

2018

# 機器學習與深度學習

## Machine Learning & Deep Learning

許晉龍

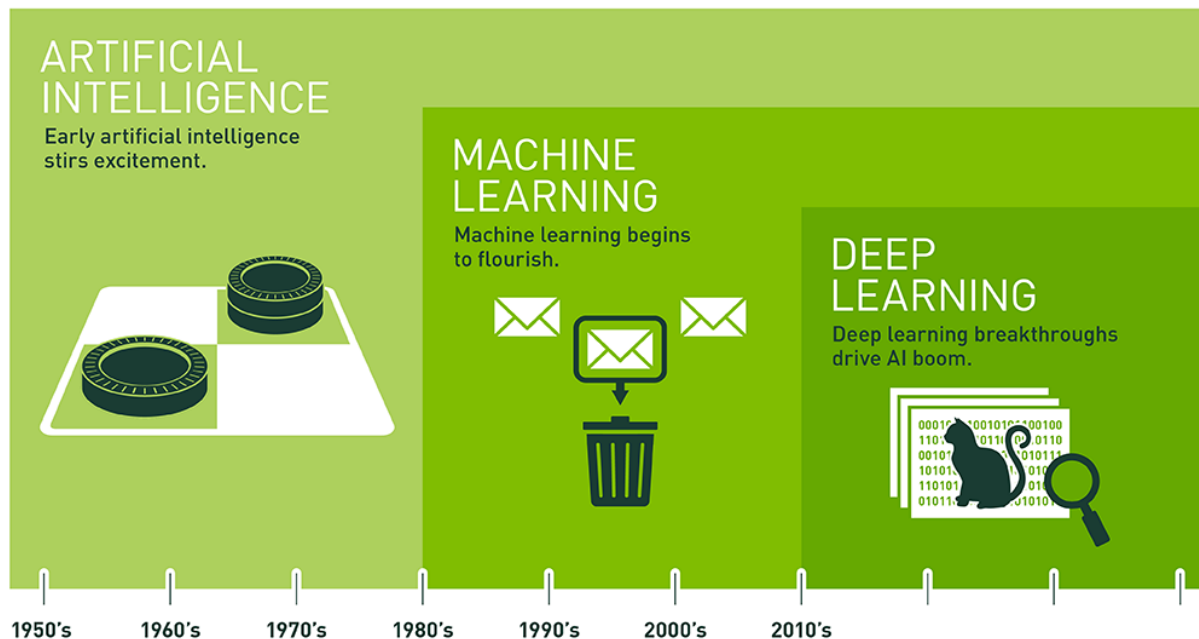
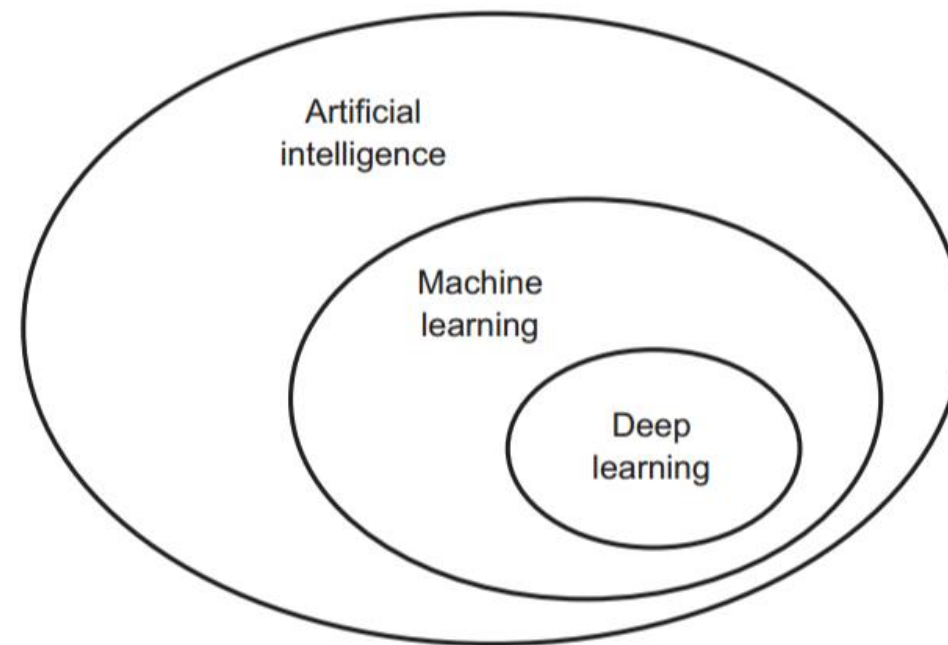
國立臺北商業大學資訊管理系

課程大綱

## 課程目的 Purpose

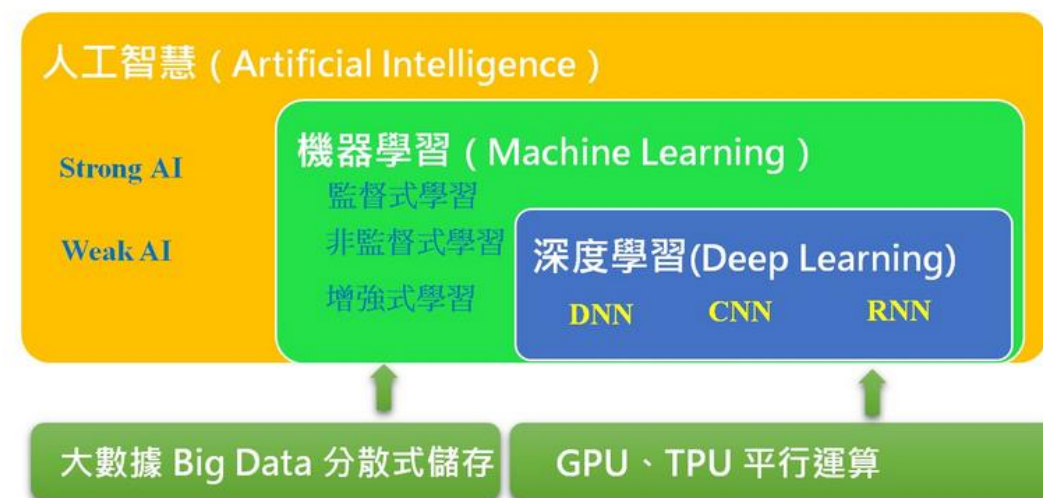
- 了解機器學習及深度學習基本概念，以python程式語言實作機器學習及深度學習，實際解決生活上或商業上問題。
- 課程強調python程式語言實作機器學習及深度學習能力養成！

# 人工智慧 機器學習 深度學習



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

<https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/>

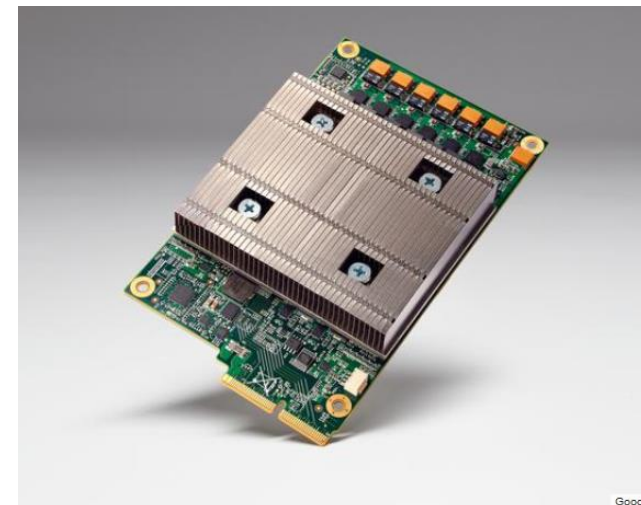


林大貴, TensorFlow+Keras深度學習人工智慧實務應用, 博碩, 2017.

