信邦電子 AI 就業學分學程

業師課程： Topic 4 – 電腦視覺與衍生應用

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少量多樣 – 少量數據集怎麼應用？

- Data Augmentation 資料擴增、SMOTE (Synthetic Minority Oversampling Technique)
- Few-shot learning
- GAN 對抗生成網絡 (Generative Adversarial Network)
- Transfer-Learning 轉移學習
- Meta-Learning 元學習
- Regularization techniques 正則化
- Loss Function 損失函數

Ref: https://medium.com/quick-code/understanding-few-shot-learning-in-machine-learning-bede251a0f67

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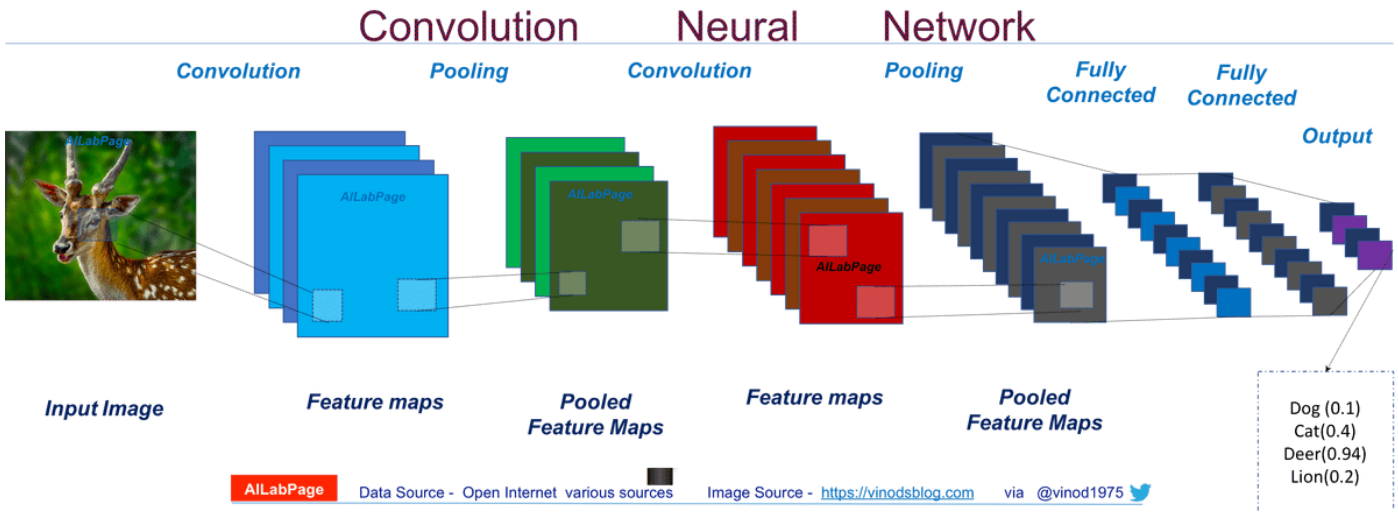
現代卷積神經網路



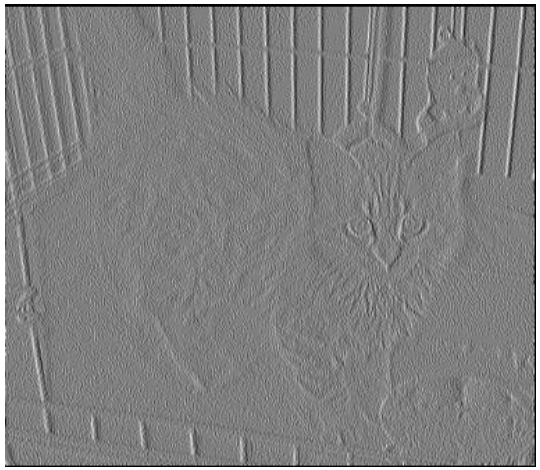
- 卷積層
- 池化層 (Pooling Layer)
- 批量標準化層 (Batch Normalization)
- 全連接層 (fully connected layer)
- Dropout

