

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

課號：Psy5352

識別碼：227U2810

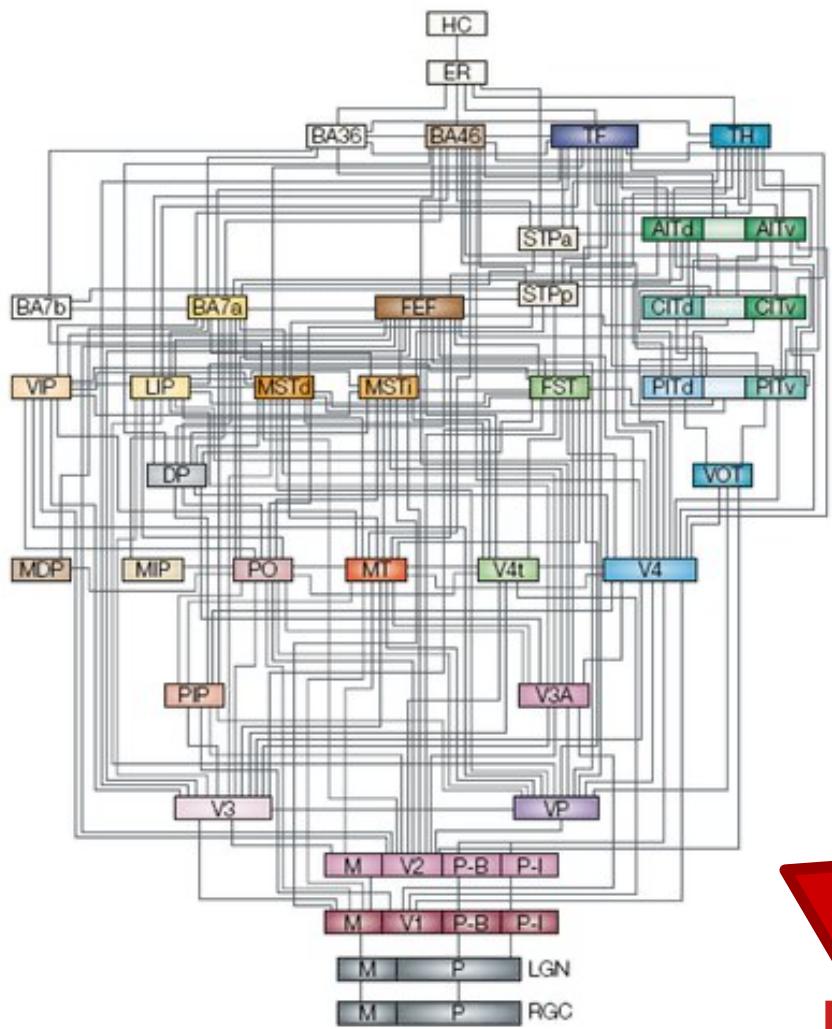
教室：普 101

時間：— 234

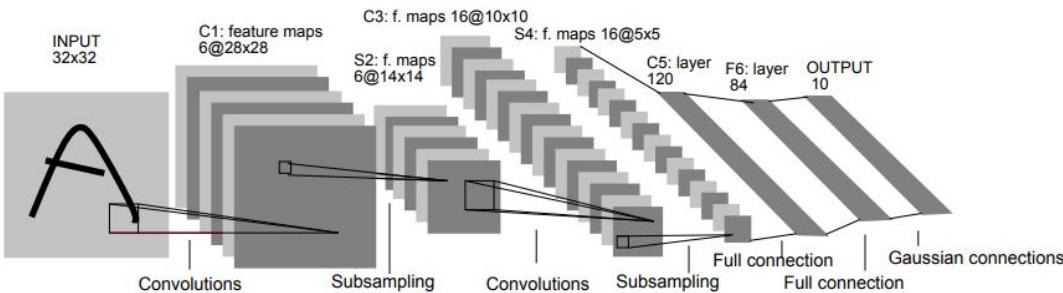
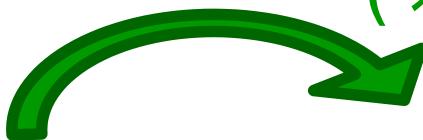


# 生物神經與類神經的三種關係

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)

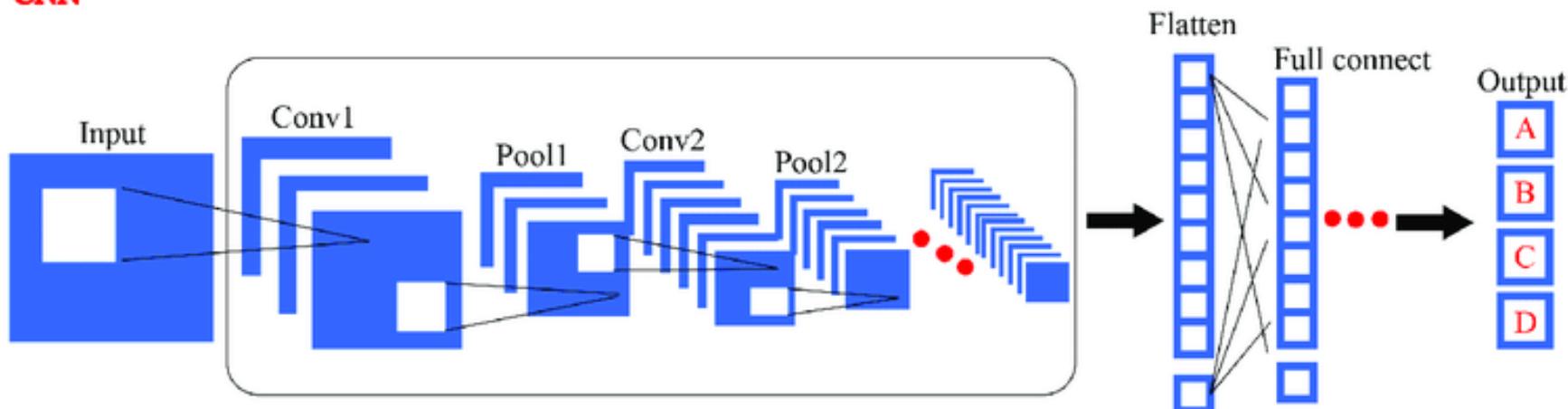


Functional Metaphors (FM)  
(本來多為計算認知 M, 現在也有深度學習 M)

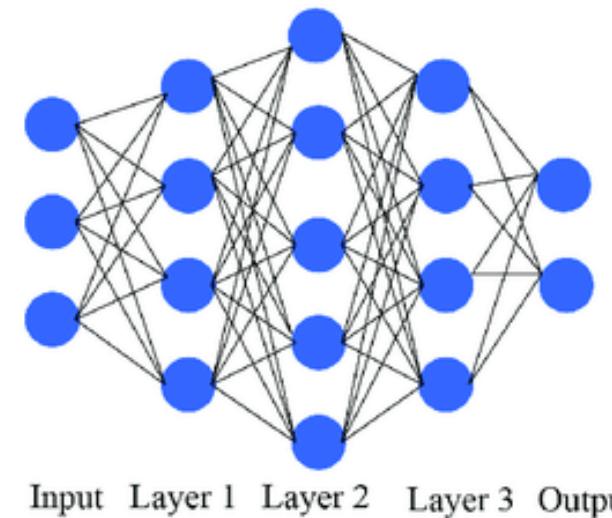
# Deep Neural Networks 的分類

CNN 通常處理影像資料；RNN 通常處理語言資料

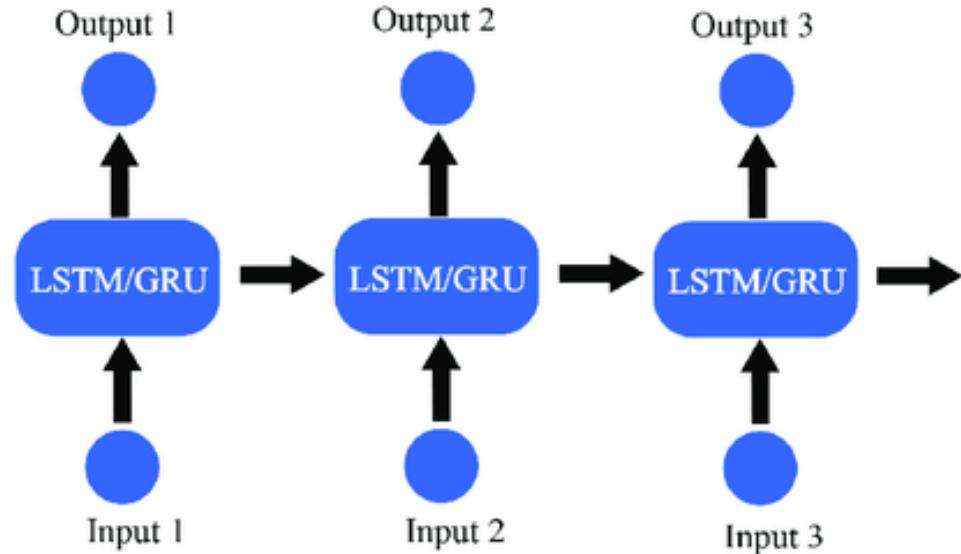
**CNN**



**DNN**

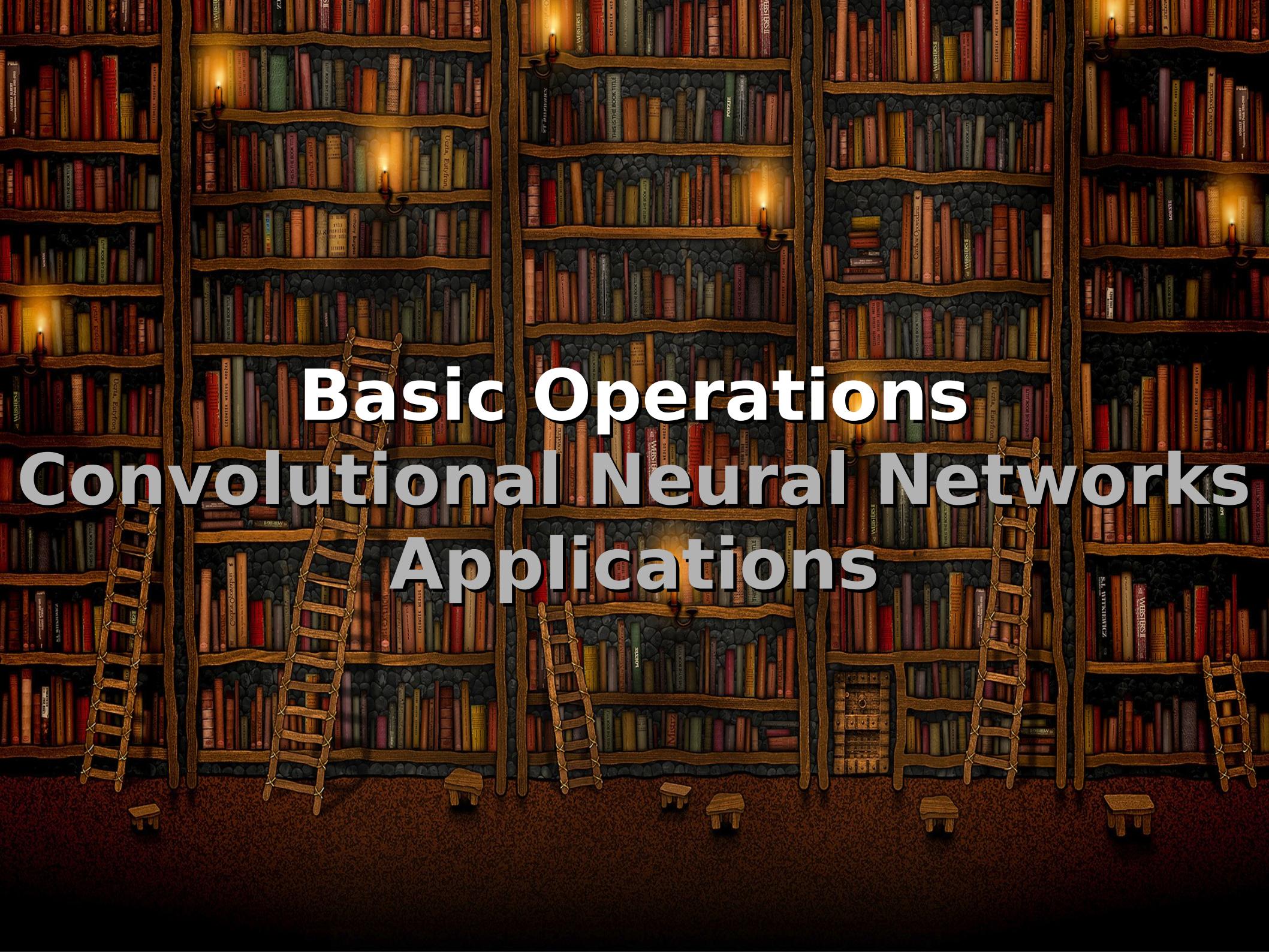


**RNN**



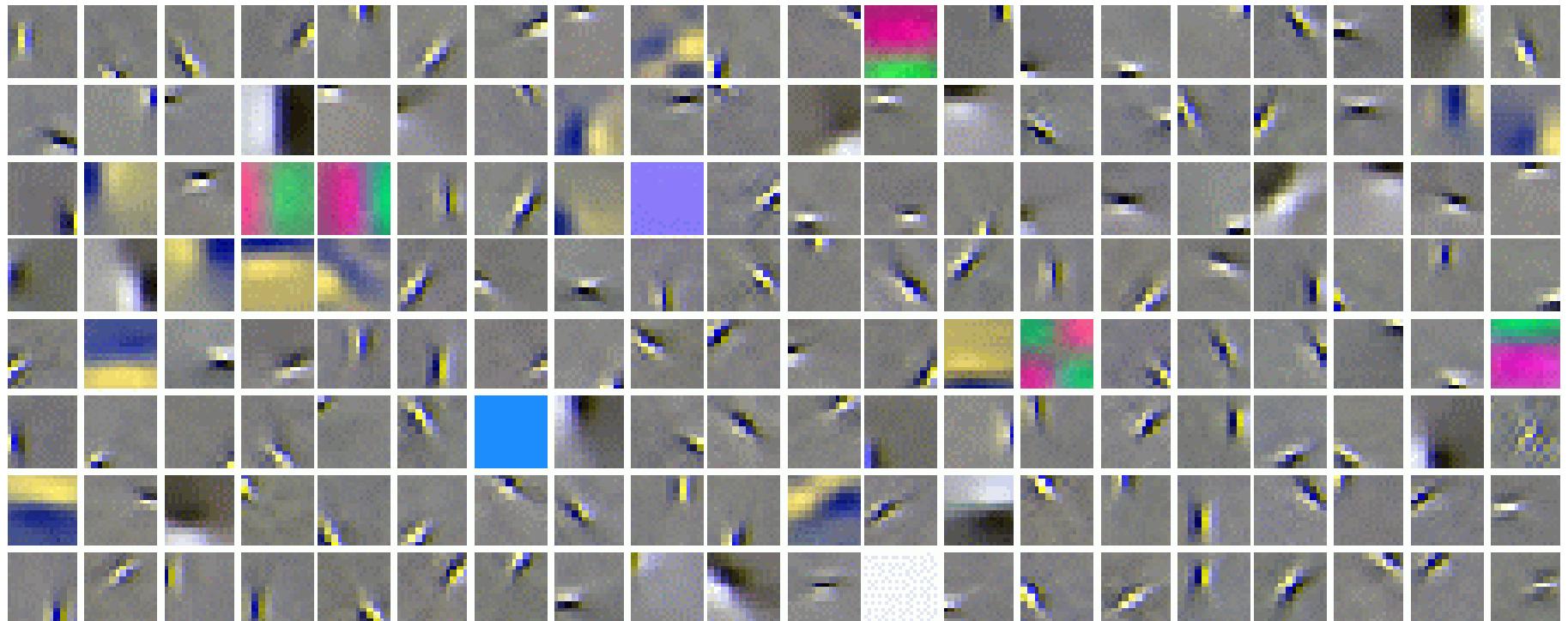
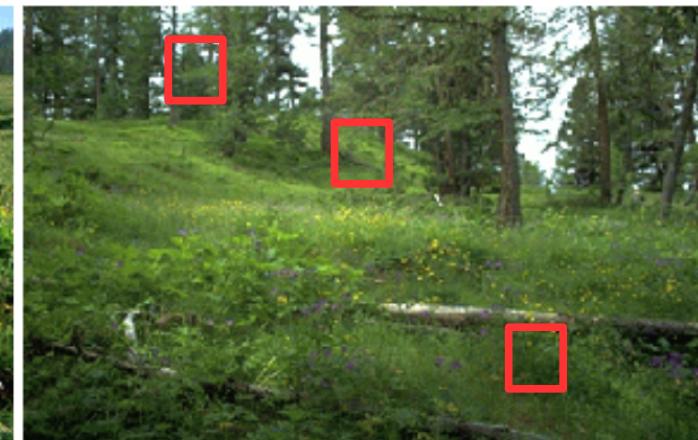
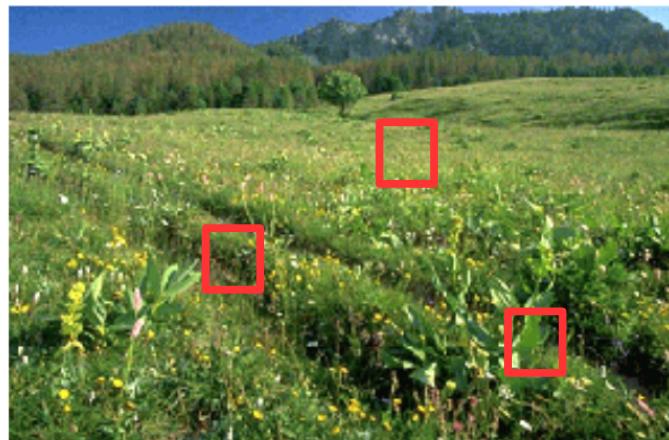
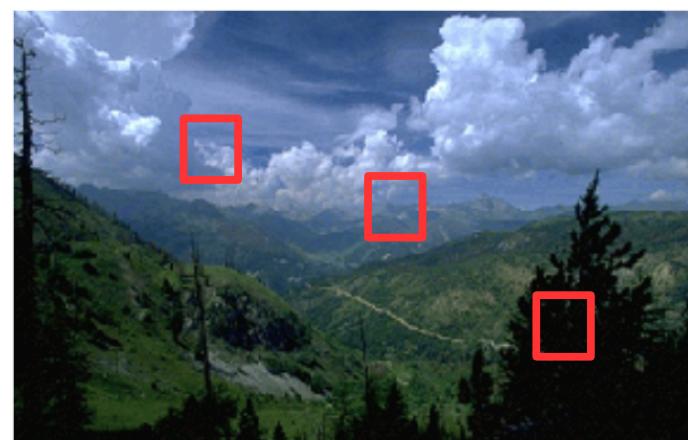
A black and white cartoon illustration of a character with a large, dark, rounded head and a small body. The character has a speech bubble coming from its mouth. Inside the speech bubble, the text "本週介紹 CNN" is written in red, followed by a red exclamation mark.