# GPU, TPU, VPU



Graphics Processing Unit



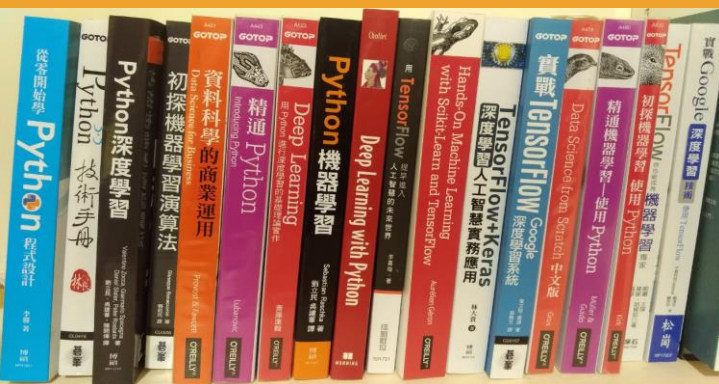
Tensor Processing Unit



Vision Processing Unit

# 課程內容

- 資料科學(Data science)
- 機器學習概論(Basic concept of machine learning)
- Python程式語言實作
- 監督式學習(Supervised learning)
- 非監督式學習(Unsupervised learning)
- 整體學習 (Ensemble learning)
- 深度學習(Deep learning)





概論

Concept

- 資料科學(Data science)
- 機器學習概論(Basic concept of machine learning)



B

# Python 程式語言實作



B1

-  01Python 資料型態與基本運算.ipynb
-  02Python 字串處理.ipynb
-  03Python 資料結構.ipynb
-  04Python 程式結構.ipynb
-  05Pandas基本處理.ipynb
-  06Numpy 矩陣.ipynb
-  07資料清理與轉換.ipynb
-  08Matplotlib 視覺化繪圖.ipynb
-  09資料聚合.ipynb
-  10樞紐分析.ipynb



B2

綜合練習  
PM2.5分析

C

# 監督式學習 Supervised learning

C1

- 迴歸 (Regression)
- 機器學習流程

C6

- 單純貝式分析  
(Naïve Bayes Classifier)

C2

- 邏輯迴歸(Logistic Regression)
- 分類模型的評估

C3

- K最近鄰(K Nearest Neighbor, KNN)

C4

- 支持向量機(Support Vector Machine, SVM)

C5

- 決策樹(Decision Tree)



D

# 非監督式學習 Unsupervised learning

D<sub>1</sub>

- 集群分析(Cluster analysis)
  - K-means, K-means++

D<sub>2</sub>

- 購物藍分析(Market Basket Analysis)
  - Apriori algorithm

D<sub>3</sub>

- 主成分分析 (Principal Components Analysis, PCA)
  - PCA, Kernel PCA



# 整體學習 Ensemble Learning

整合多種機器  
學習演算法

- 投票法 (Voting)
- 裝袋法 (Bagging)
- 隨機森林 (Random Forest)
- 自適應增強(Adaboost)
- StackingClassifier
- XGBoost (Kaggle機器學習競賽神器)



F

# 深度學習 Deep learning

F1

- 人工神經網路 ( Artificial Neural Networks, ANN )

F2

- 卷積神經網路 ( Convolutional Neural Networks, CNN )

