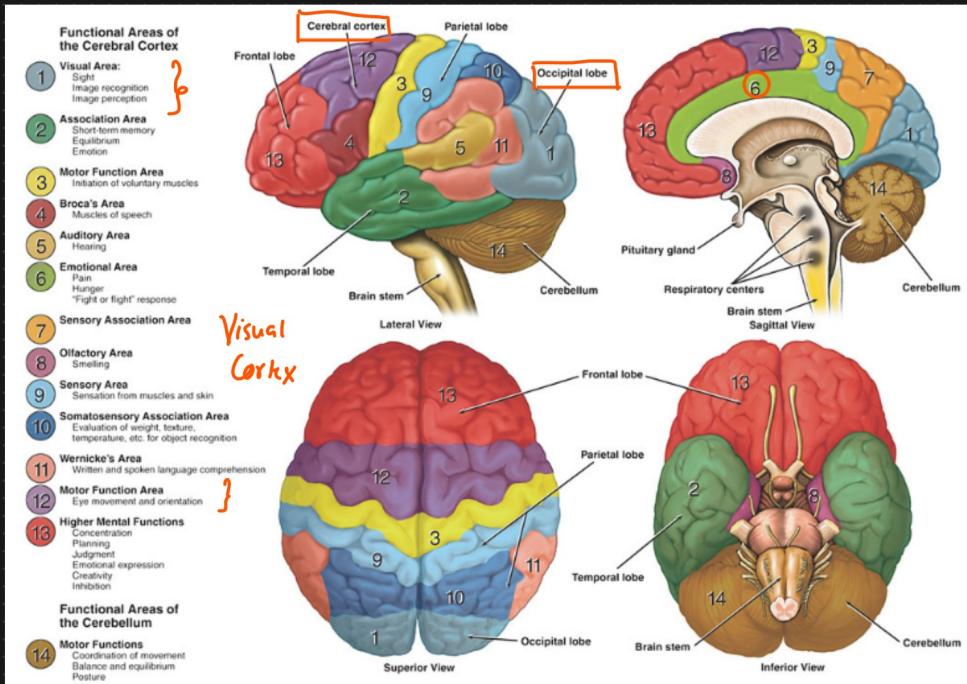


# Convolutional Neural N/w



<https://www.dana.org>

① ANN → Supervised Learning →   
 Classification  
 Regression

Dataset : I/p features      O/P

② CNN : I/p ⇒ Images Eg: Image classification,  
 Object Detection, Segmentation

② Cerebral Cortex And Visual Cortex

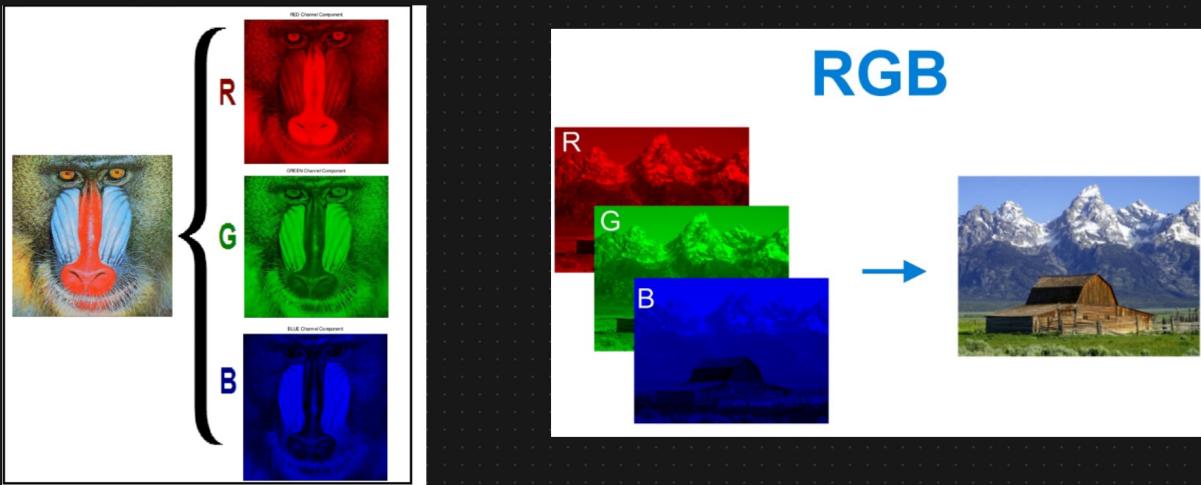
Visual Cortex (VI-V5) [Region of the brain that receives, integrates and processes visual information relayed from the retinas].