卷積矩陣

- 傳統圖像處理用途：圖像資訊擷取

X

1	0	-1
1	0	-1
1	0	-1



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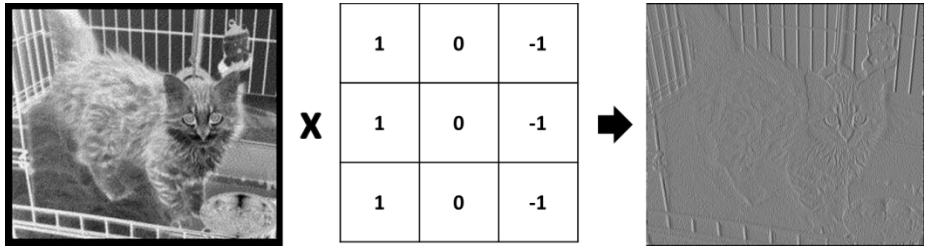
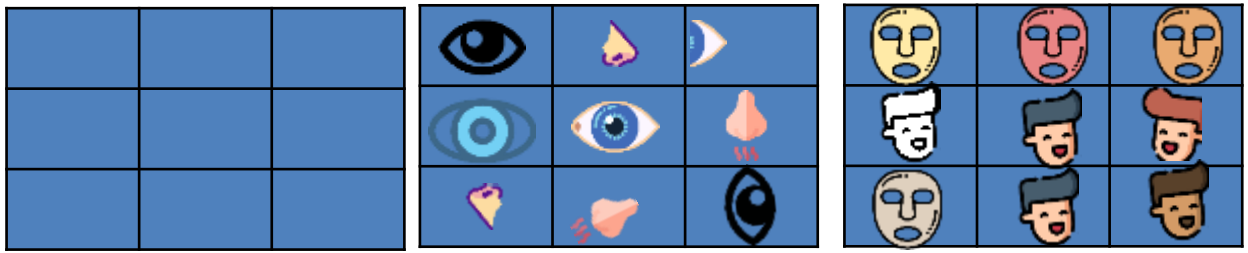
卷積神經網路

- AI 學習，自主抓取需要的資訊



以人臉辨識為例



邊緣偵測　找到五官　偵測不同的人臉

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卷積矩陣 – 邊緣偵測實作

https://colab.research.google.com/github/chenkenanalytic/ai_tutorial_class/blob/main/lesson%204/Convolution_Edge_Detection.ipynb

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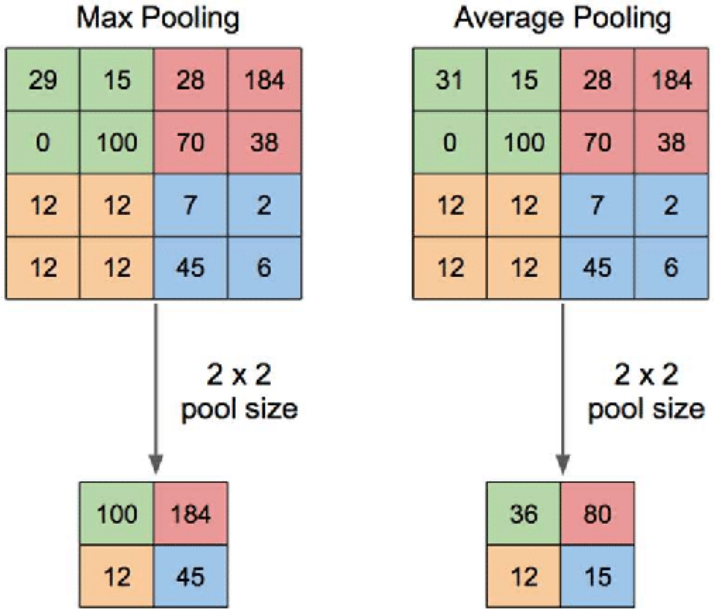
池化層 (Pooling Layer)



Src: https://www.researchgate.net/figure/Illustration-of-Max-Pooling-and-Average-Pooling-Figure-2-above-shows-an-example-of-max_fig2_333593451