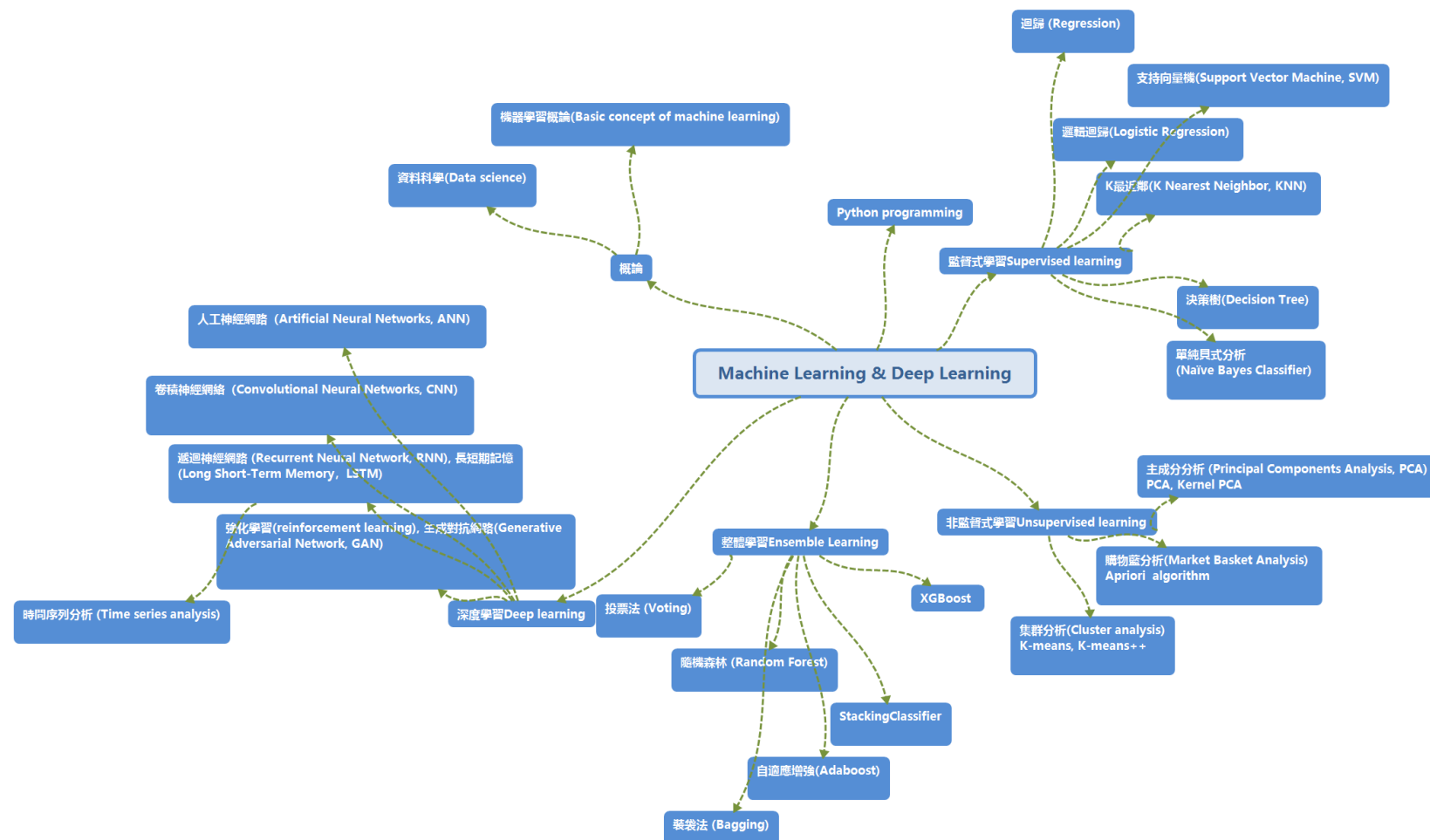
F3

- 遞迴神經網路 (Recurrent Neural Network, RNN), 長短期記憶 (Long Short-Term Memory , LSTM)
  - 時間序列分析 (Time series analysis)

F4

- 強化學習(reinforcement learning), 生成對抗網路(Generative Adversarial Network, GAN)

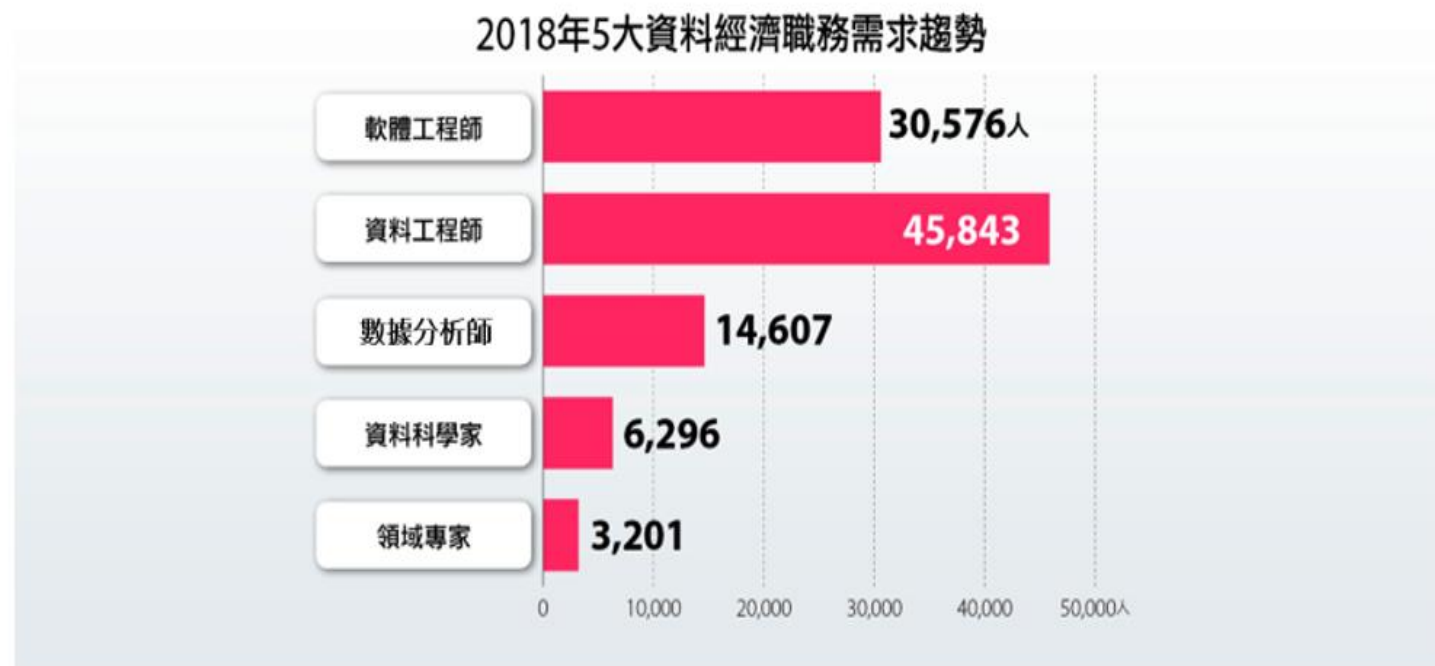
# 學習心智圖



# Why learn python

## 為什麼要學習Python?

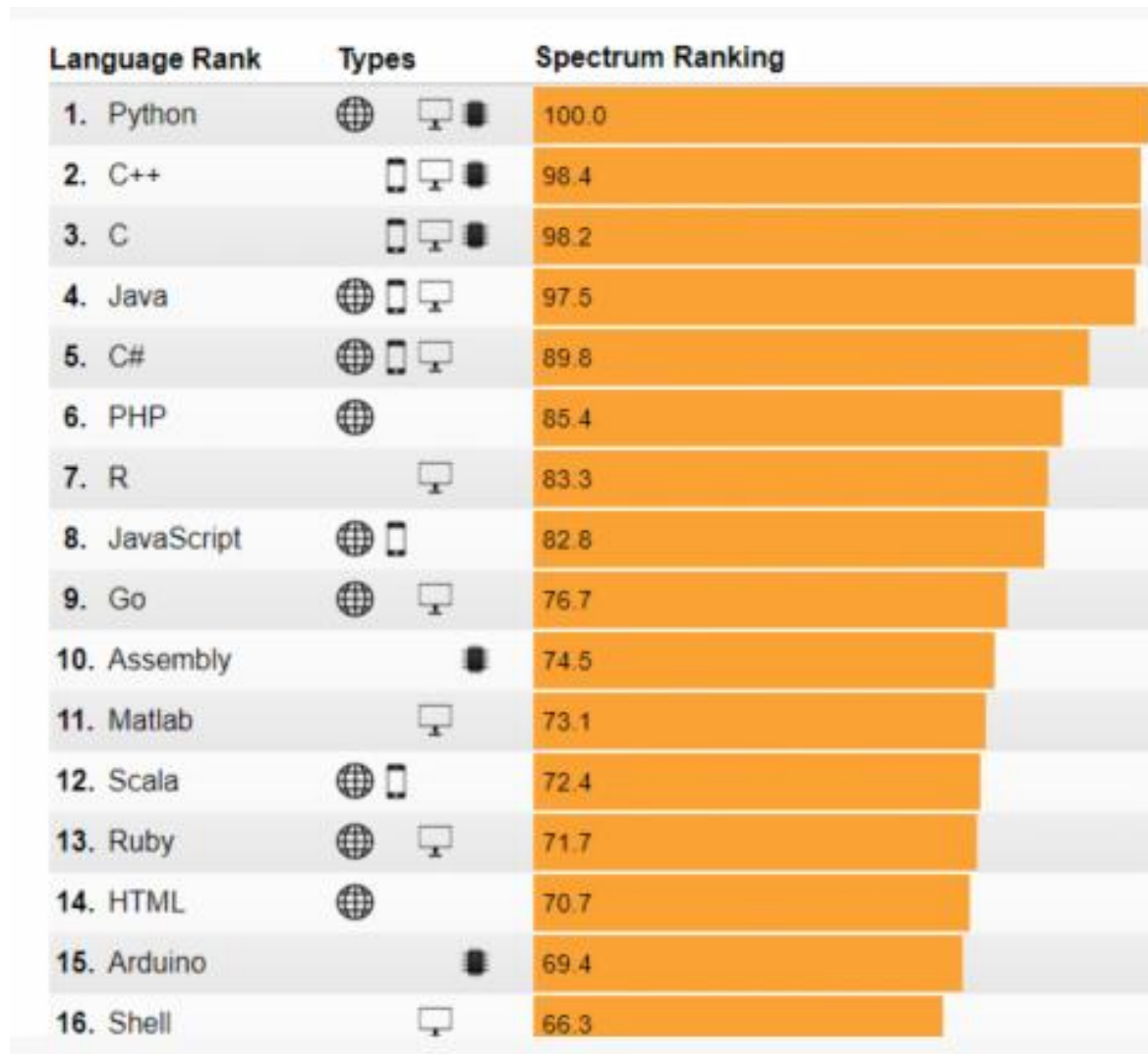
《哈佛商業評論》說「Data Scientist，數據科學家」是二十一世紀最性感的職業。根據104人力銀行預測2018年，前五大資料經濟職務需求，其中就有三個是資料分析相關職務，包括資料工程師、數據分析師與資料科學家。其求職者需要具備資料處理(ETL)工具開發經驗、熟悉R語言、Python、SQL、建置Hadoop或Spark平台經驗等等。



