

神經與行為模型建構 (Neural & Behavioral Modeling)

課號：Psy7277

識別碼：227M9280

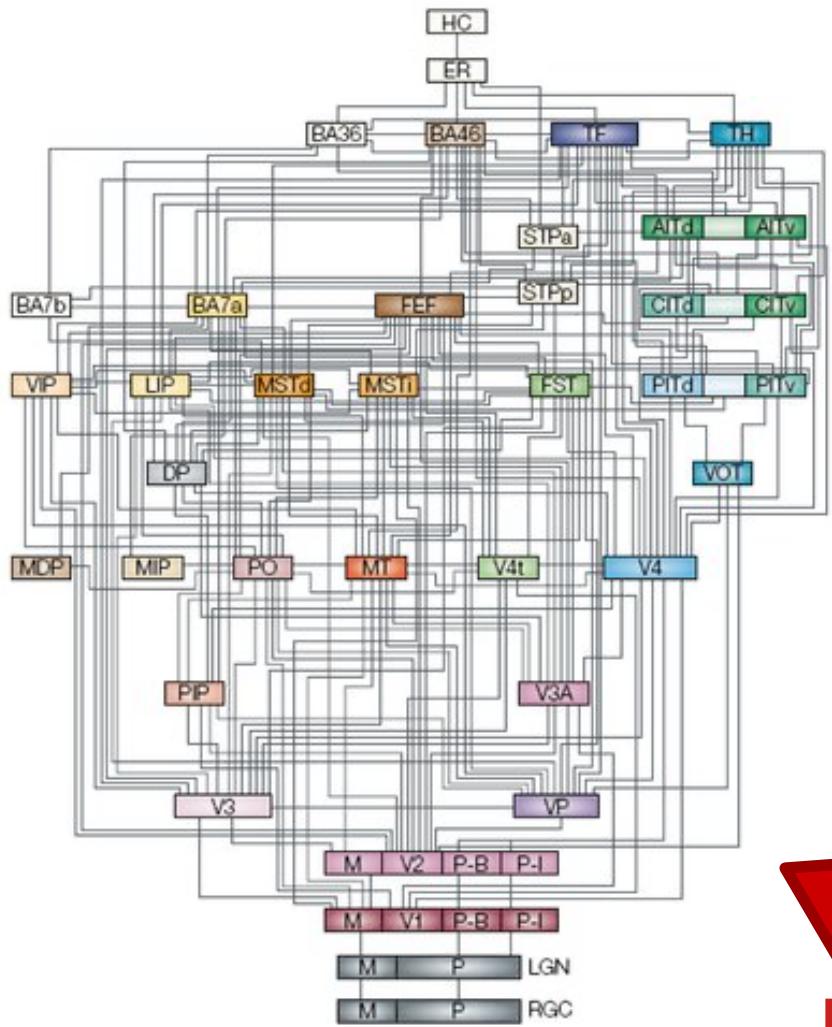
教室：北 206

時間：五 234

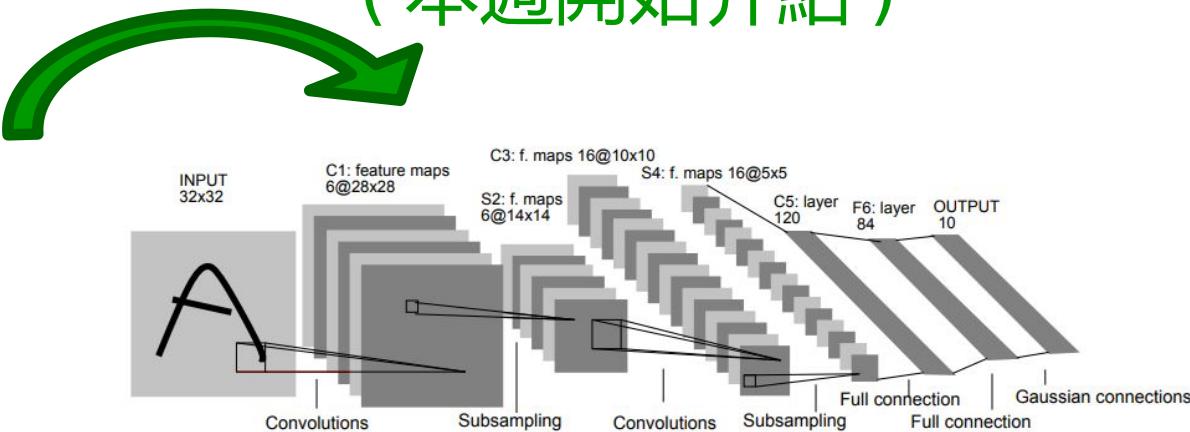


生物神經與類神經的三種關係

預測性模型也可被解釋或幫助解釋



Architectural Metaphors (AM) (本週開始介紹)



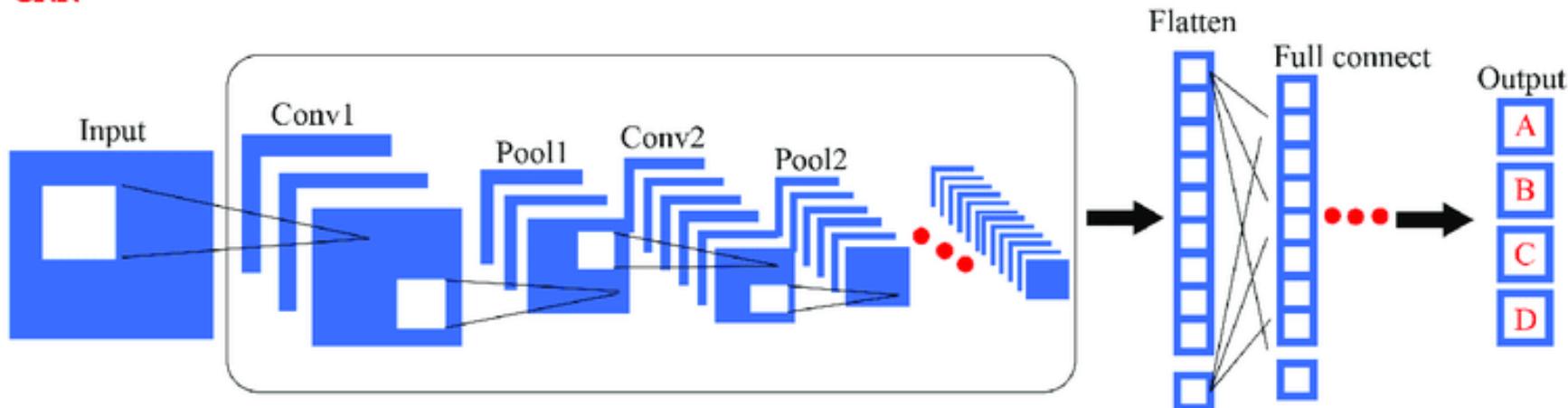
Data Modeling (DM) (如 DL 應用在大腦解碼)

Functional Metaphors (FM) (本來多為計算認知 M, 現在也有深度學習 M)

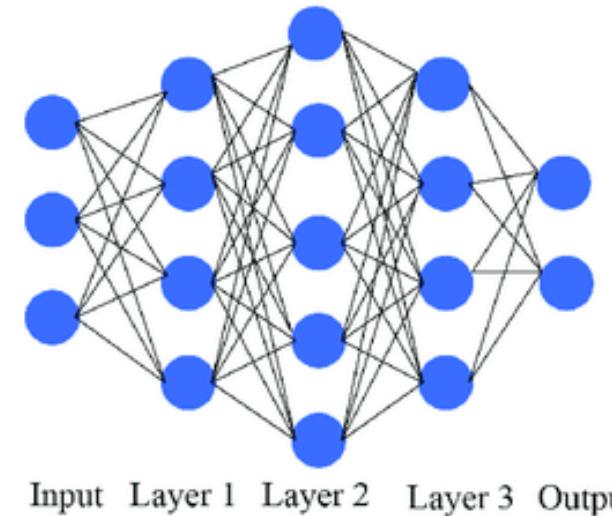
Deep Neural Networks 的分類

CNN 通常處理影像資料；RNN 通常處理語言資料

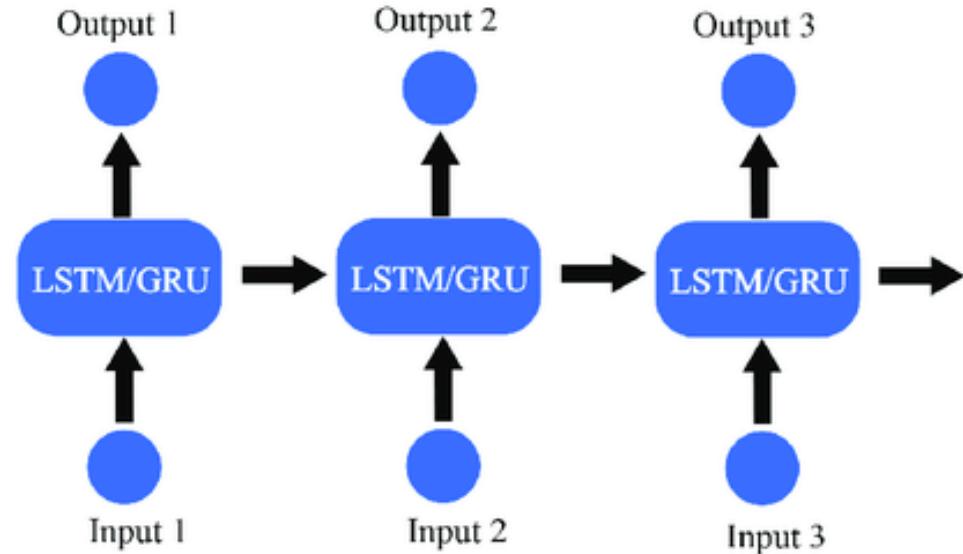
CNN



DNN



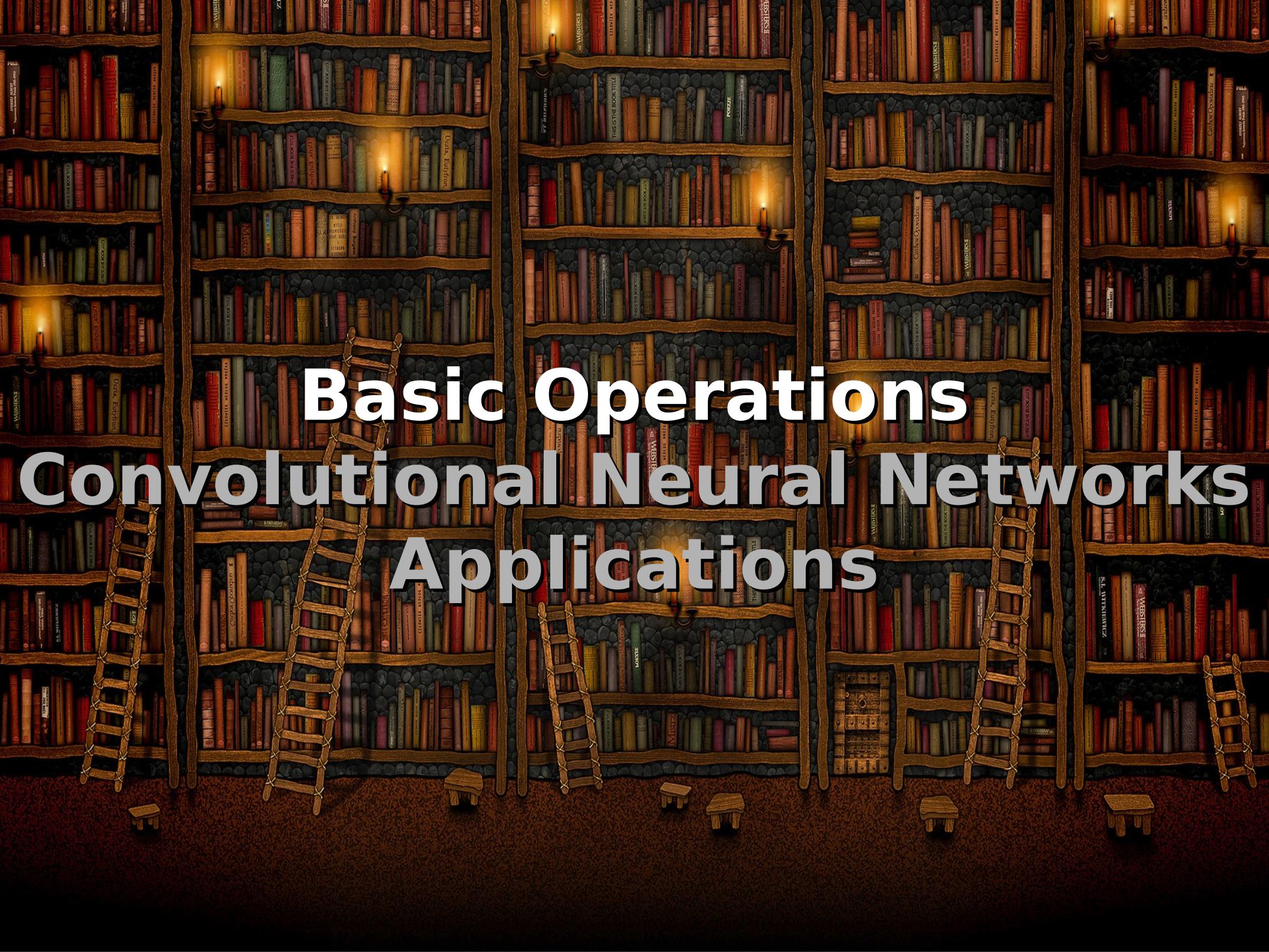
RNN



A black and white cartoon character with a large, dark, rounded head and a small body. It has a speech bubble coming from its mouth. The speech bubble contains the text "本週介紹 CNN" in red, with a red exclamation mark below it. The character has simple line drawings for eyes and a mouth, and small tufts of hair on its head.

