

AI Detecting Retina Symptom

- AI 檢測視網膜症狀



利用AI 檢測影像

有三種人一定要了解我們的專案

- 1.醫生：減少誤判，提升效能
- 2.經理人：AI用於產品檢測提升效能
- 3.工程師：AI影像辨識專案實作技巧

問題描述

醫生在做視網膜影像檢測的兩大困擾：



誤判

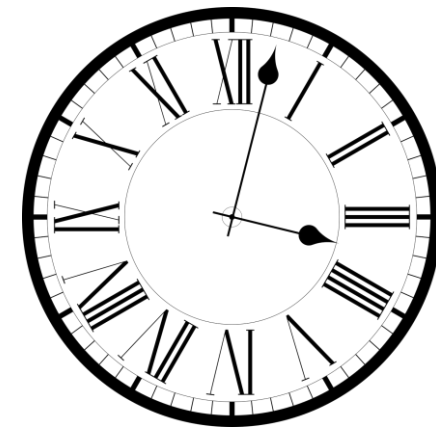


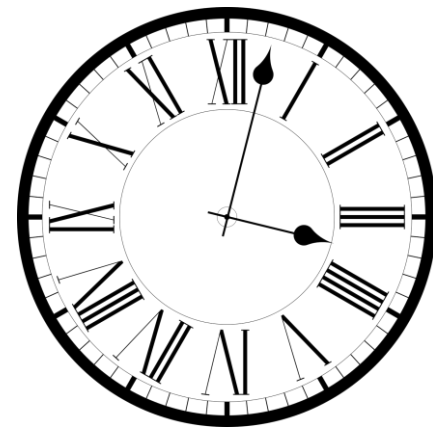
耗時

本專案期望以AI 技術輔助檢測，降低醫生診斷時負擔



案例解題過程與分享大綱

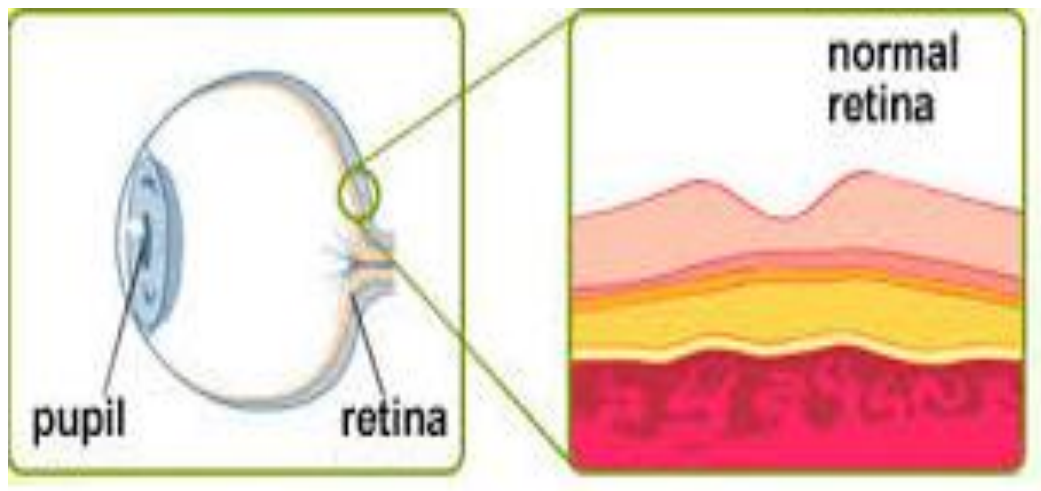
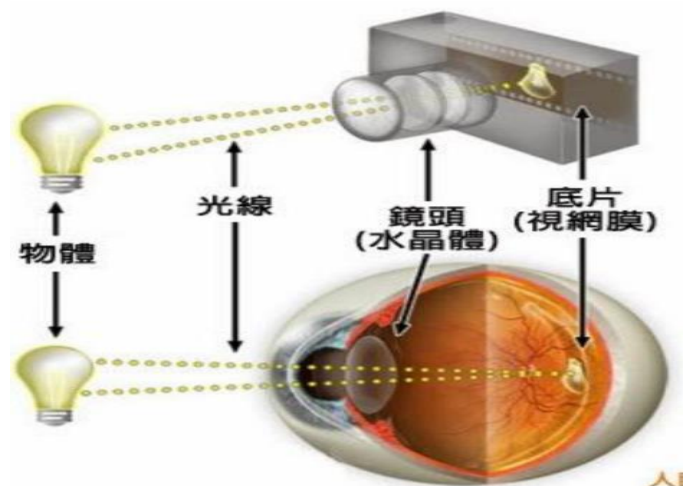


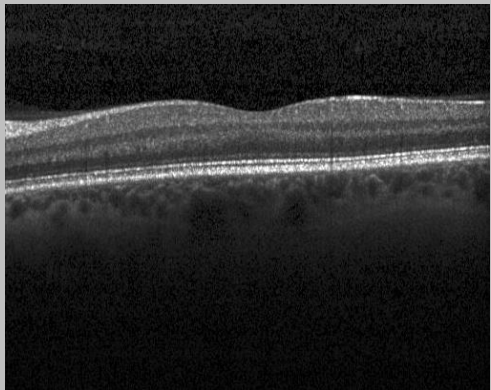
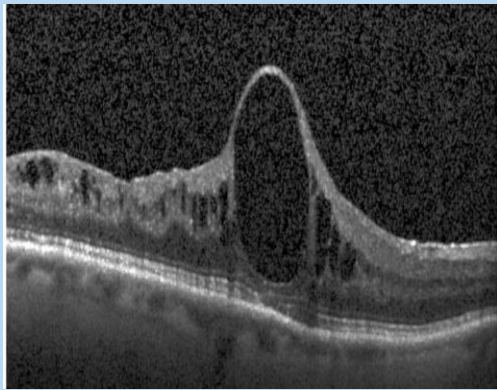
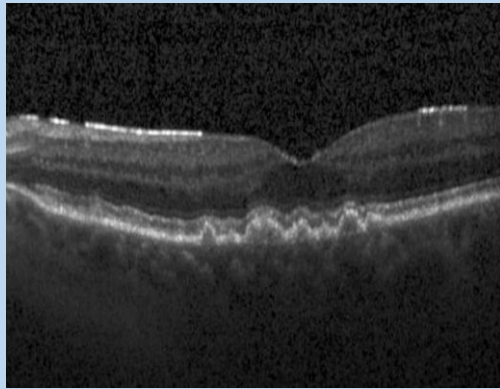
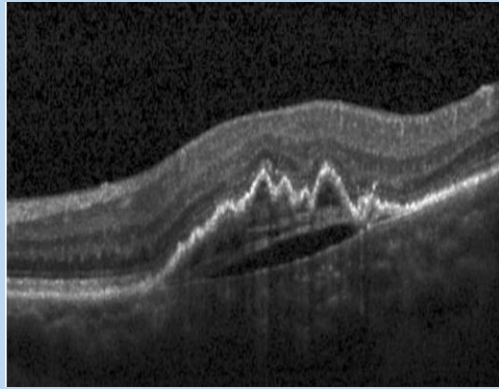