本週介紹 CNN  
!



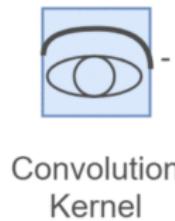
# Basic Operations Convolutional Neural Networks Applications

# Patterns shared by Patches



# 2D Spatial Convolution

Convolution與 Correlation 傻傻分不清楚

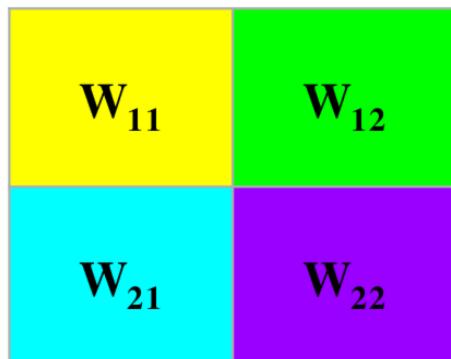


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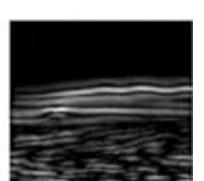
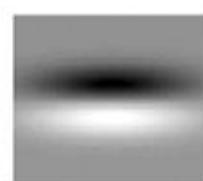
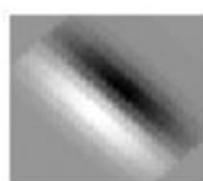
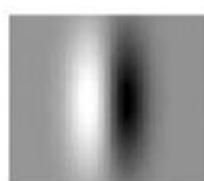
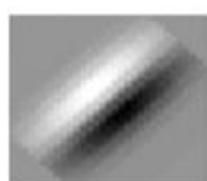
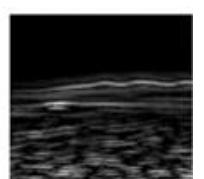
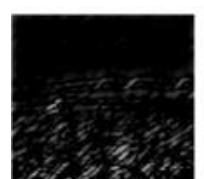
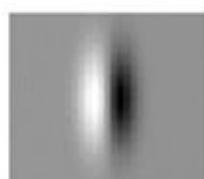
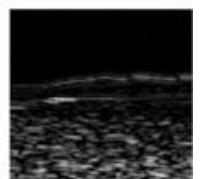
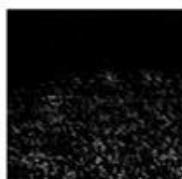
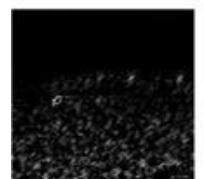
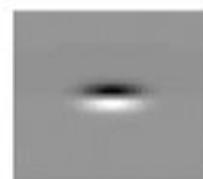
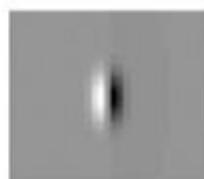
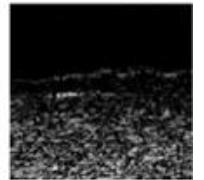
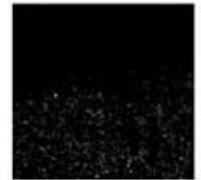
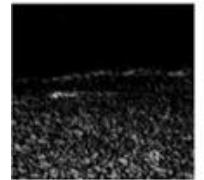
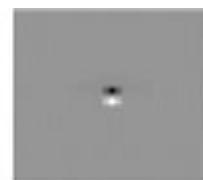
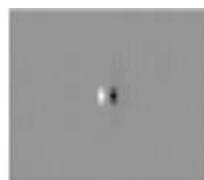
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Convolution Output