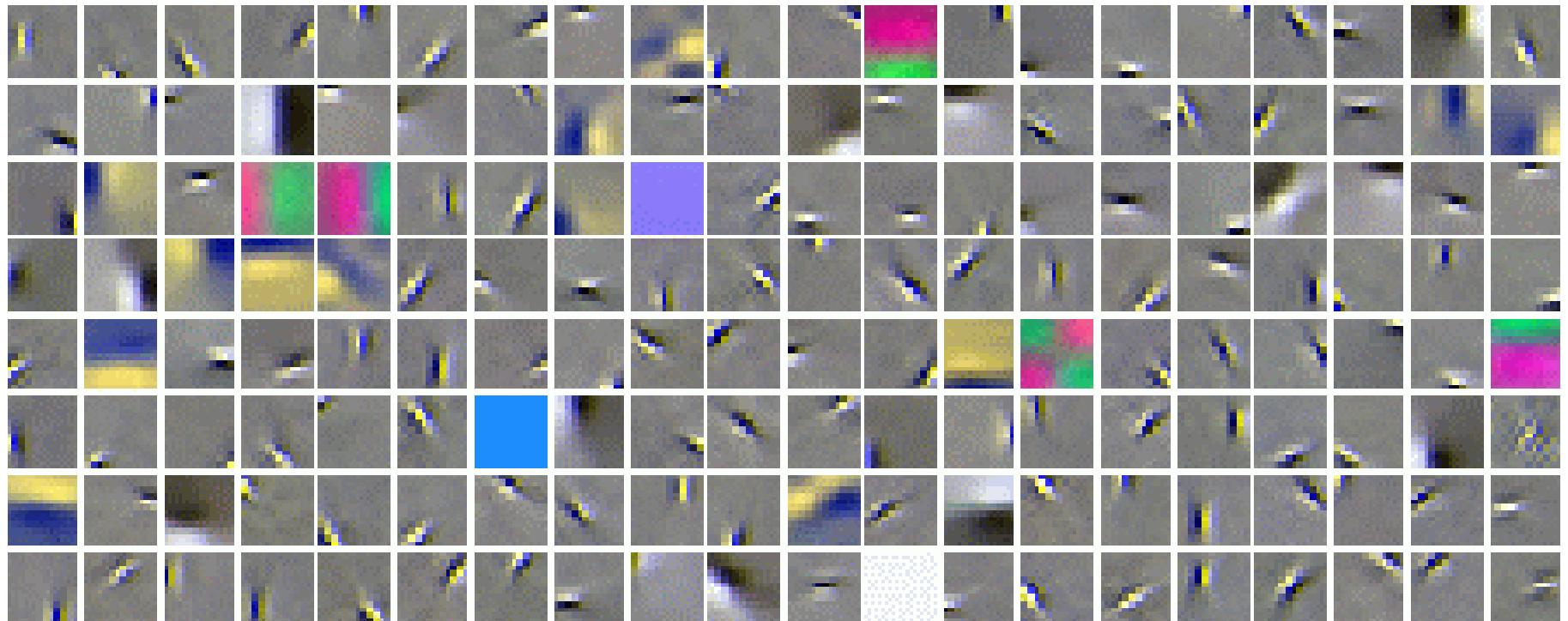
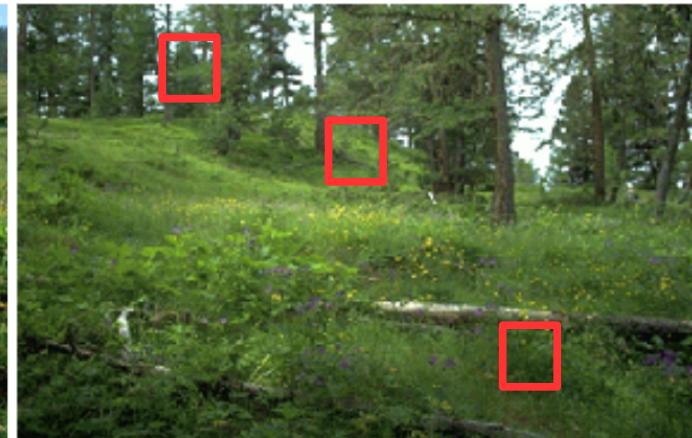
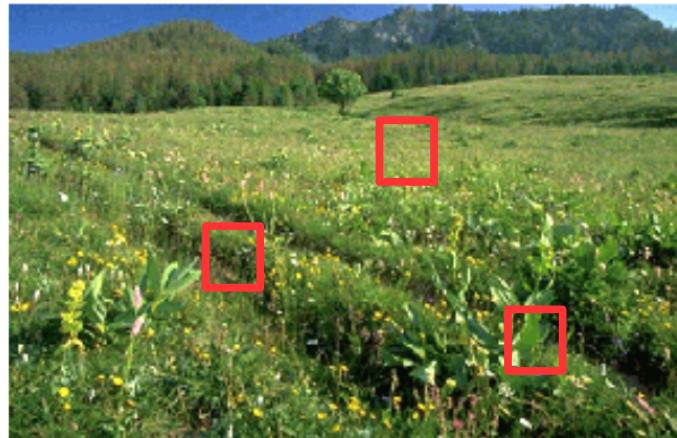
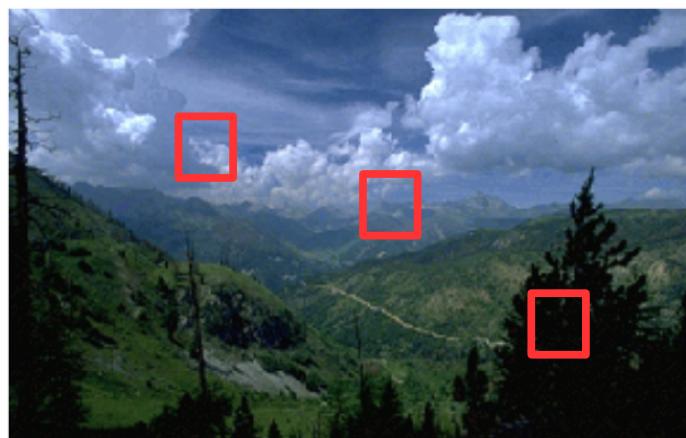
本週介紹 CNN

!



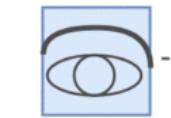
Basic Operations Convolutional Neural Networks Applications

Patterns shared by Patches

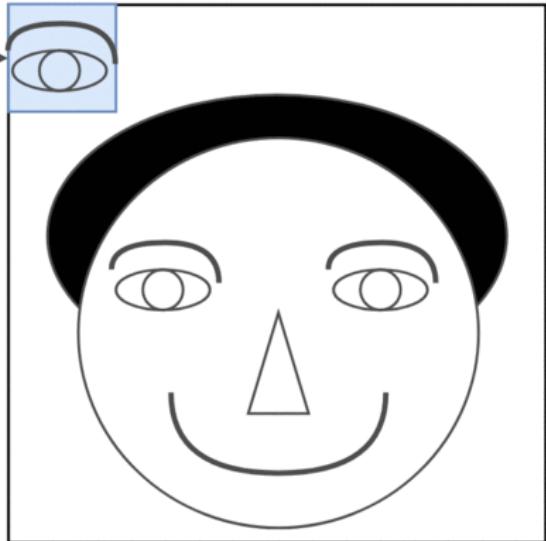
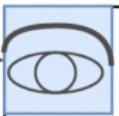


2D Spatial Convolution

Convolution與 Correlation 傻傻分不清楚



Convolution Kernel



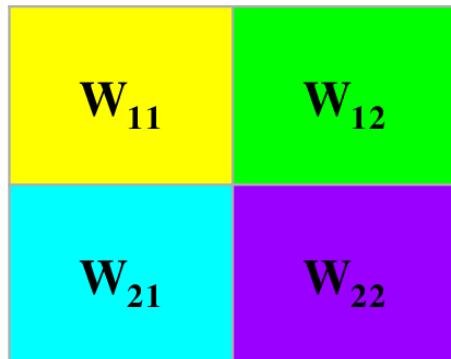
Image

=

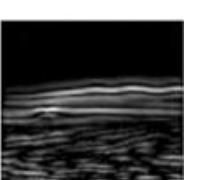
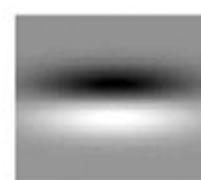
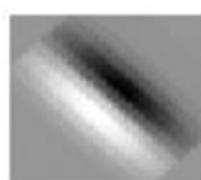
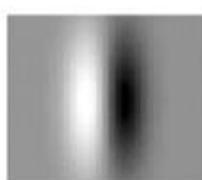
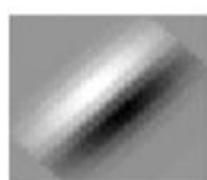
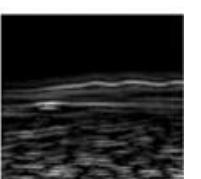
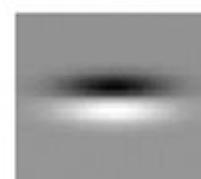
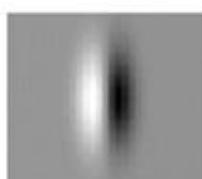
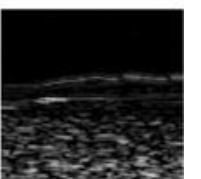
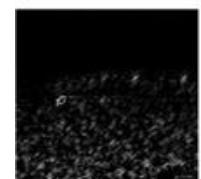
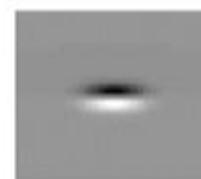
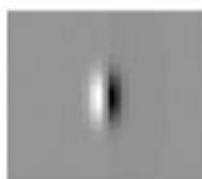
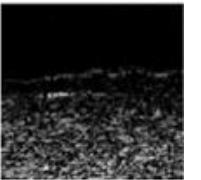
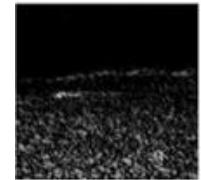
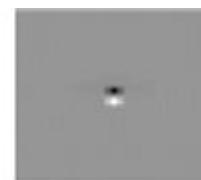
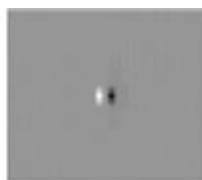
0				