圖片資料來源：104人力銀行

<https://www.tibame.com/offline/python>

# IEEE Spectrum發布 程式語言排名： Python持續強 勢、R語言逐 漸消退



<https://www.ithome.com.tw/news/125008>

# 2018 AI元年！ 人才缺口3年 翻倍

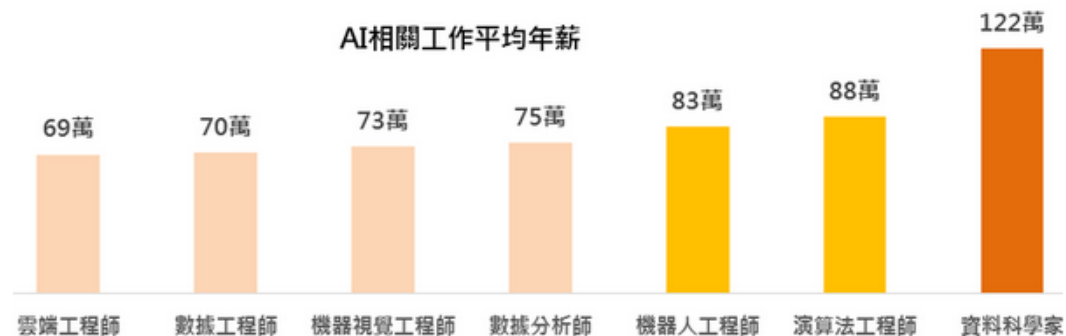


> 整體  
全職工作數  
3年增幅 31.4%

資料來源：104人力銀行

專業門檻高 薪資行情看俏

104突破傳統分類及年資限制，分析資料庫中，共1,575筆求職會員履歷填寫的AI相關工作經歷，發現AI相關工作平均年薪TOP 3依序是：資料科學家122萬、演算法工程師88萬、機器人工程師83萬。



註：此為104資料庫，工作者履歷表自填薪資（年薪包括獎金）；資料擷取時間為1/31

資料來源：104人力銀行

# 資料科學家

## 2017全美最棒的工作

排名	職務名稱	年薪中位數 (美元)
1	Data Scientist 資料科學家	\$ 110,000
2	DevOps Engineer 軟體開發測試維運工程師	\$ 110,000
3	Data Engineer 資料工程師	\$ 106,000
4	Tax Manager 稅務管理師	\$ 110,000
5	Analytics Manager 分析師	\$ 112,000
6	HR Manager 人力資源管理師	\$ 85,000
7	Database Administrator 資料庫管理員	\$ 93,000
8	Strategy Manager 策略管理師	\$ 130,000
9	UX Designer 使用者體驗設計師	\$ 92,500
10	Solutions Architect 解決方案架構師	\$ 125,000

<https://life.tw/?app=view&no=731066>

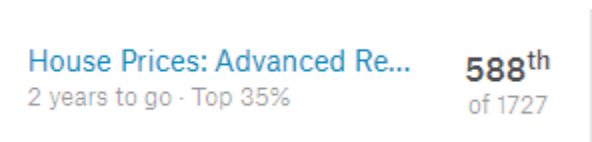
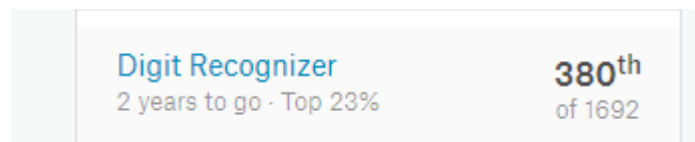


# 評分

- 期中考 – 30% (選擇題20題)
- 期末報告 – 60% (二選一): [期中考後繳交名單](#)
  - Python程式實作機器學習或深度學習 (不分組, 每位修課同學均要繳交期末報告, 程式碼及資料集於github)
    - 題目可自選
  - 直接參與Kaggle競賽 (題目可於kaggle上自選, 或使用指定題, 仍要繳交期末報告, 程式碼及資料集於github) (可組團, 1~3人)
- 課堂表現 – 10%

Top	0 – 20%	21 – 30%	31 – 40%	41 – 50%	51% - 60%	61 – 70%	71% -
成績	100	95	90	80	70	60	0

因kaggle上的成績會變動, 請上傳成績最好的top%截圖



期末報告  
60%

資料集下載

- Kaggle
  - <https://www.kaggle.com/>
- 政府開放資料平台
  - <http://data.gov.tw/>
- 美國開放資料平台
  - <https://www.data.gov/>
- 加州大學爾灣分校機器學習資料
  - <http://archive.ics.uci.edu/ml/>
- Stanford Large Network Dataset Collection
  - <https://snap.stanford.edu/data/>
- Google Dataset Search
  - <https://toolbox.google.com/datasetsearch>

Google Dataset Search 測試版

搜尋資料集



試用 [boston education data](#) 或 [weather site: noaa.gov](#)

# 期末報告 60%

## 期末報告 格式

- 摘要
  - 介紹 (研究背景及研究目的)
  - 資料集介紹(含資料特徵)及資料集來源
  - 資料預處理
  - 機器學習或深度學習方法 (使用何種方法)
  - 研究結果及討論 (含模型評估與改善)
  - 結論
  - 參考文獻
- 
- **研究報告**請以pdf格式上傳至github, 並同時上傳**程式碼**及**資料集**