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




# 2D Spatial Filtering



# Padding & Stride

Input 與 Output 的維度關係一定要會算

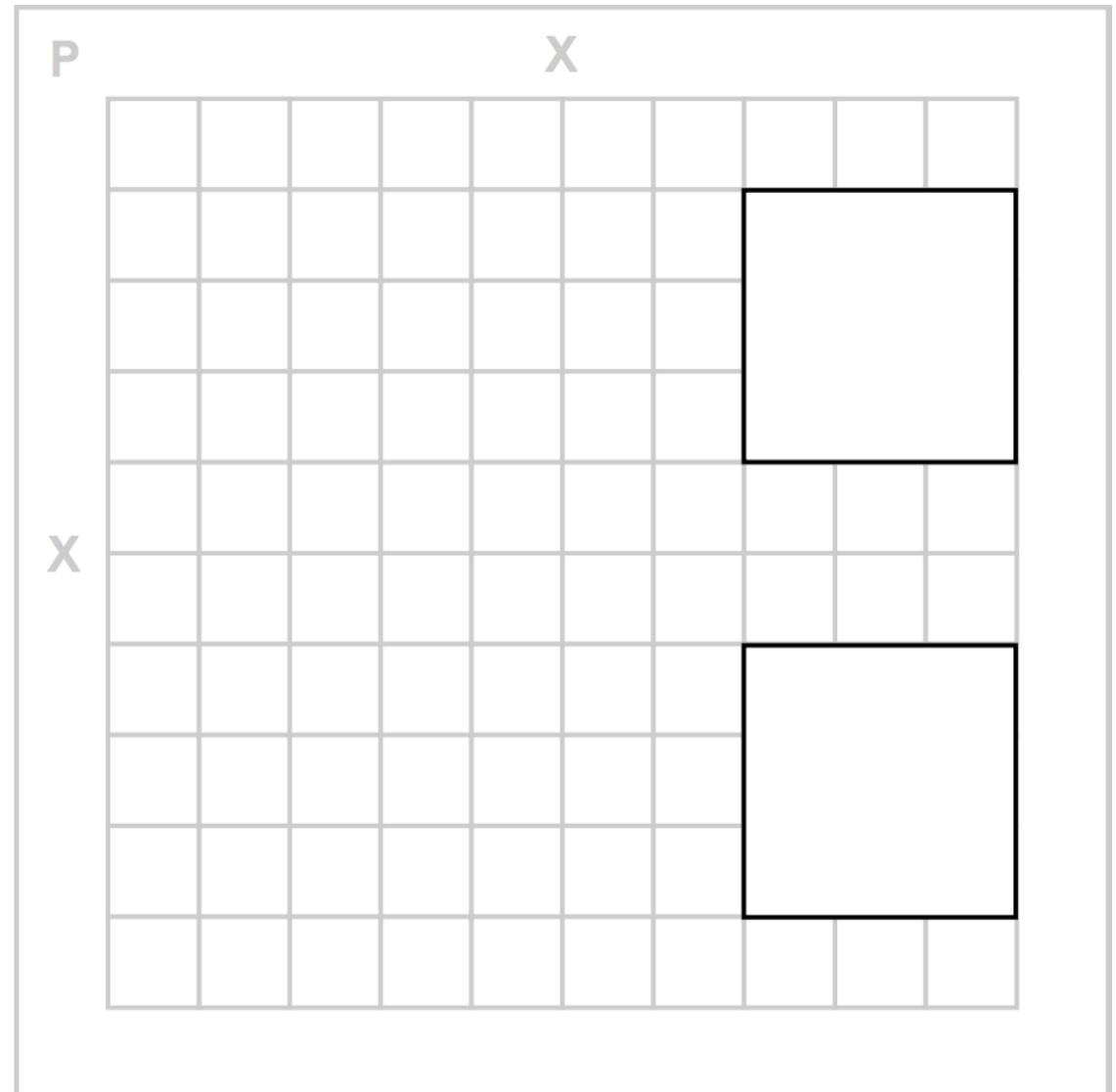
$$1 + \frac{X - F + 2P}{S}$$

X = image size

F = filter size

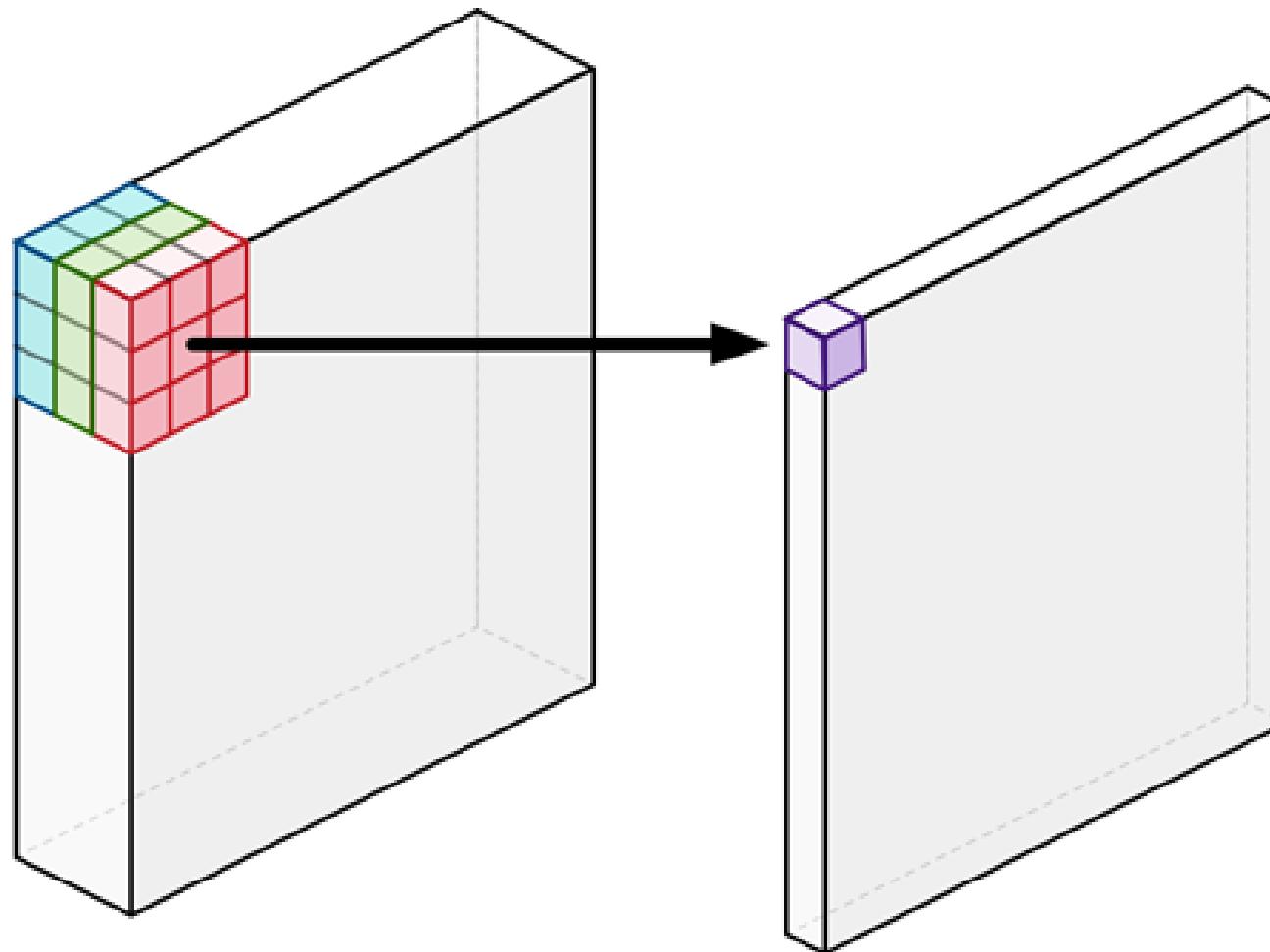
P = padding

S = stride



# 3D Spatial Convolution

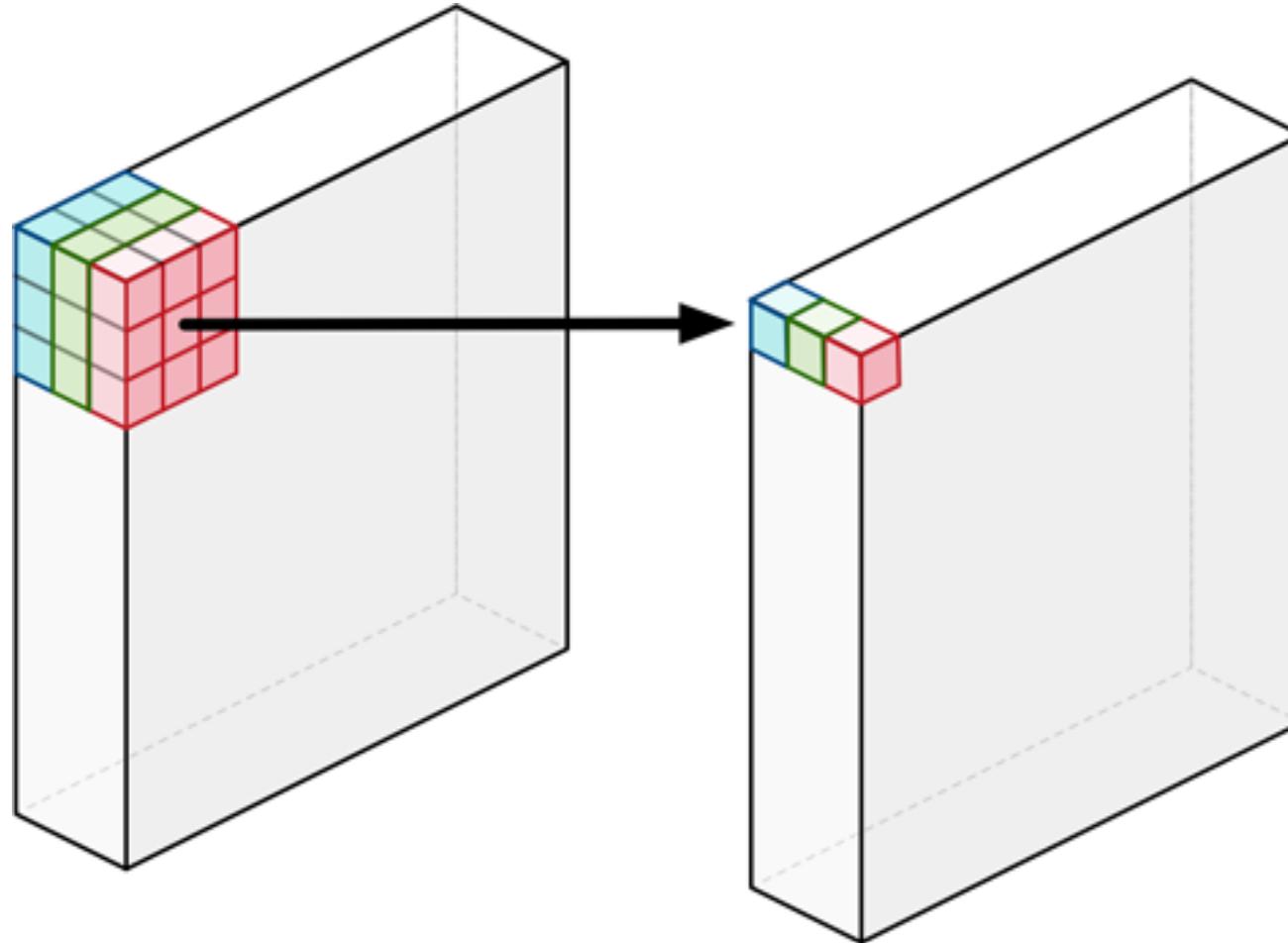
和 2D 一樣就是 template matching



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

# Depthwise Separable Conv.

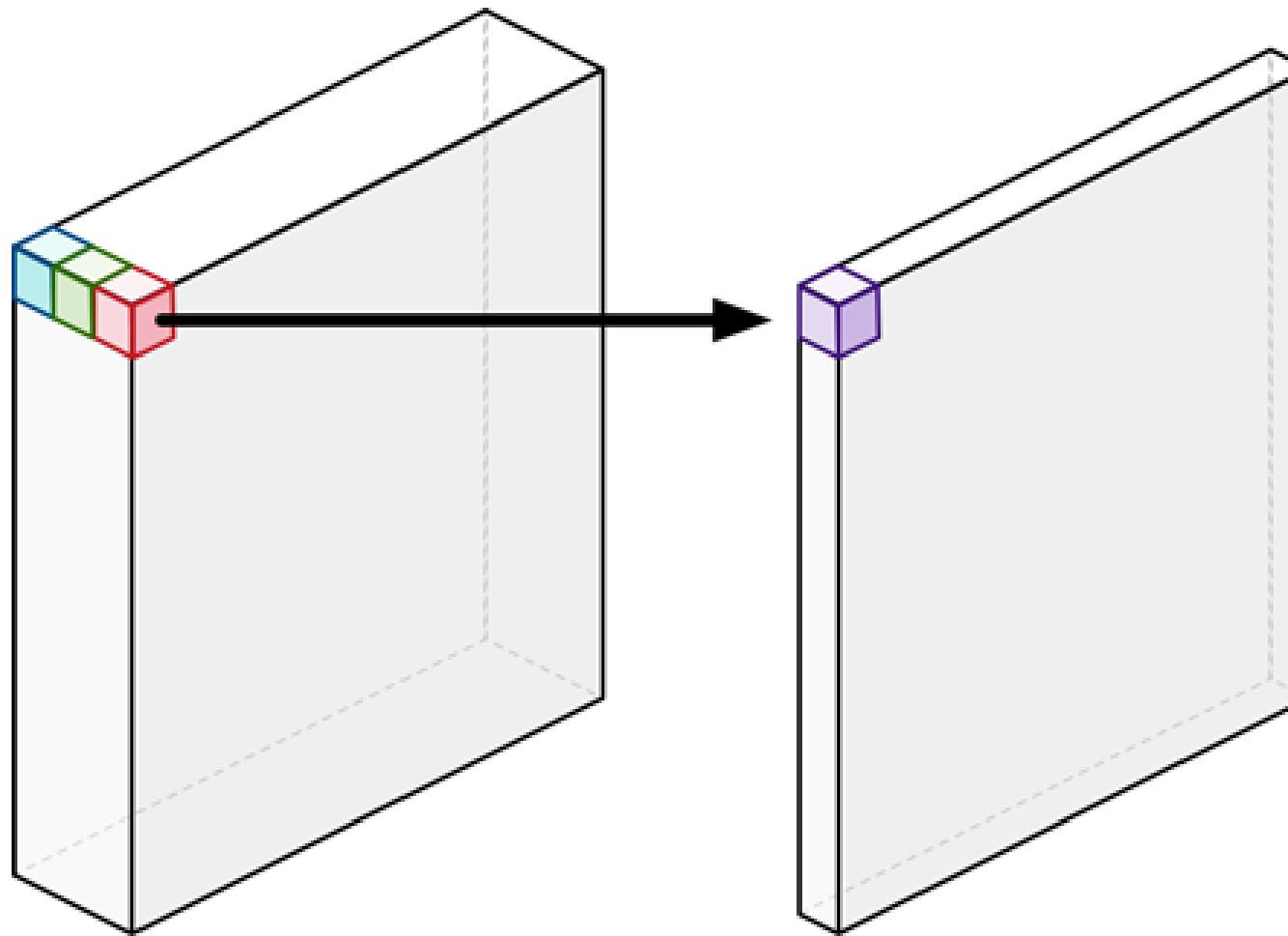
出現在 Xception Net 及其後繼的 Mobile Net 中



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

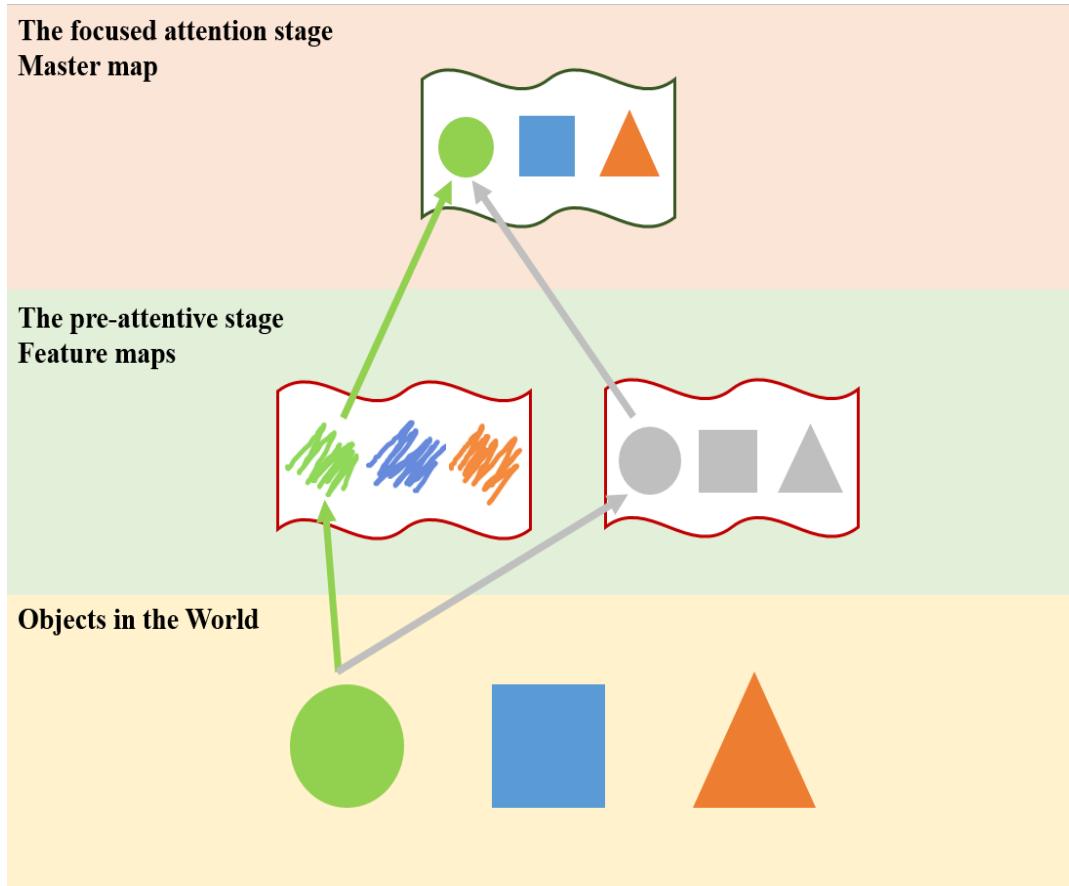
# Pointwise Convolution

Inception, Xception, Squeeze, Mobile Nets 皆有

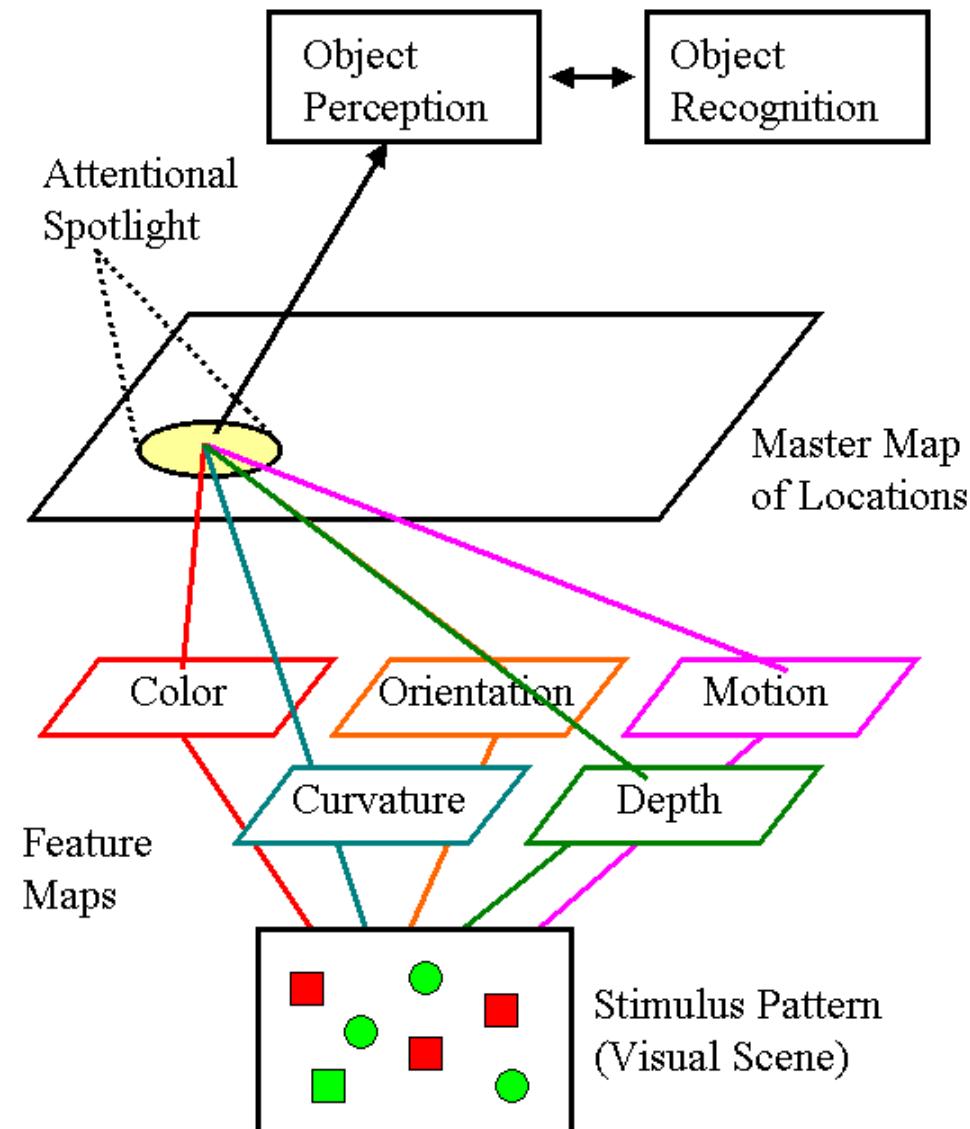


# Feature Integration Theory

就是 Features 分開處理再整合

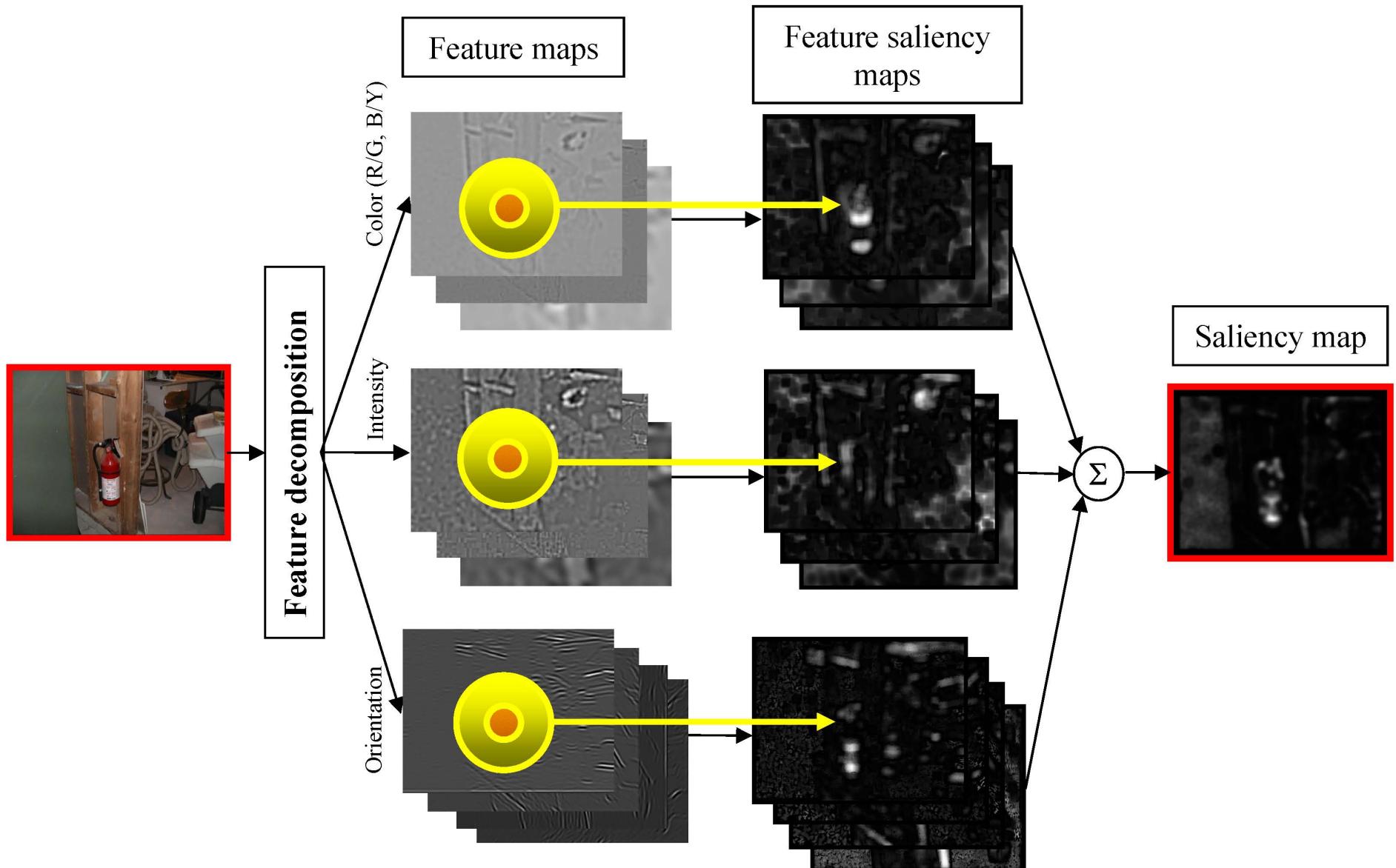


Feature Integration Theory (Treisman)