優點

- 提取重要的特徵 (顯著的特徵)
- 減少傳遞不必要的資訊 (減少變數)

缺點

- 太快縮減數據大小 (造成資訊遺失)

※ *Future: Capsule Networks 膠囊網路*
https://arxiv.org/pdf/1710.09829.pdf

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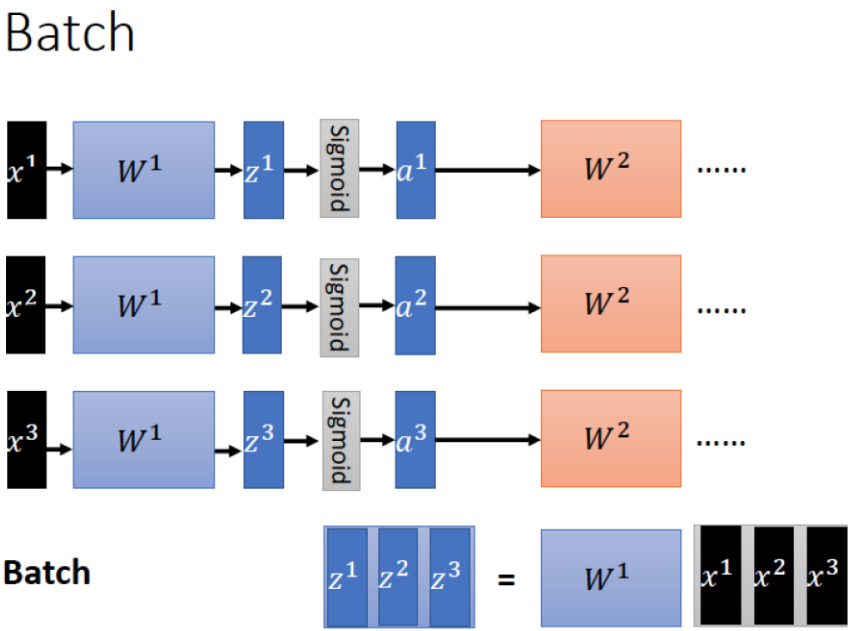
批量標準化層 (Batch Normalization)



- 批次訓練時，資料集分布不同
  - 卷積神經網路訓練時，
    梯度大小不同 → 學習率不同
    (學習困難)
- 透過批次資料集做標準化
  - 方便神經網絡學習 (提升成效 & 效率)
- 衍伸議題：梯度消失

Ref1: https://keras.io/api/layers/normalization_layers/batch_normalization/
Ref2: https://violin-tao.blogspot.com/2018/02/ml-batch-normalization.html

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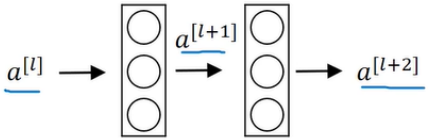
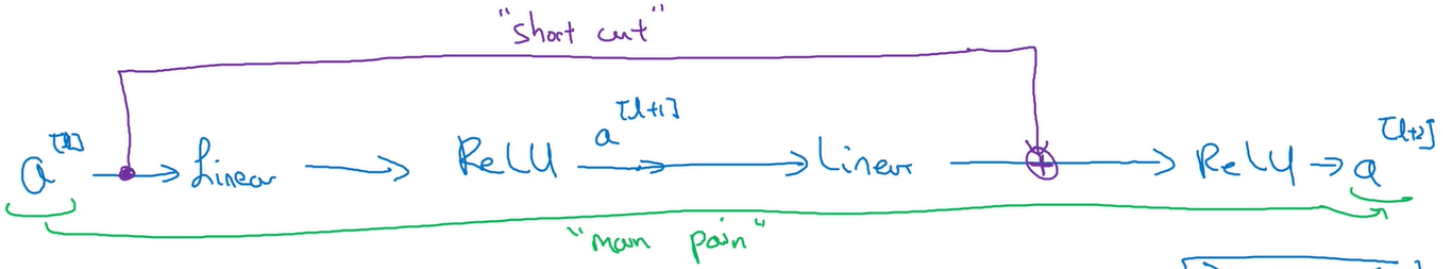
Residual Neural Network (ResNet)