↓  
→ VI → Primary Visual Cortex [Orientation of edges  
And lines]

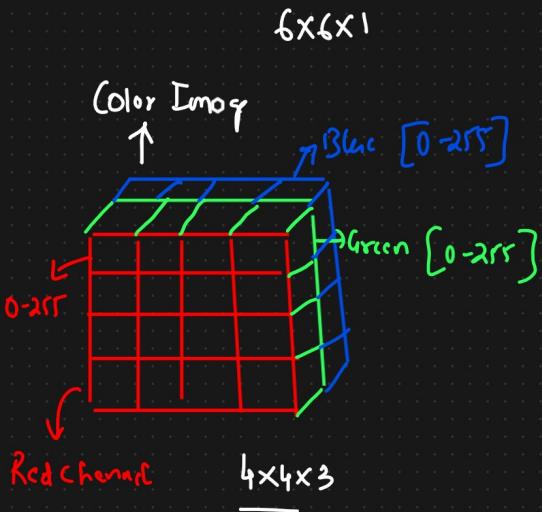
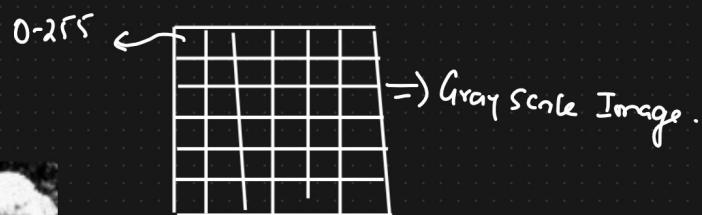
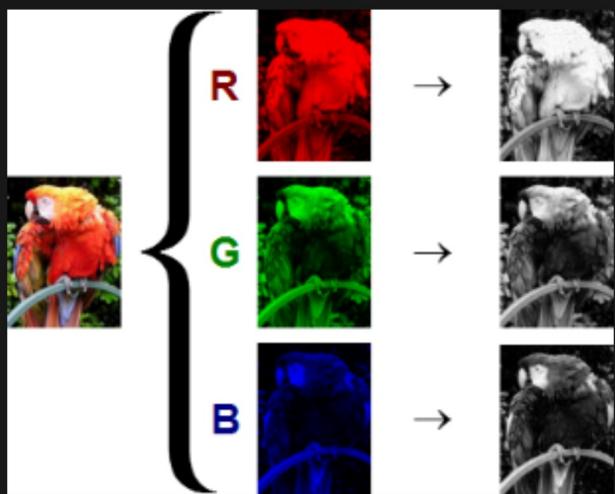
V2  
|  
V3 V4  
|  
V5 [Object Recognition]  
[Differences in color, complex patterns, object orientation]

Visualize the Image

### ③ RGB Images And Gray Scale Images



<https://www.researchgate.net/>



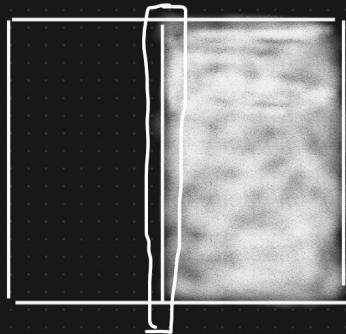
<https://commons.wikimedia.org/>

### ④ Convolution Operation In CNN

→ (0,1)

0	0	0	255	255	255
0	0	0	255	255	255
0	0	0	255	255	255
0	0	0	255	255	255
0	0	0	255	255	255
0	0	0	255	255	255