Convolution Output

X_{11}	X_{12}	X_{13}
X_{21}	X_{22}	X_{23}
X_{31}	X_{32}	X_{33}



2D Spatial Filtering



Padding & Stride

Input 與 Output 的維度關係一定要會算

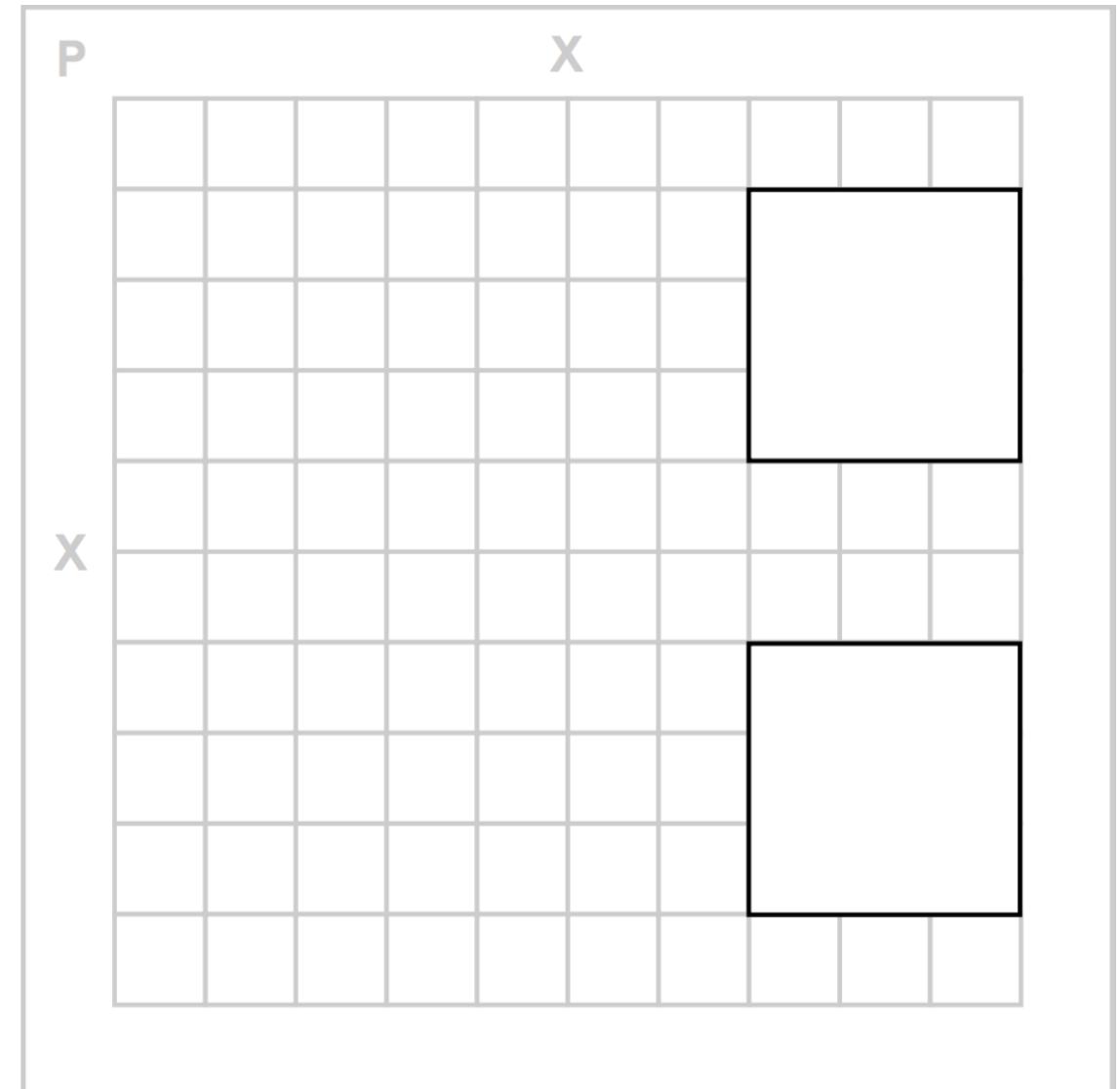
$$1 + \frac{X - F + 2P}{S}$$

X = image size

F = filter size

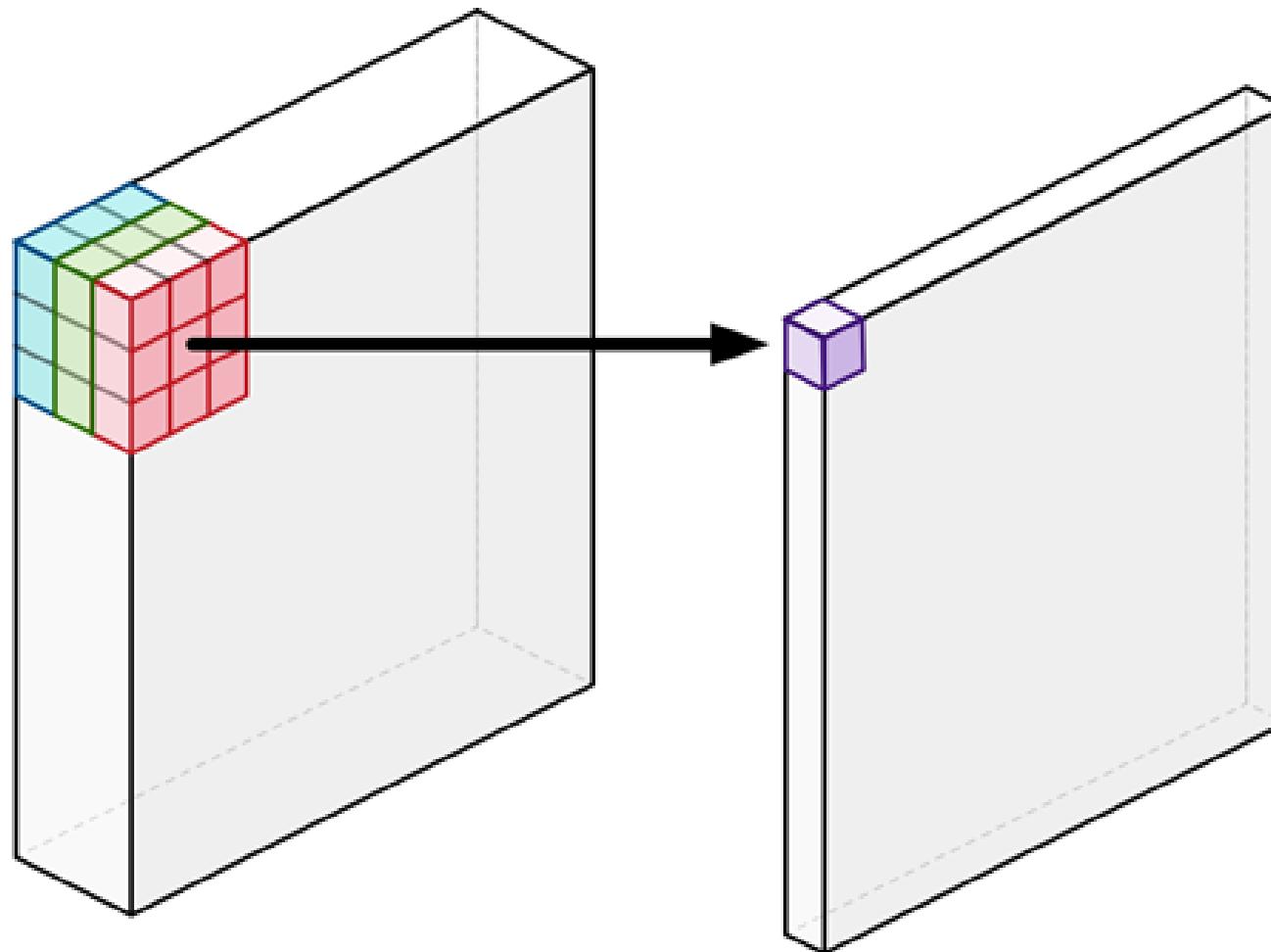
P = padding

S = stride



3D Spatial Convolution

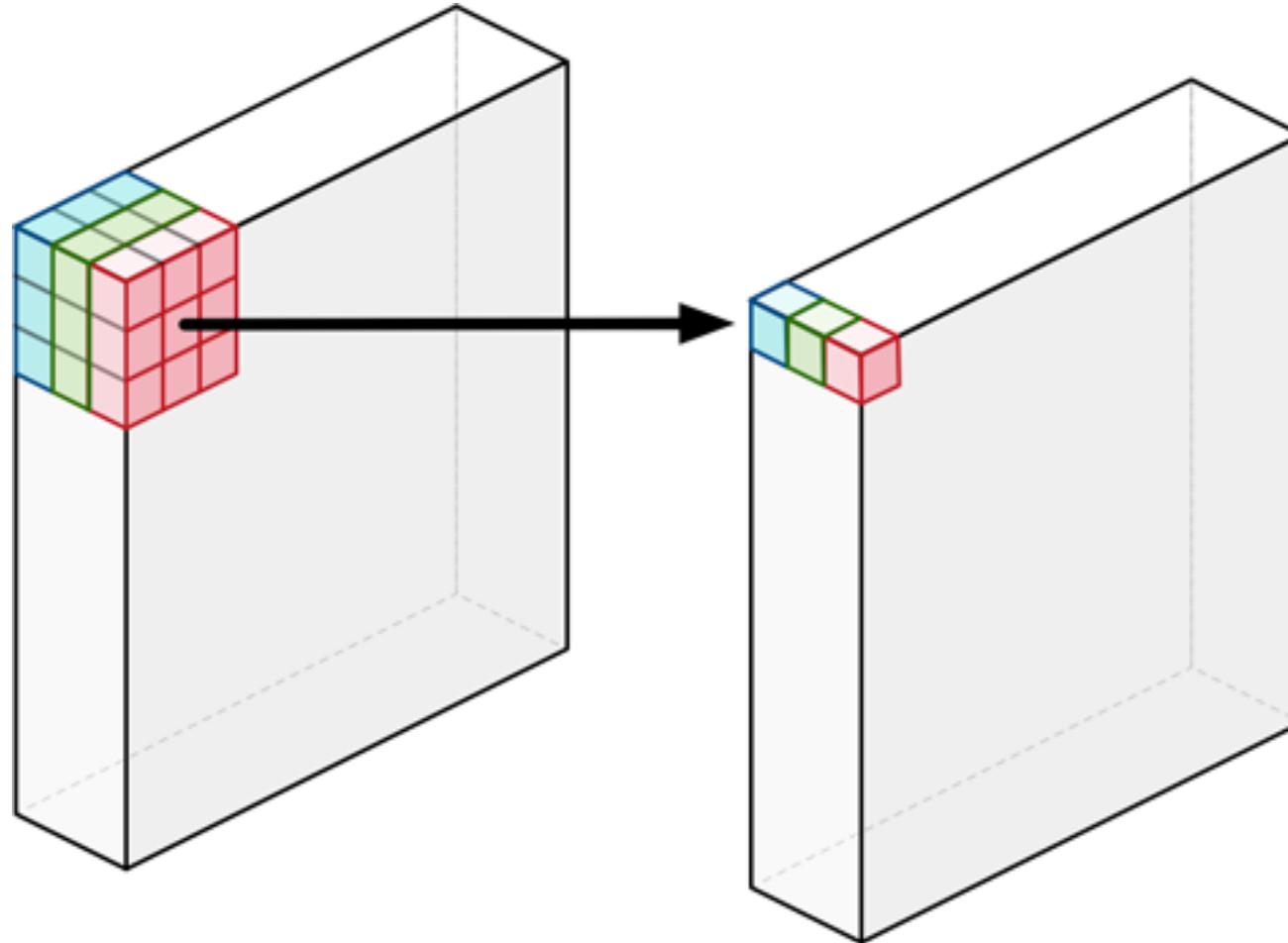
和 2D 一樣就是 template matching



Search Space 大小 : $2^{(3*3*3)} = 2^{27}$

Depthwise Separable Conv.

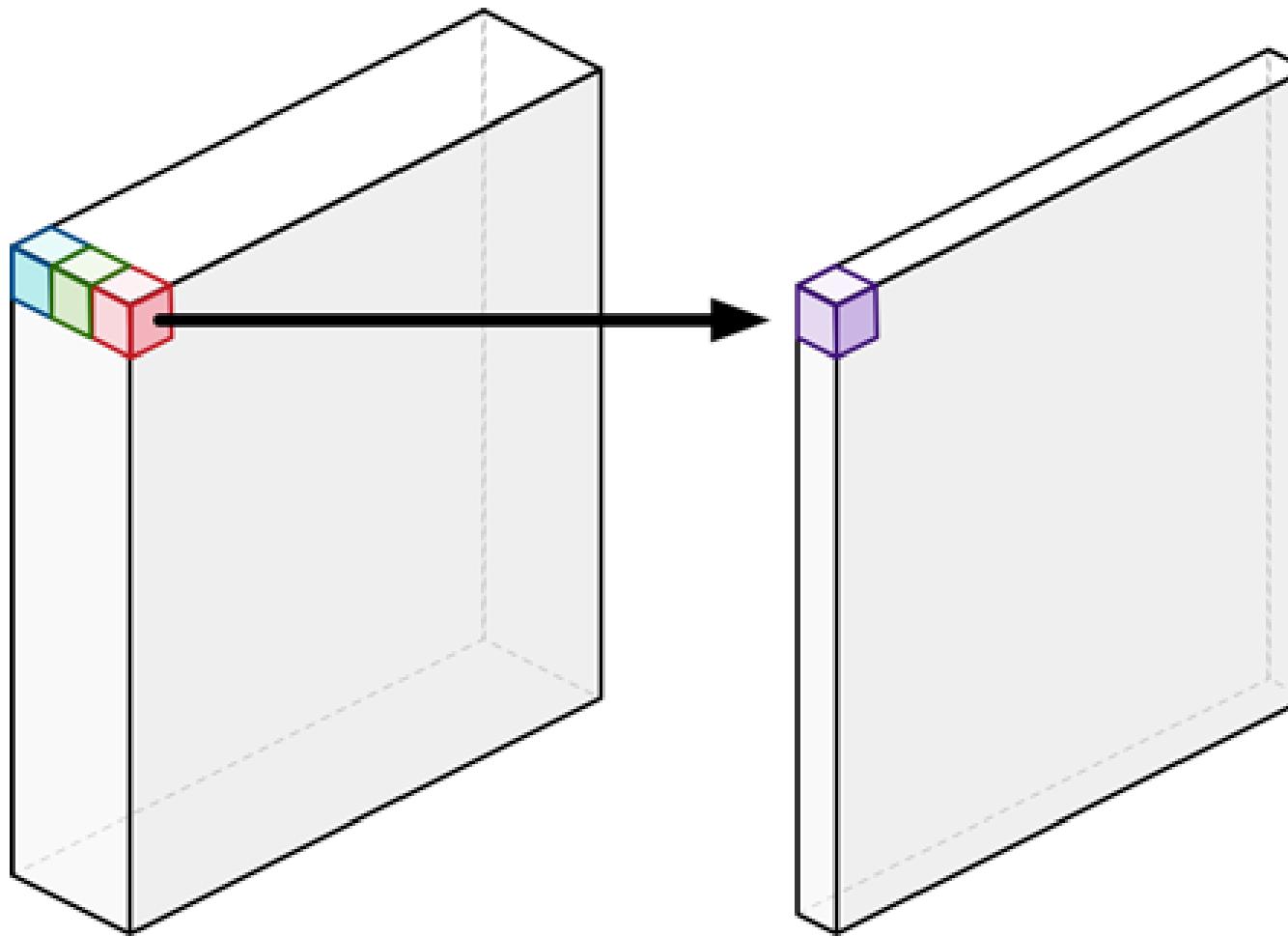
出現在 Xception Net 及其後繼的 Mobile Net 中



Search Space 大小: $2^{(3*3)*3} = 2^{9*3}$

Pointwise Convolution

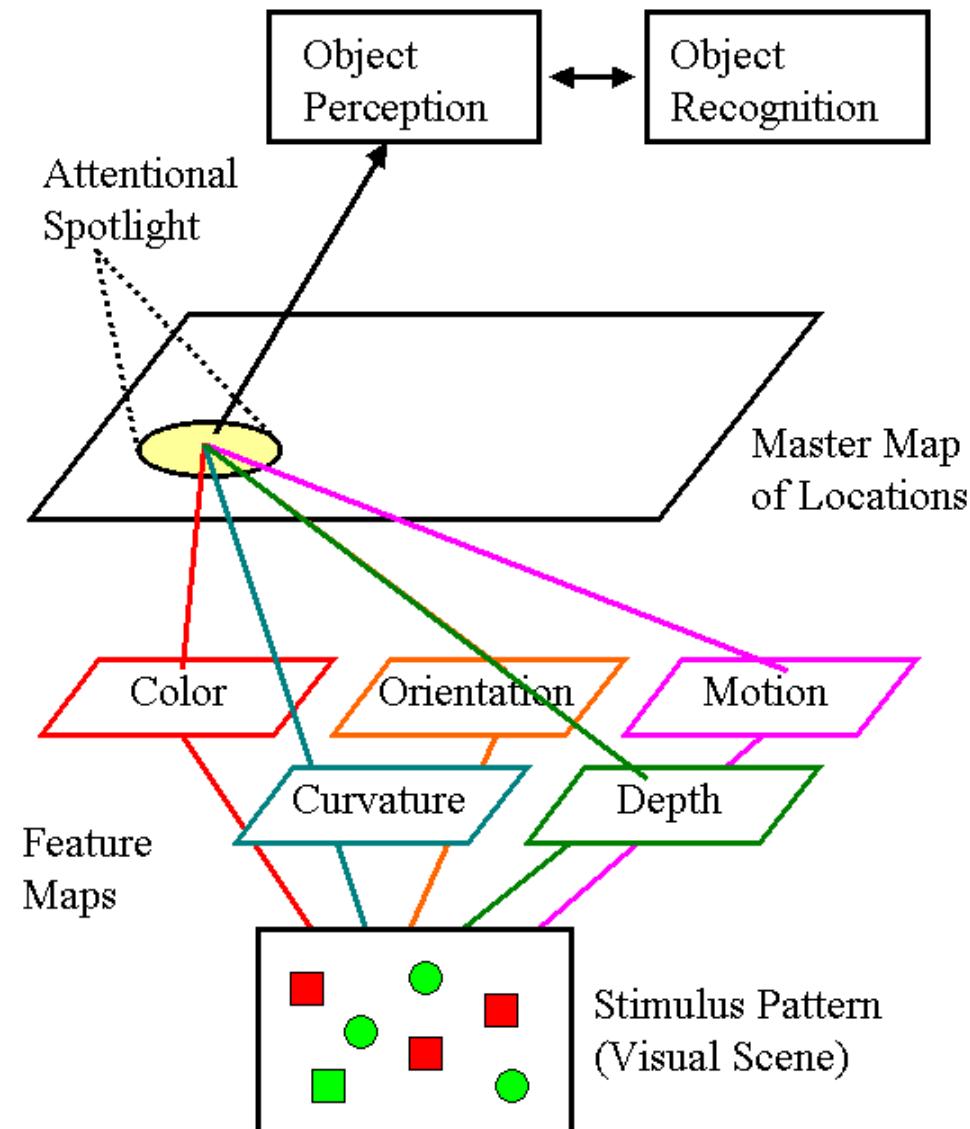
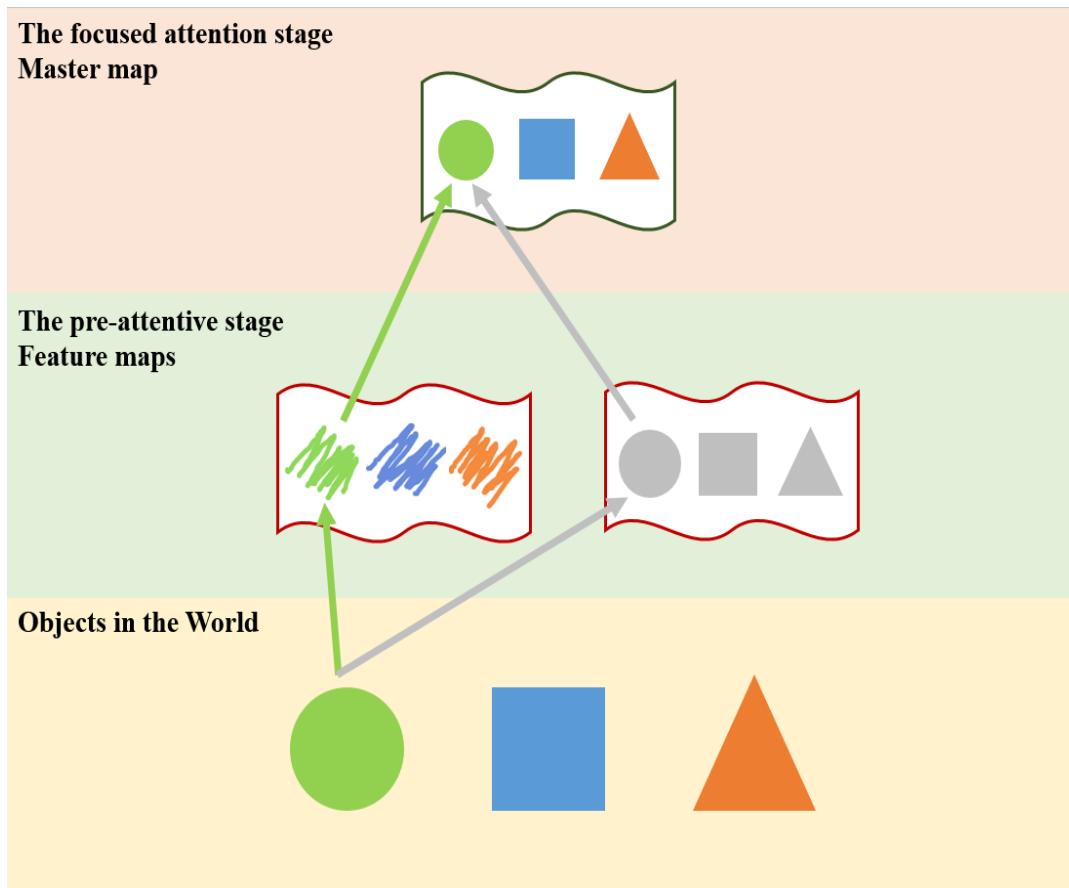
Inception, Xception, Squeeze, Mobile Nets 皆有



Feature Integration Theory

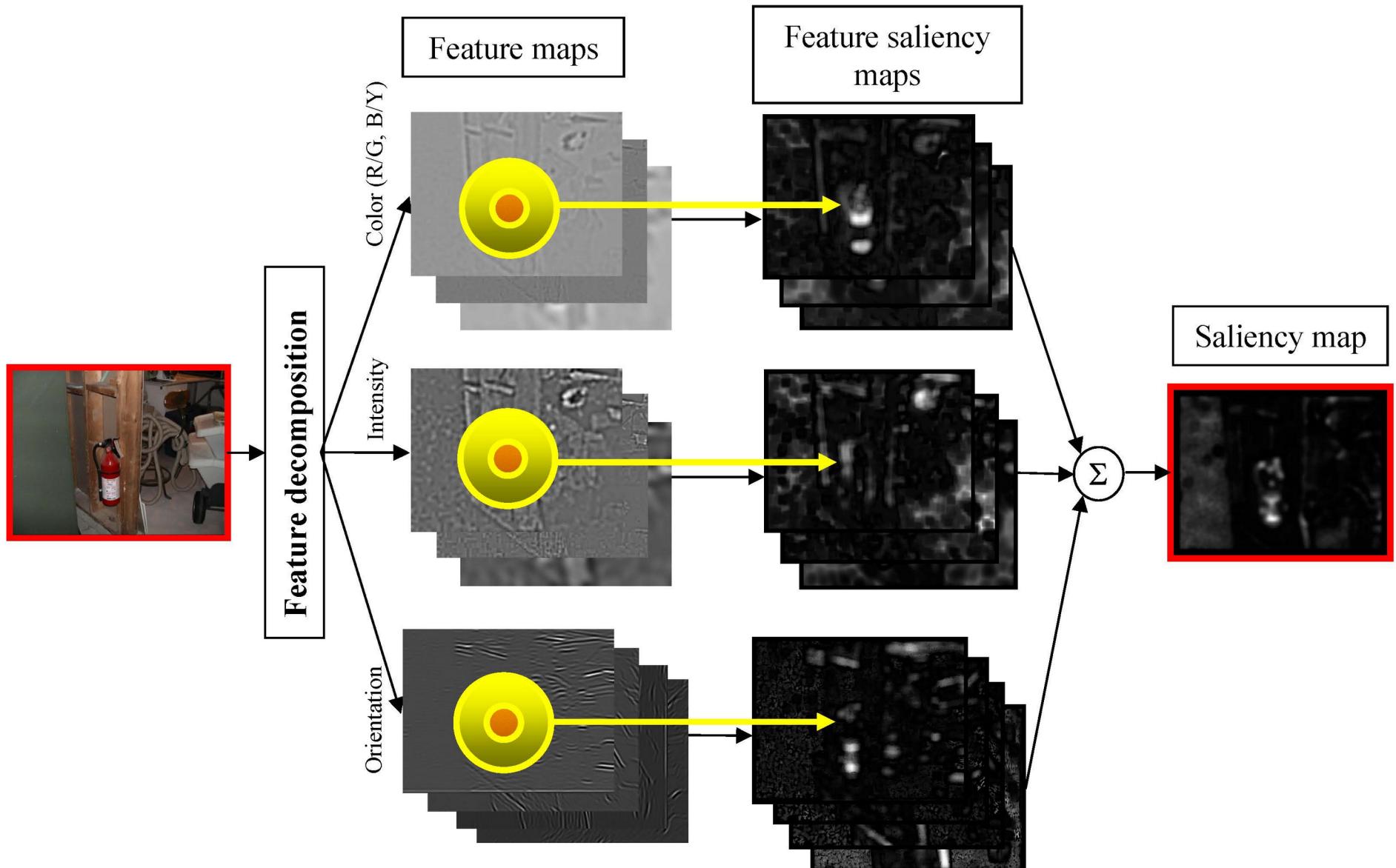
就是 Features 分開處理再整合

Feature Integration Theory (Treisman)



