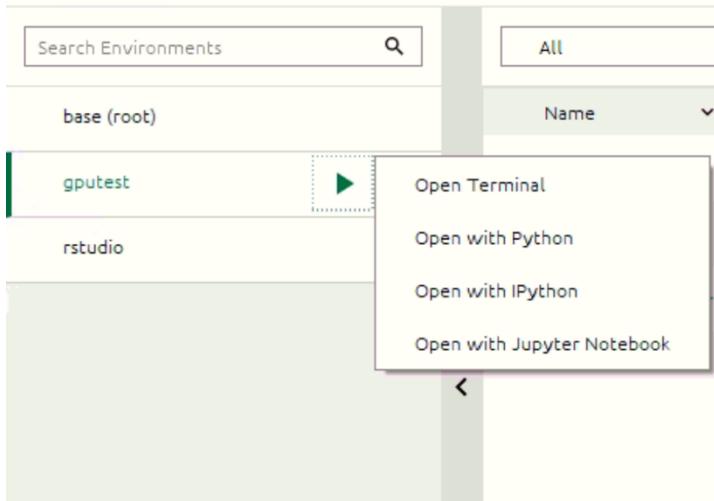
以安裝功能來安裝 Jupyterlab

The screenshot shows a software interface for managing packages. At the top, there is a search bar with the text "jupyterlab" and a "Channels" button. Below the search bar is a table with two columns: "Name" and "Description". The first row contains a checked checkbox next to "jupyterlab", followed by the text "Jupyterlab pre-alpha". The second row contains an unchecked checkbox next to "jupyterlab\_launcher", followed by the text "A launcher for jupyterlab based applications.". The third row contains an unchecked checkbox next to "jupyterlab\_server", followed by the text "A set of server components for jupyterlab and jupyterlab like applications.". At the bottom of the table, a message states "3 packages available matching "jupyterlab" 1 package selected".