→



Convolution operation

Step 1

① Normalize

Divide by 255

+1	+2	-1
0	0	0
-1	-2	-1

Stride=1

0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1

$n=6$

\*

$f=3$

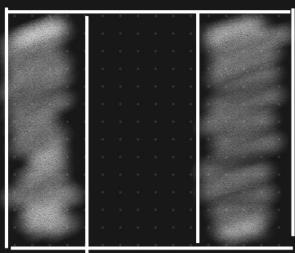
+1	0	-1
+2	0	-2
+1	0	-1

=

0	-4	-4	0
0	-4	-4	0
0	-4	-4	0
0	-4	-4	0

$4 \times 4$

$6 \times 6 \times 1$



filters  
vertical edge filters

$\leftarrow$

arr	0	0	arr
arr	0	0	arr
arr	0	0	arr
arr	0	0	arr

$$\begin{aligned} h - f + 1 &= \\ &= 6 - 3 + 1 = 4 \end{aligned}$$

## ⑤ Padding In CNN

0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0	0	0	0	1	1	1	1
0							

$6 \times 6$

$n=6$

$8 \times 8$

① Zero padding

② Neighbour padding

$f=3$

+1	0	-1
+2	0	-2
+1	0	-1

0	-4	-4	0	
0	-4	-4	0	
0	-4	-4	0	
0	-4	-4	0	

$6 \times 6$   
=

$n-f+2p+1$

$6 - 3 + 2p + 1 = 6$

$3 + 2p + 1 = 6$

$2p = 6 - 4$

$p = \frac{2}{2} = 1$

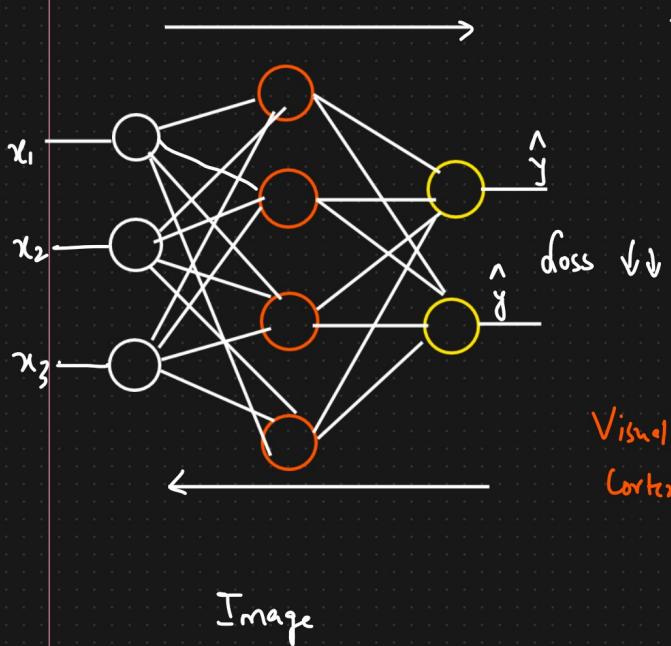
$7 \times 7$

$3 \times 3$

$7 \times 7$

How much padding you need to apply?

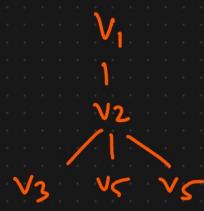
## ⑥ Operation of CNN vs ANN



$$z = w^T x_i + b$$

$$\text{ReLU}(z)$$

Visual  
Cortex



$\rightarrow$  ReLU operation  $\max(0, x)$

0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1
0	0	0	1	1	1

\*

+1	0	-1
+2	0	-2
+1	0	-1



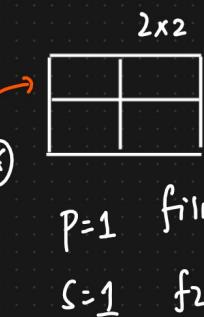
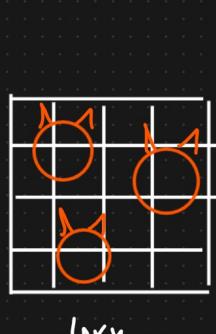
0	-4	-4	0
0	-4	-4	0
0	-4	-4	0
0	-4	-4	0