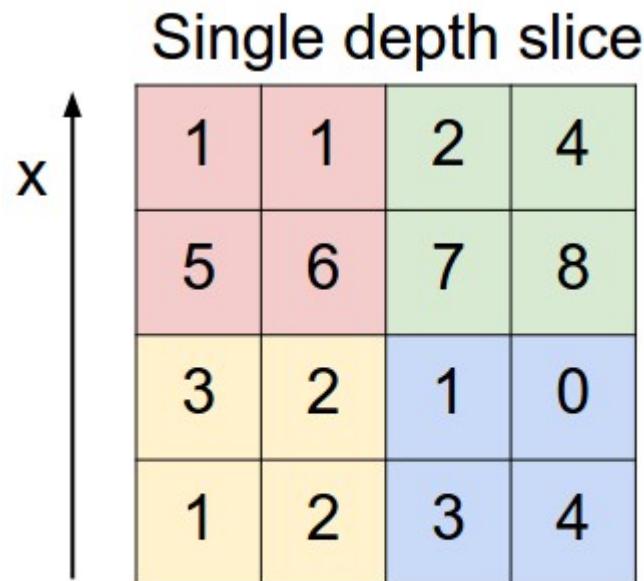
Saliency Map

只是 Feature Integration Theory 的實境版



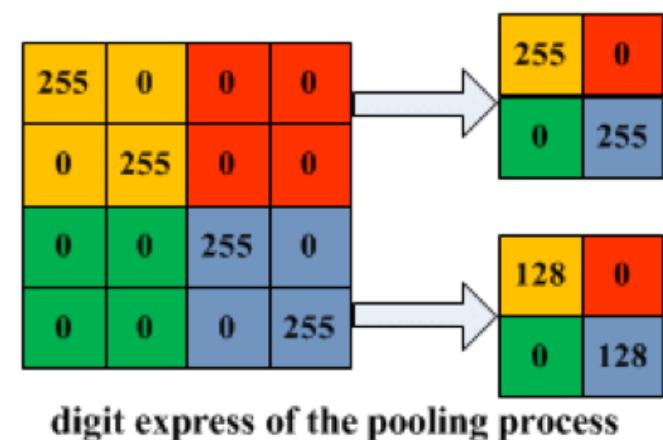
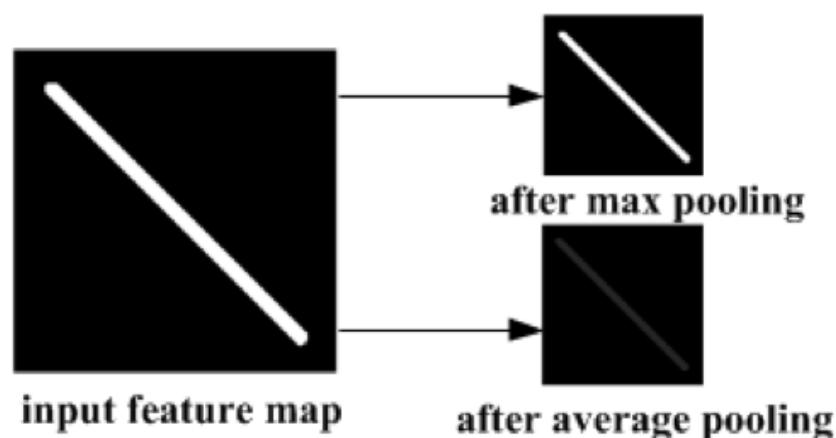
(Max) Pooling

就是 downsampling



max pool with 2x2 filters
and stride 2

6	8
3	4



CNN Terms

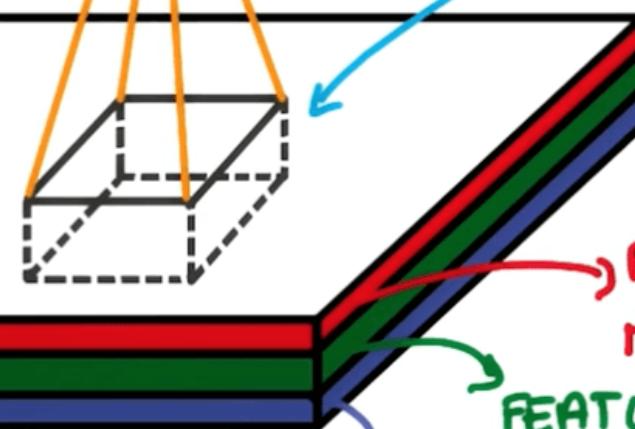
Kernel 對應到的就是生物上的 Receptive Field

CONVOLUTIONAL
LINGO

INPUT
DEPTH



$K = \text{OUTPUT DEPTH}$



PATCH /
KERNEL

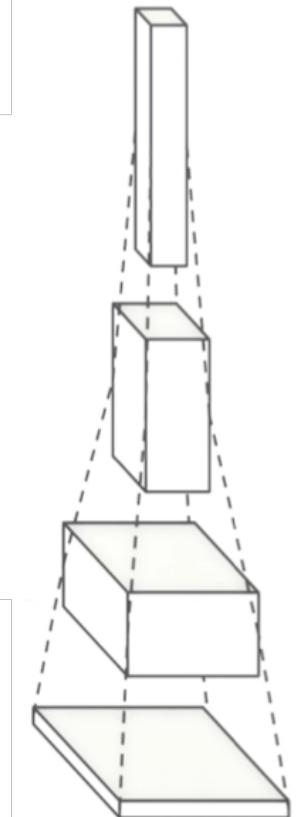
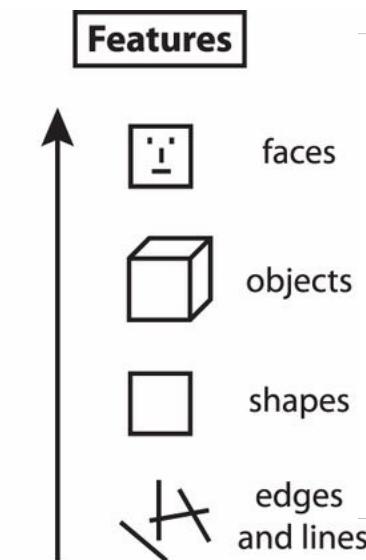
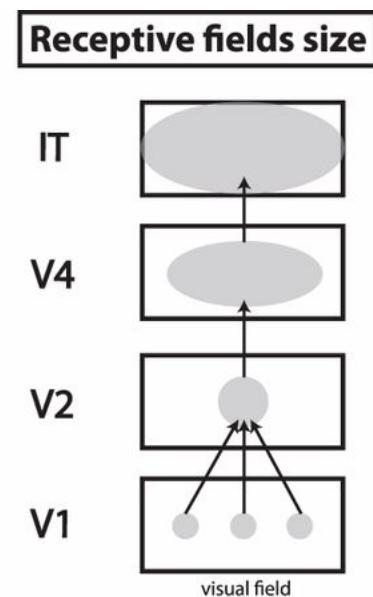
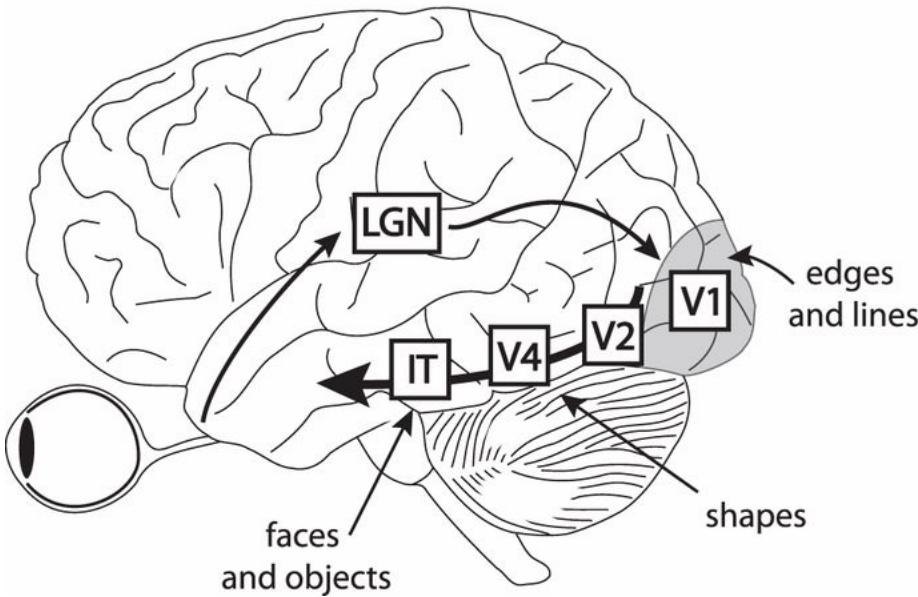
FEATURE
MAP

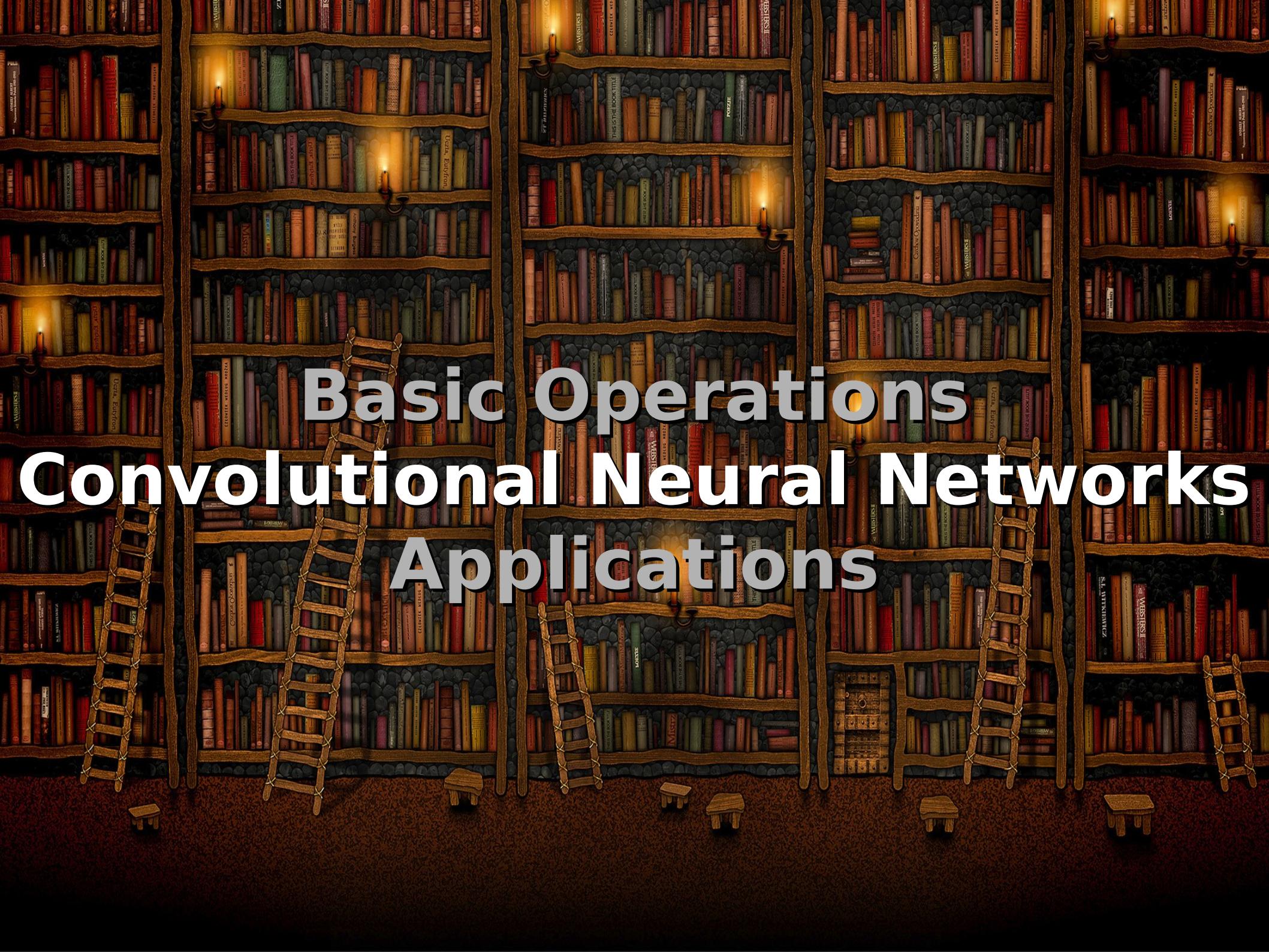
FEATURE
MAP

FEATURE
MAP

CNN 的金字塔結構

是在仿 ventral visual pathway in the brain

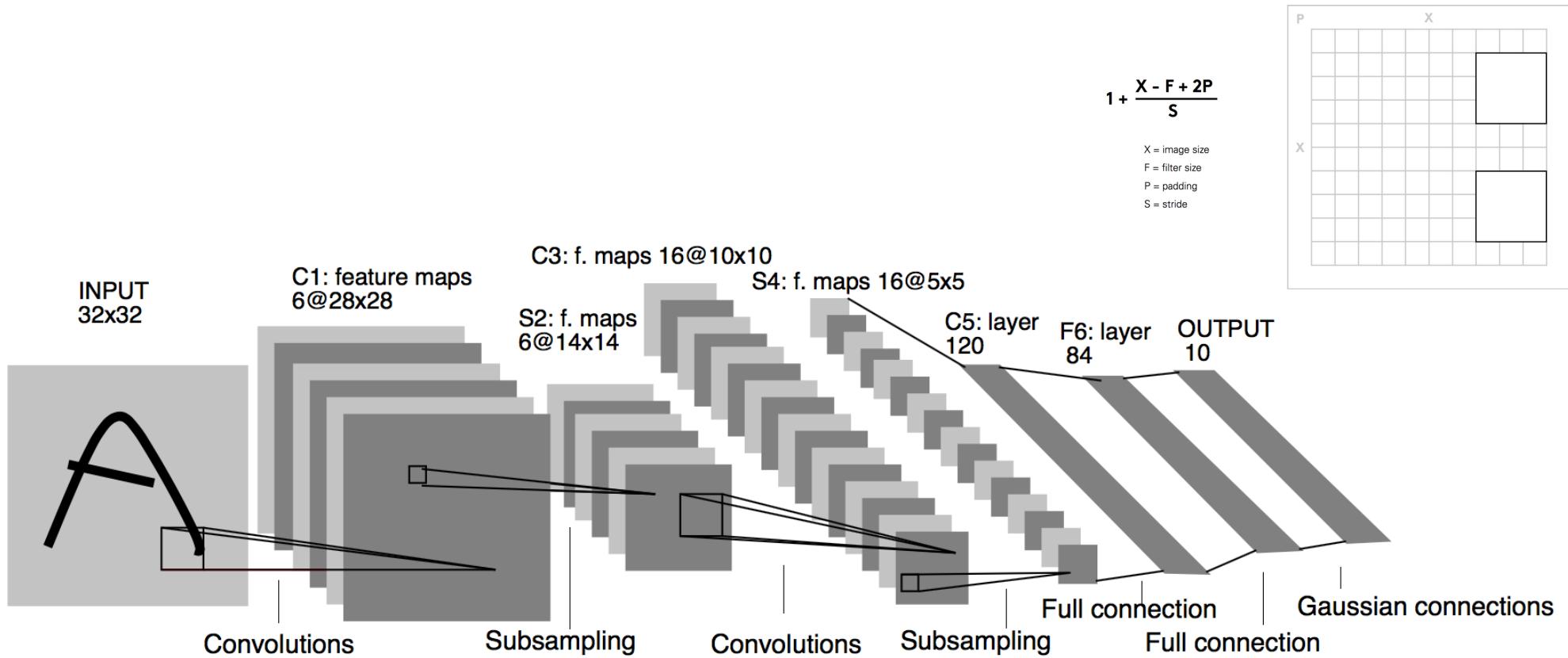




Basic Operations Convolutional Neural Networks Applications

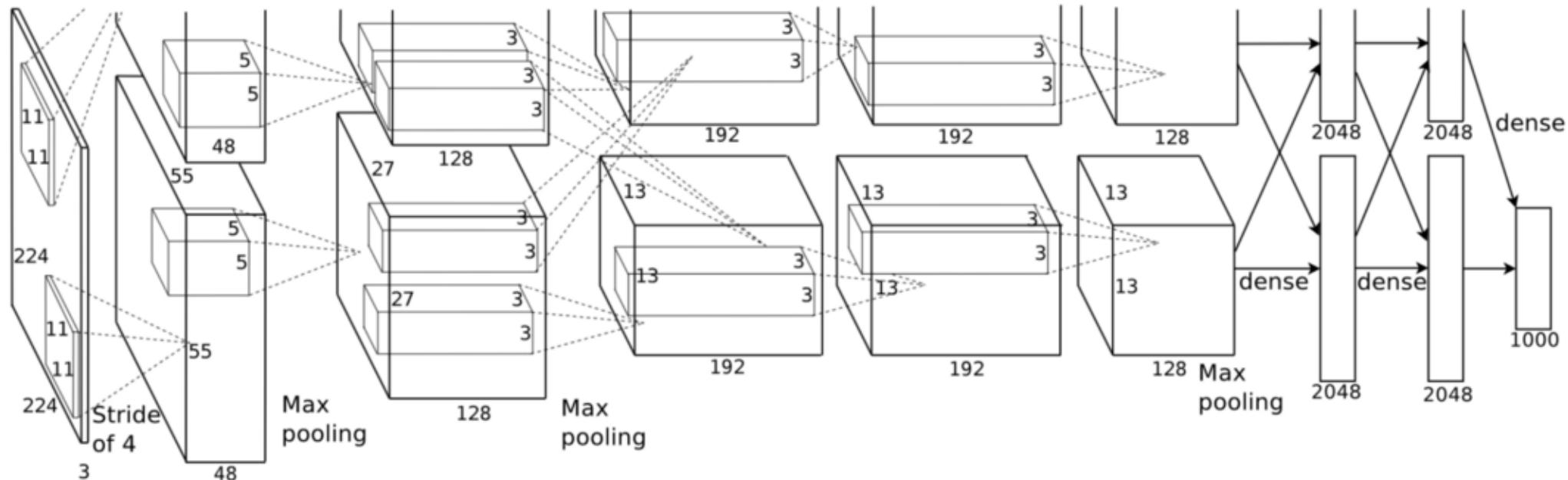
LeNet (1998)