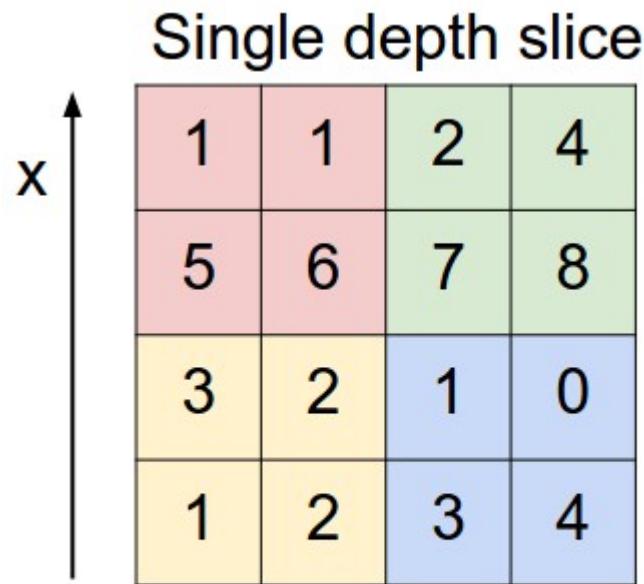
# Saliency Map

只是 Feature Integration Theory 的實境版



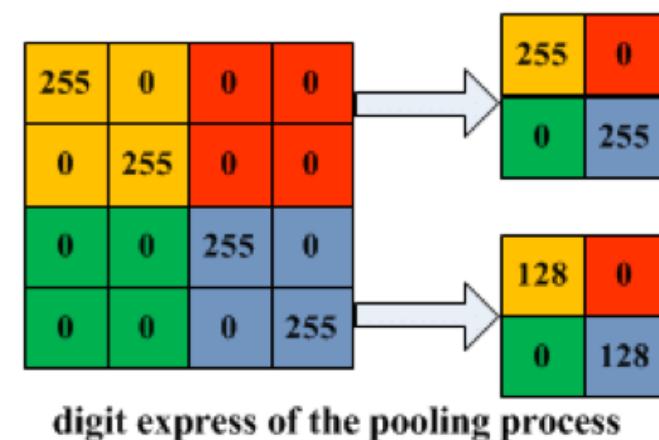
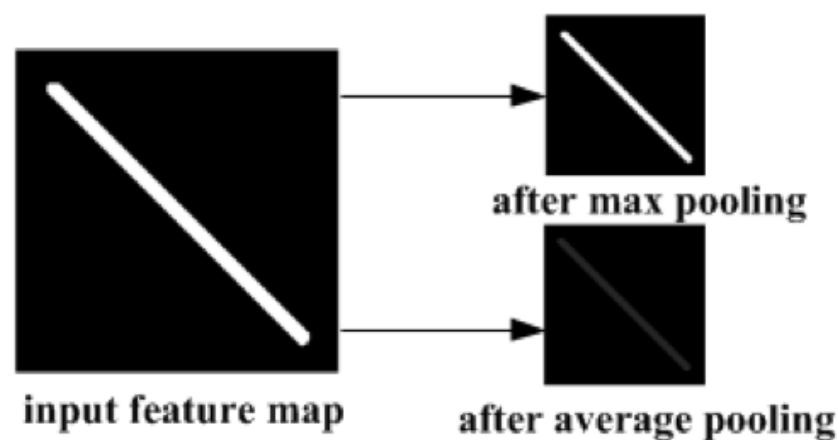
# (Max) Pooling

就是 downsampling



max pool with 2x2 filters  
and stride 2

6	8
3	4

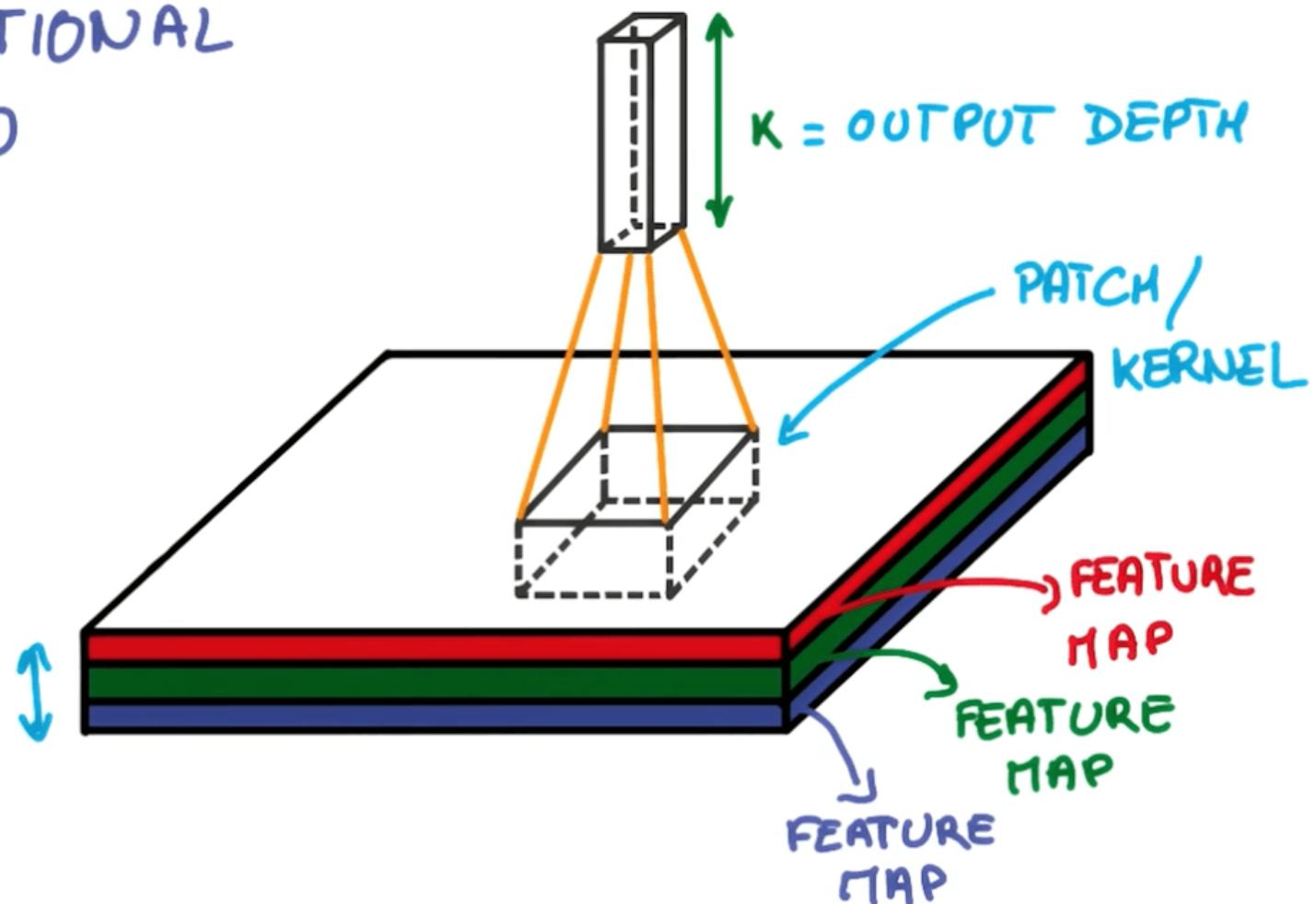


# CNN Terms

Kernel 對應到的就是生物上的 Receptive Field

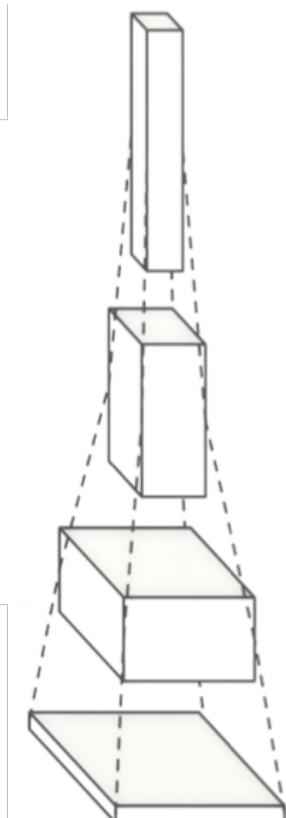
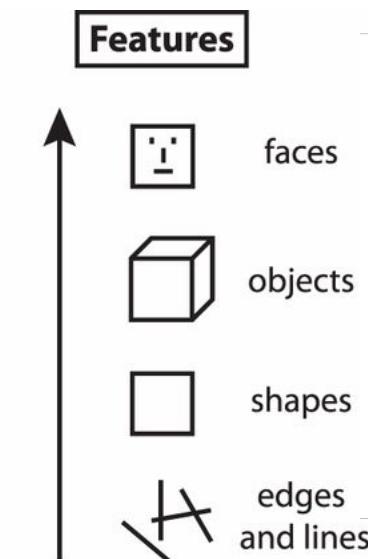
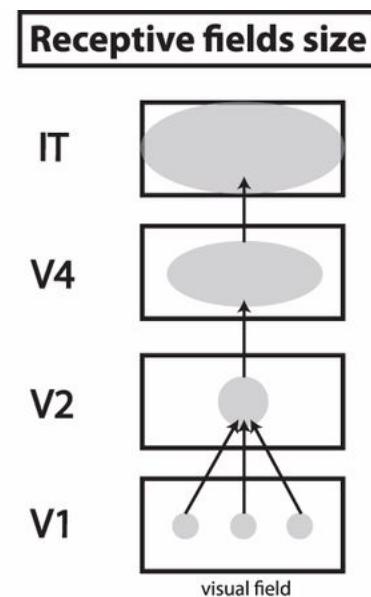
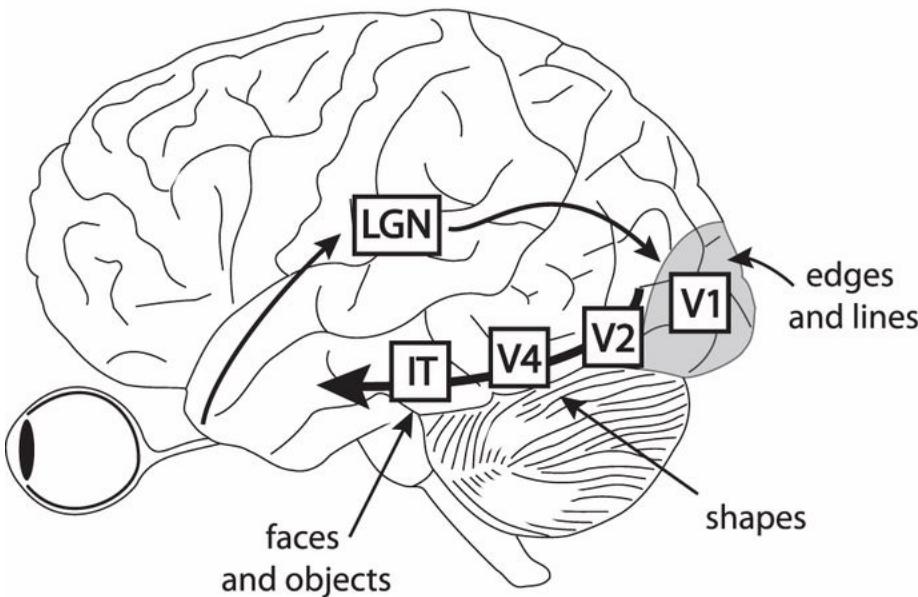
CONVOLUTIONAL  
LINGO