期末報告  
60%  
期末報告  
格式範例

# Sample

Stanford  
SCHOOL OF EARTH, ENERGY  
& ENVIRONMENTAL SCIENCES

## Earthquake warning system: Detecting earthquake precursor signals using deep neural networks

Mustafa Al Ibrahim, Jihoon Park, and Noah Athens  
{malibrah, jhpark3, natheens}@stanford.edu

### ABSTRACT

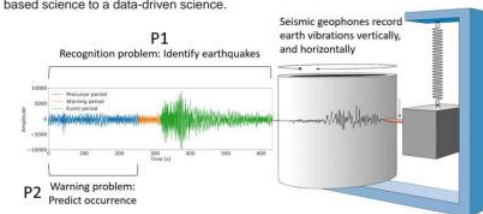
Earthquake prediction is one of the great unsolved problems in the earth sciences. In recent years, the number of seismic monitoring stations has increased, thereby enabling deep learning and other data-driven methods to be applied to this problem. In this study, we test the performance of 1D CNN, 2D CNN, and RNN neural networks on predicting an imminent earthquake given 100 seconds of seismic data. Preliminary results show that RNN with class weighting is preferred. We also show the performance of these methods on earthquake recognition, a simpler problem with applications to data mining earthquake statistics.

### INTRODUCTION

"Journalists and the general public rush to any suggestion of earthquake prediction like hogs toward a full trough... [Prediction] provides a happy hunting ground for amateurs, cranks, and outright publicity-seeking fakers."

Charles Richter, 1977

Earthquake seismology is a major topic relevant to understanding hazards due to natural and induced earthquakes as well as understanding physical properties of the earth's crust. In the past decade, the number of seismic monitoring stations has increased dramatically, leading the field of research to transition from an observation-based science to a data-driven science.



Two binary classification problems addressed:

(P1) Given a seismic waveform, **has** an earthquake occurred?

The earthquake recognition problem is useful for data mining massive volumes of seismic data in which smaller magnitude earthquakes may not have been previously detected. State of the art performance is high, ~87% accuracy is achievable [1].

(P2) Given a seismic waveform, **will** an earthquake occur?

The earthquake warning problem is important for developing a warning system that can alert people to an imminent earthquake. Although long-studied in the field of seismology, there is no proven analytical method to predict earthquakes before they occur [2].

### STUDY AREA

The Geysers study area:

- The area is seismically active.
- 46 seismometer stations.
- Single channel (vertical).
- Decades of monitoring data.
- An enhanced geothermal system program (EGS) began in 2009 and seismic data was recorded before and after water injection to study induced seismicity.

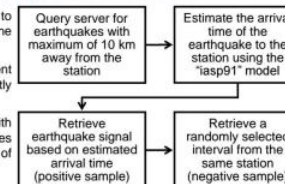


### DATASET AND FEATURES

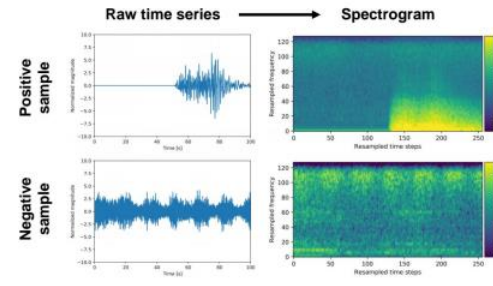
We used the Obspy library [3] to assemble the dataset through the procedure outlined.

We experimented with different datasets, determining that tightly clustered stations is preferred.

Three datasets are assembled with 1671, 614, and 176 earthquakes using a minimum magnitude (M) of 3, 3.5, and 4 respectively.

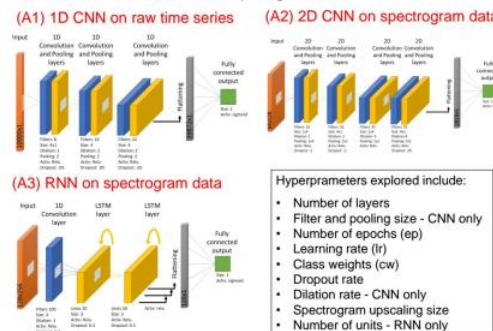


Spectrogram (a representation of energy of the signal at different frequencies) is calculated and used as an input for the 2D CNN and the RNN network architectures.



### DEEP LEARNING APPROACH

Multiple neural network architecture were tested starting with a simple 1D CNN on the raw time series data to an RNN on the spectrogram data.



Hyperparameters explored include:

- Number of layers
- Filter and pooling size - CNN only
- Number of epochs (ep)
- Learning rate (lr)
- Class weights (cw)
- Dropout rate
- Dilation rate - CNN only
- Spectrogram upscaling size
- Number of units - RNN only

### RESULTS & DISCUSSION

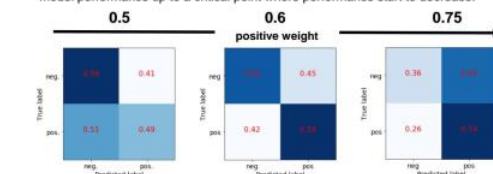
(P1) Earthquake recognition:

Model	Parameters	Training Accuracy	Test Accuracy
1D CNN	M = 3.5, lr = 0.001, ep = 10	97.5%	94.4%
2D CNN	M = 3.5, lr = 0.001, ep = 10	100%	100%
RNN	M = 3.5, lr = 0.001, ep = 50	100%	100%

(P2) Earthquake prediction:

Model	Parameters	Training Accuracy	Test Accuracy
1D CNN	M = 3, lr = 0.002, ep = 40	56.0%	54.2%
2D CNN	M = 3, lr = 0.001, ep = 12	60.0%	52.6%
	M = 3, lr = 0.001, ep = 100, cw = [0.5, 0.5]	82.5%	54.5%
RNN	M = 3, lr = 0.001, ep = 100, cw = [0.4, 0.6]	83.8%	56.4%
	M = 3, lr = 0.001, ep = 100, cw = [0.25, 0.75]	74.7%	53.9%

- Our results demonstrate high performance on the earthquake recognition problem (P1) but low performance on the prediction problem (P2).
- 2D CNN and RNN models both performed better than the 1D CNN model. This is expected as the spectrogram is a more convenient representation of the data and information contained in the signal.
- Preliminary results suggest that slightly penalizing false positives might improve model performance up to a critical point where performance start to decrease.



### CONCLUSIONS

- All of the presented neural network models achieved high performance on the earthquake recognition problem (P1).
- Predicting earthquakes before they occur (P2) is still a challenging problem. Based on the current analysis, some seismic precursor signal may exist.

### FUTURE WORK

- Experiment with cleaner and bigger datasets.
- Study the neural layers that activate for the true positive cases in the prediction problem (P2).
- Explore the relationship between warning time and prediction accuracy.