Residual block



※ 學習殘差
→ 能建置更深層的網絡



$$z^{[l+1]} = W^{[l+1]}\, a^{[l]} + b^{[l+1]} \qquad a^{[l+1]} = g(z^{[l+1]}) \qquad z^{[l+2]} = W^{[l+2]} a^{[l+1]} + b^{[l+2]} \qquad a^{[l+2]} = g(z^{[l+2]})$$

$$a^{[l+2]} = g\left(z^{[l+2]} + a^{[l]}\right)$$

Ref1: https://www.youtube.com/watch?v=ZILIbUvp5lk
Ref2: https://www.itread01.com/content/1544868722.html

[He et al., 2015. Deep residual networks for image recognition]

Andrew Ng

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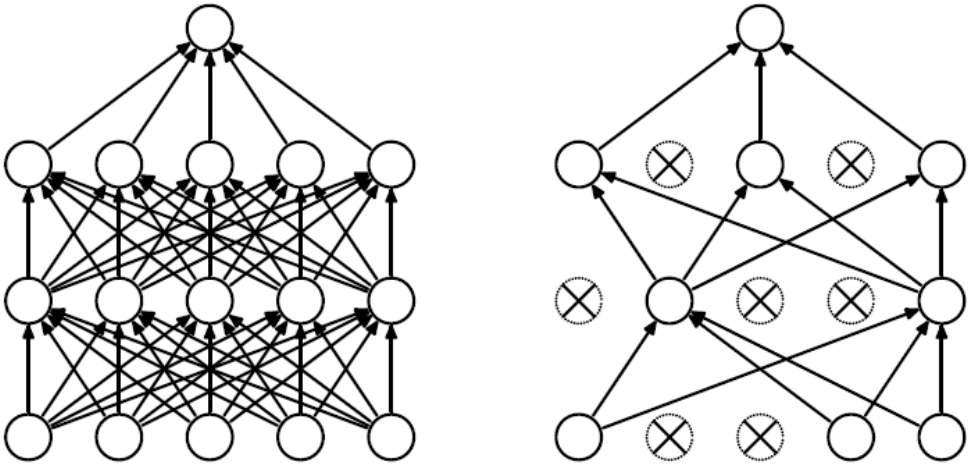
Dropout



(a) Standard Neural Net (b) After applying dropout.

Src: https://www.itread01.com/content/1547209261.html

- 避免 Overfitting

Ref1: https://keras.io/api/layers/regularization_layers/dropout/
Ref2: https://www.youtube.com/watch?v=ARq74QuavAo
Paper: https://jmlr.org/papers/volume15/srivastava14a/srivastava14a.pdf

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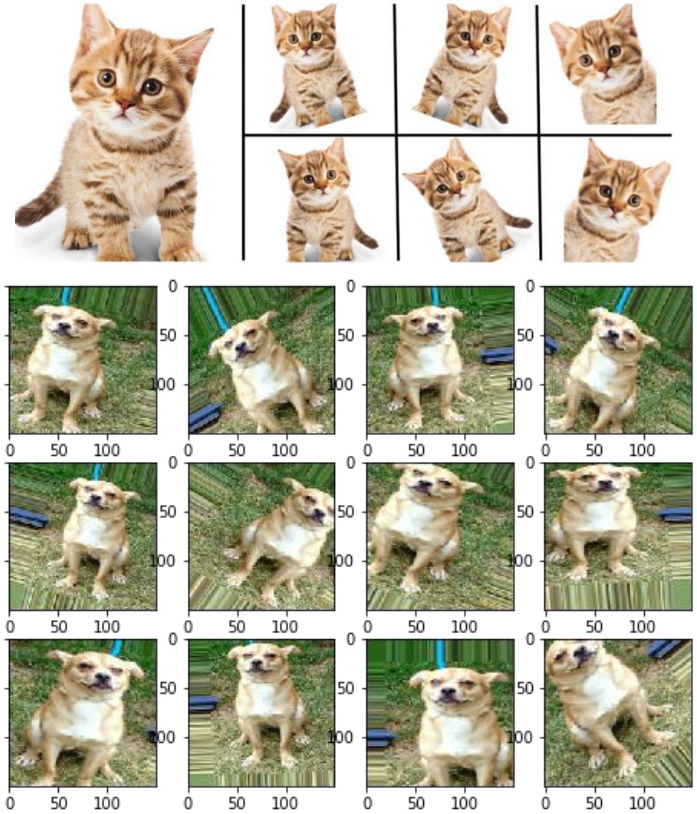
Data Augmentation 資料擴增