問題定義

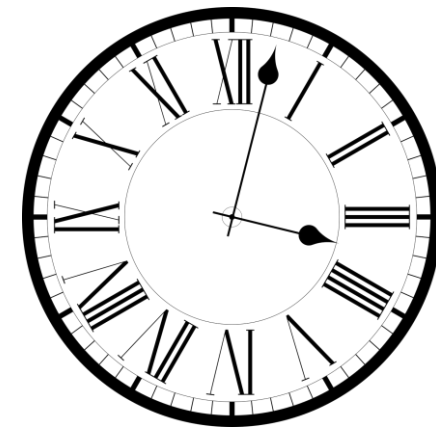
- 視網膜介紹
與症狀

問題定義-視網膜介紹與症狀



<p>Normal (正常)</p> 	<p>DME (糖尿病性黃斑水腫)</p> 
<p>CNV (脈絡膜新生血管)</p> 	<p>DRUSEN (玻璃疣)</p> 

案例解題過程與分享大綱



- 看診流程與解題技術分析

解題思維

問題定義

- 視網膜介紹與症狀



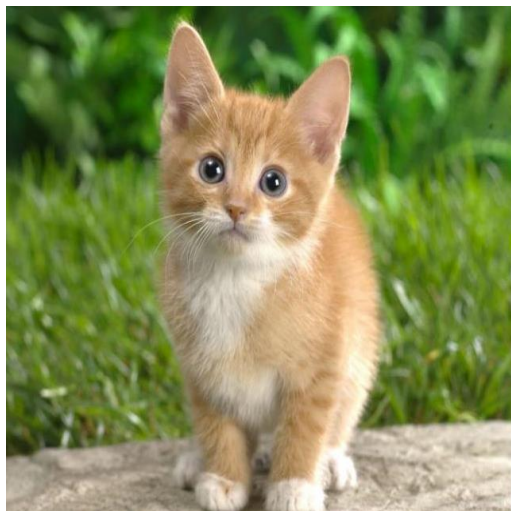
醫生看診流程攻堅

有沒有症狀?

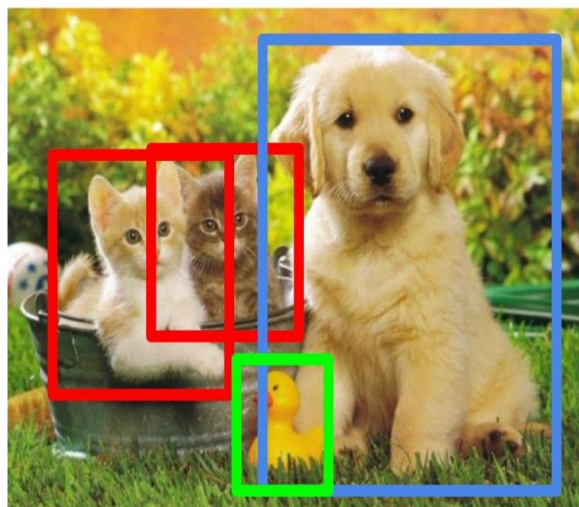
發生在那?

多大?

物件分類
Classification



物件偵測
Object Detection

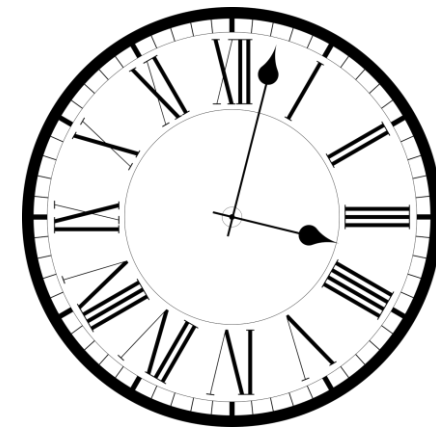


語意分析
Instance Segmentation



本專案以AI電腦視覺三大方法做為主要攻堅計劃

案例解題過程與分享大綱



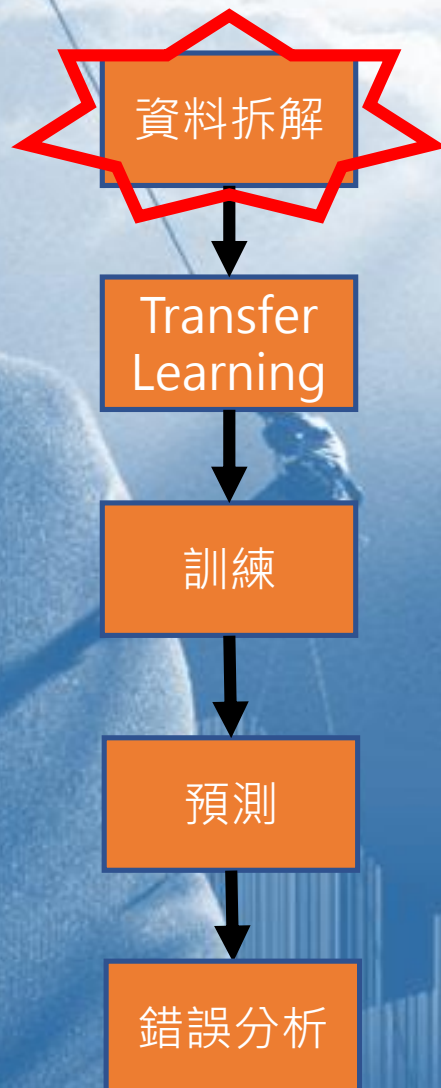
流程



技巧

- 資料拆成 Training / Validation / Test
- Transfer Learning (Weights: ImageNet , COCO)
- 注意 High Bias and High Variance
- 注意 Validation set and Test Set same distribution
- Error Analysis (找出分類錯誤的原因並改善)

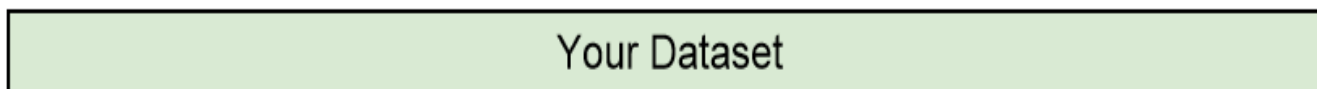
流程



資料拆成 TRAINING / VAL / TEST

Idea #1: Choose hyperparameters that work best on the data

BAD: Easy works perfectly on training data



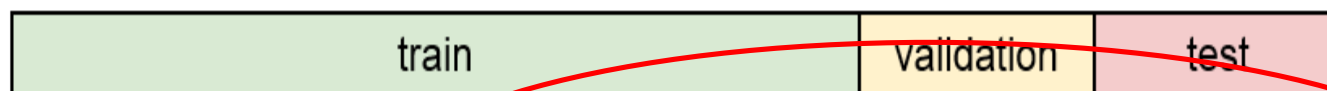
Idea #2: Split data into **train** and **test**, choose hyperparameters that work best on test data

BAD: No idea how algorithm will perform on new data



Idea #3: Split data into **train**, **val**, and **test**; choose hyperparameters on val and evaluate on test

Better!