### REFERENCES

- Yoon, C.E., O'Reilly, O., Bergen, K.J., and Berzosa, G.C., 2015, Earthquake detection through computationally efficient similarity search: Science Advances, 13 p.
- Geller, R.J., Jackson, D.D., Kagan, Y.Y., and Mulargia, F., 1997, Earthquakes cannot be predicted: Science, vol. 275, 1 p.
- Krischer, L., Megies, T., Barsch, R., Beyreuther, M., Lecocq, T., Caudron, C., Wassermann, J., 2015, ObsPy: a bridge for seismology into the scientific Python ecosystem: Computational Science & Discovery.



期末報告  
60%

期末報告  
格式範例

## Sample



# LeafNet: A Deep Learning Solution to Tree Species Identification

Elena Galbally, Krishna Rao, and Zoe Pacalin  
CS230 Deep Learning, Stanford University

### Abstract

Species identification of vegetation is a key step in plant biodiversity research and conservation biology. Speeding up this process can boost humanity's ability to mitigate climate change impacts by simplifying species conservation efforts and helping educate the public. In this study we used a Residual Network to classify 185 tree species from North America using leaf images.

### Dataset and Features

LeafSnap dataset:

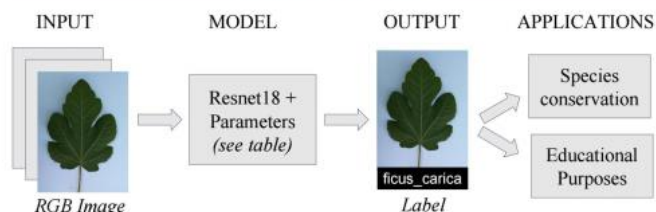
- 224x224 RGB images
- 185 species
- 23,147 lab images (top)
- 7719 phone images (bottom)

Modifications:

- Geolocation labelling: assign random coordinate pair within the growing region of a species.
- Data augmentation through rotations



### Model and Results



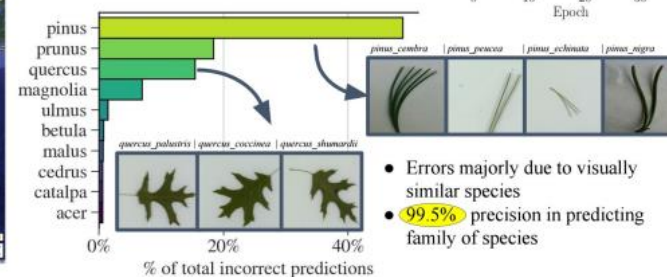
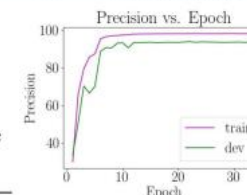
Model	Opt.	Input Size	Epochs	Precision (%)	Comments
Logistic Reg.	SGD	224	35	10.4	Baseline
ResNet18	SGD	16	35	60.5	Low resolution image
ResNet18	SGD	224	35	86.7	Full resolution image
ResNet18	Adam	224	35	41.1	Adam optimizer
<b>ResNet18</b>	<b>SGD</b>	<b>224</b>	<b>35</b>	<b>93.8%</b>	<b>Data augmentation</b>
ResNet50	SGD	224	78	85.4	Loss not yet stabilized

Performance Criteria

- Optimizing metric: maximize top-1 precision
- Satisficing metric: model < 100 Mb

System performance:

- Beats the highest performing system on the LeafSnap dataset by 7.5%



### Conclusions

The results of our ResNet model show deep learning offers a high precision and throughput solution for leaf species classification.

Compared to state-of-art methods our system:

- Has the best precision
- Uses a relatively small number of layers
- Requires less epochs to converge

Novelties of the approach:

- Deployed on a phone app
- Geolocation input feature
- SGD optimizer w/ Nesterov momentum
- Fewer layers

### Try it now!

- Open Hangouts with [leafnetstanford@gmail.com](mailto:leafnetstanford@gmail.com)
- Say "Hi bot" and start using!

server-side app gives **lightning fast** predictions and near real-time performance improvement



active internet connection required



**Acknowledgements:** CS230 teaching staff, leafsnap.com, Dr. Joseph Berry, Dr. Leander Anderegg

# Kaggle競賽

- 三選一
- 波士頓房價預測
  - <https://www.kaggle.com/c/house-prices-advanced-regression-techniques>
- 鐵達尼號生存預測
  - <https://www.kaggle.com/c/titanic>
- 自選Competition on Kaggle

# Kaggle

企業



Kaggle是一個數據建模和數據分析競賽平台。企業和研究者可在其上發布數據，統計學者和數據挖掘專家可在其上進行競賽以產生最好的模型。這一眾包模式依賴於這一事實，即有眾多策略可以用於解決幾乎所有預測建模的問題，而研究者不可能在一開始就了解什麼方法對於特定問題是最為有效的。[維基百科](#)

**創辦人：**安東尼·戈德布盧姆

**創立於：**2010 年 4 月

**執行長：**安東尼·戈德布盧姆 (2010 年 4 月-)

**總部：**美國加利福尼亞州舊金山

**上級機構：**[Google](#)

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Manually create an account:

chinlung@ntub.edu.tw

.....

Sign Up

# Kaggle

The screenshot shows the Kaggle website interface for the 'Digit Recognizer' competition. At the top is a dark navigation bar with the Kaggle logo, a search bar, and links to Competitions, Datasets, Kernels, Discussion, and Learn. Below this, the competition header features a grid of handwritten digits, the title 'Digit Recognizer', a description 'Learn computer vision fundamentals with the famous MNIST data', and the status '2,740 teams · Ongoing'. A horizontal menu contains tabs for Overview, Data (which is active), Kernels, Discussion, Leaderboard, Rules, and Team. On the right of this menu are links for 'My Submissions' and a prominent blue 'Submit Predictions' button. The 'Competition Data' section lists three files: 'sample\_submission.csv', 'test.csv', and 'train.csv' (which is selected). The 'train.csv' file is shown with a size of 73.22 MB and a 'Download' button. At the bottom, a terminal window displays the command 'kaggle competitions download -c digit-recognizer'.

kaggle Search kaggle Competitions Datasets Kernels Discussion Learn

**Digit Recognizer**  
Learn computer vision fundamentals with the famous MNIST data  
2,740 teams · Ongoing

Overview **Data** Kernels Discussion Leaderboard Rules Team My Submissions **Submit Predictions**

Competition Data

sample_submission.csv	<b>train.csv</b> 73.22 MB <a href="#">Download</a>
test.csv	
<b>train.csv</b>	

```
> kaggle competitions download -c digit-recognizer
```



# Kaggle

jupyter CNN for MNIST-kaggle Last Checkpoint: 32分鐘前 (autosaved)

File Edit View Insert Cell Kernel Help Trusted Python 3

Save Add Open Recent Up Down Run Restart Previous Next Markdown Help

資料匯入與預處理

In [1]:

```
import numpy as np
from keras.datasets import mnist

from keras.utils import np_utils
from keras.models import Sequential
from keras.layers import Dense, Activation, Conv2D, MaxPooling2D, Dropout, Flatten

Using TensorFlow backend.
```