安裝過程可能有部份軟體需要使用者帳號授權，請以“是”來安裝



啟動 jupyter lab，在方才建立的環境中，以 Open Terminal 打開終端機

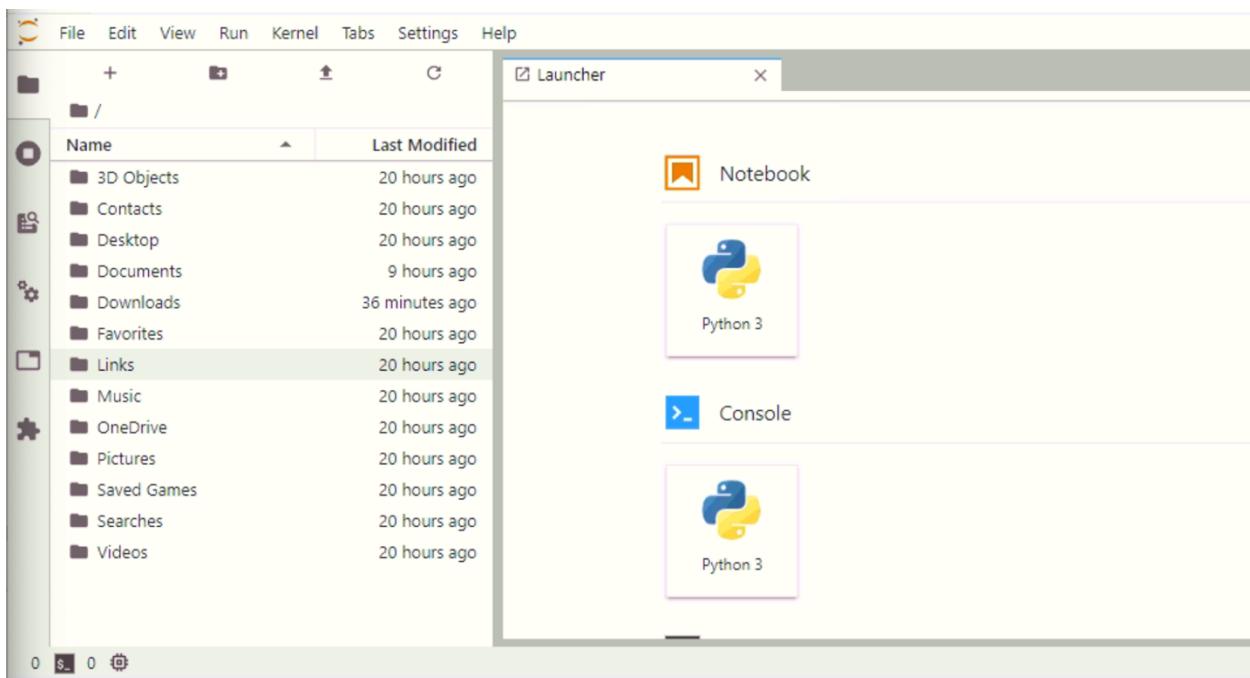


輸入 “jupyter lab” 來啟動 Jupyter Lab

```
(gputest) C:\Users\aiteacher01>jupyter lab
[1 21:30:47.117 LabApp] Writing notebook server cookie secret to C:\Users\aiteacher01\AppData\Roaming\jupyter\runtime\notebook_cookie_secret
[1 21:30:47.622 LabApp] JupyterLab extension loaded from C:\Users\aiteacher01\.conda\envs\gputest\lib\site-packages\jupyterlab
[1 21:30:47.622 LabApp] JupyterLab application directory is C:\Users\aiteacher01\.conda\envs\gputest\share\jupyter\lab
[1 21:30:47.626 LabApp] Serving notebooks from local directory: C:\Users\aiteacher01
[1 21:30:47.627 LabApp] The Jupyter Notebook is running at:
[1 21:30:47.627 LabApp] http://localhost:8888/?token=fe7e2be6cebc661cd3b9d9a6ecc5df3b29a55cb01827449
[1 21:30:47.627 LabApp] or http://127.0.0.1:8888/?token=fe7e2be6cebc661cd3b9d9a6ecc5df3b29a55cb01827449
[1 21:30:47.627 LabApp] Use Control-C to stop this server and shut down all kernels (twice to skip confirmation).
[C 21:30:47.685 LabApp]

To access the notebook, open this file in a browser:
file:///C:/Users/aiteacher01/AppData/Roaming/jupyter/runtime/nbserver-4384-open.html
Or copy and paste one of these URLs:
http://localhost:8888/?token=fe7e2be6cebc661cd3b9d9a6ecc5df3b29a55cb01827449
or http://127.0.0.1:8888/?token=fe7e2be6cebc661cd3b9d9a6ecc5df3b29a55cb01827449
[W 21:31:02.256 LabApp] Could not determine jupyterlab build status without nodejs
```

啟動完成畫面



## 7. 使用 Use a GPU 檢查 GPU

前往 <https://www.tensorflow.org/guide/gpu>

使用 Download notebook 來下載 gpu.ipynb 檔案

The screenshot shows the TensorFlow Core documentation page. On the left, there's a sidebar with links like '儲存模型', '查核點', 'SavedModel', '具體函式', 'GPU' (which is highlighted), 'TPU', and '效能'. The main content area has a breadcrumb navigation: TensorFlow > 學習 > TensorFlow Core > 指南. The title is 'Use a GPU'. Below the title are three buttons: 'Run in Google Colab', 'View source on GitHub', and 'Download notebook'. A note below says: 'TensorFlow code, and `tf.keras` models will transparently run on a single GPU with no configuration required.'

## 使用 Jupyter LAB 開啟 gpu.ipynb

The screenshot shows Jupyter LAB with a file browser on the left showing a file named 'gpu.ipynb' in the '/Downloads/' directory. The main area displays the content of the 'gpu.ipynb' notebook, which includes the Apache License 2.0 header and a section titled 'Use a GPU'. At the bottom of the notebook area, there are four buttons: 'View on TensorFlow.org', 'Run in Google Colab', 'View source on GitHub', and 'Download notebook'.