Train Data ≈ 70%

CNV 484
DME 400
DRUSEN 464
Normal 412

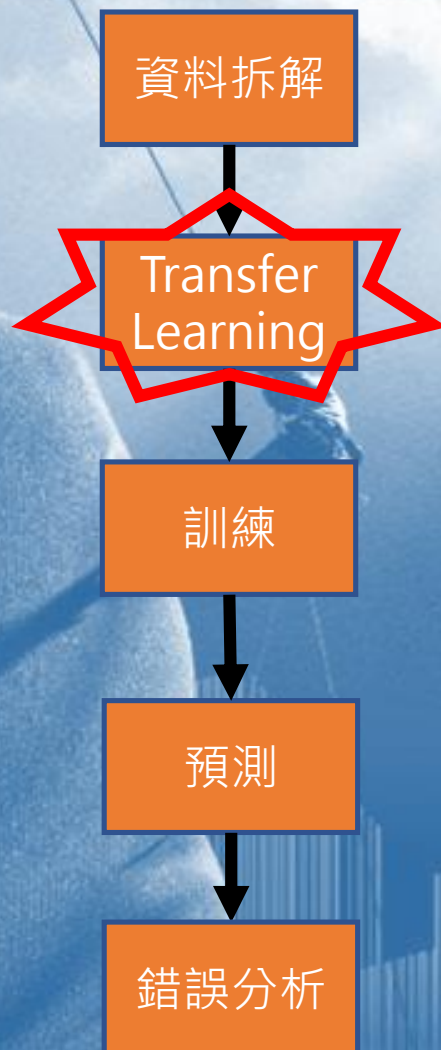
Validation Data ≈ 15%

CNV 121
DME 100
DRUSEN 116
Normal 104

Test Data ≈ 15%

CNV 100
DME 100
DRUSEN 100
Normal 100

流程



TRANSFER LEARNING

Transfer Learning with CNNs

本例 $C = 4$
Weights: ImageNet
Weights: COCO

Donahue et al, "DeCAF: A Deep Convolutional Activation Feature for Generic Visual Recognition", ICML 2014
Razavian et al, "CNN Features Off-the-Shelf: An Astounding Baseline for Recognition", CVPR Workshops 2014

1. Train on Imagenet



2. Small Dataset (C classes)



Reinitialize
this and train

Freeze these

3. Bigger dataset



Train these

With bigger
dataset, train
more layers

Freeze these

Lower learning rate
when finetuning;
1/10 of original LR
is good starting
point

流程

✓ 注意 HIGH BIAS AND HIGH VARIANCE

本例 human-level performance ≈ 1

資料拆解

Transfer Learning

訓練

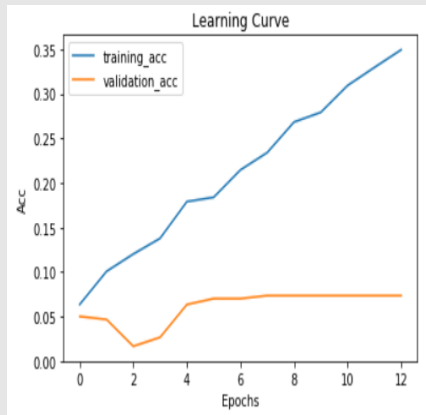
預測

錯誤分析

情境

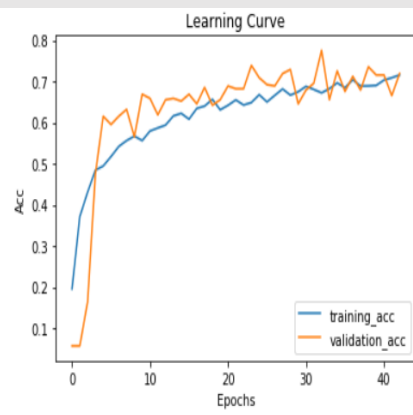
對策

High Bias & High Variance



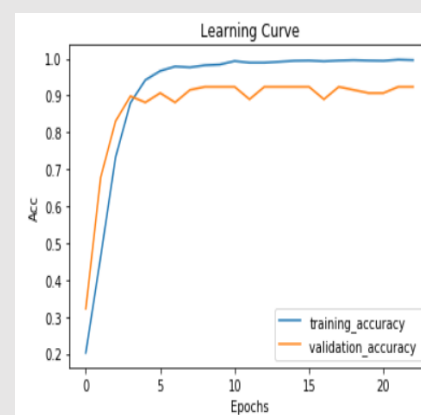
A and B

High Bias



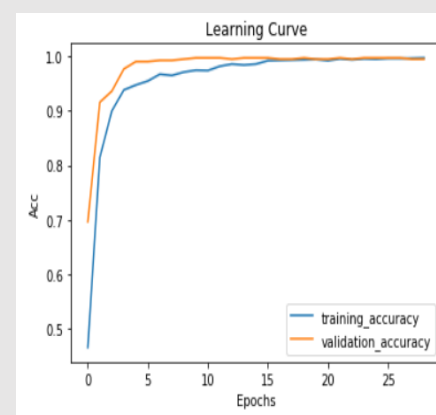
A

High Variance



B

Perfect



NA

A

High Bias

對策

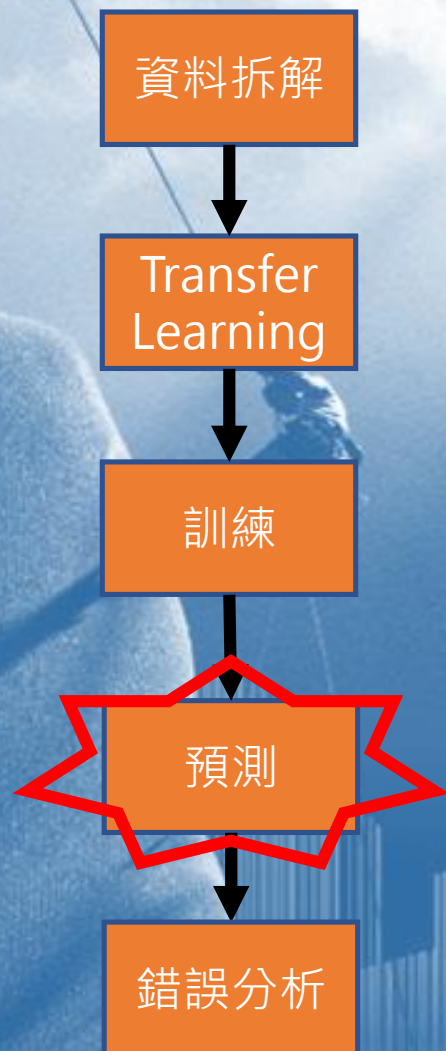
1. Train bigger model
2. Train longer/better optimization algorithms
3. NN architecture / hyperparameters search