In [2]:

```
import pandas as pd
train = pd.read_csv('train.csv')
test = pd.read_csv('test.csv')
```

In [3]:

```
X_train = (train.ix[:,1:].values).astype('float32') # all pixel values
y_train = train.ix[:,0].values.astype('int32') # only labels i.e targets digits
X_test = test.values.astype('float32')
```

C:\Users\alung\Anaconda3\envs\gpu\lib\site-packages\ipykernel\_launcher.py:1: DeprecationWarning: .ix is deprecated. Please use .loc for label based indexing or .iloc for positional indexing

本機 > Windows (C:) > Users > alung > 2018課程資料 > F\_深度學習 > (F2)卷积神经网络CNN > Minist\_On\_Kaggle

.ipynb\_checkpoints

CNN for MNIST-kaggle.ipynb

DR

sample\_submission

test

train

In [29]:

```
predictions = model.predict_classes(X_test, verbose=0)

submissions=pd.DataFrame({"ImageId": list(range(1,len(predictions)+1)),
                          "Label": predictions})
submissions.to_csv("DR.csv", index=False, header=True)
```

# Kaggle

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Name	Submitted	Wait time	Execution time	Score
DR.csv	9 months ago	0 seconds	0 seconds	0.99100

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Make a submission for [alung](#)

You have 5 submissions remaining today. This resets a day from now (00: 00 UTC).

Step 1

Upload submission file

Upload Submission File

# Kaggle

You have 5 submissions remaining today. This resets a day from now (00:00 UTC).

Step 1  
Upload submission file



test.csv (48.75 MB)    Uploading    20%    38.91 MB left

File Format  
Your submission should be in CSV format. You can upload this in a zip/gz/rar/7z archive, if you prefer.

Number of Predictions  
We expect the solution file to have 28000 prediction rows. This file should have a header row. Please see sample submission file on the [data page](#).

Make a submission for **alung**

You have 5 submissions remaining today. This resets a day from now (00:00 UTC).

Step 1  
Upload submission file



test.csv (48.75 MB)    Complete    100%    48.75 MB

File Format  
Your submission should be in CSV format. You can upload this in a zip/gz/rar/7z archive, if you prefer.

Number of Predictions  
We expect the solution file to have 28000 prediction rows. This file should have a header row. Please see sample submission file on the [data page](#).

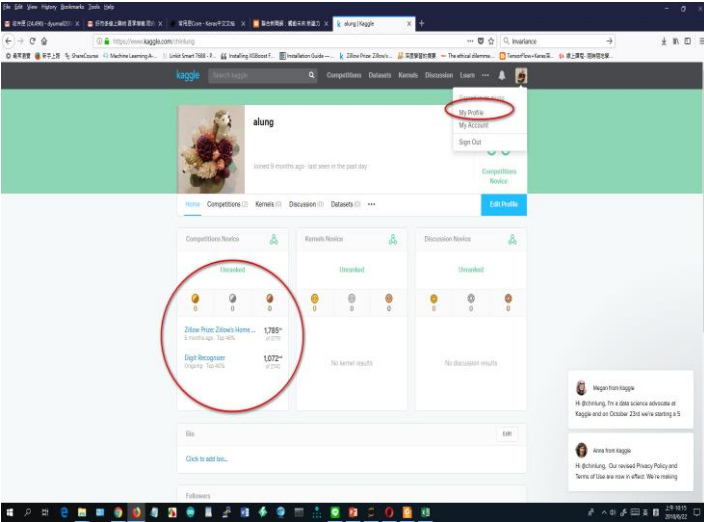
Step 2  
Describe submission

B / I / ... Styling with Markdown supported

Briefly describe your submission.

Make Submission

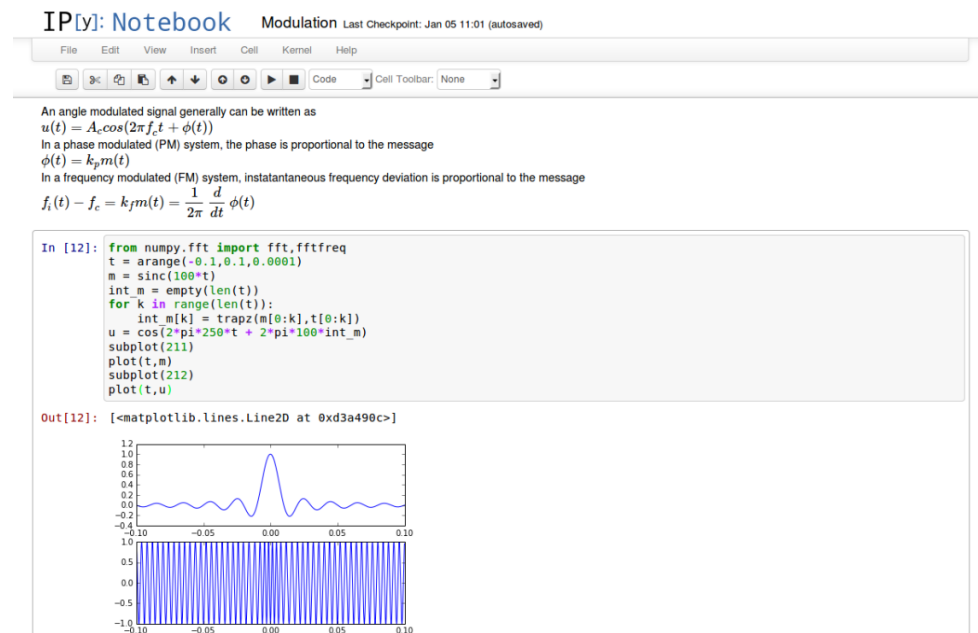
1059	▼ 91	Kristian Møller Schmidt		0.98942	4	1mo
1060	▼ 91	Rajat Bhatt		0.98942	1	1mo
1061	▼ 91	larry141186		0.98942	2	1mo
1062	▼ 91	yufeng1995		0.98942	13	24d
1063	▼ 91	Megaciel		0.98942	17	1mo
1064	▼ 91	younmin		0.98942	1	18d
1065	▼ 91	ploes753		0.98942	1	18d
1066	▼ 91	Shijie Sun		0.98942	1	18d
1067	▼ 91	qinghuaxiaohao		0.98942	5	12d
1068	▼ 91	czt2016011370		0.98942	3	12d
1069	▼ 91	Jeffrey Rhoads		0.98942	3	10d
1070	new	Rohit Mazumder		0.98942	2	3d
1071	new	onadelot		0.98942	1	1d
1072	new	alung		0.98942	1	-10s
Your Best Entry ↗ Your submission scored 0.98942, which is not an improvement of your best score. Keep trying!						
1073	▼ 94	Rundong		0.98928	1	1mo
1074	▼ 94	harman_		0.98928	3	1mo