有 convolution 有 pooling



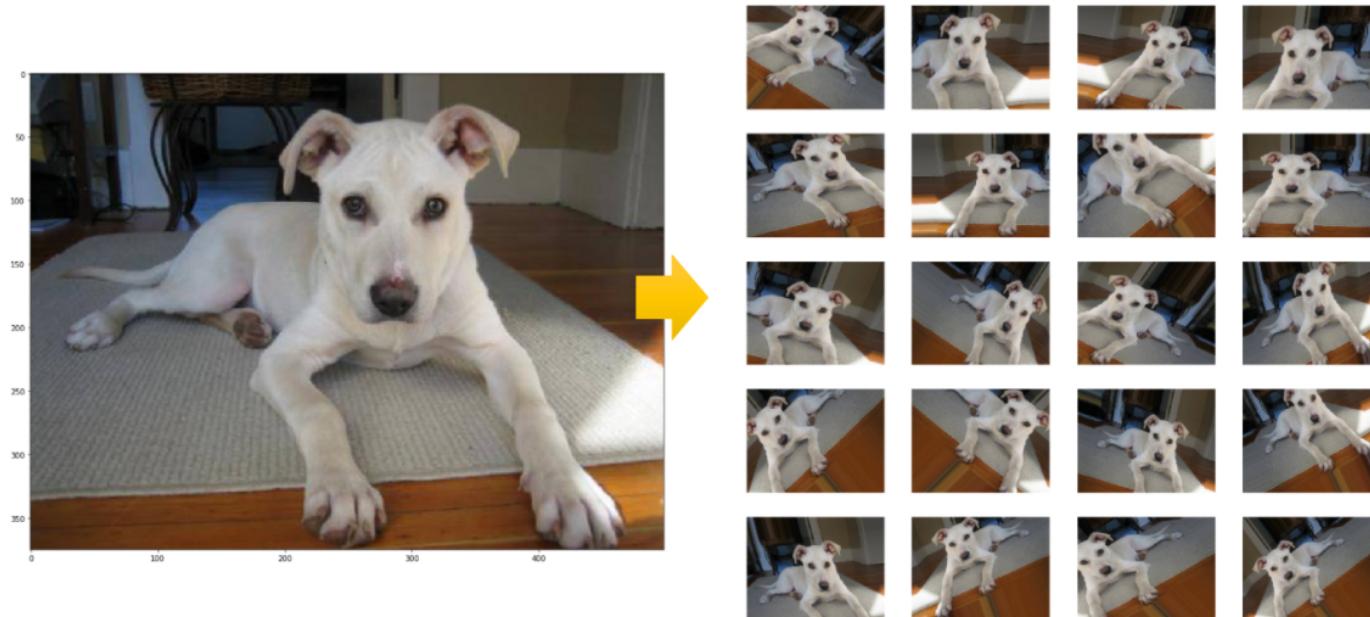
AlexNet (2012)

引入 Relu, LRN, Data Augmentation, Dropout
並用兩顆 Nvidia GTX580 訓練 6 天



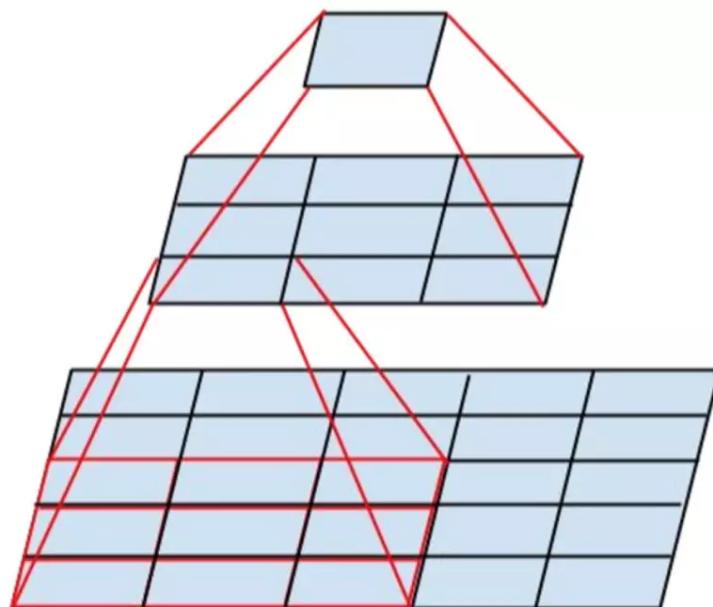
Data Augmentation

把資料集變大：仿造視覺的 tolerance (“invariance”)



VGG Net (2014)

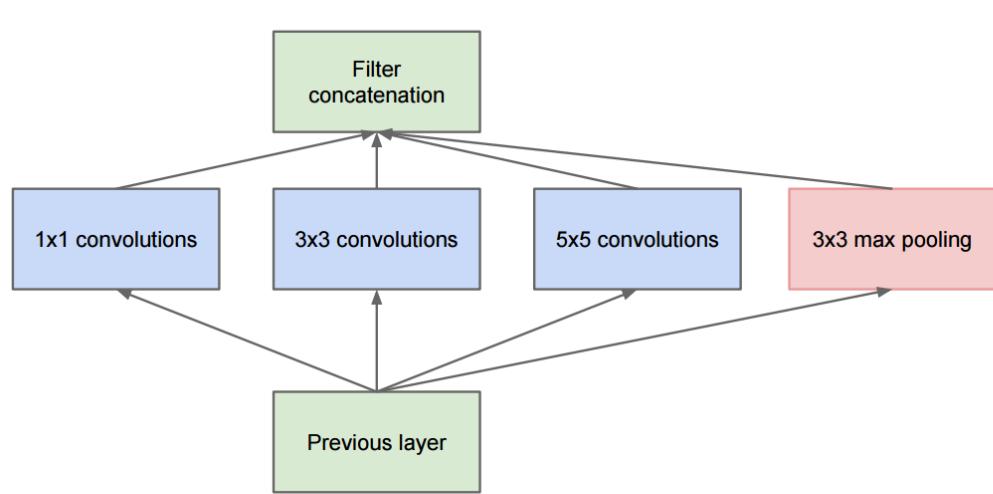
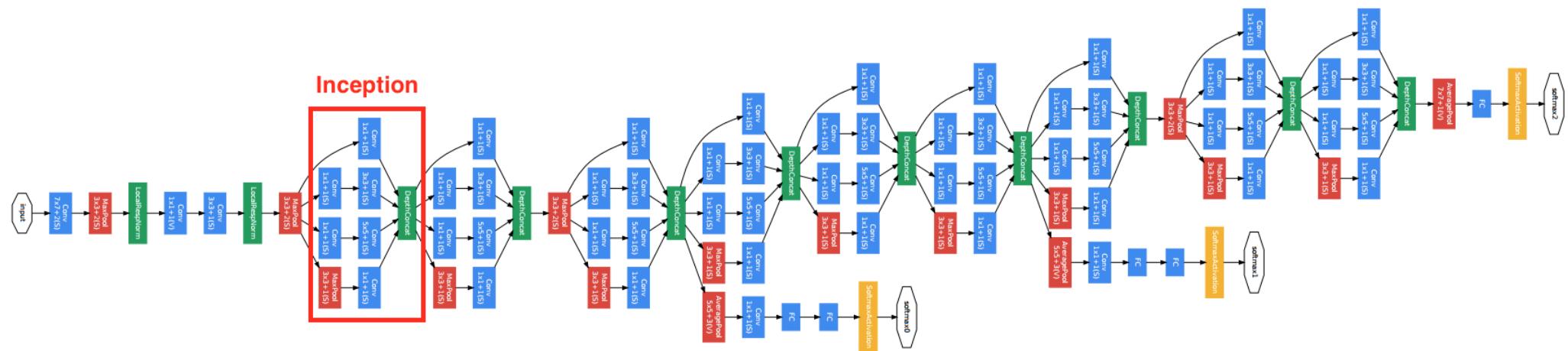
闡明下游 convolution kernels 只要 3×3



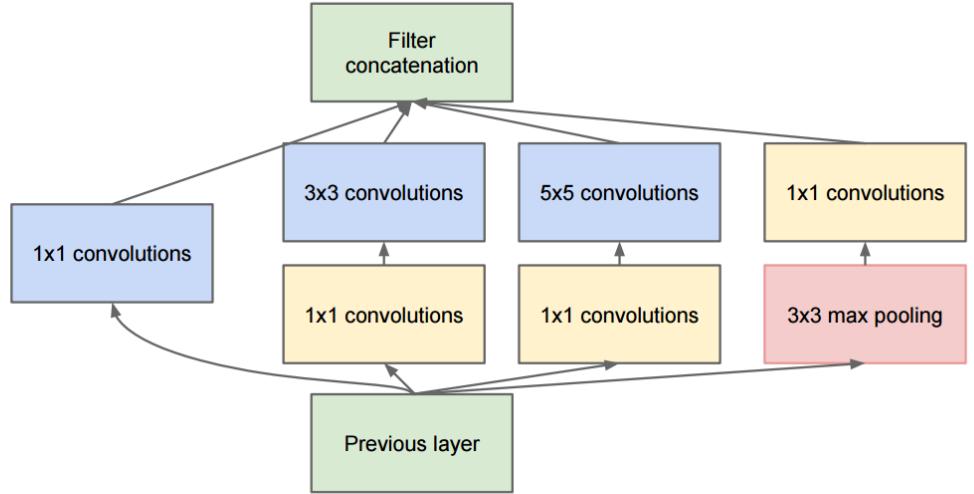
ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 \times 224 RGB image)					
conv3-64	conv3-64 LRN	conv3-64 conv3-64	conv3-64	conv3-64	conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 conv3-128	conv3-128	conv3-128	conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 conv1-256	conv3-256 conv3-256 conv3-256	conv3-256 conv3-256 conv3-256 conv3-256
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 conv1-512	conv3-512 conv3-512 conv3-512	conv3-512 conv3-512 conv3-512 conv3-512
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 conv1-512	conv3-512 conv3-512 conv3-512	conv3-512 conv3-512 conv3-512 conv3-512
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

GoogLeNet (2015)

Inception module 主要仿製 multiscale vision



(a) Inception module, naïve version

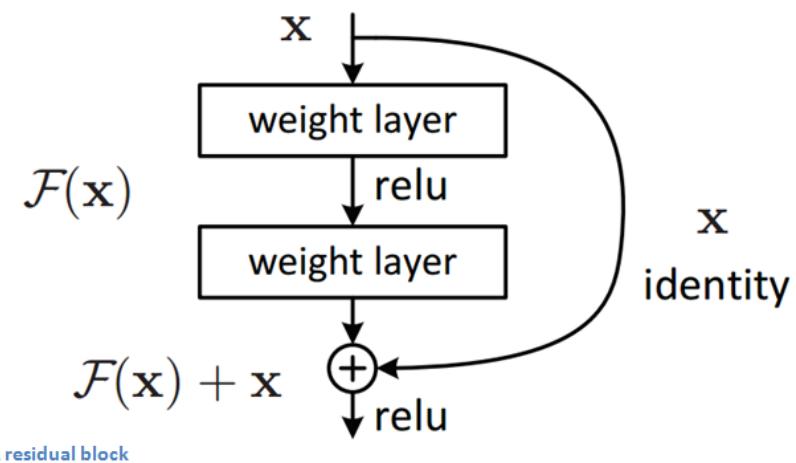
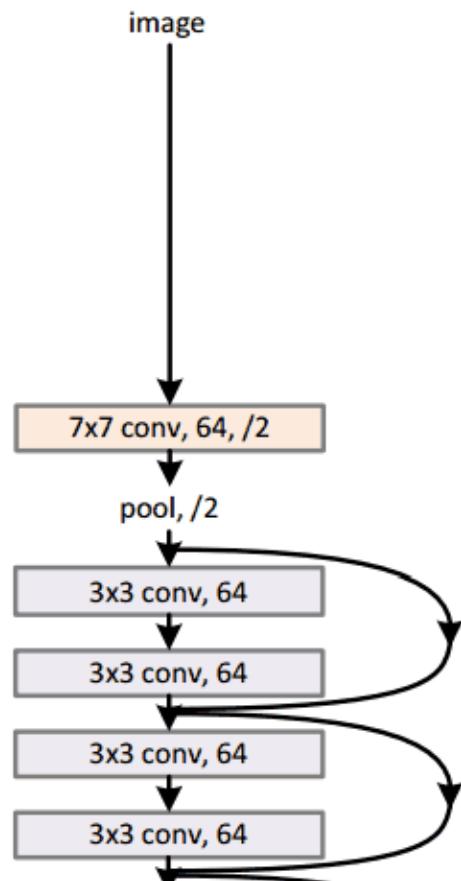