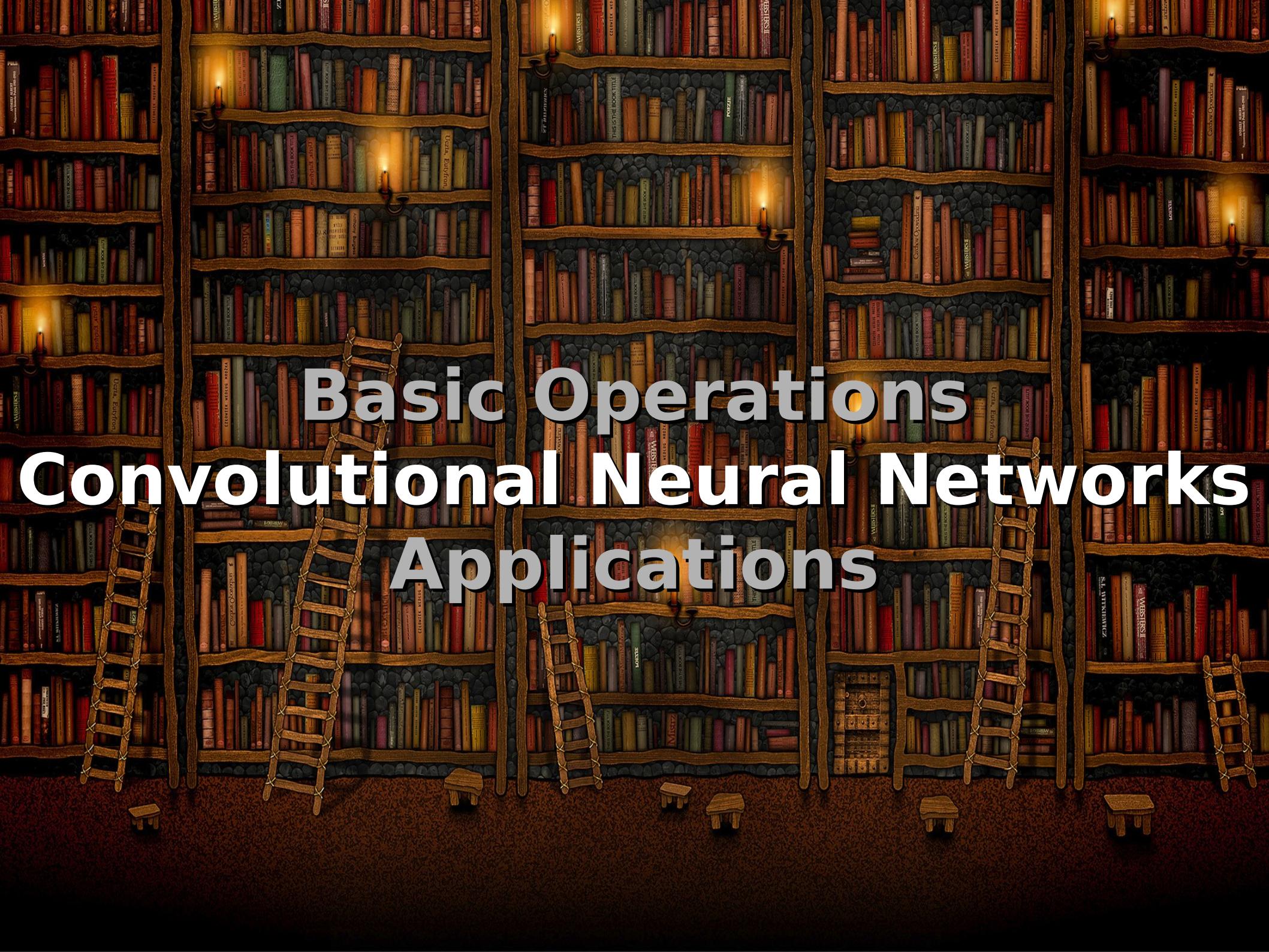
INPUT  
DEPTH



# CNN 的金字塔結構

是在仿 ventral visual pathway in the brain

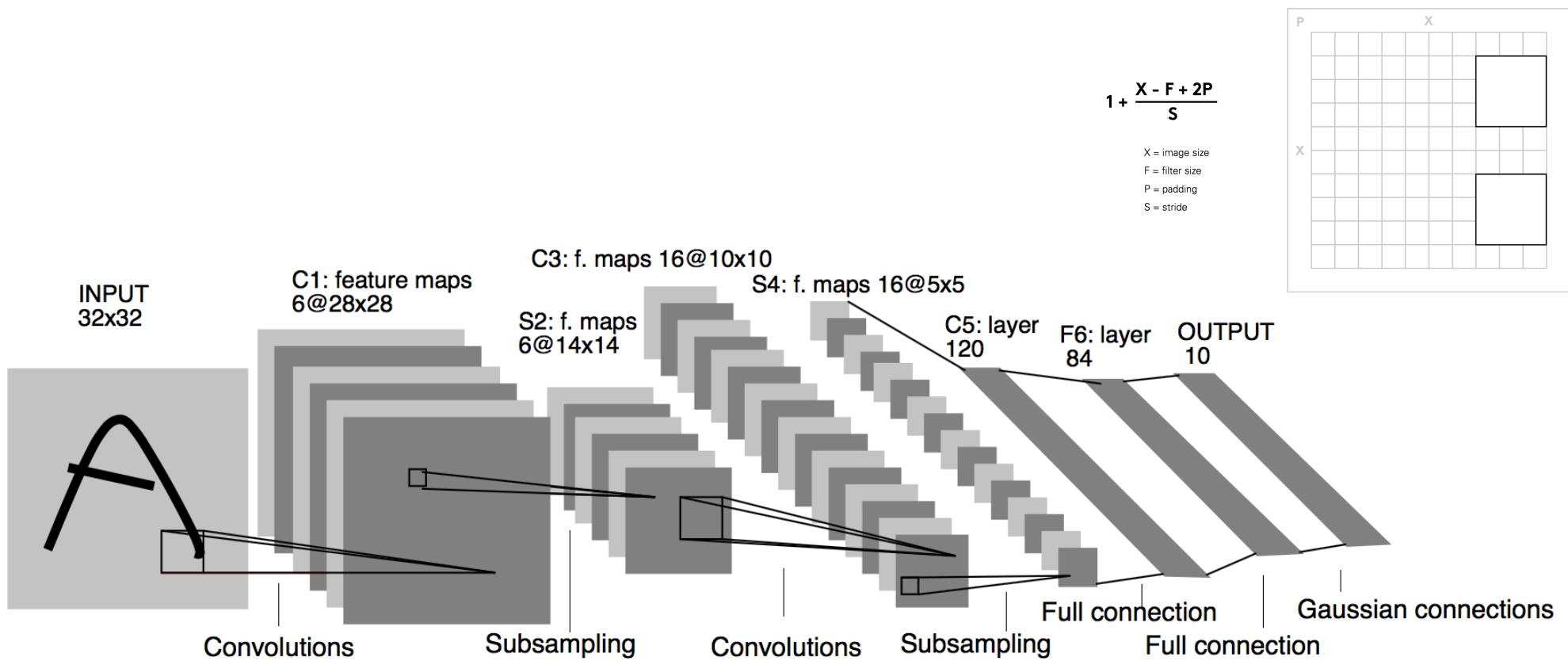




# Basic Operations Convolutional Neural Networks Applications

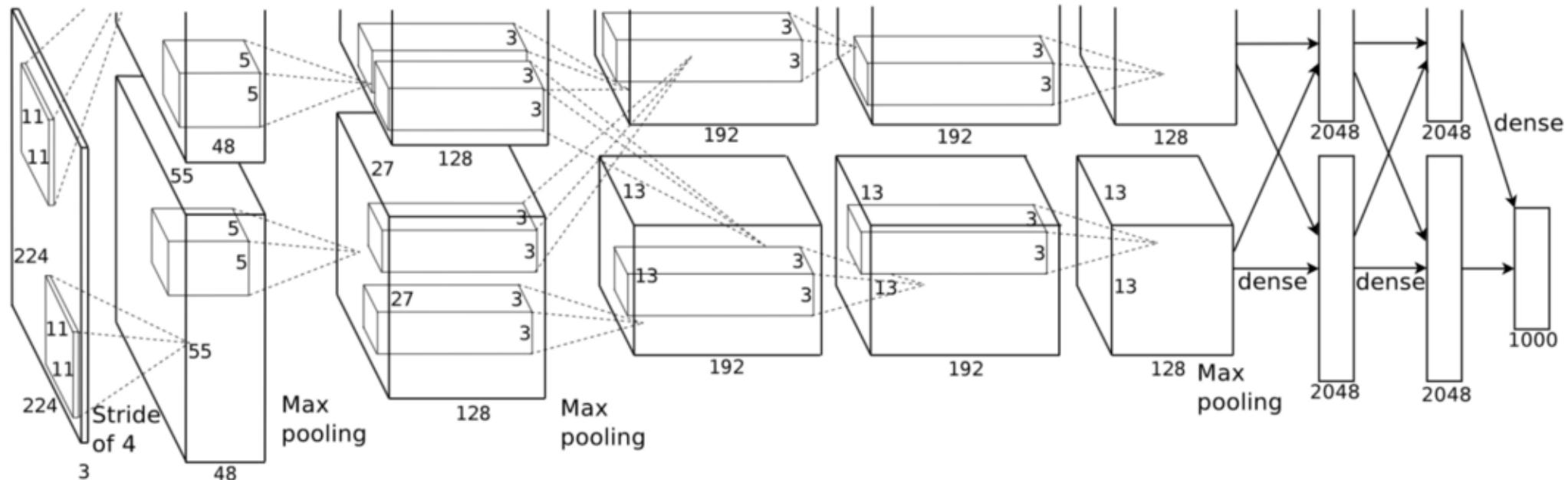
# LeNet (1998)

有 convolution 有 pooling



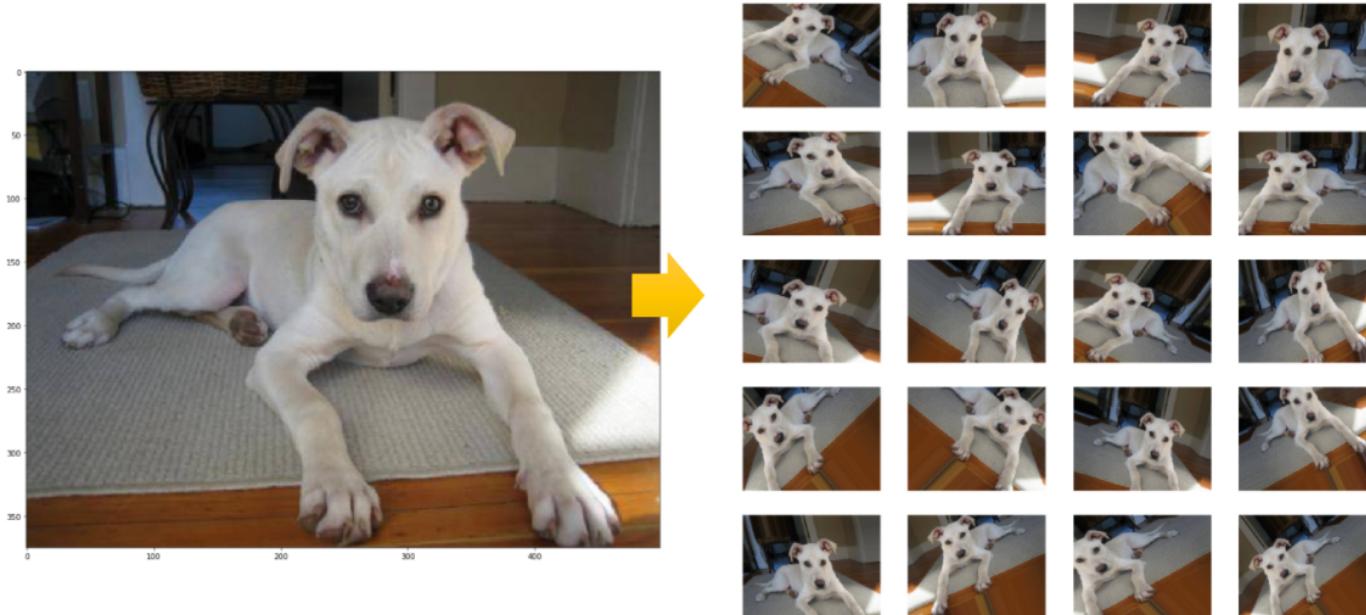
# AlexNet (2012)

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



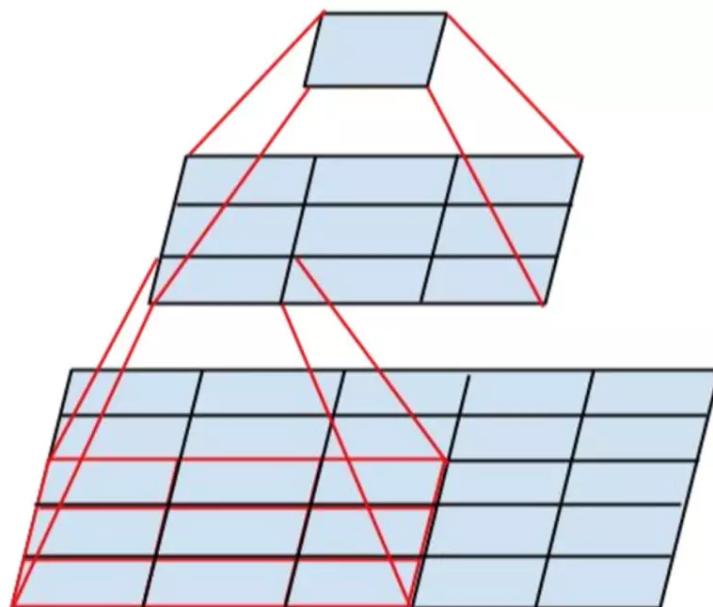
# Data Augmentation

把資料集變大：仿造視覺的 tolerance (“invariance”)



# VGG Net (2014)

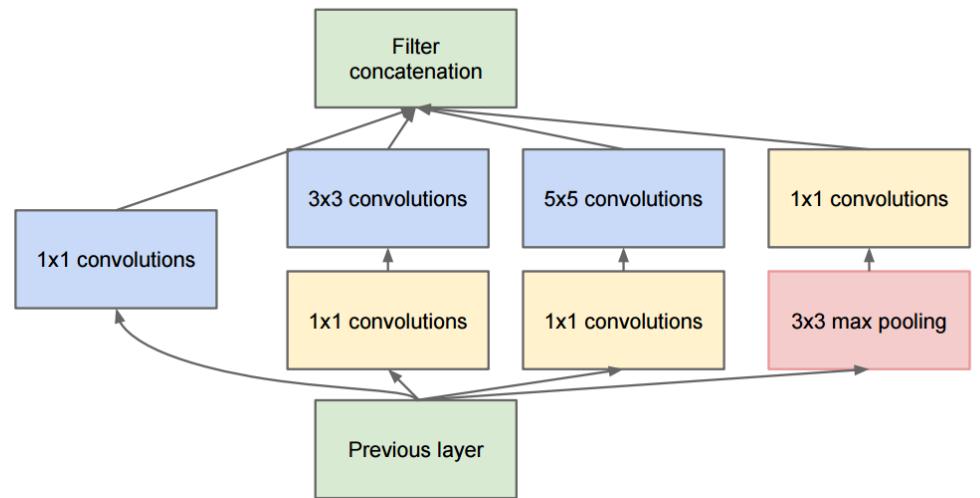
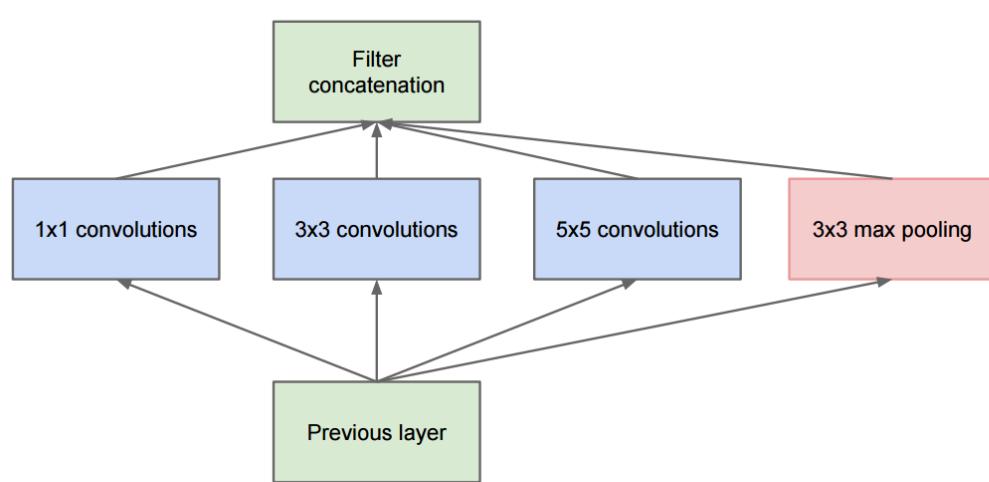
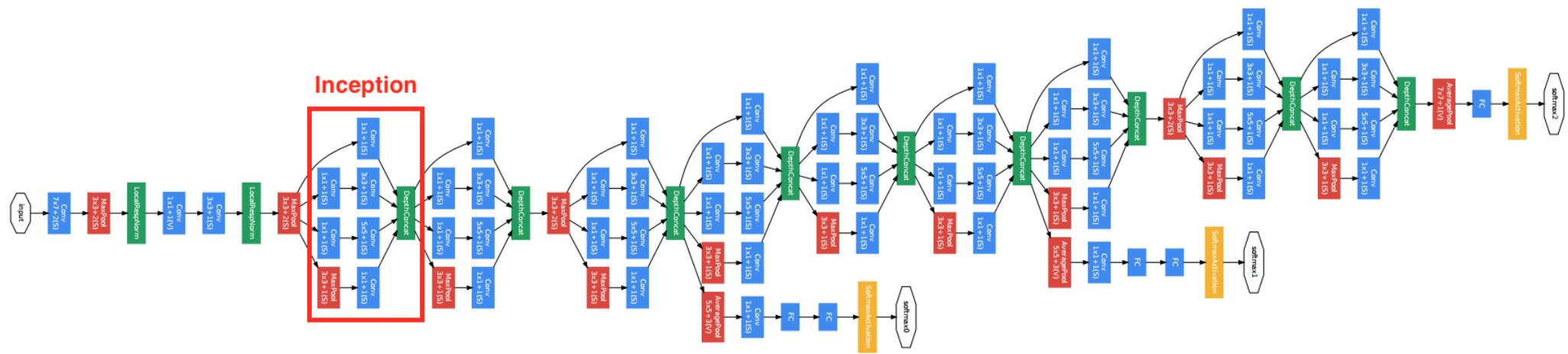
闡明下游 convolution kernels 只要  $3 \times 3$



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 <b>conv3-64</b>	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 <b>conv3-128</b>	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 <b>conv1-256</b>	conv3-256 conv3-256 <b>conv3-256</b>	conv3-256 conv3-256 conv3-256 <b>conv3-256</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 <b>conv1-512</b>	conv3-512 conv3-512 <b>conv3-512</b>	conv3-512 conv3-512 conv3-512 <b>conv3-512</b>
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

# GoogLeNet (2015)

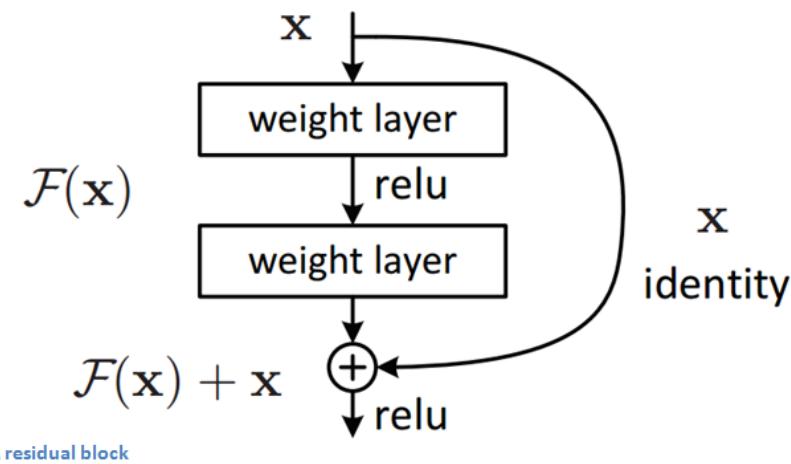
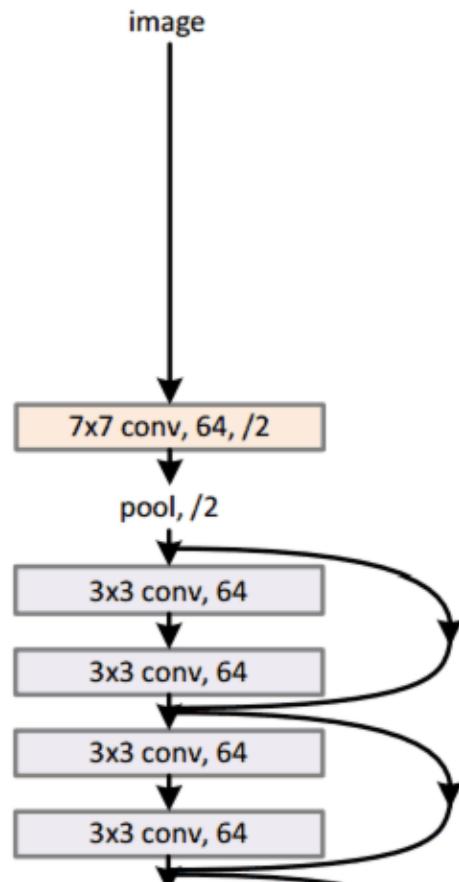
Inception module 主要仿製 multiscale vision