B

High Variance

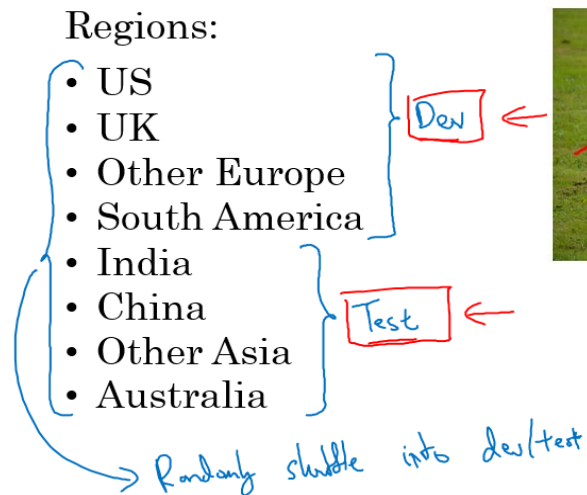
1. More data
2. Regularization
3. NN architecture / hyperparameters search

流程



資料來源:
Coursera, Deep Learning, Structuring Machine Learning Projects, Andrew Ng

✓ 注意 VAL SET AND TEST SET SAME DISTRIBUTION



Same Distribution

Guideline:

Choose a val set and test set to reflect data you expect to get in the future and consider important to do well on.

train	validation	test
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Train Data 80%

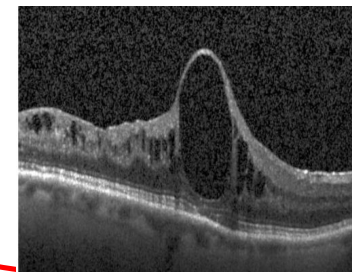
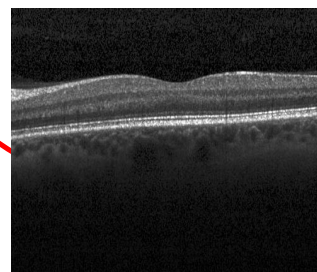
CNV 484
DME 400
DRUSEN 464
Normal 412

Validation Data 20%

CNV 121
DME 100
DRUSEN 116
Normal 104

Test Data

CNV 100
DME 100
DRUSEN 100
Normal 100



本例確認
VAL SET AND TEST SET
為 Same Distribution

流程

資料拆解

Transfer Learning

訓練

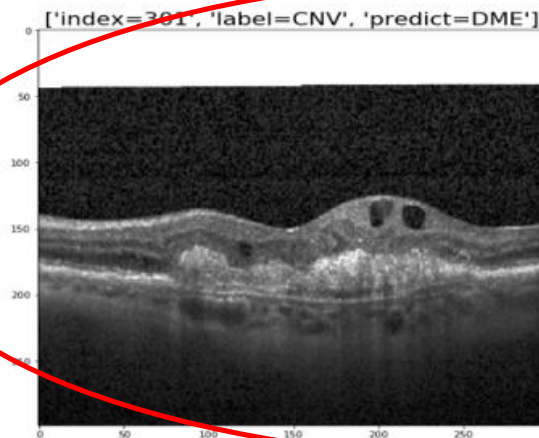
預測

錯誤分析

✓ ERROR ANALYSIS

➤ 針對分類錯誤的 Image 下 Comments

Image	Dog	Great Cat	Blurry	Incorrectly labeled	Comments
1				✓	Labeler missed cat in background
2		✓			
3				✓	Drawing of a cat; Not a real cat.
...					



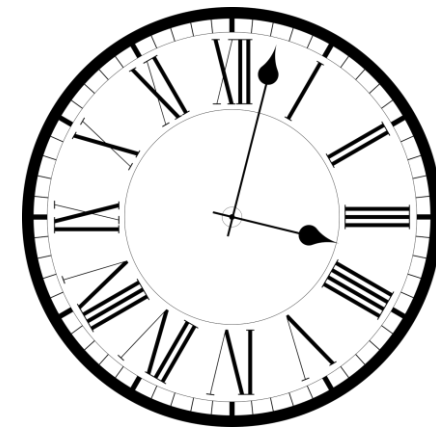
針對分類錯誤的 image ,
找出並分析



有了執行 AI Project Knowledge 後

實作開始！！

案例解題過程與分享大綱



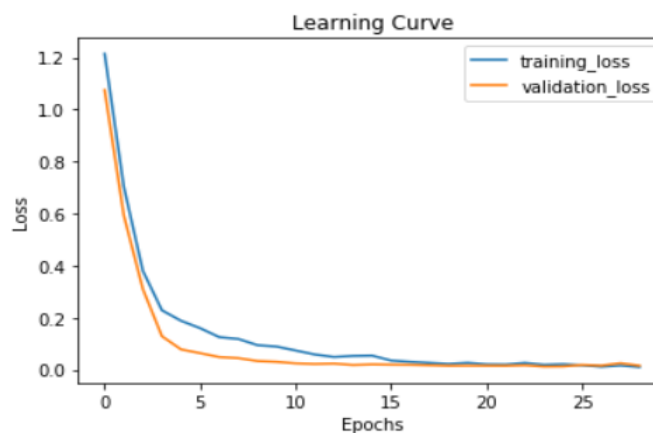
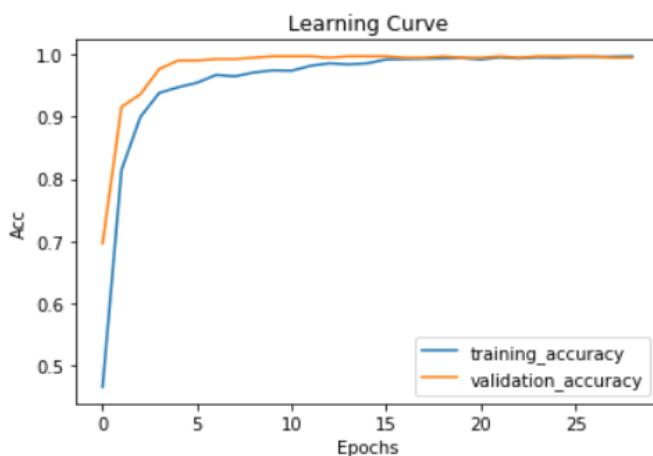
攻堅計劃一：影像分類判定症狀

● Basic Information

Method	Transfer Learning
Weights	ImageNet
Model	Xception
Hyperparameter optimizer	Adam(lr=10e-6)
epochs	100
Data Augmentation	ImageDataGenerator rotation_range=10, width_shift_range=0.1, height_shift_range=0.1, shear_range=0.1, zoom_range=0.1, horizontal_flip=True, fill_mode='nearest')
Earlystop	val_loss 連續 5 epoch 無下降
Data	CNV 705 DME 600 DRUSEN 680 Normal 616
Train_Test_Split	0.7/0.15/0.15