(b) Inception module with dimension reductions

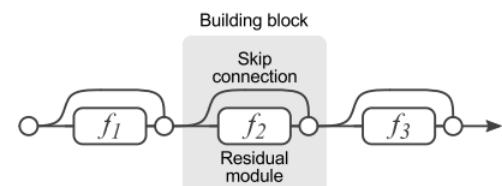
ResNet (2015)

$$f(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \dots$$

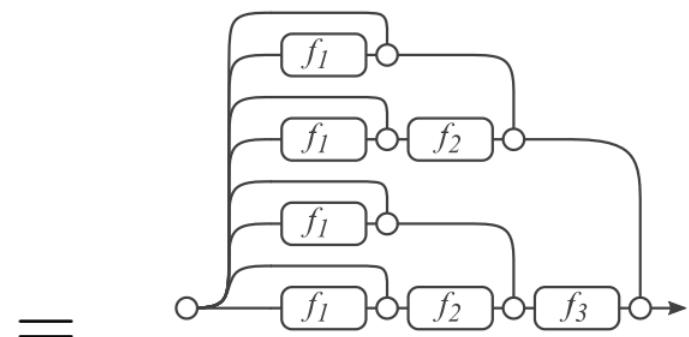
34-layer residual



A residual block



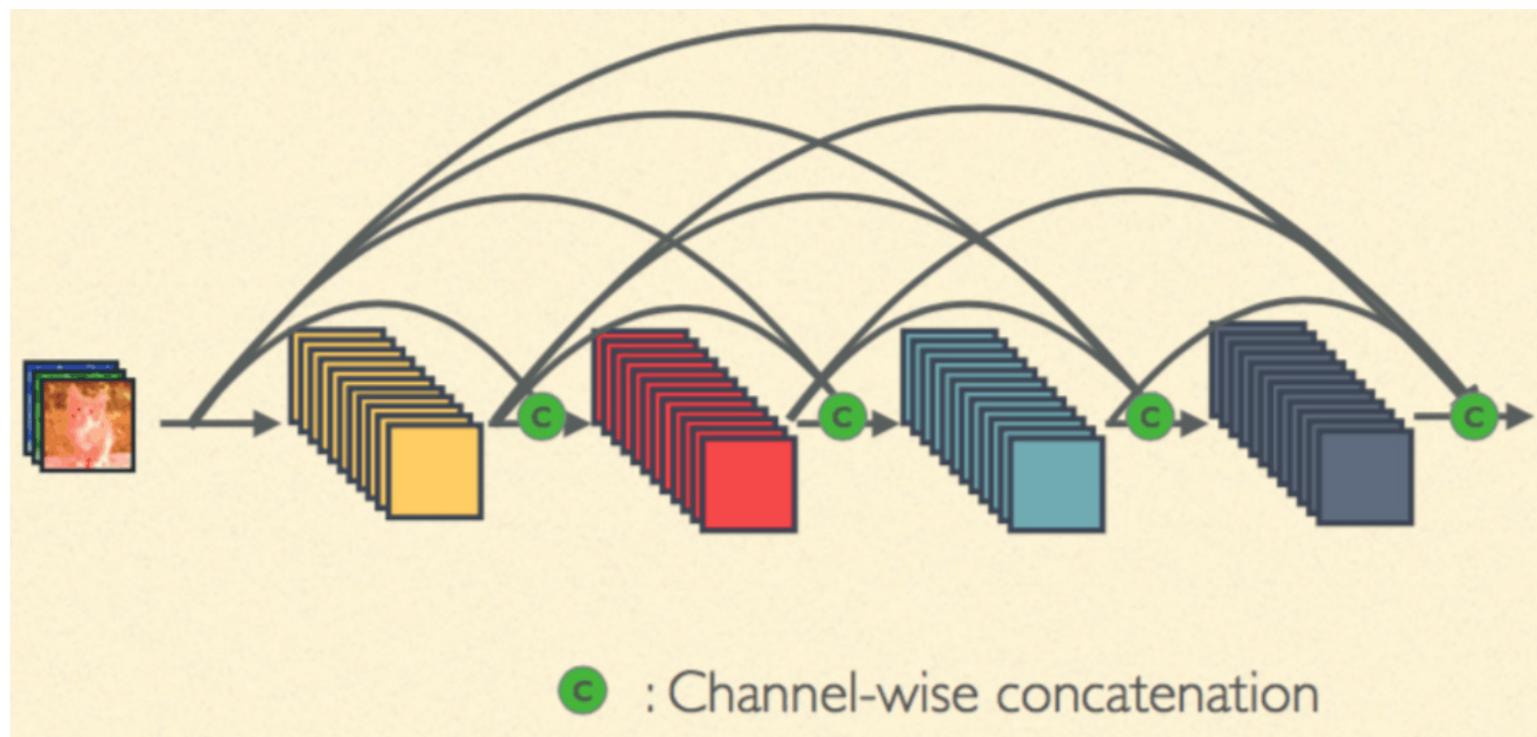
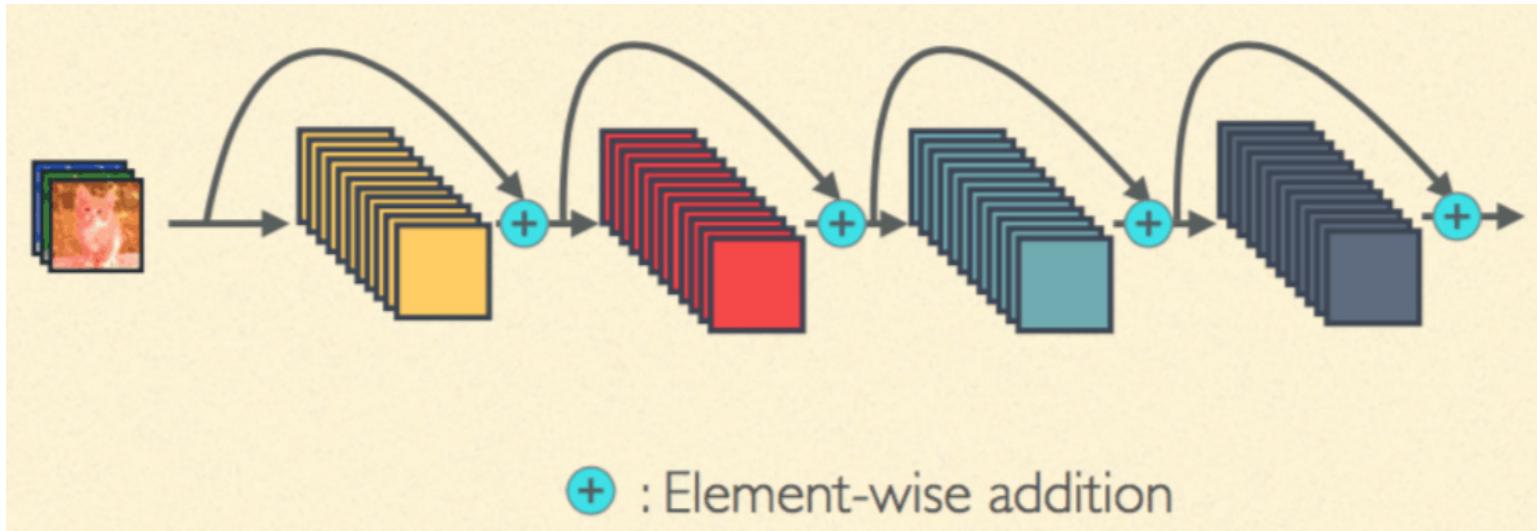
(a) Conventional 3-block residual network



(b) Unraveled view of (a)

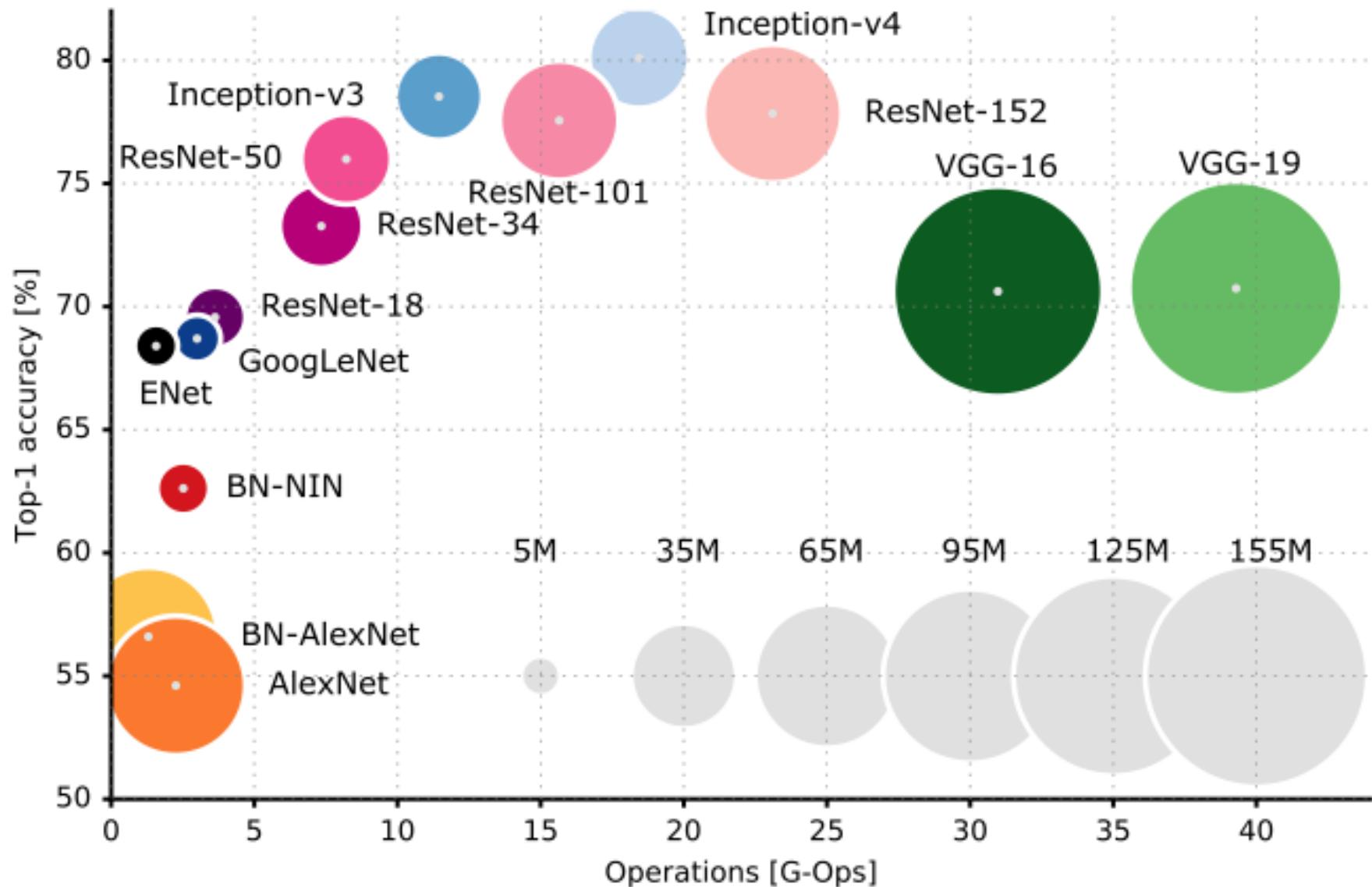
DenseNet (2017)