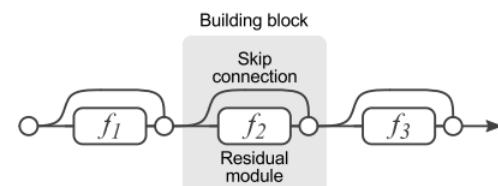
# ResNet (2015)

讓 deep net 的某些 layers 可以要廢

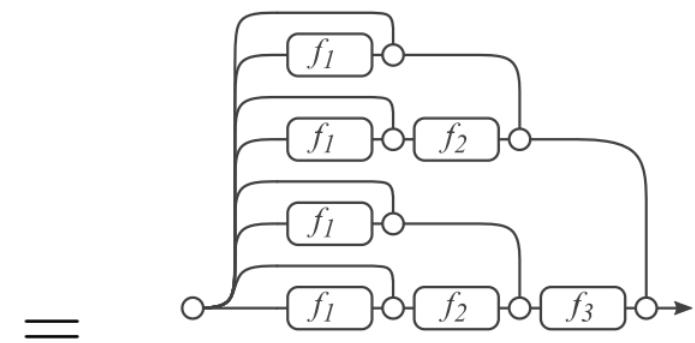
34-layer residual



A residual block



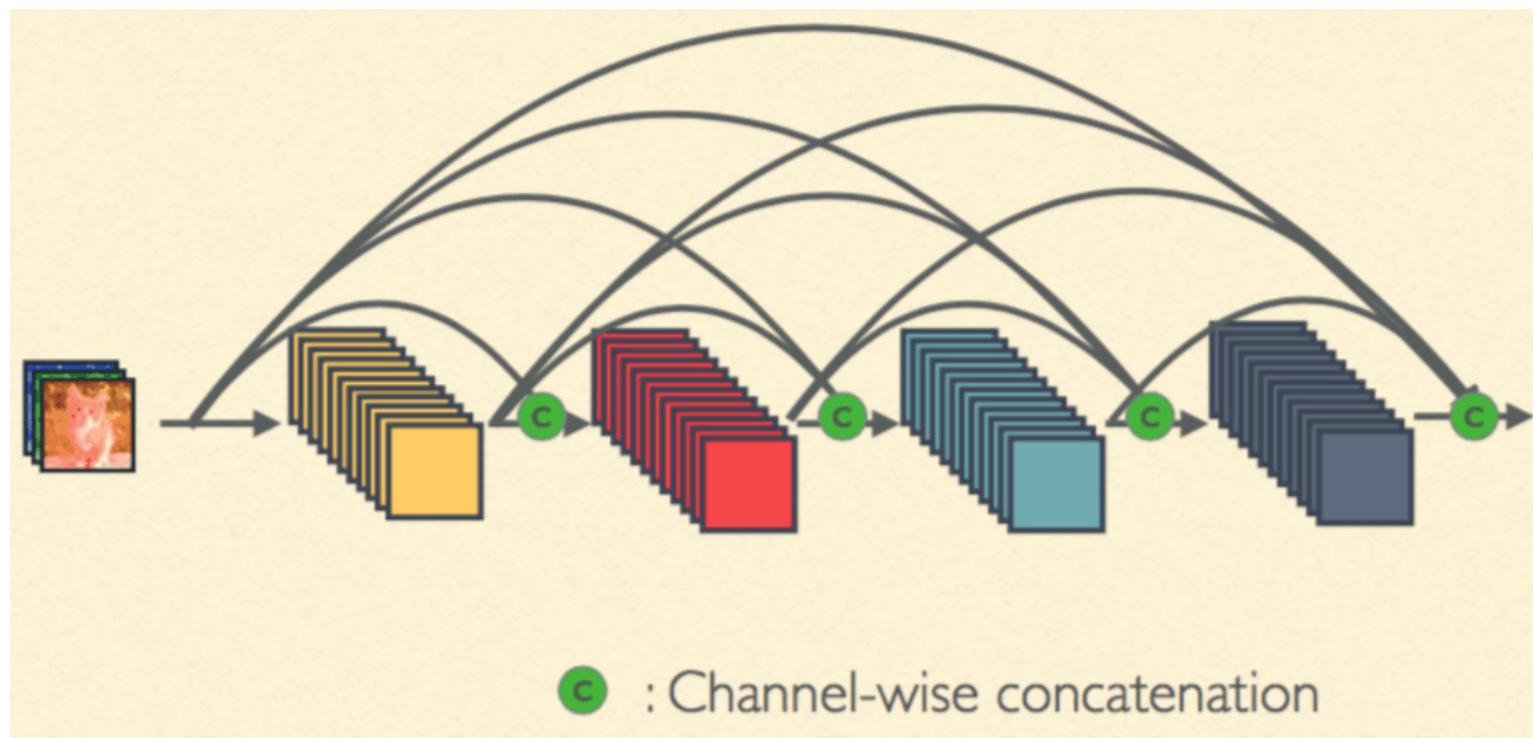
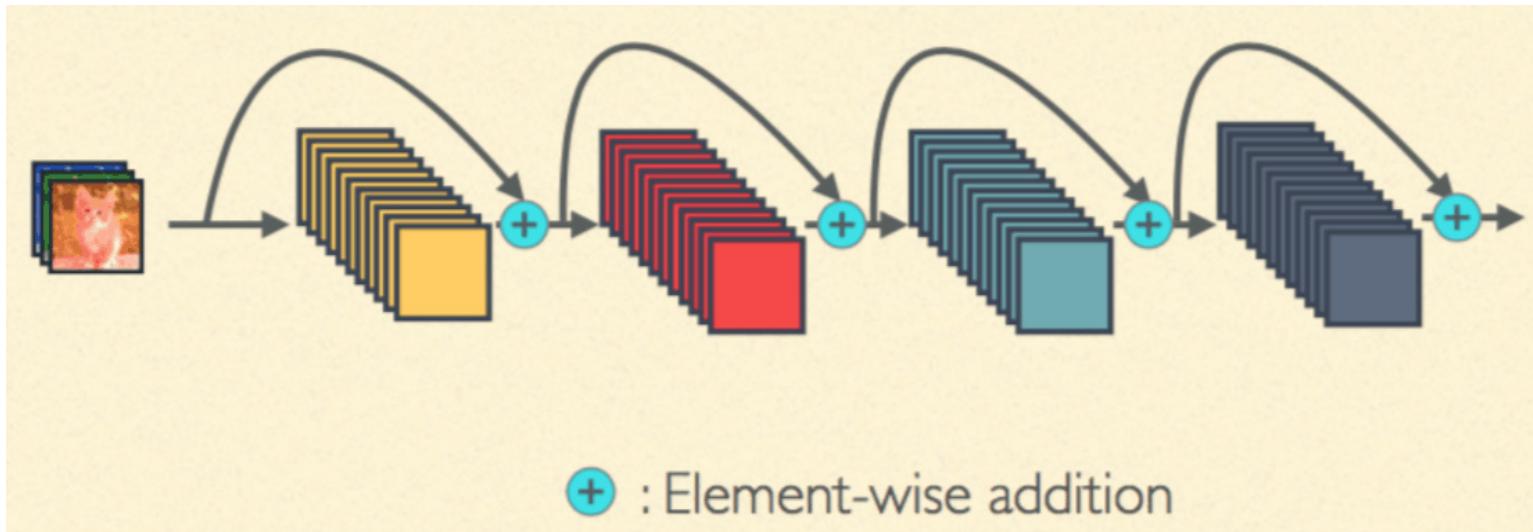
(a) Conventional 3-block residual network



(b) Unraveled view of (a)

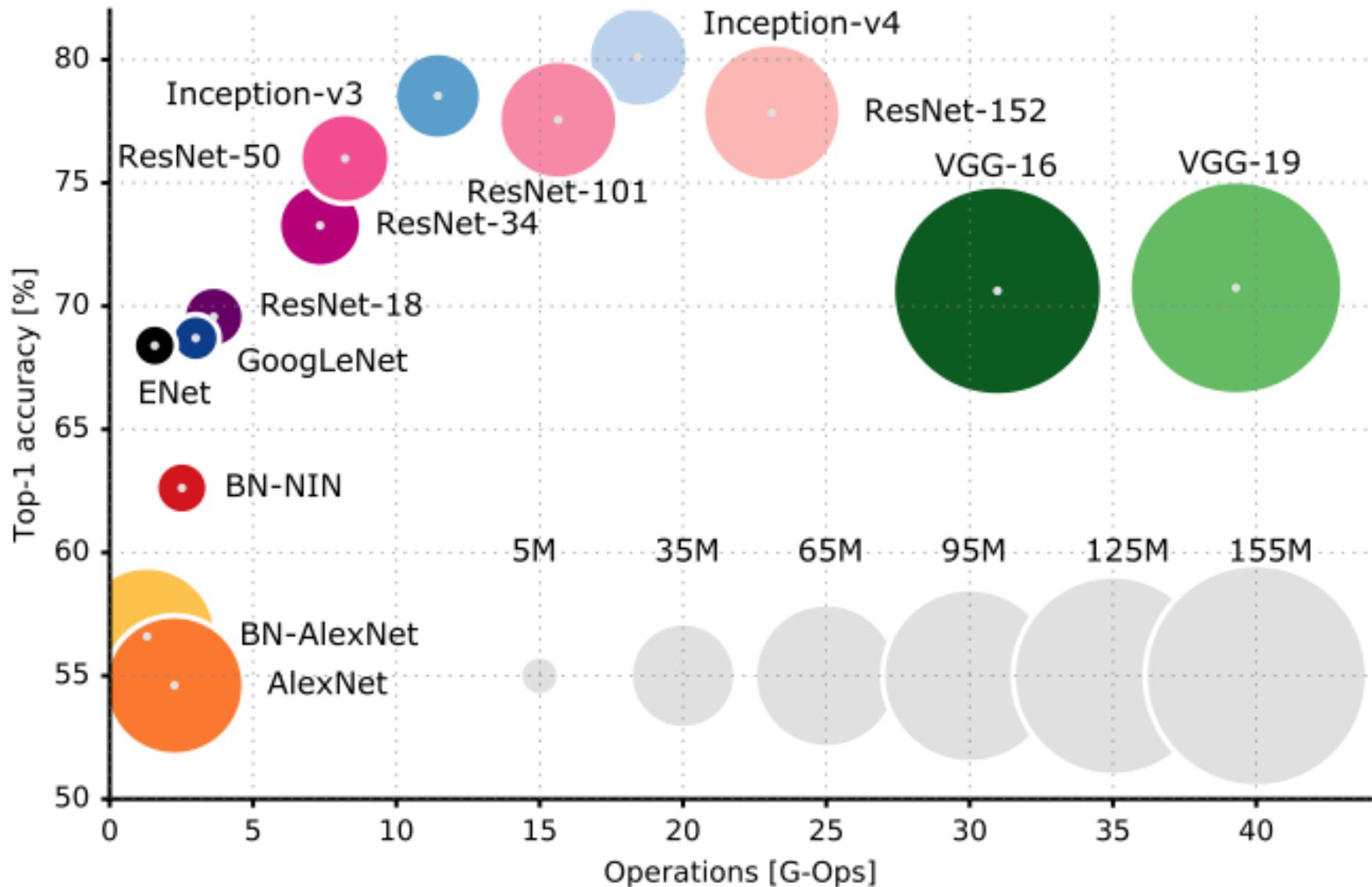
# DenseNet (2017)