-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

Convolution Layer

$f_n$

## ⑦ Max Pooling, Min Pooling, Mean Pooling



$P=1$

$f_1$   
 $f_2$   
 $f_3$   
 $f_4$

$S=1$

1	2	3
4	3	6
2	8	4

$3 \times 3$  Slide=2

1

$2 \times 2$

$\downarrow$

4	6
8	4

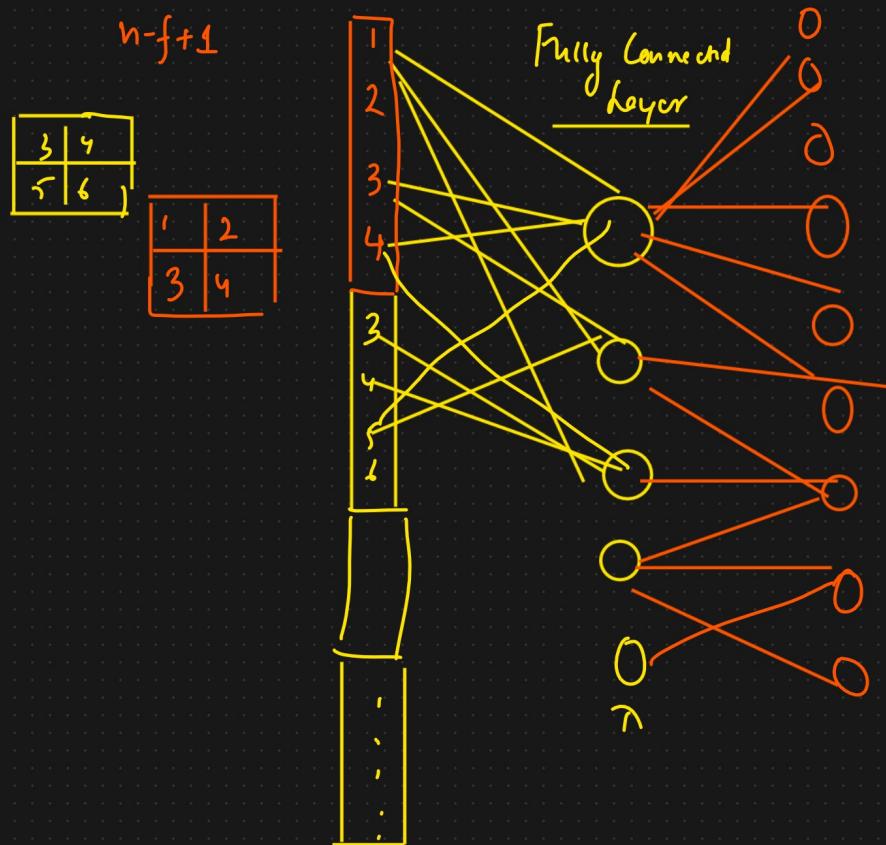
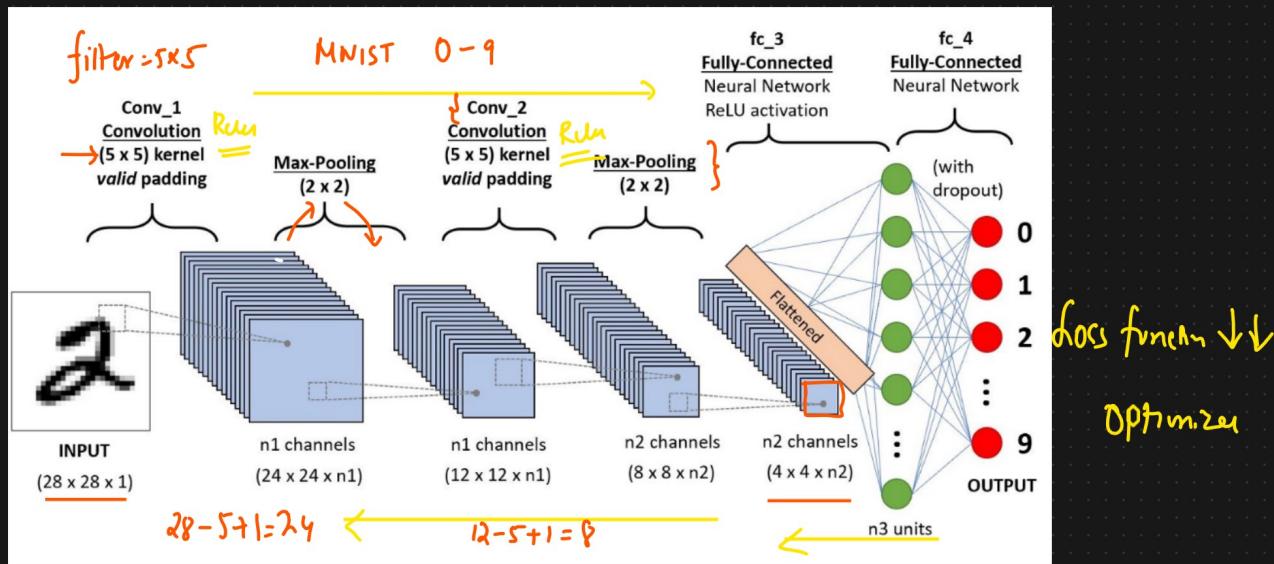
?
---