● Training/Validation Accuracy/Loss

- Model 無 bias · variance 問題



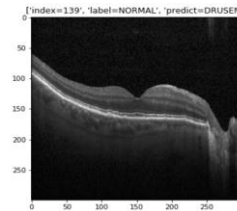
- 錯誤分析: 模型預測 Validation Set 結果
正常照片 recall 0.99/異常照片 recall 1
=> Model 無漏篩問題

predict	CNV	DME	DRUSEN	NORMAL
label				
CNV	117	0	0	0
DME	0	87	0	0
DRUSEN	0	0	112	0
NORMAL	0	0	1	124

Validation loss: 0.011931998532713135

Validation accuracy: 0.9977324

	precision	recall	f1-score	support
CNV	1.00	1.00	1.00	
DME	1.00	1.00	1.00	
DRUSEN	0.99	1.00	1.00	
NORMAL	1.00	0.99	1.00	
accuracy			1.00	441
macro avg	1.00	1.00	1.00	441
weighted avg	1.00	1.00	1.00	441



攻堅計劃一：影像分類成效驗證

- Test set 預測 (每類各 100 張)

正常照片 recall 為 1 (100/100)

異常照片 recall 為 0.987 (4/300)

=> Model 無漏篩問題

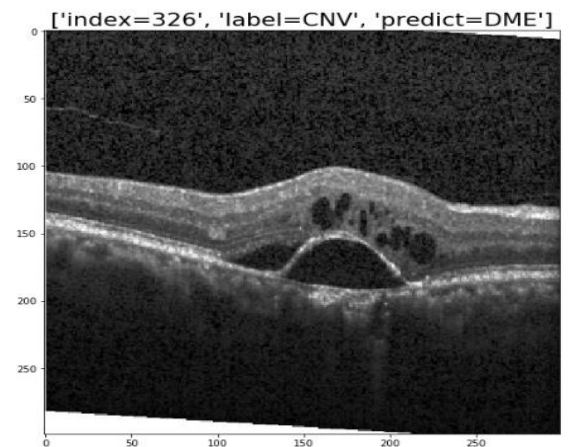
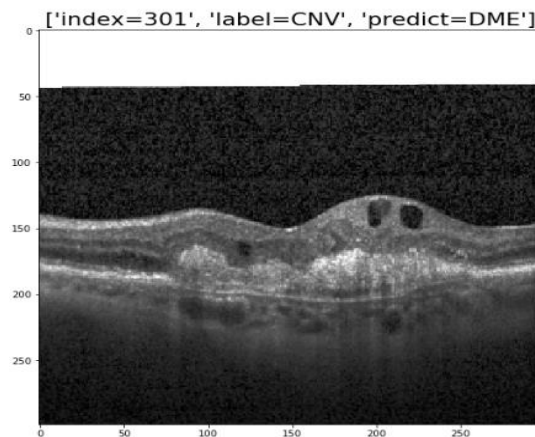
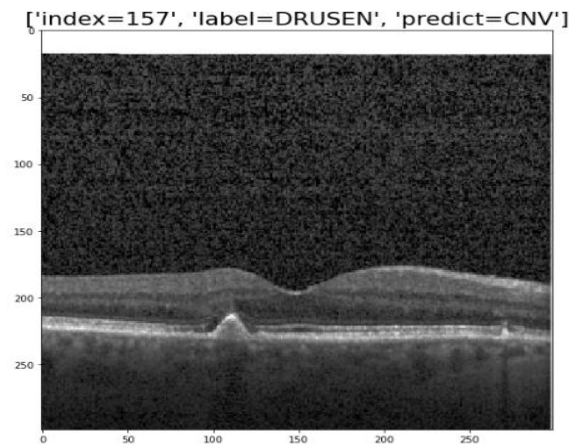
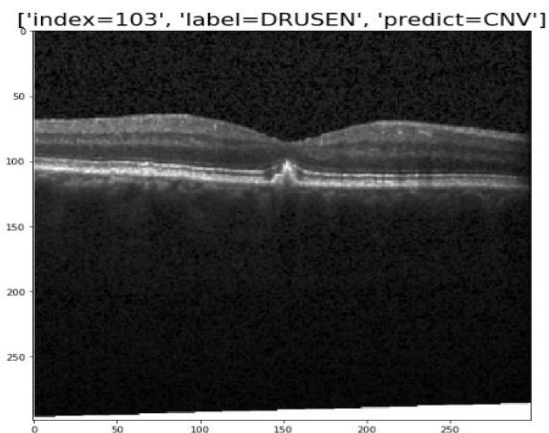
predict \ label	CNV	DME	DRUSEN	NORMAL
CNV	98	2	0	0
DME	0	100	0	0
DRUSEN	2	0	98	0
NORMAL	0	0	0	100

label \ predict	CNV	DME	DRUSEN	NORMAL
CNV	98	2	0	0
DME	0	100	0	0
DRUSEN	2	0	98	0
NORMAL	0	0	0	100

	precision	recall	f1-score	support
CNV	0.98	0.98	0.98	100
DME	0.98	1.00	0.99	100
DRUSEN	1.00	0.98	0.99	100
NORMAL	1.00	1.00	1.00	100
accuracy			0.99	400
macro avg	0.99	0.99	0.99	400
weighted avg	0.99	0.99	0.99	400

- 失效影像驗證:

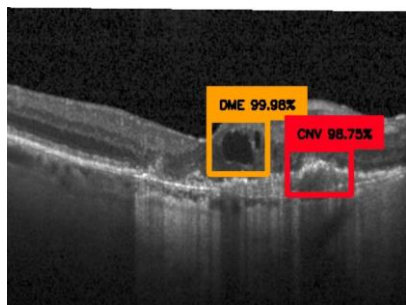
複合型異常，導致分類錯誤。解法: Object Detection



攻堅計劃二：物件偵測解決複合型異常

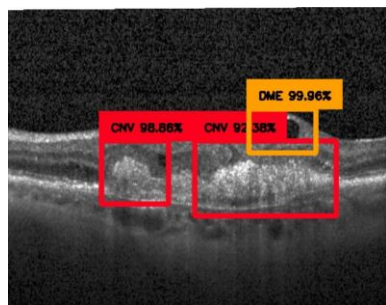
● Basic Information

Object Detection Method		YOLOv3
Method		Transfer Learning
Weights		ImageNet
Weights		COCO
Model		VGG
Hyperparameter	epochs	30
Number of label		CNV 252 DME 146 DRUSEN 183