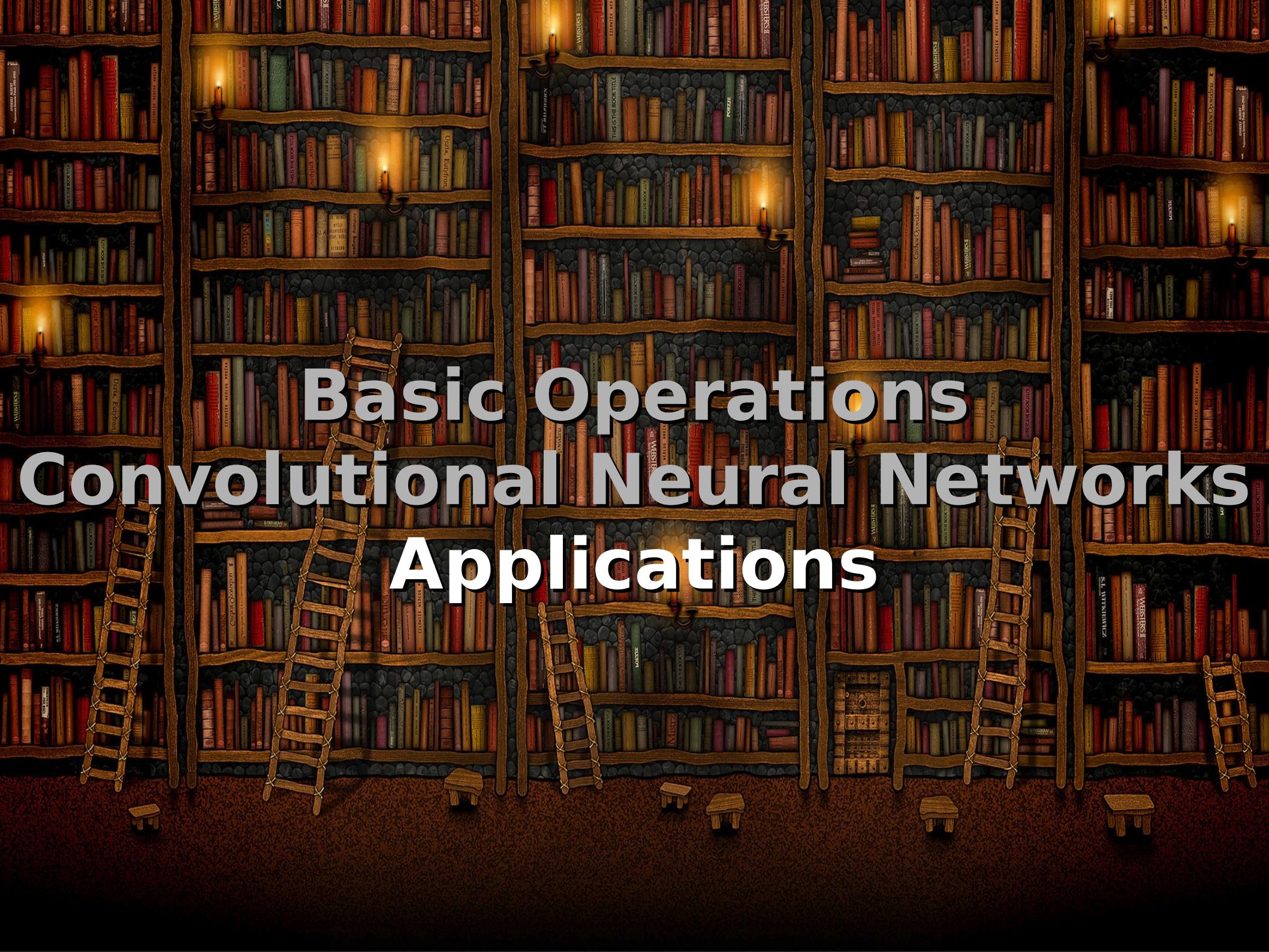
比 ResNet 加入更多跳接



CNN 模型比較

有些雖強大但計算太重

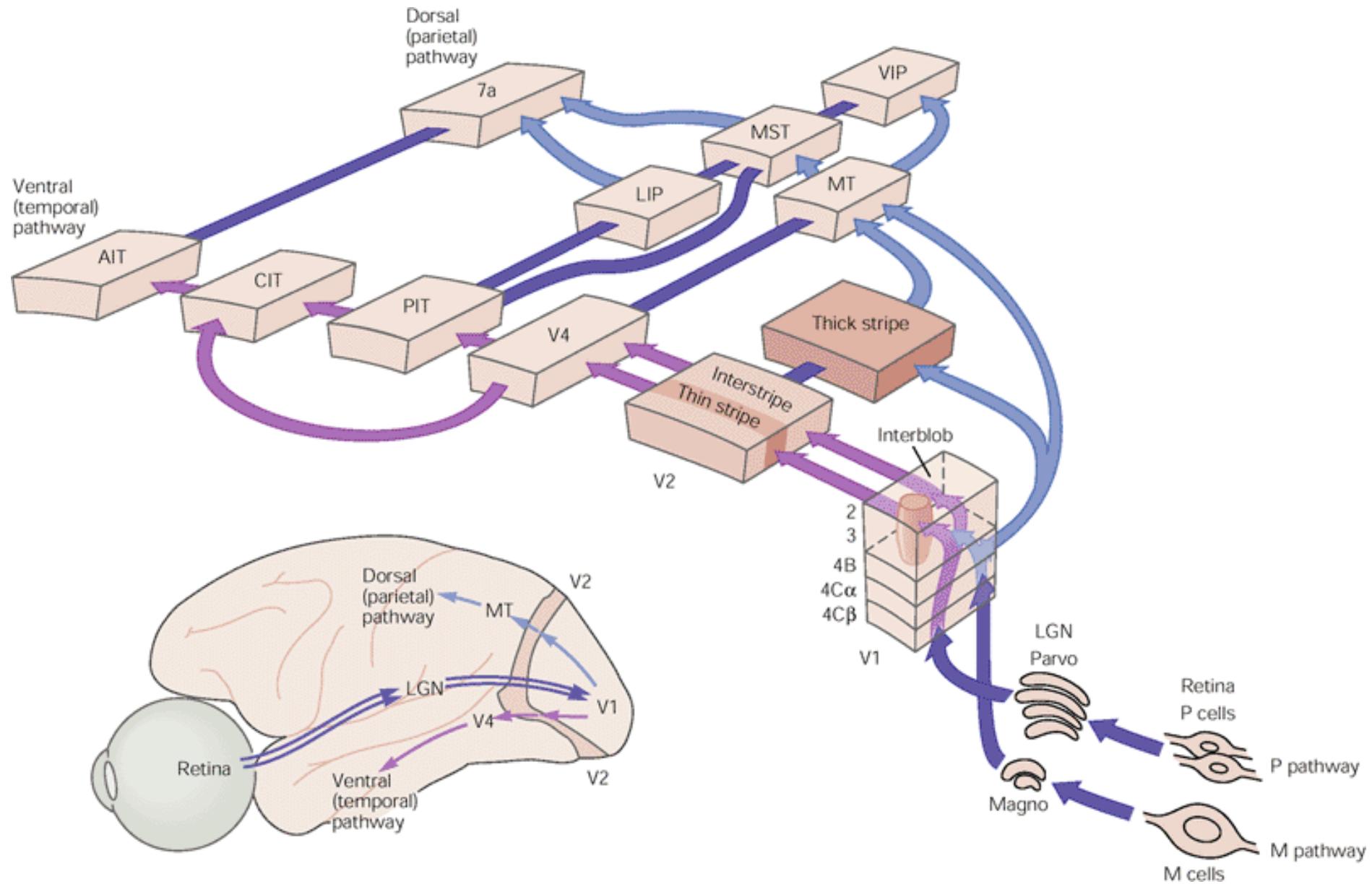




Basic Operations Convolutional Neural Networks Applications

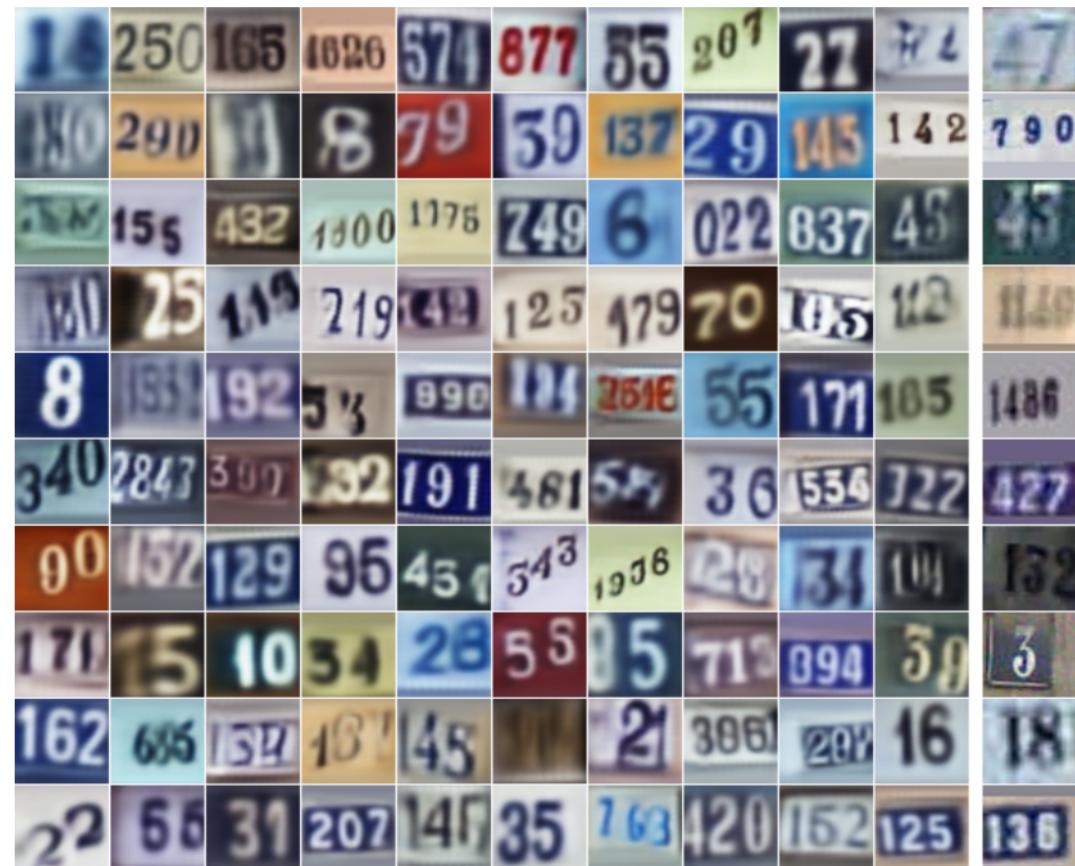
CNN 只模仿了 What Pathway

但還有 Where Pathway

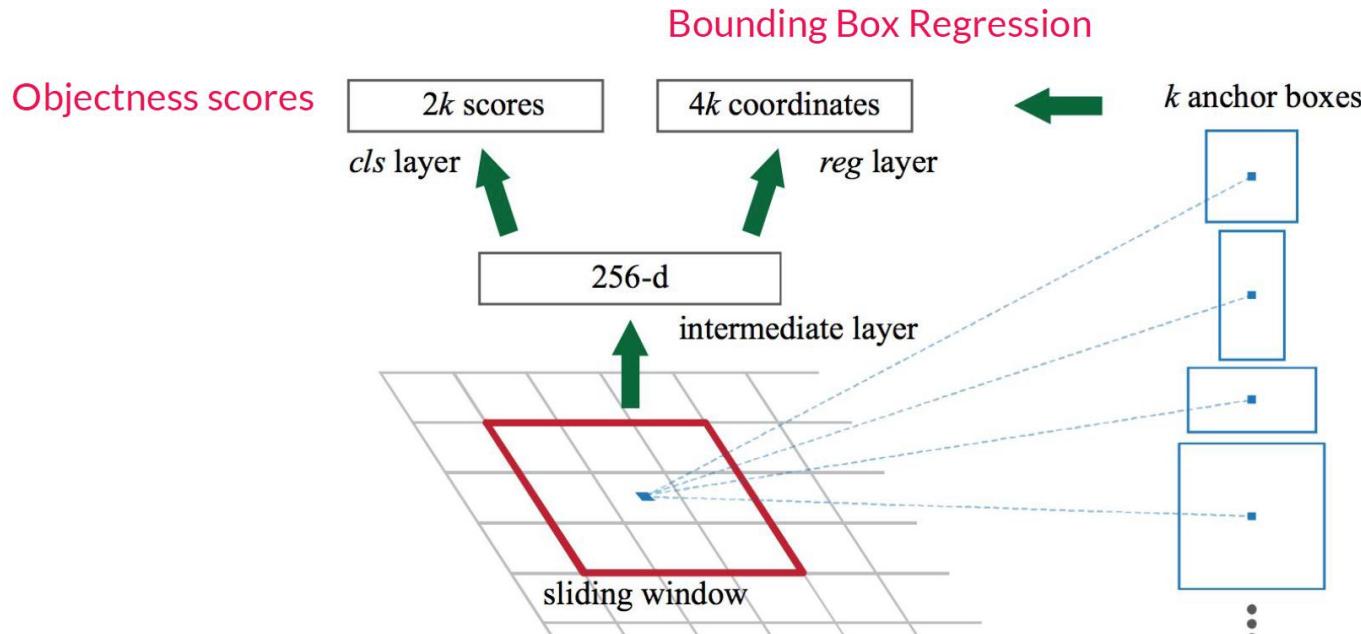


只模仿 What Pathway 的不足

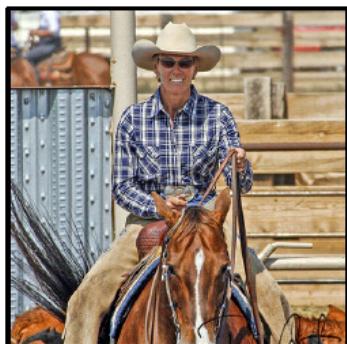
無法分解問題來各個擊破



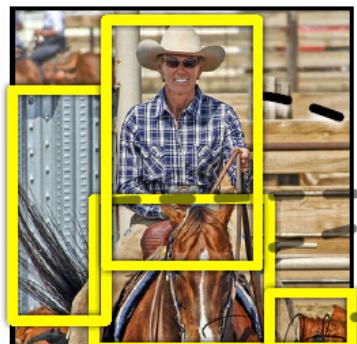
Region-based CNN (R-CNN)



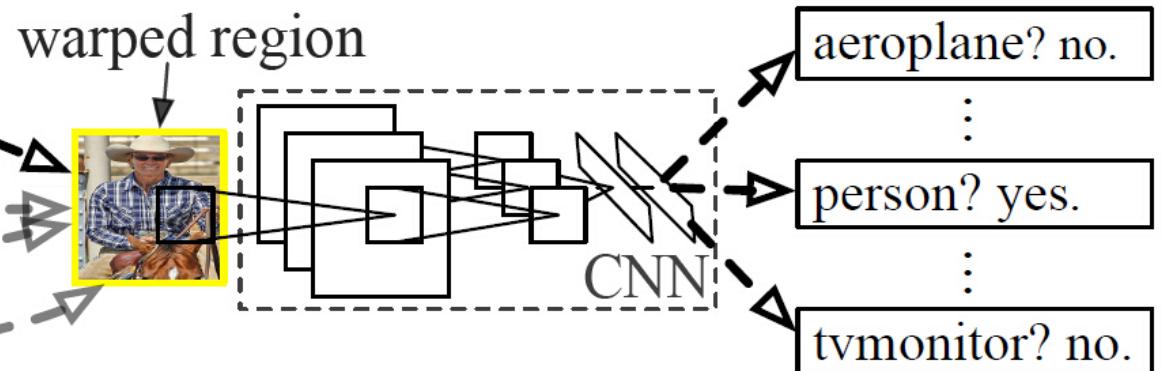
R-CNN: *Regions with CNN features*



1. Input image



2. Extract region proposals ($\sim 2k$)

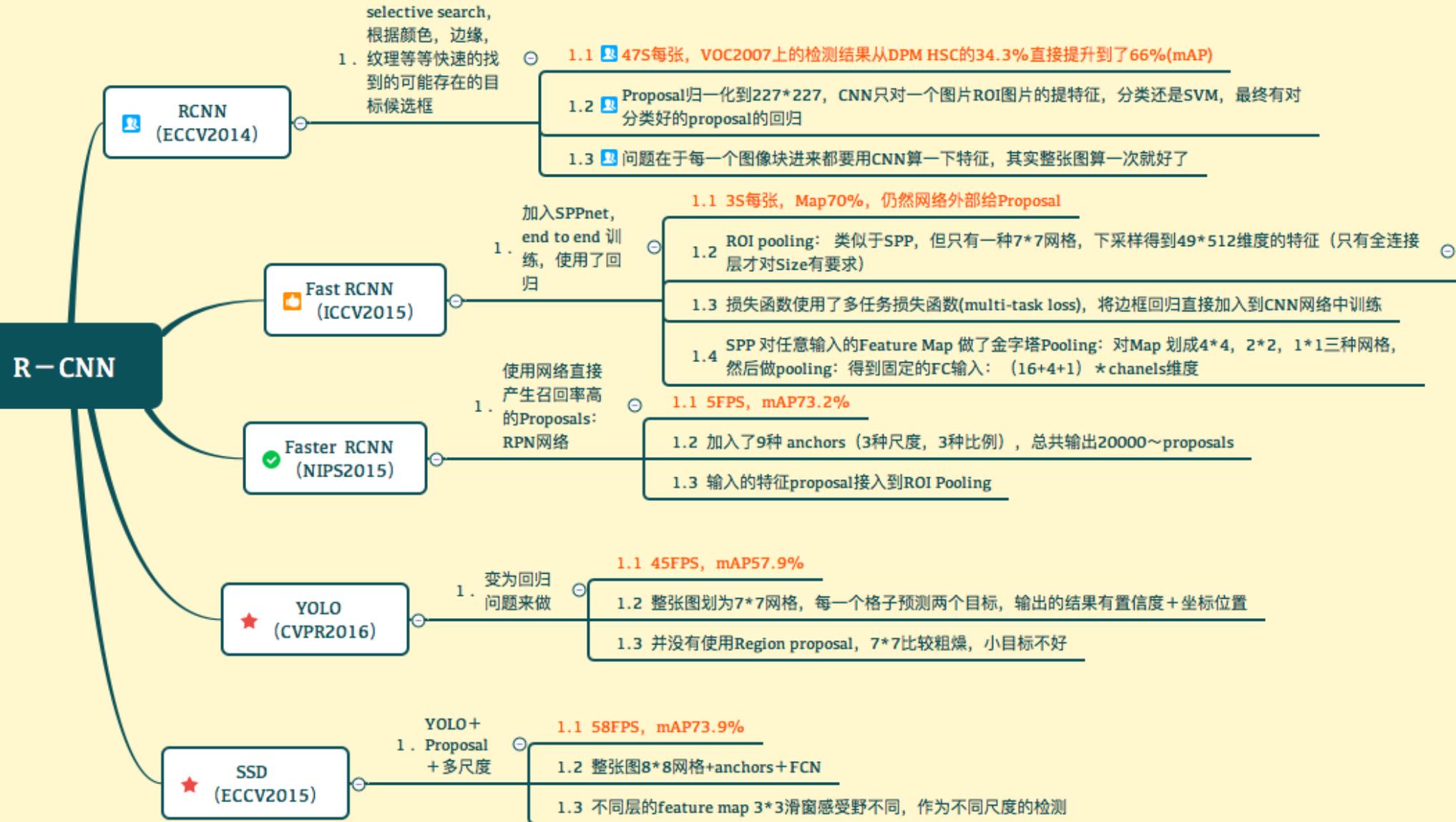


3. Compute CNN features

4. Classify regions

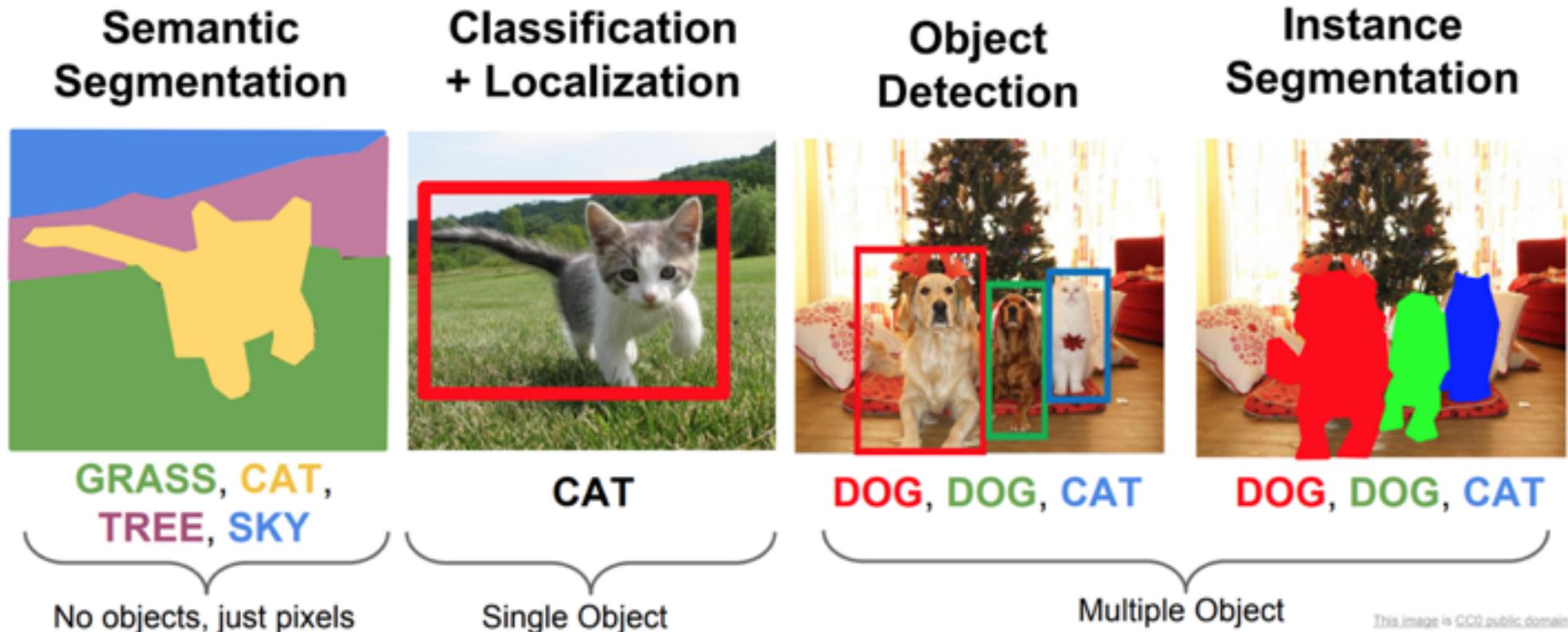
R-CNN 的徒子徒孫

族繁不及備載



電腦視覺的幾類問題

都是用 CNN 來處理



在生醫影像的應用中也都是這幾類問題

Object Classification (1/2)