Convolution Layer

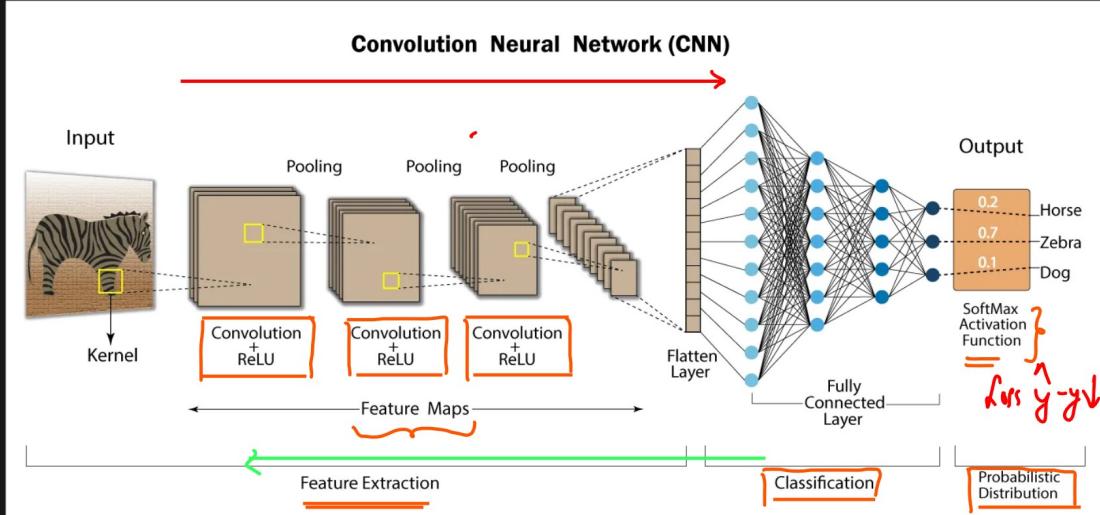
Max Pooling

## ⑦ Location Invariant

## ⑧ Fully Connected layer In CNN [Flattened Layer]



# ⑨ CNN Complete Example



<https://developersbreach.com/convolution-neural-network-deep-learning/>

0	0	0	
0	0	0	
0	0	0	
0	0	0	
0	0	0	
0	0	0	

\*

+1	0	-1
+2	0	-2
+1	0	-1

0	-4	-4	0
0	-4	-4	0
0	-4	-4	0
0	-4	-4	0