執行文件中可用 GPU 數量檢查 cell，顯示可使用的 GPU 數量為 1

## Setup

Ensure you have the latest TensorFlow gpu release installed.

```
[1]: import tensorflow as tf  
print("Num GPUs Available: ", len(tf.config.experimental.list_physical_devices('GPU')))  
Num GPUs Available: 1
```

### 8. 執行一個深度學習的任務

前往 <https://www.tensorflow.org/tutorials/keras/classification>

下載 “Basic classification: Classify images of clothing”

TensorFlow > 學習 > TensorFlow Core > 教學課程



## Basic classification: Classify images of clothing

Run in Google Colab

View source on GitHub

Download notebook

This guide trains a neural network model to classify images of clothing, like sneakers and shirts. It's okay if you don't understand all the details; this is a fast-paced overview of a complete TensorFlow program with the details explained as you go.

### 依序執行程式

執行前安裝 numpy, matplotlib,

The screenshot shows a Jupyter Notebook interface with two files listed in the sidebar: "gpu.ipynb" and "classification.ipynb". The "classification.ipynb" file is currently selected and open in the main pane. The code cell [1] contains the Apache License 2.0 header:

```
#@title Licensed under the Apache License, Version 2.0 (the "License");  
# you may not use this file except in compliance with the License.  
# You may obtain a copy of the License at  
#  
# https://www.apache.org/licenses/LICENSE-2.0  
#  
# Unless required by applicable law or agreed to in writing, software  
# distributed under the License is distributed on an "AS IS" BASIS,  
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied  
# See the License for the specific language governing permissions and  
# limitations under the License.
```

## 執行訓練任務

```
[1]: model.fit(train_images, train_labels, epochs=10)

Train on 60000 samples
Epoch 1/10
60000/60000 [=====] - 10s 165us/sample - loss: 0.4945 - accuracy: 0.8253
Epoch 2/10
60000/60000 [=====] - 7s 118us/sample - loss: 0.3758 - accuracy: 0.8648
Epoch 3/10
8224/60000 [==>.....] - ETA: 6s - loss: 0.3598 - accuracy: 0.8666

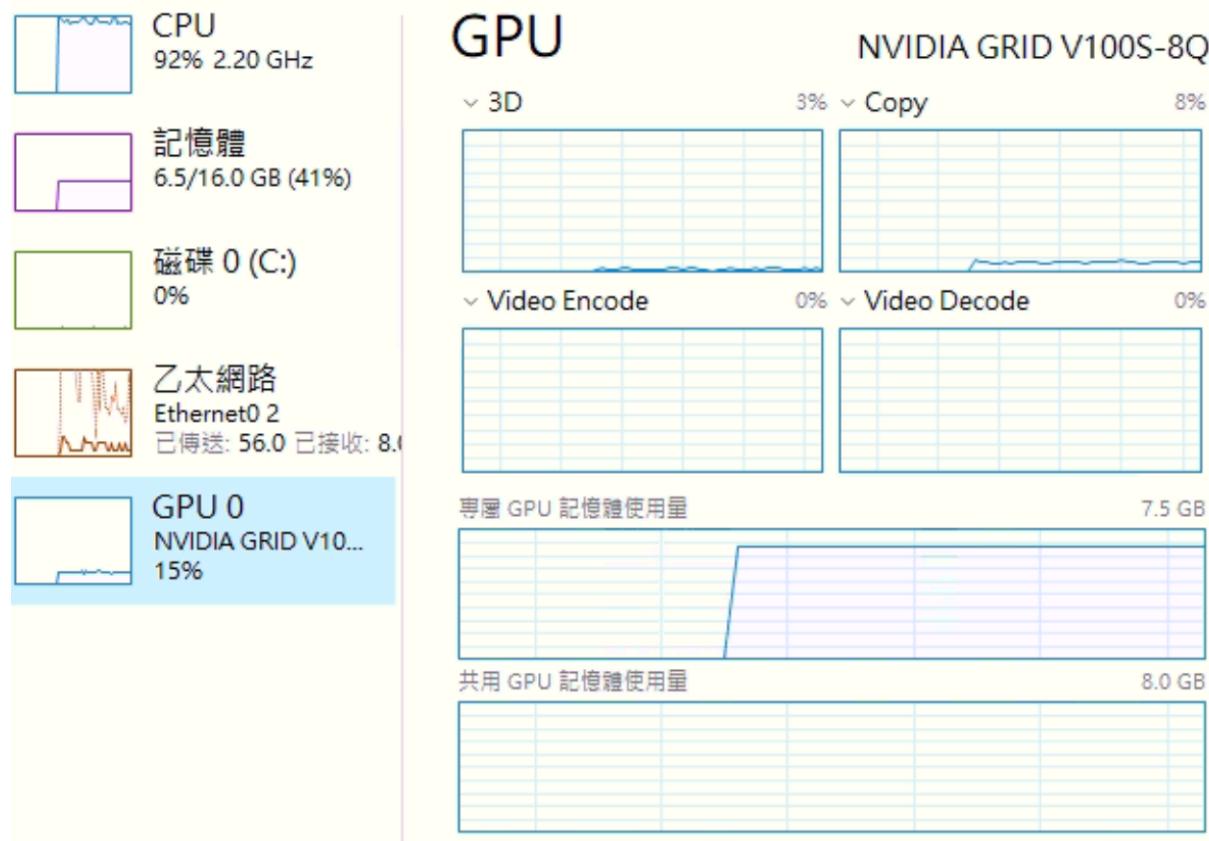
As the model trains, the loss and accuracy metrics are displayed. This model reaches an accuracy of about 0.91 (or 91%) on the training data.
```