準確度

CNV: 0.9020
DME: 0.9540
DRUSEN: 0.9279
mAP: 0.9280

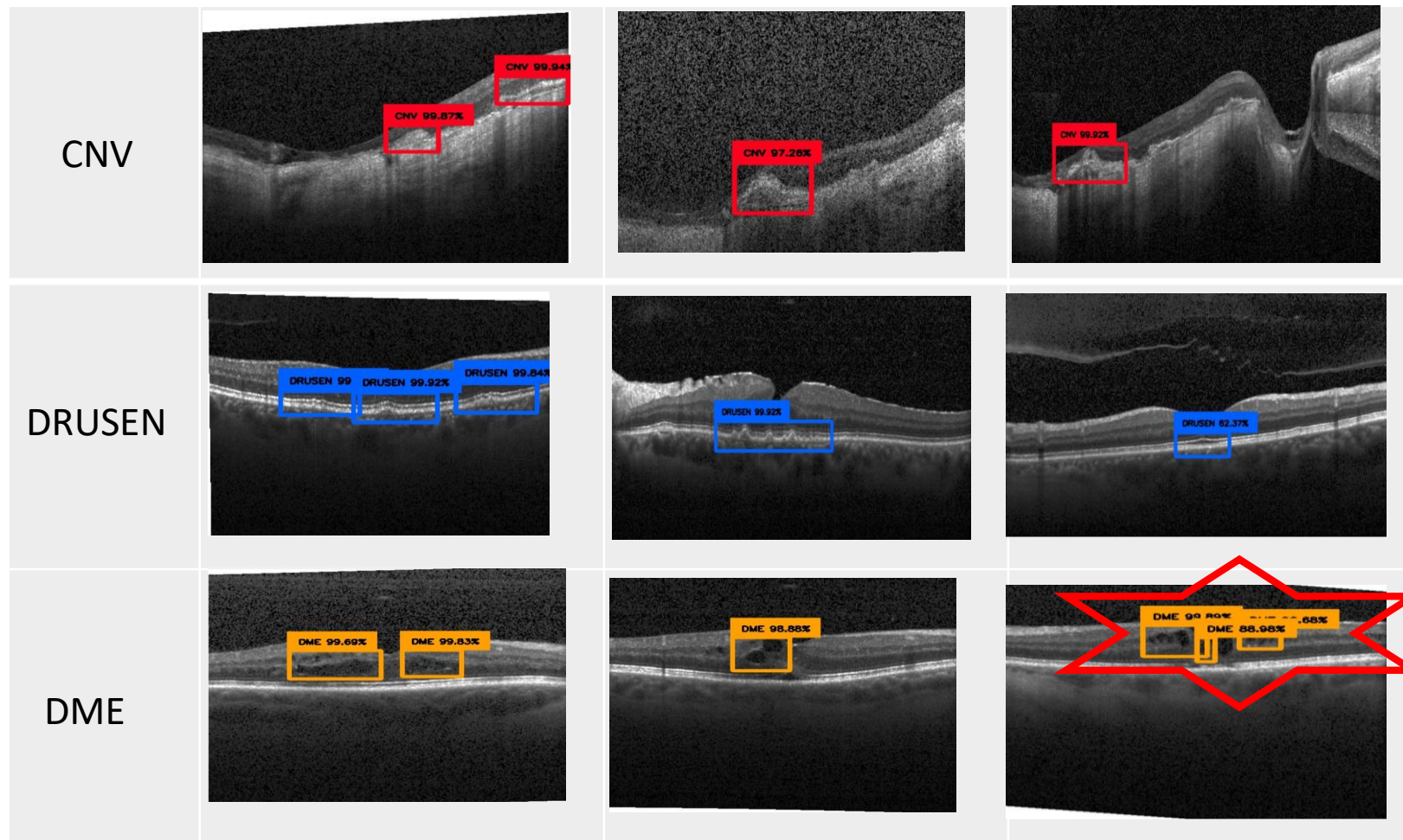


平均準確度

結果: mAP: 0.928

● 成效驗證：平均準確度mAP 達92.8%

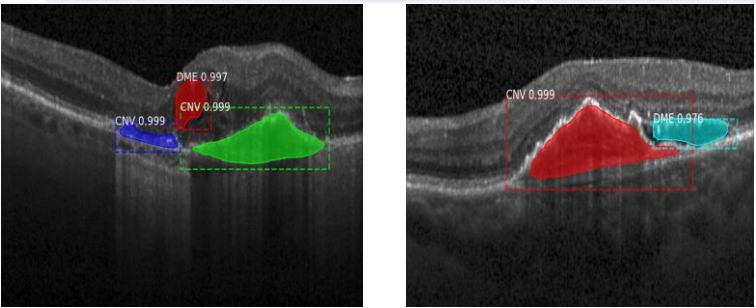
● 後續問題：偵測的 Box 集中不美觀。解法: Segmentation



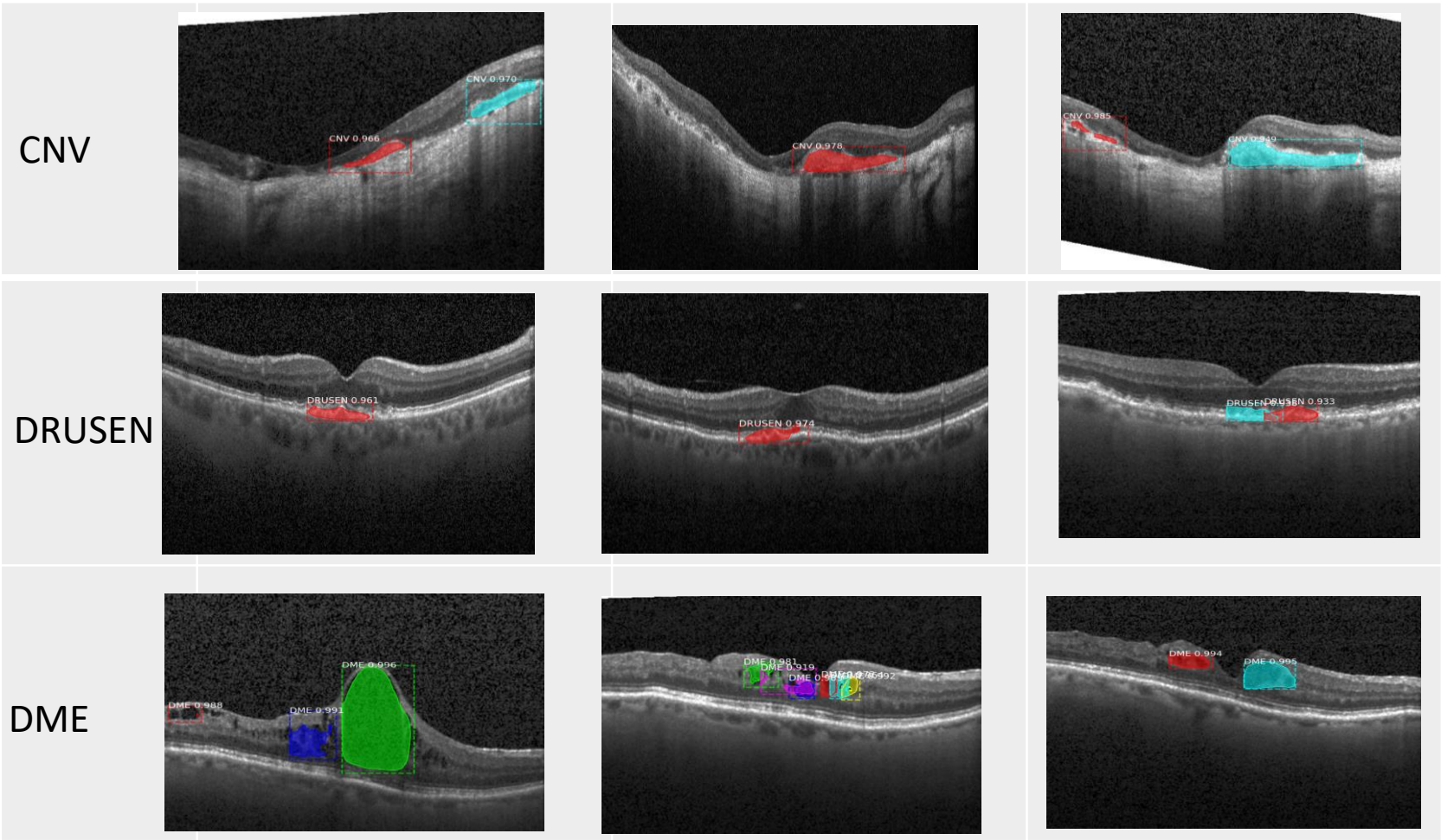
攻堅計劃三：語意分析解決偵測BOC 集中問題

- Basic Information

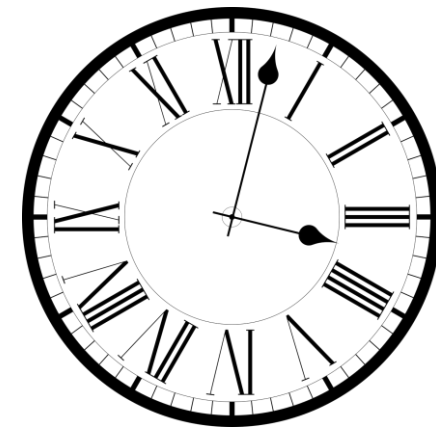
Segmentation Method		Mask R-CNN
Method		Transfer Learning
Weights		ImageNet
Weights		COCO
Model		ResNet101
Hyperparameter	epochs	10
STEPS_PER_EPOCH		100
Detection min confidence		0.9
Number of label		CNV 90 DME 90 DRUSEN 90