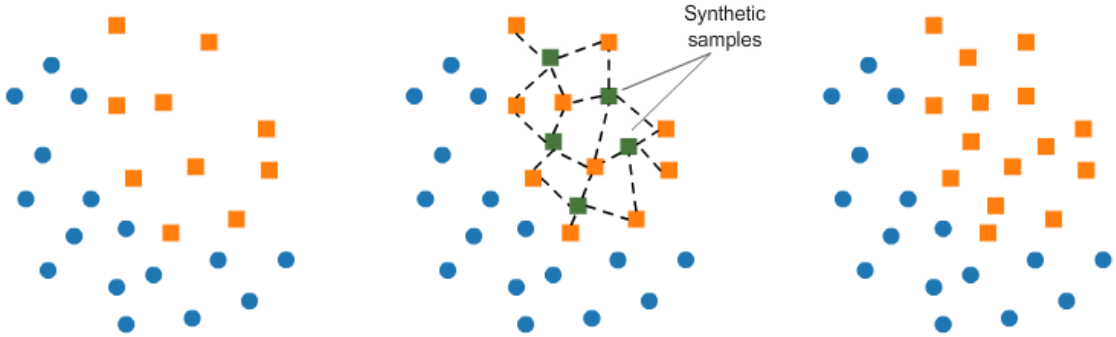
資料擴增方式：

- 圖片翻轉 (水平、垂直)
- 圖片旋轉 (角度)
- 裁切
- 放大縮小
- 圖像偏移
- 色調微調
- 解析度

https://keras.io/api/preprocessing/image/

Src1:http://datahacker.rs/tf-data-augmentation/
Src2: https://www.kdnuggets.com/2018/05/data-augmentation-deep-learning-limited-data.html

SMOTE



- **使用在 imbalanced data 的機器學習問題**
- **常見的不平衡資料集議題：**
  - 信用卡盜刷
  - 廣告投放商品購買
  - 跨國銀行洗錢
  - 瑕疵檢測

Ref: https://imbalanced-learn.org/stable/over_sampling.html

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轉移學習 Transfer Learning

- 將應用在其他任務的已訓練模型，改應用在現行任務。 (常應用在CV)
- 各式知名競賽模型 (已訓練)：https://keras.io/api/applications/
- 常見應用方式：

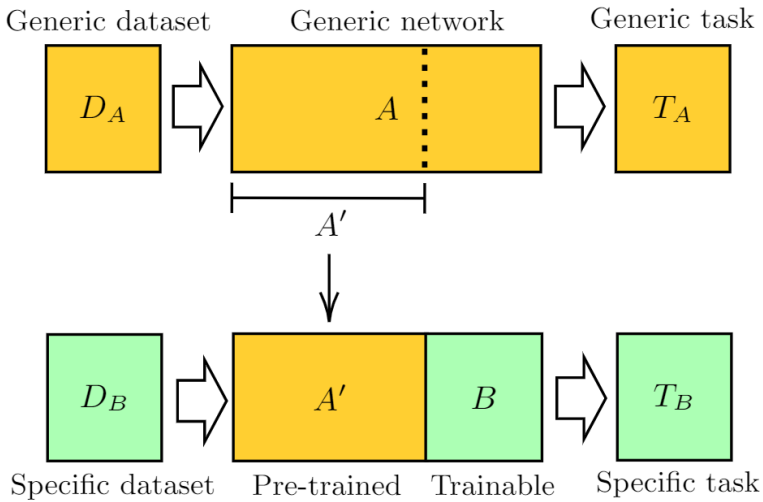

Image src: https://pennylane.ai/qml/demos/tutorial_quantum_transfer_learning.html