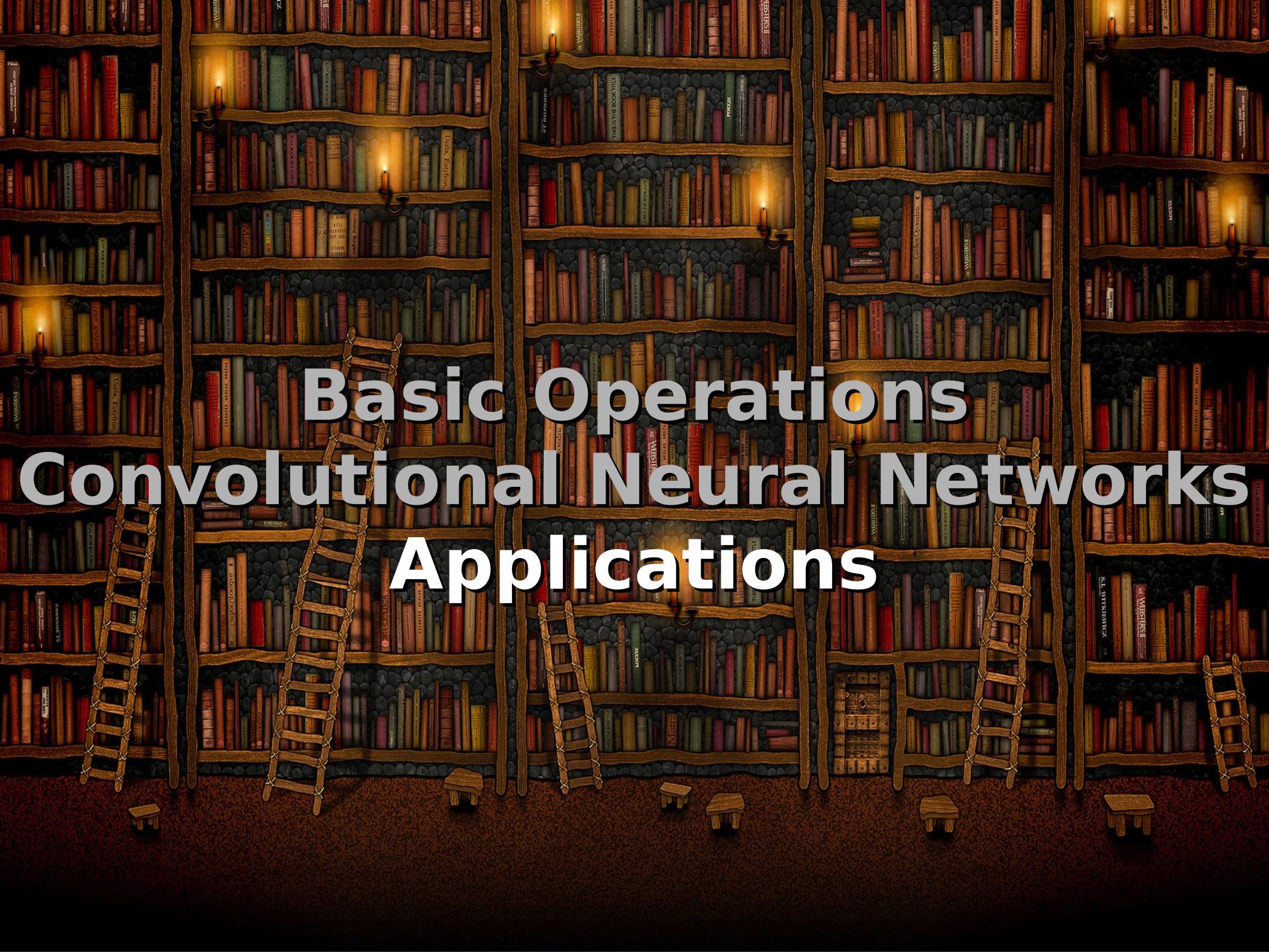
比 ResNet 加入更多 "增加特徵" 的跳接



# CNN 模型比較

有些雖強大但計算太重

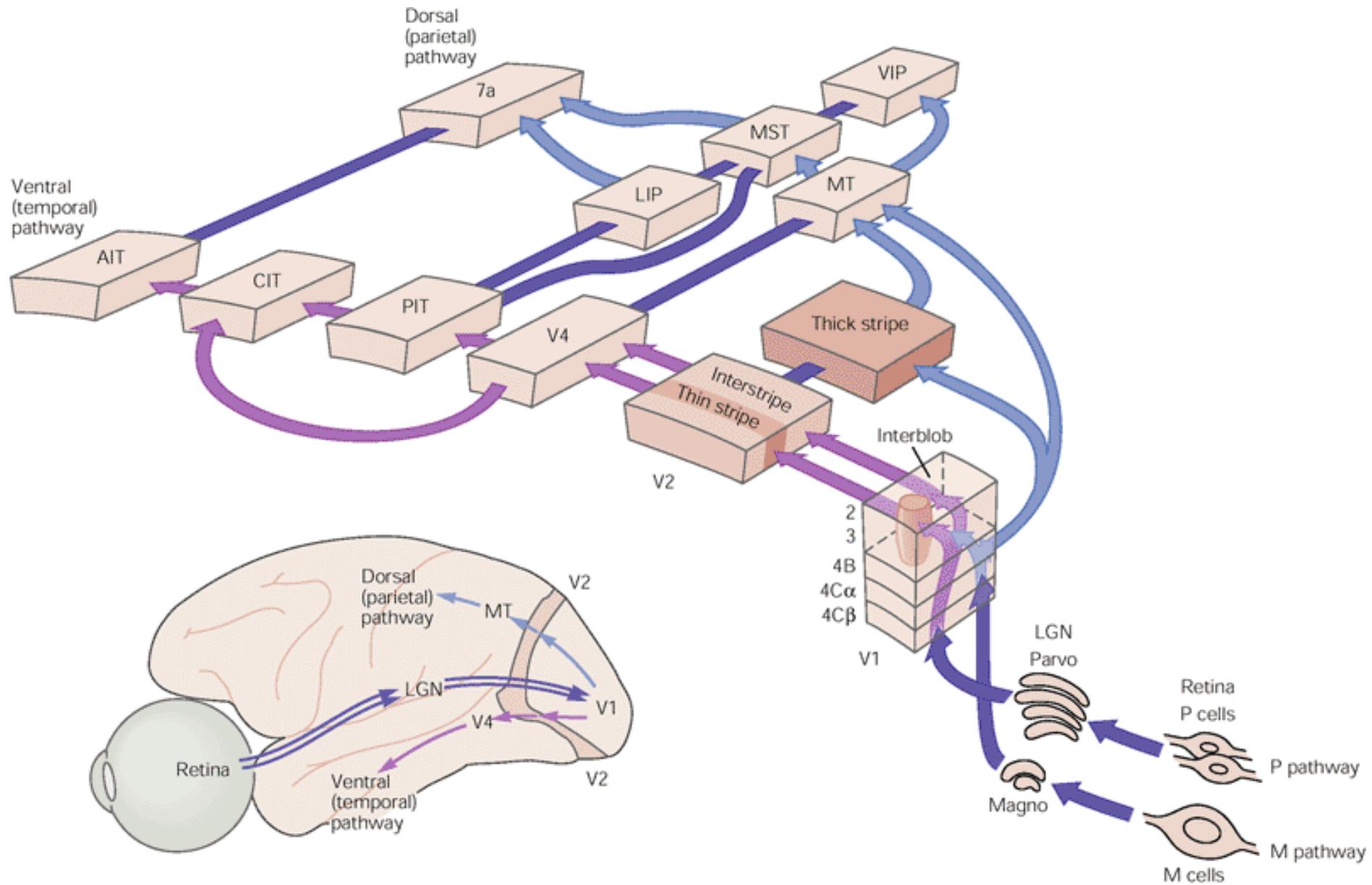




# Basic Operations Convolutional Neural Networks Applications

# CNN 只模仿了 What Pathway

但還有 Where Pathway

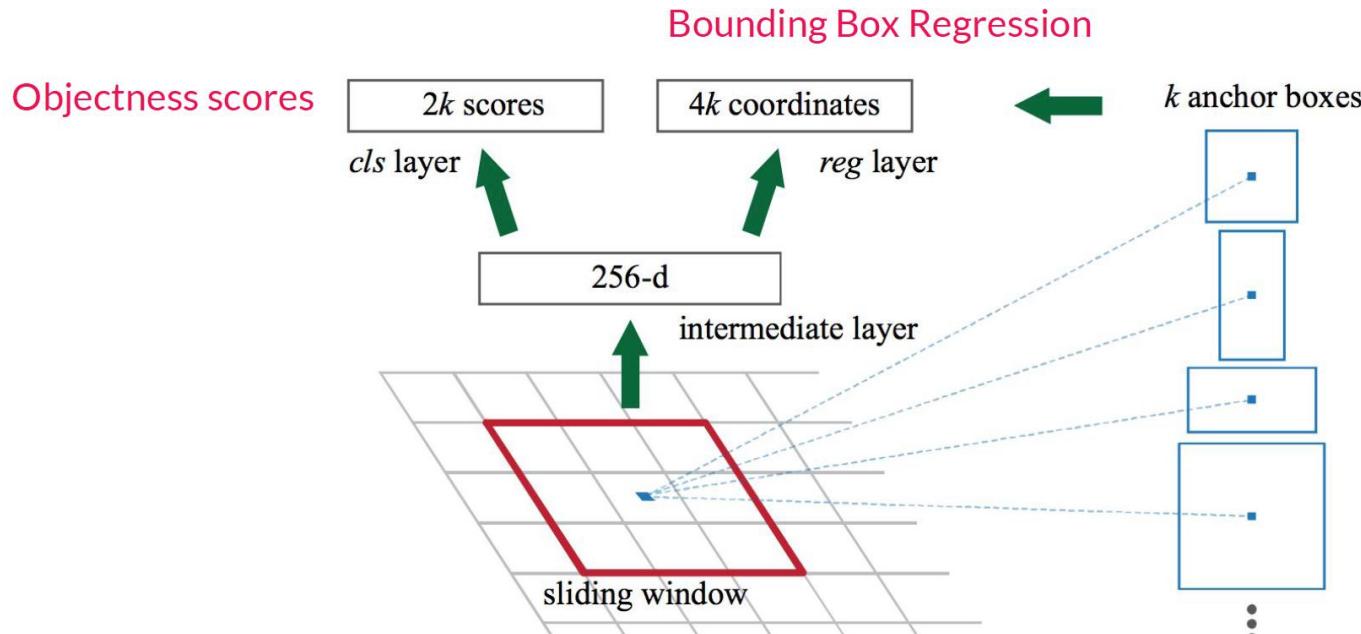


# 只模仿 What Pathway 的不足

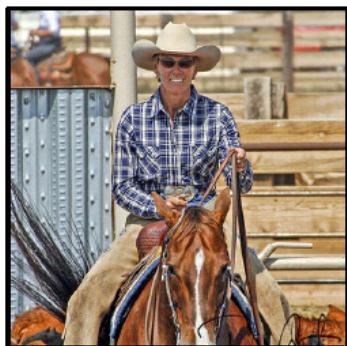
無法分解問題來各個擊破



# Region-based CNN (R-CNN)



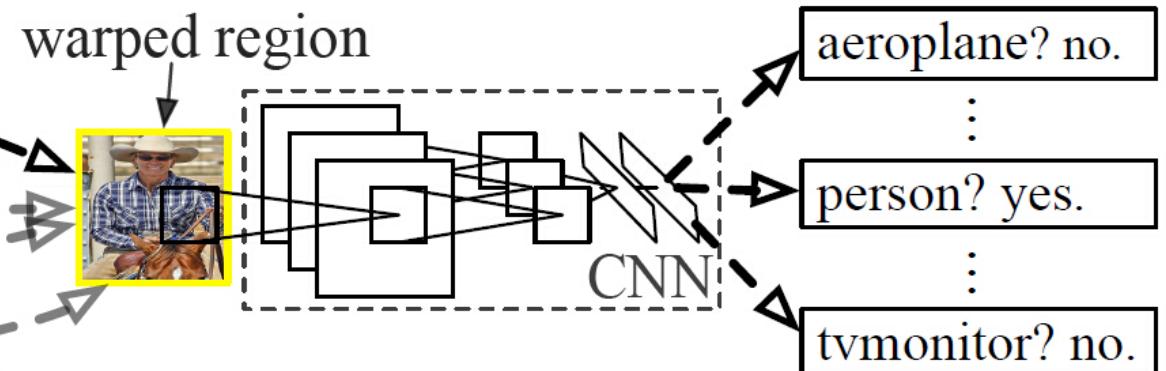
## R-CNN: *Regions with CNN features*



1. Input image



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

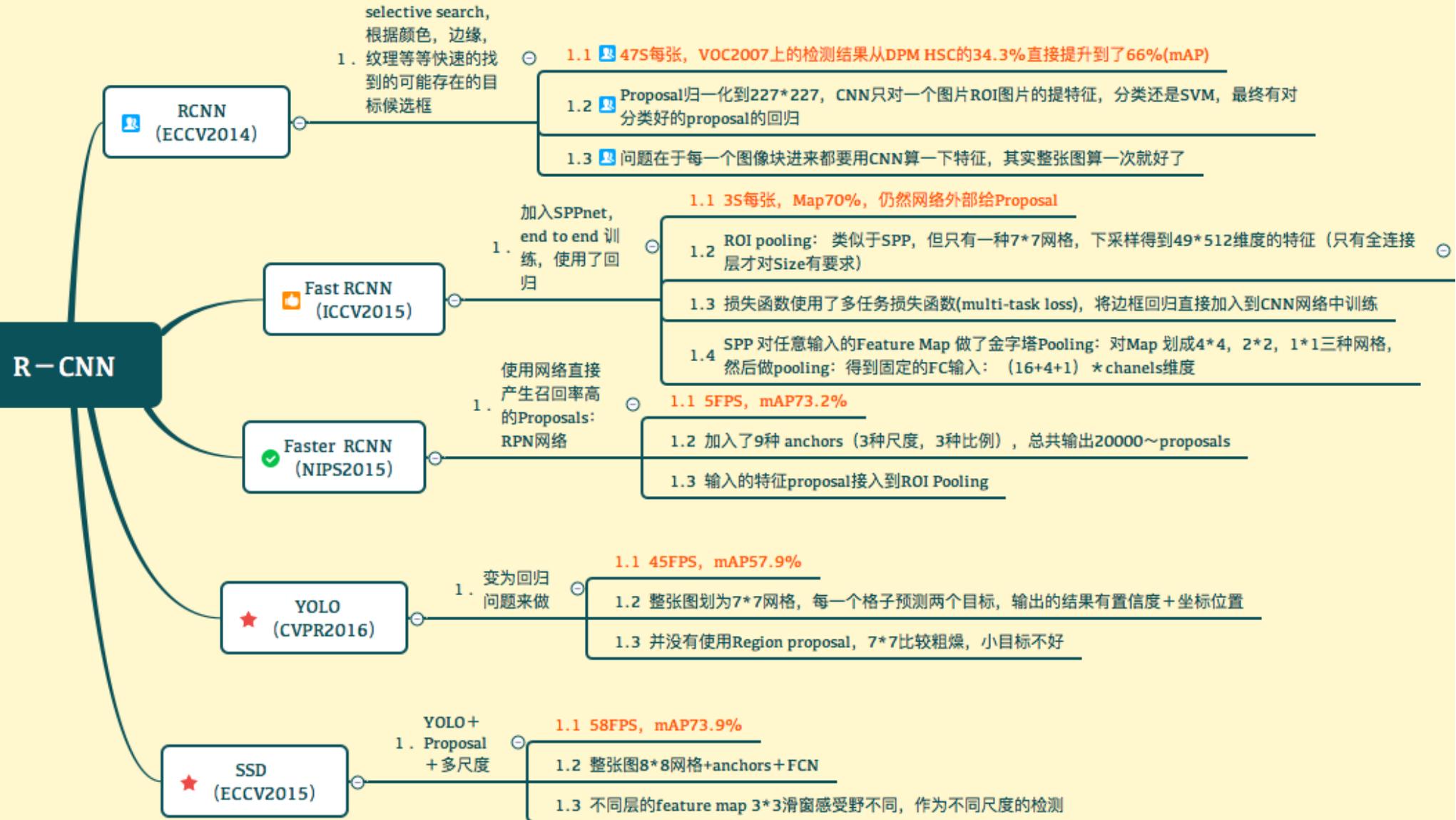


3. Compute CNN features

4. Classify regions

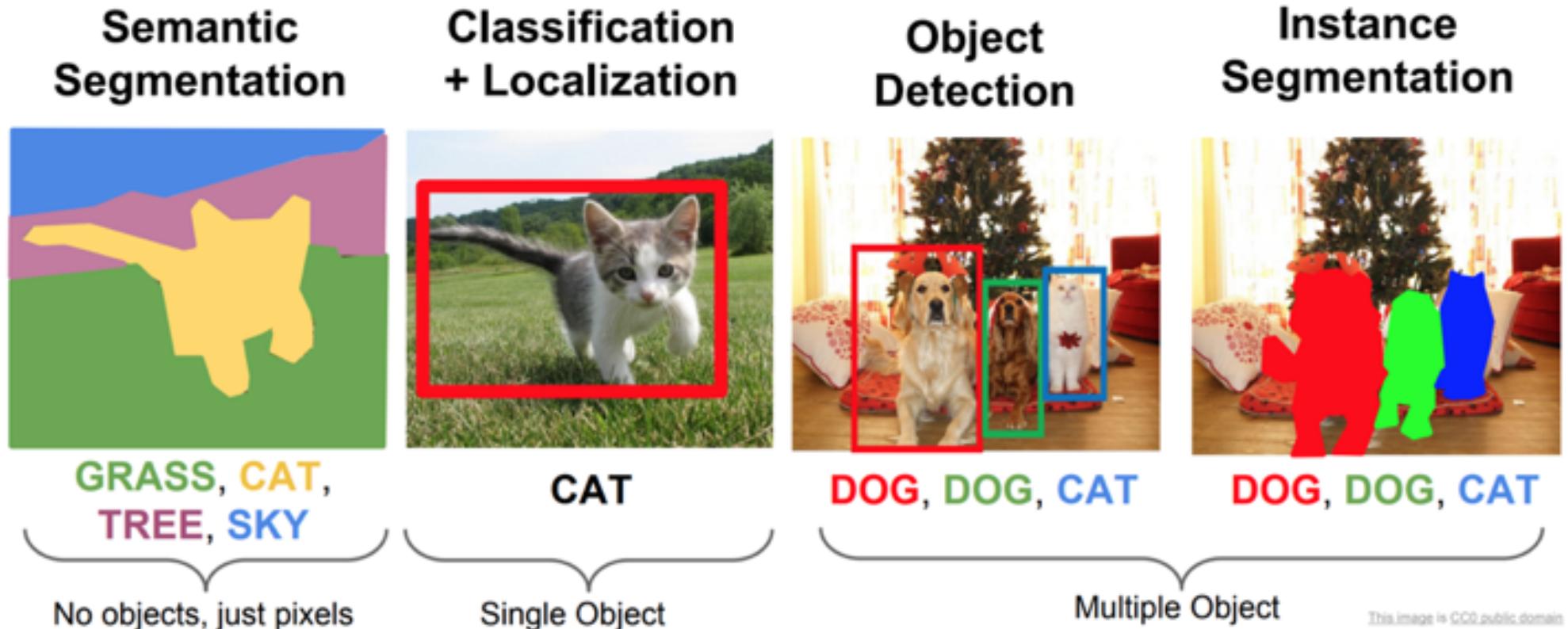
# R-CNN 的徒子徒孫

## 族繁不及備載



# 電腦視覺的幾類問題

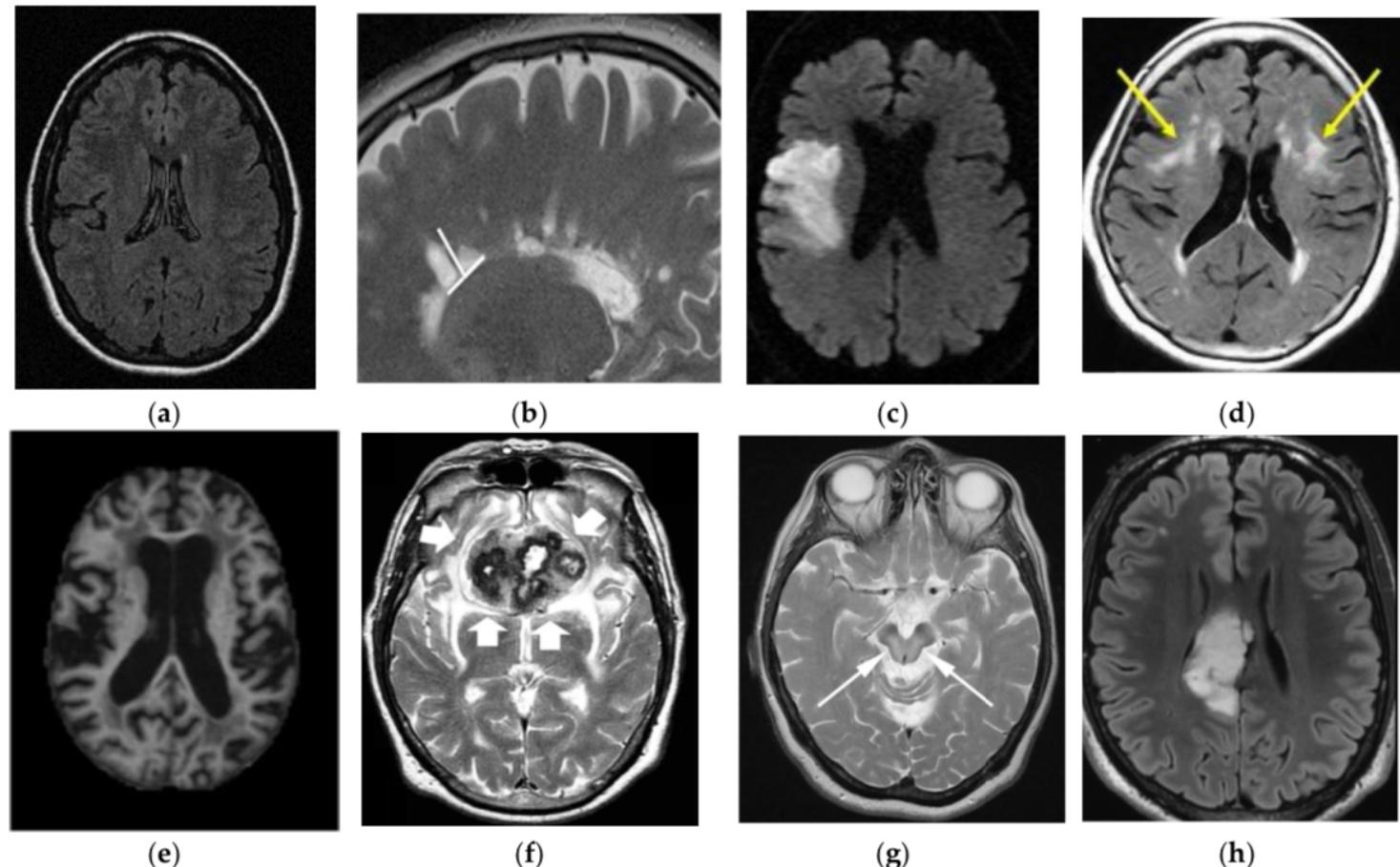
都是用 CNN 來處理



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

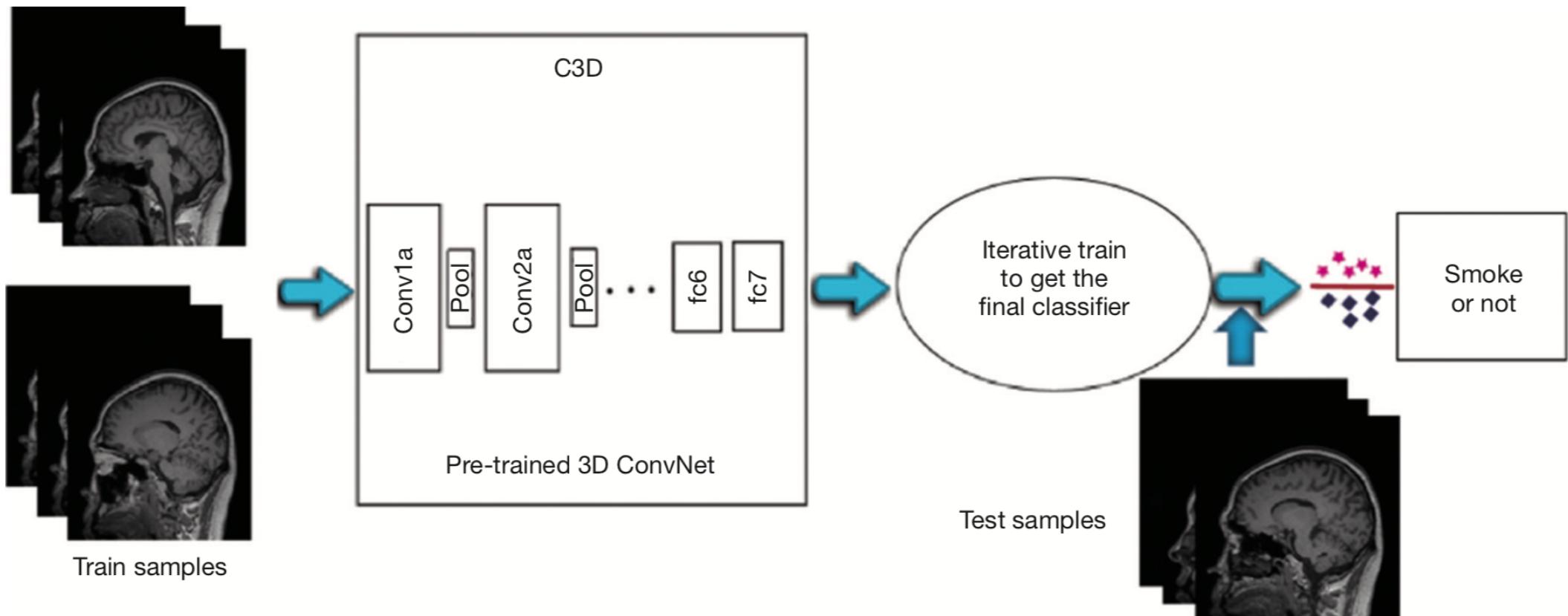


**Figure 17.** Comparison of brain tumor with other brain disorders (image permission requested from sources). (a) Normal Brain [AtheroPoint<sup>TM</sup>]; (b) Multiple Sclerosis [113]; (c) Stroke [114]; (d) Leukoaraiosis [115]; (e) Alzheimer's Disease [116]; (f) Parkinson's Disease [117]; (g) Wilson's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

# Object Classification (2/2)

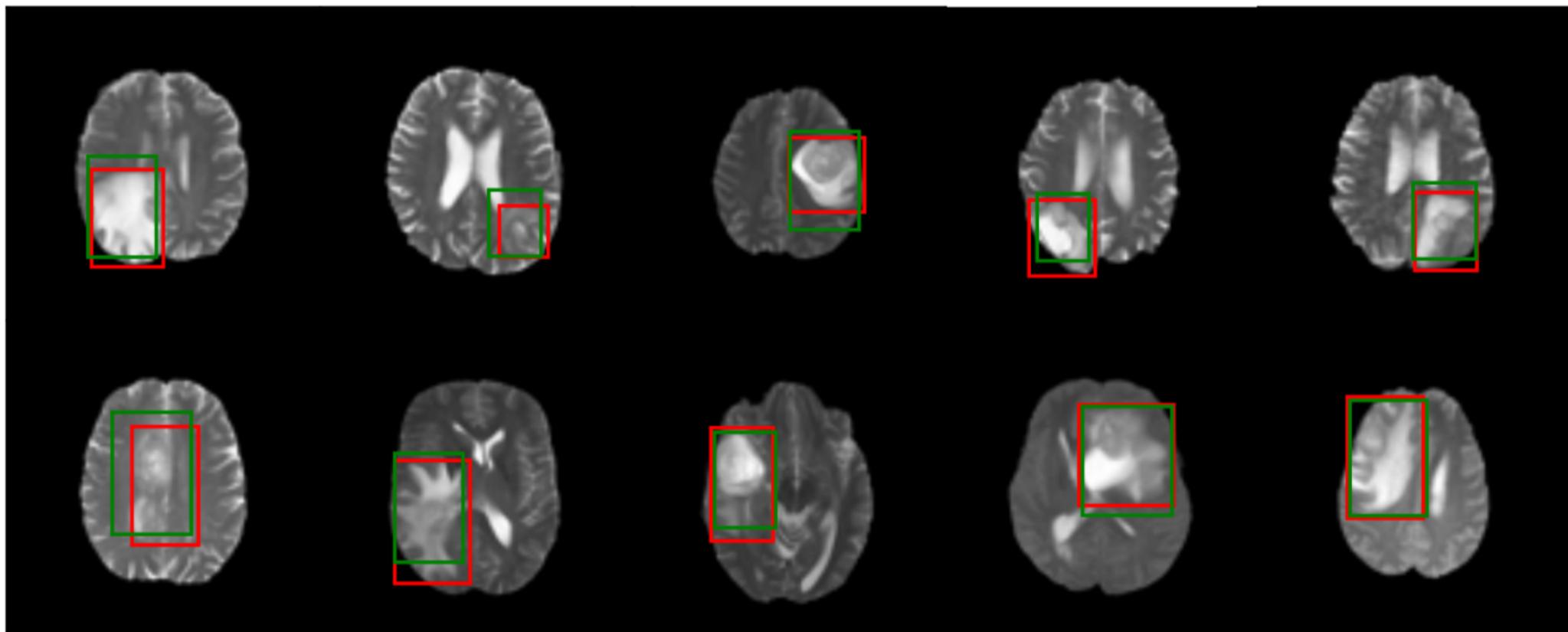
如判斷一個人是否有抽煙

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



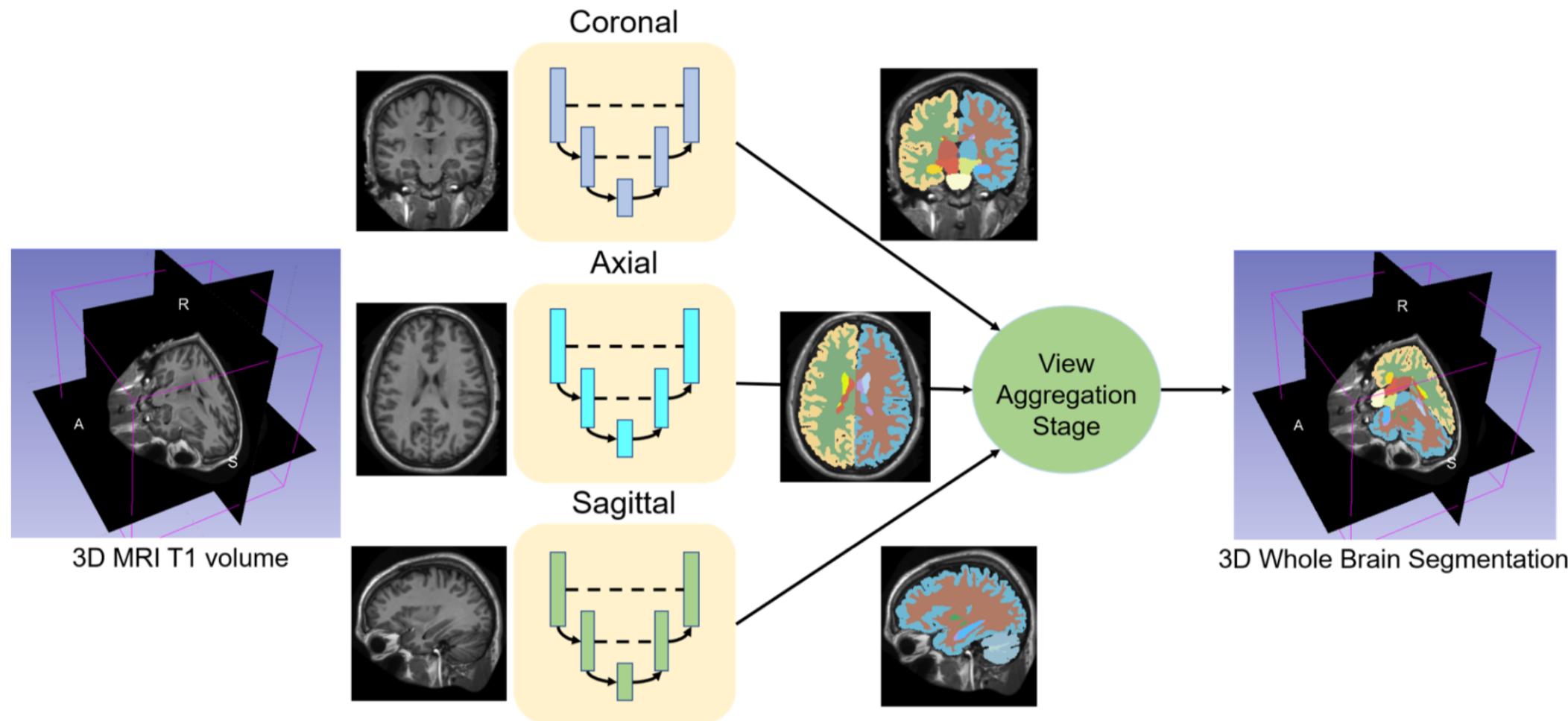
# Object Detection

有沒有辦法能 localize?



# Semantic Segmentation (1/3)

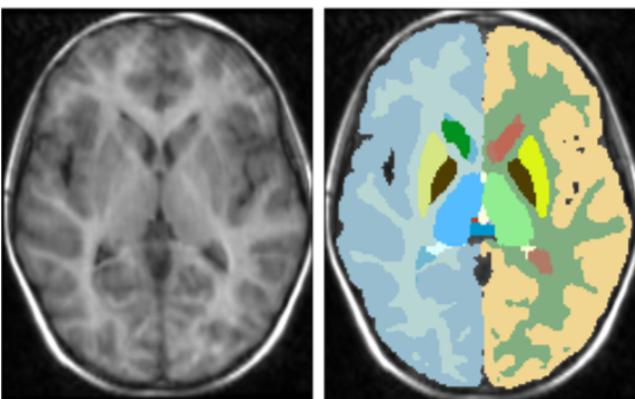
QuickNAT 使用 U-net



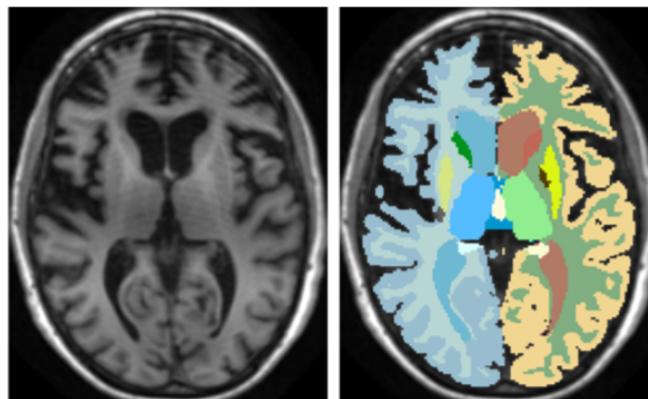
# Semantic Segmentation (2/2)

QuickNAT 可以快速且精準地做區域分割

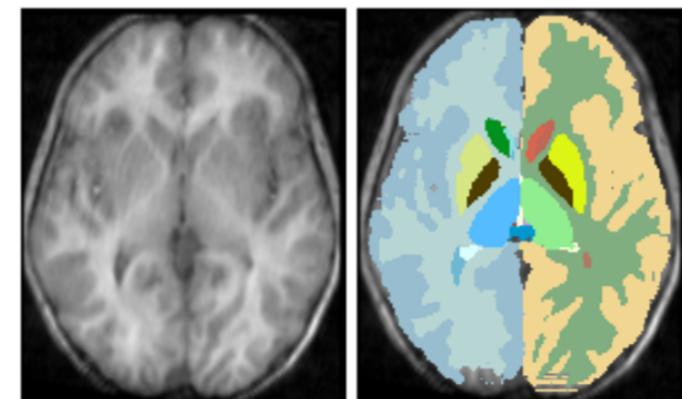
	Method	ADNI-29	CANDI	IBSR
All scans	<b>QuickNAT</b>	<b><math>0.825 \pm 0.027</math></b>	<b><math>0.819 \pm 0.028</math></b>	<b><math>0.820 \pm 0.035</math></b>
	<b>FreeSurfer</b>	$0.745 \pm 0.042$	$0.780 \pm 0.025$	$0.776 \pm 0.025$
	<b>FSL</b>	$0.643 \pm 0.290$	$0.647 \pm 0.369$	$0.461 \pm 0.419$
	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



(a) IBSR dataset



(b) ADNI dataset



(c) CANDI dataset

# Game Over