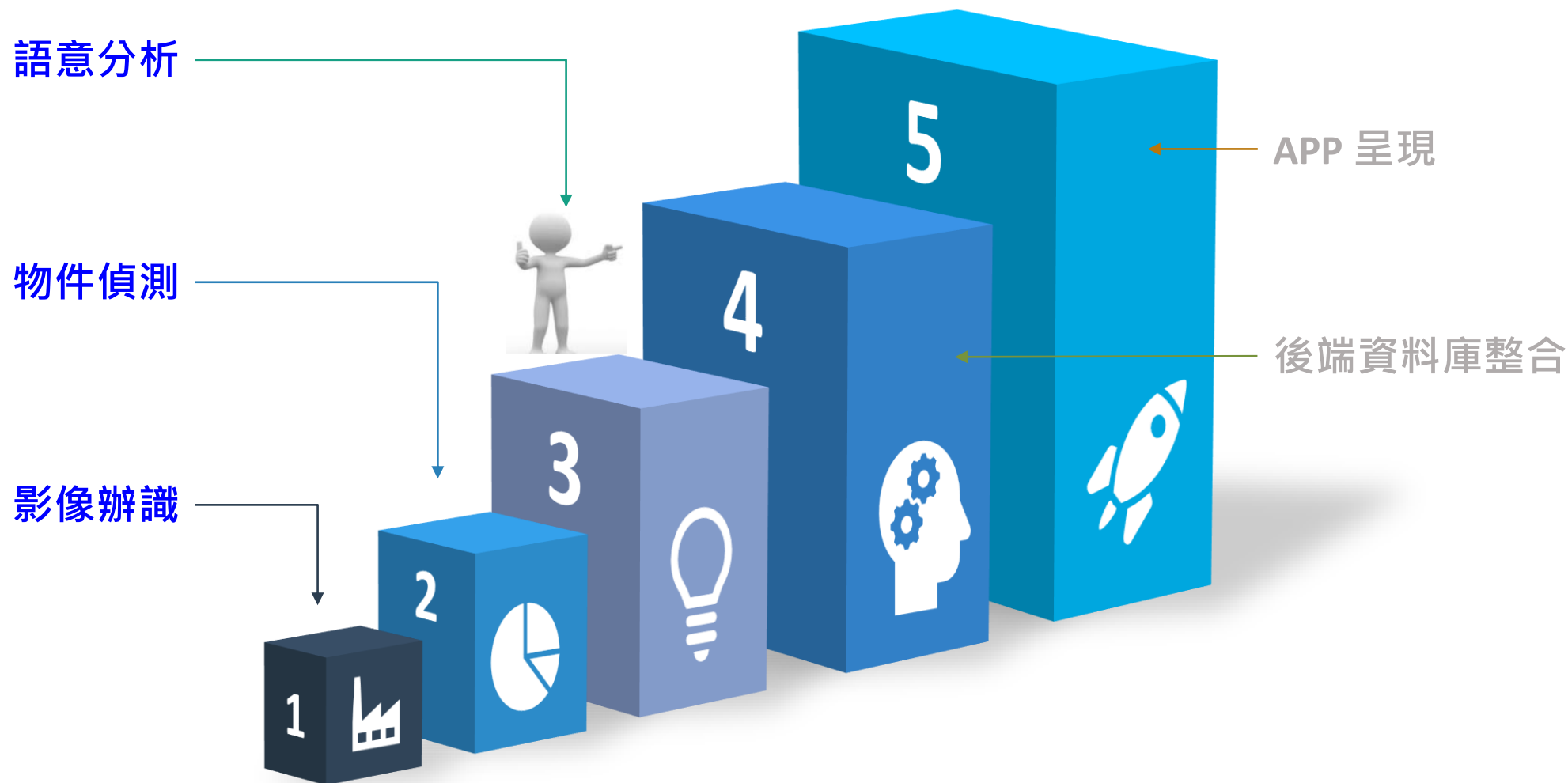
- 成效驗證：有效解決物件偵測BOS 集中，不美觀問題
並與物件偵測手法比較



案例解題過程與分享大綱



AI檢測視網膜症狀現況與未來

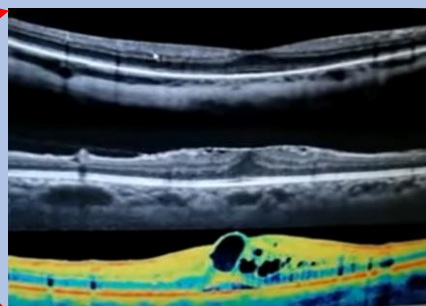


AI 導入前

醫生盯著螢幕看症狀



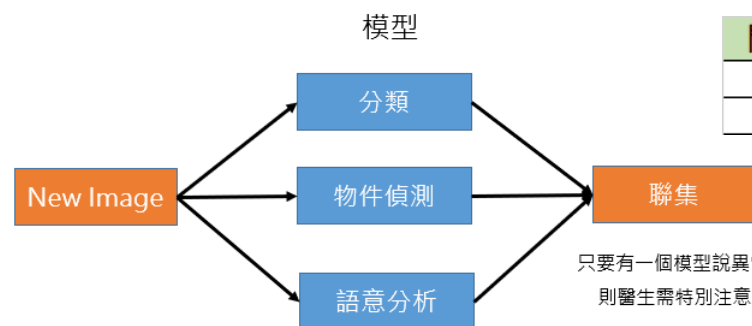
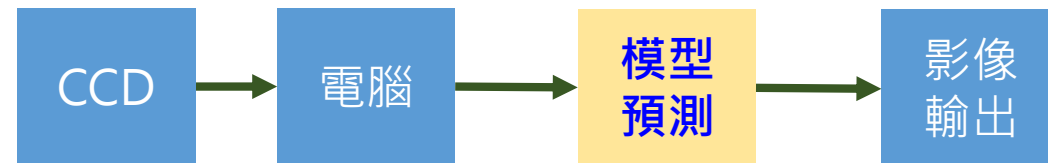
螢幕



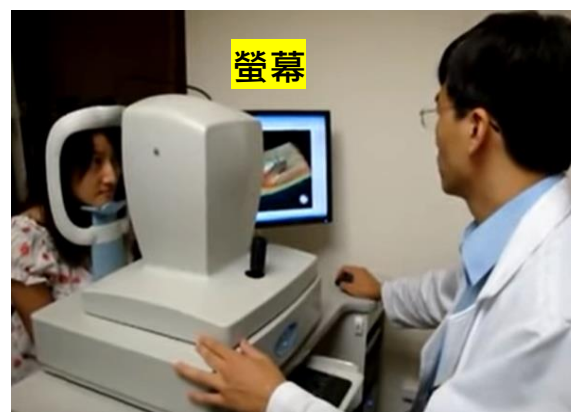
資料來源:
高雄榮總台南分院眼科李尹暘醫師

AI 導入後

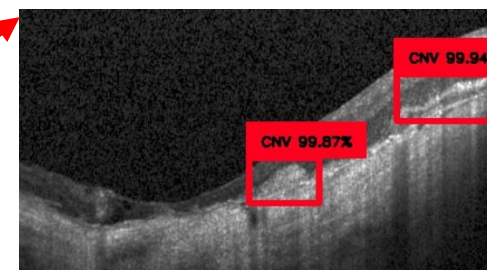
分類與偵測顯示於螢幕輔助判斷



問題	解法 (AI 導入)
誤判	Ensemble methods 提高準確率
耗時	Model 提醒醫生該把注意力放在那裡



螢幕



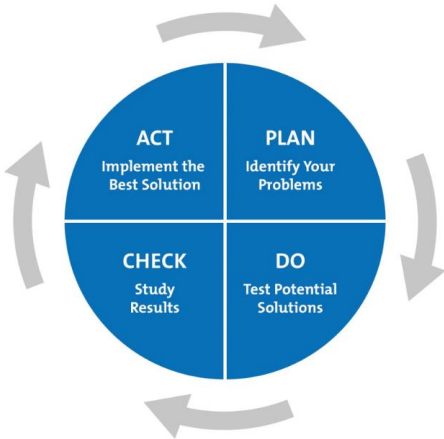
AI 模型上線注意事項

1. 上線前 2 周: 醫生紀錄每次看診紀錄。並 Comment 模型是否有幫助

AI 模型上線確認表					
	分類	物件偵測	語意分析	醫生判斷	Gap
Image 1	正常	正常	正常	正常	N
Image 2	正常	正常	正常	正常	N
Image 3	CNV	CNV	正常	CNV	Y
Image 4	DRUSEN	DRUSEN	DRUSEN	DRUSEN	N
Image 5	CNV	CNV	CNV	CNV	N
Image 6	DME	正常	DME	DME	Y