# 上課平台

課程將以windows 10為教學作業系統

使用Anaconda 之 Jupyter Notebook實作機器學習與深度學習



<https://en.wikipedia.org/wiki/IPython>

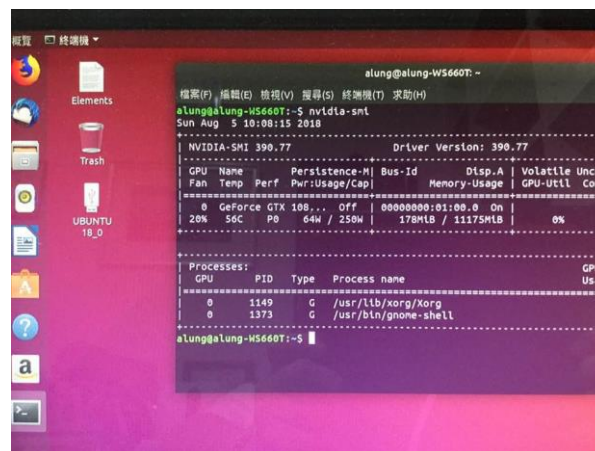
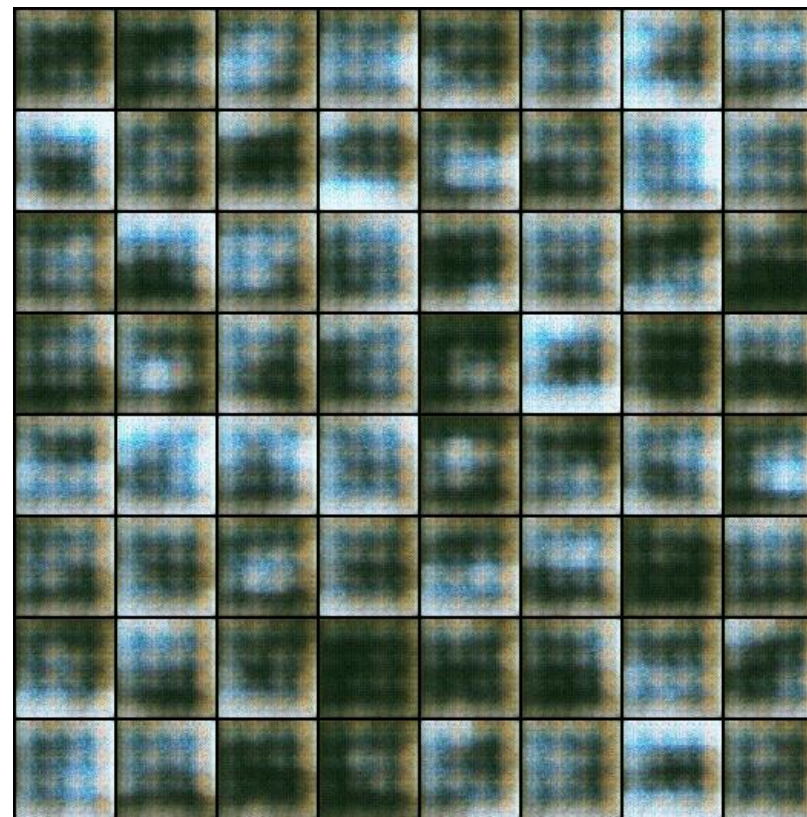
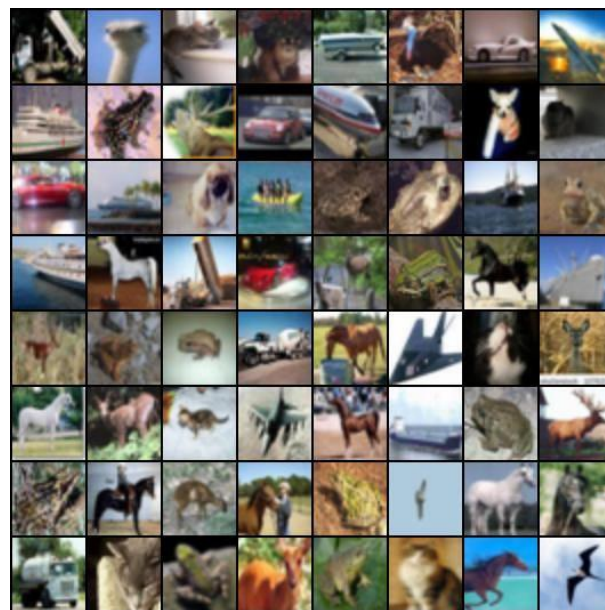
# GAN

CPU on windows 10 : about 8 hours +  
GPU on windows 10: about 21 mins  
GPU on Ubuntu 18.04: about 14 mins

結論: 安裝GPU on linux is a good choice for deep learning.  
測試環境

主機 : WS660T  
中央處理器 : Intel Xeon E3-1245V6  
記憶體 : 32GB DDR4 2400 ECC UDIMM  
顯示卡 : Turbo GTX 1080 Ti ( 3584 CUDA Core , 11GB GDDR5X )  
硬碟 : 512GB M.2 2280 SATA3 SSD

生成式對抗網路(GAN),第一張是真圖, 第二張的生成的假圖



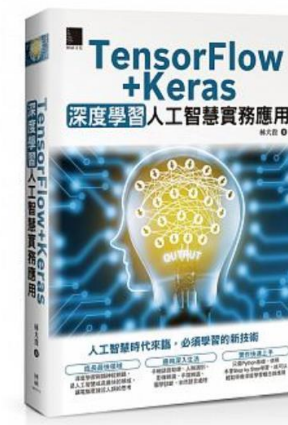
# 提醒

- 課程講義投影片, python程式碼與數據集皆以RAR壓縮檔上傳至系上ftp server, 需以密碼開啟 (密碼於課堂上公告)
  - 課程講義投影片-.pdf
  - 程式碼 -.ipynb
  - 數據集 -.csv
    - 部分數據集需由網路上下載, 若有亂碼產生, 可google查詢轉換方法.

- 善用google找資源 (教學影片, 網站, fb社團: 台灣「人工智慧」社團)



- scikit-learn Machine Learning in Python (推薦)
  - <http://scikit-learn.org/stable/index.html>
- TensorFlow+Keras深度學習人工智慧實務應用 (推薦)
  - <https://www.books.com.tw/products/0010754327>





# 提醒

請同學攜帶 u s b 隨身碟儲存講義投影片, 程式碼與數據集

勿將課程所使用之講義投影片, 程式碼與數據集儲存在學校公共電腦內。

# 提醒

- 本講義所使用之圖片, 表格, 文字, 內容, 書籍資料, 引用統計資料與程式碼及數據集資料等, 除自製外, 其智慧財產權為原網站, 作者, 公司所擁有。
- 講義投影片, 程式碼與數據集僅供教學使用, 請同學勿將課程所使用之講義投影片, 程式碼與數據集放在網路上供人下載及分享, 也請勿做商業用途。



# Movie Time

- <https://www.youtube.com/watch?v=h2jSSAObA8s&t=7s>
- 1:30 -