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貓狗辨識挑戰 – Kaggle

競賽網址： https://www.kaggle.com/c/dogs-vs-cats/

Ref: https://blog.gtwang.org/programming/keras-resnet-50-pre-trained-model-build-dogs-cats-image-classification-system/

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趣味實作：神經風格轉換

趣味實作：神經風格轉換


內容C


風格S


生成G


內容C


風格S

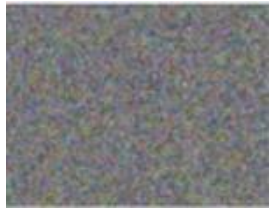

生成G

$$J(G) = \alpha J_{\text{content}}(C, G) + \beta J_{style}(S, G)$$

內容成本函數 **風格成本函數**


內容C


風格S


隨機初始化「生成圖片」(G)

- 使用深度卷積神經網絡 (已訓練)
- 選取中間的層數作為風格層 (具備相關特徵處理資訊)
- 結合內容成本函數及風格成本函數進行訓練

趣味實作：
https://colab.research.google.com/github/tensorflow/docs/blob/master/site/en/tutorials/generative/style_transfer.ipynb

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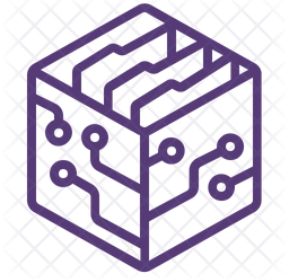
Few-shot Learning

少量的資料集

(樣本數)



模型訓練

(預訓練)

達到相對

理想的準確率

適用情境：

- ✓ Imbalanced Data
- ✓ Little Data
- ✓ 少量多樣數據集

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元學習 Meta Learning

Task 1.


Task 2.


Task 3.



Current Task

Ref: https://www.youtube.com/watch?v=DijI4XrhqNo

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元學習 Meta Learning

相關學習資源

- 中文學習筆記：https://dboyliao.medium.com/meta-learning-%E6%A5%B5%E7%B0%A1%E4%BB%8B-part-1-f8be3cb898f6
- ICML 線上直播教學：https://www.youtube.com/watch?v=DijI4XrhqNo
- OpenAI 論文：https://arxiv.org/abs/1803.02999
- **OpenAI 開發者介紹文件：**https://openai.com/blog/reptile/
- **Reptile 實作：**https://colab.research.google.com/github/keras-team/keras-io/blob/master/examples/vision/ipynb/reptile.ipynb

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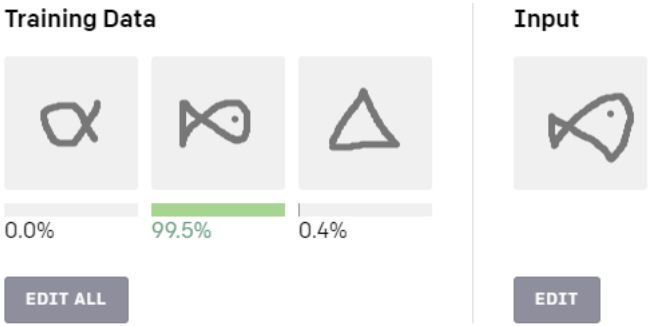
課程實作 - 衍生嘗試

Practice 1.

■ 使用 VGG19 以外模型，做轉移學習

Practice 2.



■ 嘗試使用繁體中文字集，做元學習

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課程之後...

- 複習 (搞懂每一個關鍵字)
- 自學 (網路文章、網路課程、讀書會、Paper 研讀)
- 掌握趨勢 (社群新聞、技術論壇)
- 持續進修 (攻讀碩士、博士、論文發表)
- Side Project (Github、技術專題發想)
- 外部競賽 (Kaggle, Aidea, AIGO, T-brain...)
- 實習 / 工作 / 接案兼職 ...

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