### Evaluate accuracy

Next, compare how the model performs on the test dataset:

```
[1]: test_loss, test_acc = model.evaluate(test_images, test_labels, verbose=2)
```

使用工作管理員，觀察 GPU 使用率



## 使用 nvidia-smi 查詢 GPU 使用狀態

NVIDIA-SMI 441.66			Driver Version: 441.66		CUDA Version: 10.2	
GPU	Name	TCC/WDDM	Bus-Id	Disp.A	Volatile	Uncorr. ECC
Fan	Temp	Perf	Pwr:Usage/Cap	Memory-Usage	GPU-Util	Compute M.
0	GRID V100S-8Q	WDDM	00000000:02:02.0	On	8%	0
N/A	N/A	PO	N/A / N/A	7261MiB / 8160MiB	Default	
Processes:						
GPU	PID	Type	Process name	GPU Memory Usage		
0	1212	C+G	Insufficient Permissions		N/A	
0	1264	C+G	Insufficient Permissions		N/A	
0	1528	C+G	C:\Windows\System32\MicrosoftEdgeCP.exe		N/A	
0	1560	C+G	Insufficient Permissions		N/A	
0	1932	C+G	C:\Windows\explorer.exe		N/A	
0	2428	C+G	...6)\Google\Application\chrome.exe		N/A	
0	4112	C+G	...oftEdge_8wekyb3d8bbwe\MicrosoftEdge.exe		N/A	
0	7884	C+G	...dows.Cortana_cw5n1h2txyewy\SearchUI.exe		N/A	
0	8440	C+G	C:\Windows\System32\MicrosoftEdgeCP.exe		N/A	
0	9164	C+G	...hell.Experiences.TextInput.InputApp.exe		N/A	
0	9888	C	...aiteacher01\.conda\envs\test\python.exe		N/A	
0	10164	C+G	Insufficient Permissions		N/A	

## 9. 參考文件

- <https://docs.nvidia.com/cuda/cuda-installation-guide-microsoft-windows/index.html>
- <https://www.tensorflow.org/guide/gpu>
- <https://en.wikipedia.org/wiki/CUDA>
- <https://docs.nvidia.com/deploy/cuda-compatibility/index.html>