Image 7	DME	DME	DME	DME	N
Image 8	正常	正常	正常	正常	N
Image 9					
Image 10					
模型是否對醫師有幫助: Y [] , N []					
填單者: 王大明 醫師					

2. AI 工程師每半年定時檢討模型有無異常

	分類	物件偵測	語意分析	Gap
Image 1	正常	正常	正常	N
Image 2	正常	正常	正常	N
Image 3	CNV	CNV	正常	Y
Image 4	DRUSEN	DRUSEN	DRUSEN	N
Image 5	CNV	CNV	CNV	N
Image 6	DME	正常	DME	Y
...
...
...
Image 666	CNV	CNV	CNV	N



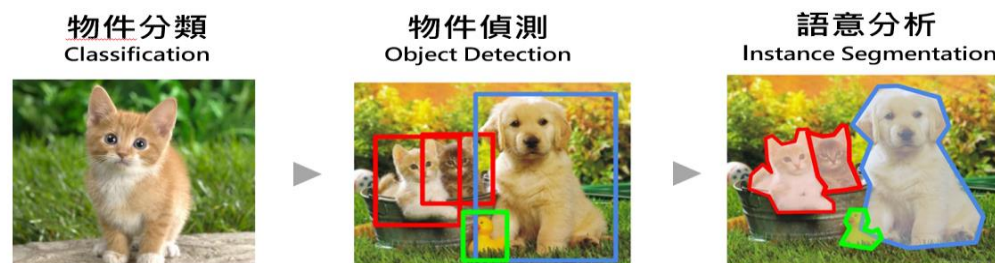
結論

本報告**三大亮點**

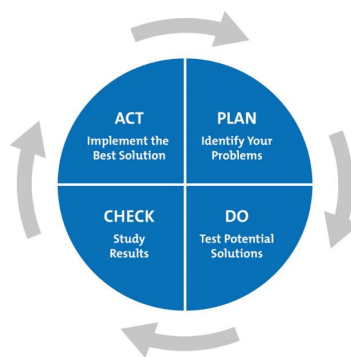
1. 介紹電腦視覺專案的流程與需注意事項



2. 電腦視覺主要方法皆有介紹



3. 介紹如何正確上線與 Model 持續改善



參考資料

- Coursera , Deep Learning, Structuring Machine Learning Projects, Andrew Ng
- Stanford University CS231n
- AI 學校技術班 YOLOv3 教材
- ORAI Mask R-CNN
- 高雄榮總台南分院眼科李尹暘醫師:視網膜眼斷層掃描 Retina OCT
<https://www.youtube.com/watch?v=T2kuA5ZfKL4>