如判斷大腦是否有腫瘤

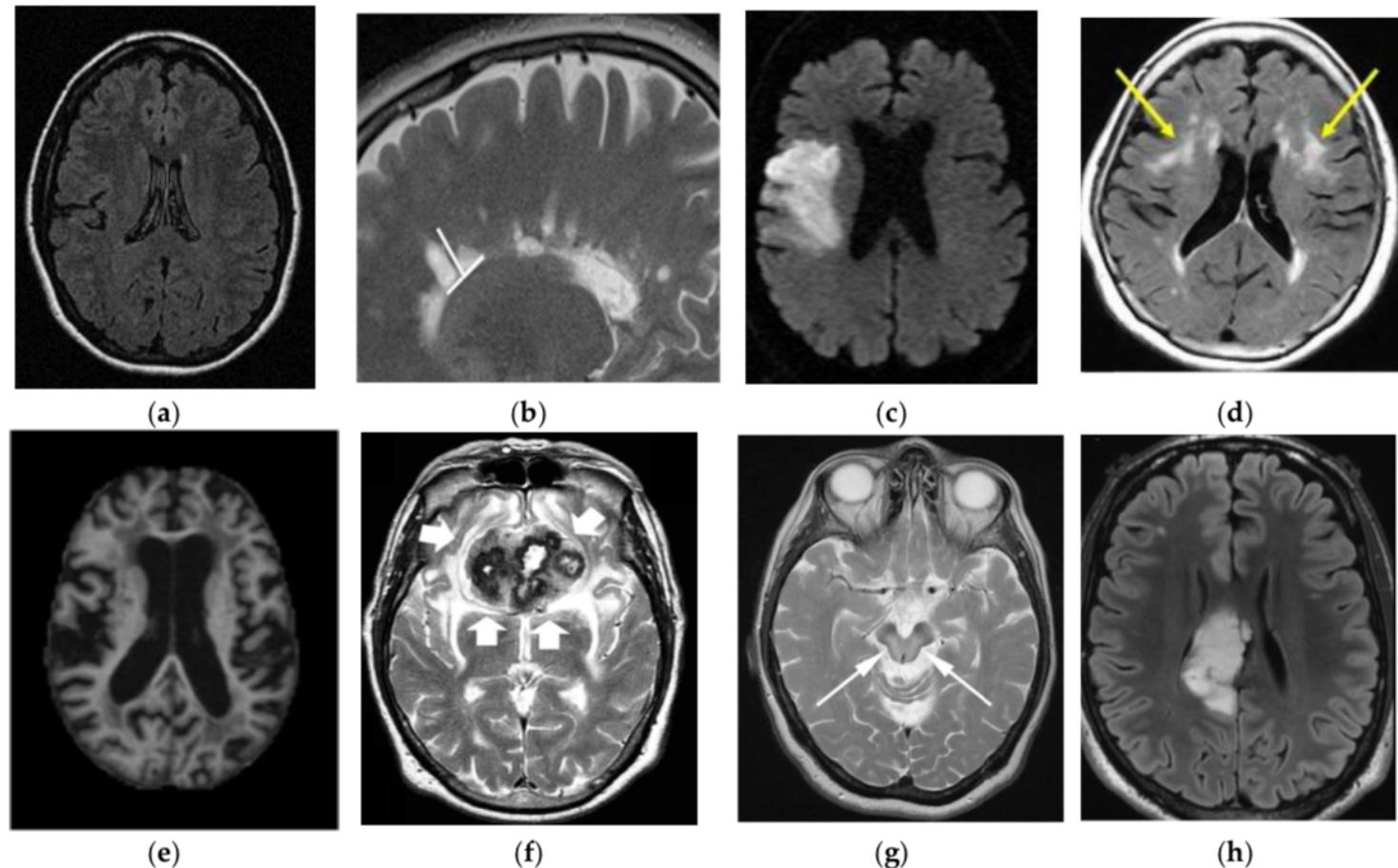
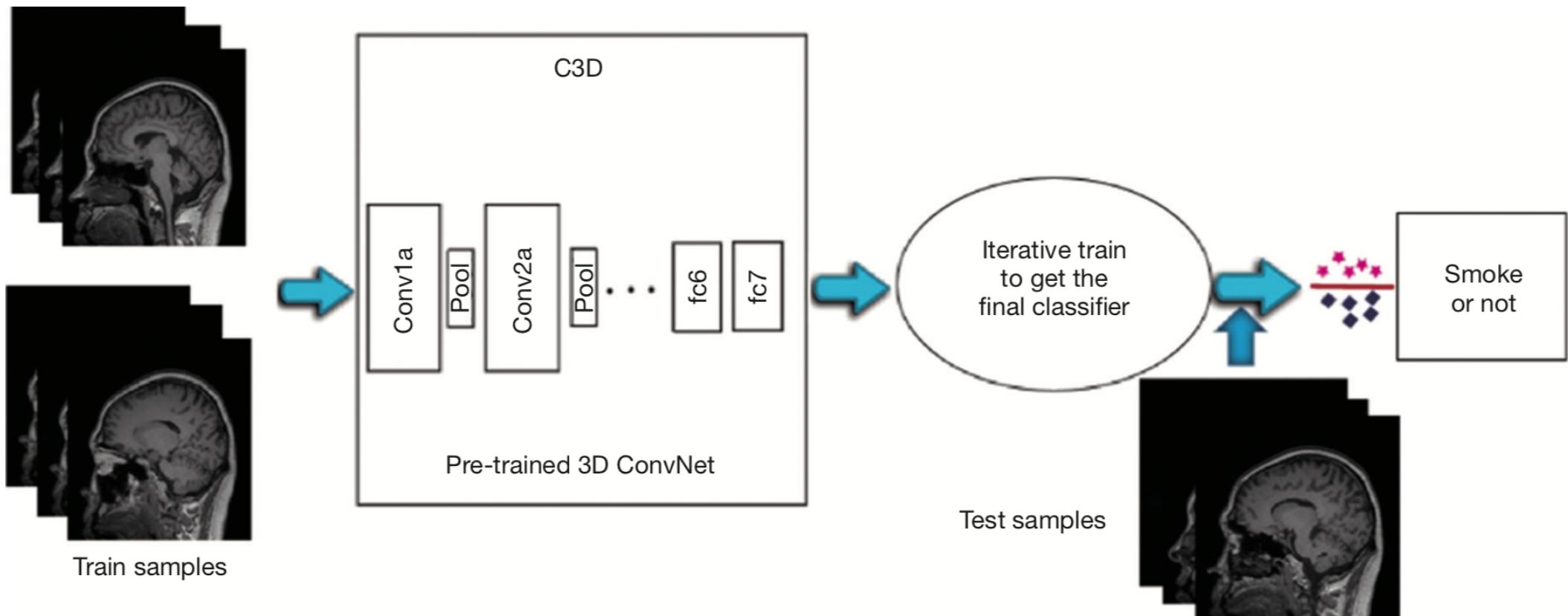


Figure 17. Comparison of brain tumor with other brain disorders (image permission requested from sources). (a) Normal Brain [AtheroPointTM]; (b) Multiple Sclerosis [113]; (c) Stroke [114]; (d) Leukoaraiosis [115]; (e) Alzheimer's Disease [116]; (f) Parkinson's Disease [117]; (g) Wilson's Disease [118]; (h) Brain Tumor [119].

Object Classification (2/2)

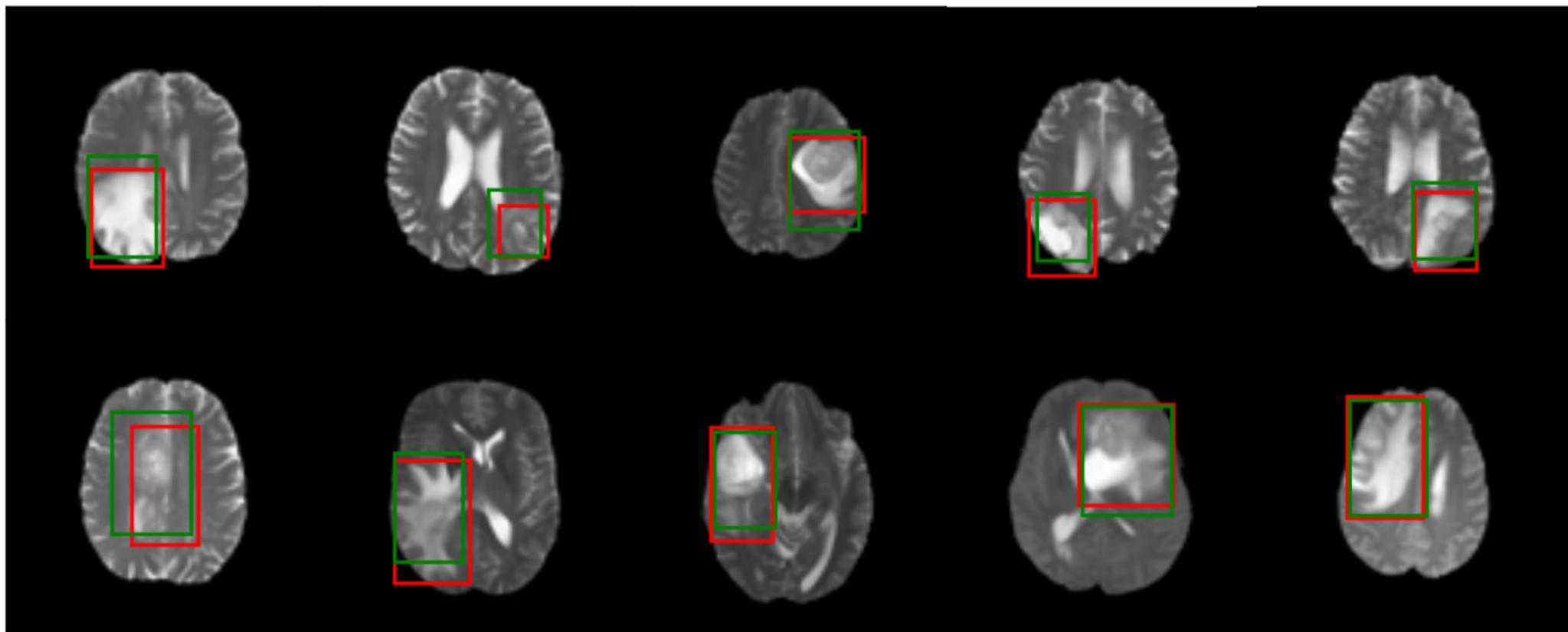
如判斷一個人是否有抽煙

Methods	Conv3D (%)	SVM (%)	ConvLSTM (%)
Sensitivity	80.0	84.0	93.33
Specificity	81.3	83.75	93.75
Overall accuracy	80.6	83.8	93.5



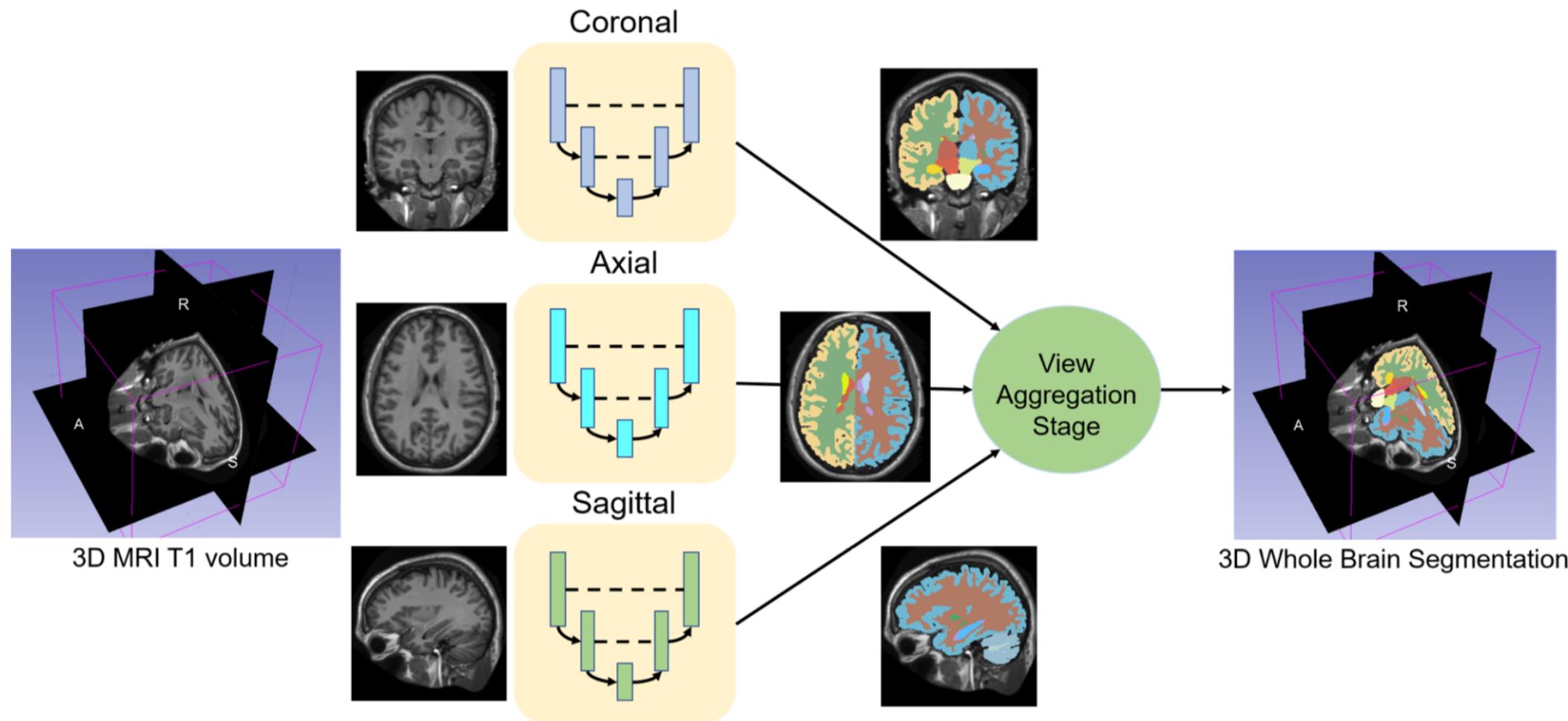
Object Detection

有沒有辦法能 localize?



Semantic Segmentation (1/3)

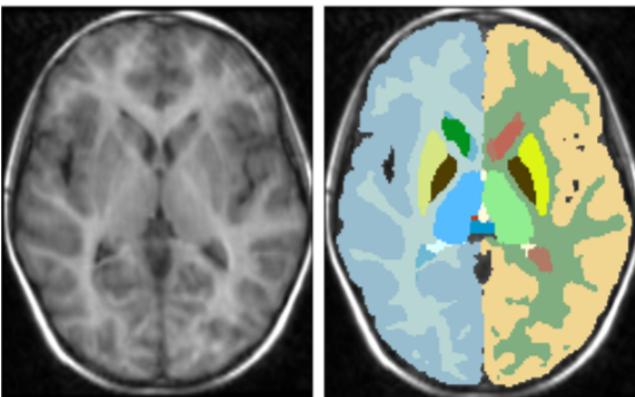
QuickNAT 使用 U-net



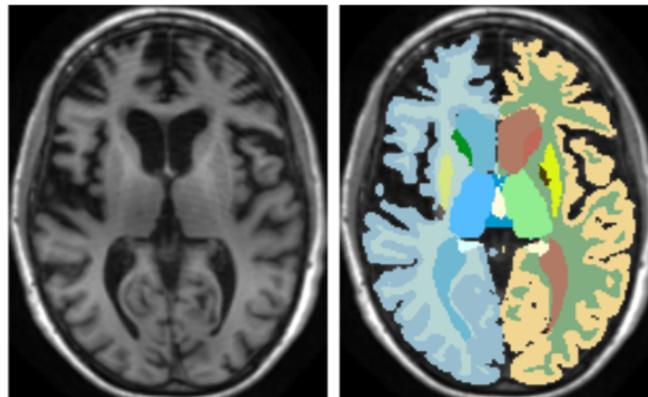
Semantic Segmentation (2/2)

QuickNAT 可以快速且精準地做區域分割

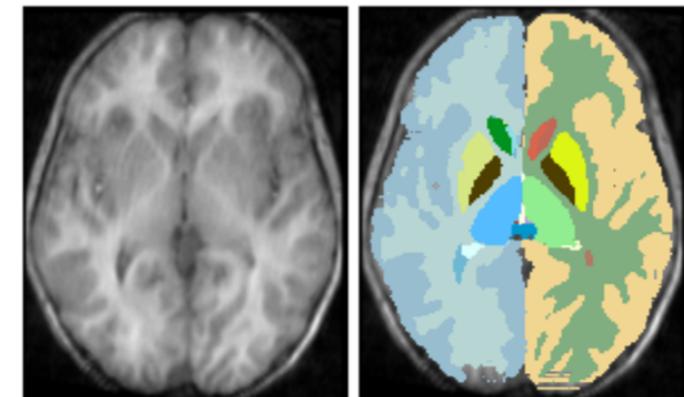
	Method	ADNI-29	CANDI	IBSR
All scans	QuickNAT	0.825 ± 0.027	0.819 ± 0.028	0.820 ± 0.035
	FreeSurfer	0.745 ± 0.042	0.780 ± 0.025	0.776 ± 0.025
	FSL	0.643 ± 0.290	0.647 ± 0.369	0.461 ± 0.419
	Failure of FSL	5 out of 29 (17%)	3 out of 13 (23%)	8 out of 18 (44%)
Scans where FSL succeeded	QuickNAT	0.823 ± 0.027	0.817 ± 0.032	0.817 ± 0.035
	FreeSurfer	0.745 ± 0.045	0.775 ± 0.027	0.772 ± 0.022
	FSL	0.775 ± 0.024	0.841 ± 0.013	0.825 ± 0.013



(a) IBSR dataset



(b) ADNI dataset



(c) CANDI dataset

Game Over

