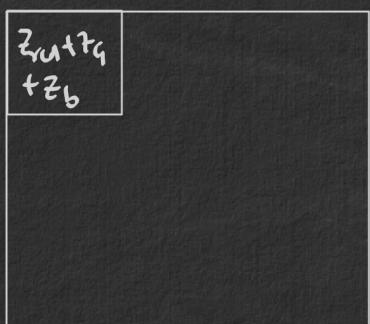
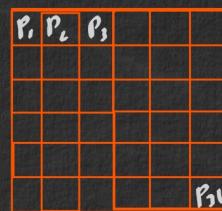
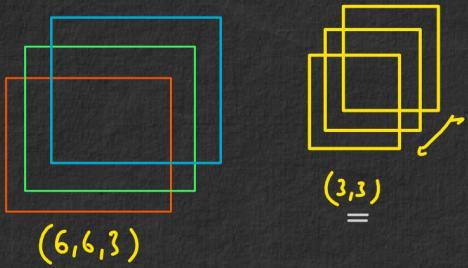
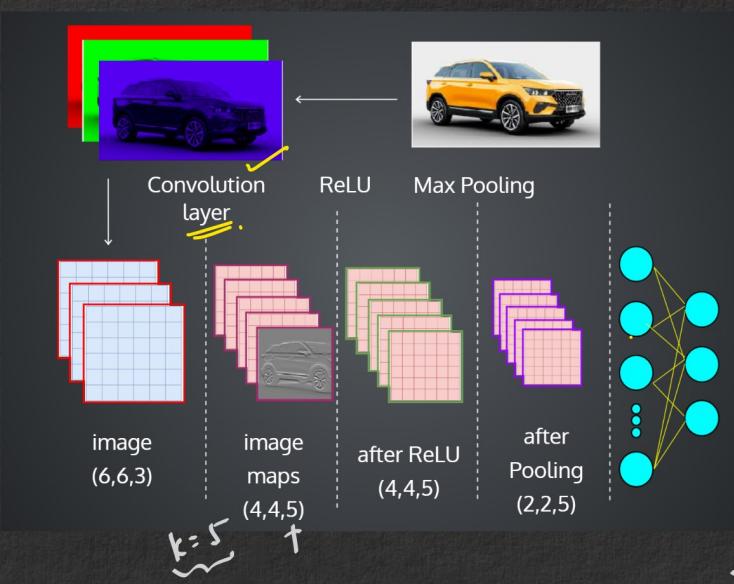


# AGENDA

- 1> CNN operations ( Convolution , Pooling, activation )
- 2> CNN architecture ( basic )
- 3> Practicals using Tf.



$(4,4) \rightarrow \text{slip one filter}$   
 5 filters  $\rightarrow (4,4,5)$

## Summary of Conv Layer

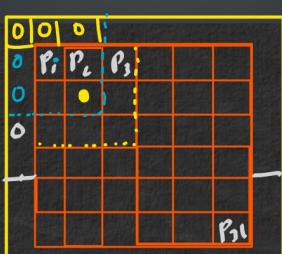
$$\text{input image size} = W_1 \times H_1 \times D_1$$

$$\text{output image size} = W_2 \times H_2 \times D_2$$

$$W_2 = \frac{(W_1 - F + 2P)}{S} + 1$$

$$H_2 = \frac{(H_1 - F + 2P)}{S} + 1$$

$$D_2 = K$$



$$\begin{aligned} Z_{out,1} &= p_1 w_1 + p_2 w_2 + \dots + p_s w_s \\ &= \sum_{i=1}^s p_i w_i \end{aligned}$$

$$Z_{green,1} =$$

$$Z_{blue,1} =$$

↓  
5b.

3,4

$$\text{i/p image} = 6, 6, 3 \quad F = 3$$

$$\text{o/p image} = W_2, H_2, D \quad \text{square.}$$

$$W_2 = \frac{6 - 3 + 2(0)}{1} + 1 = \frac{3}{1} + 1 = 4$$

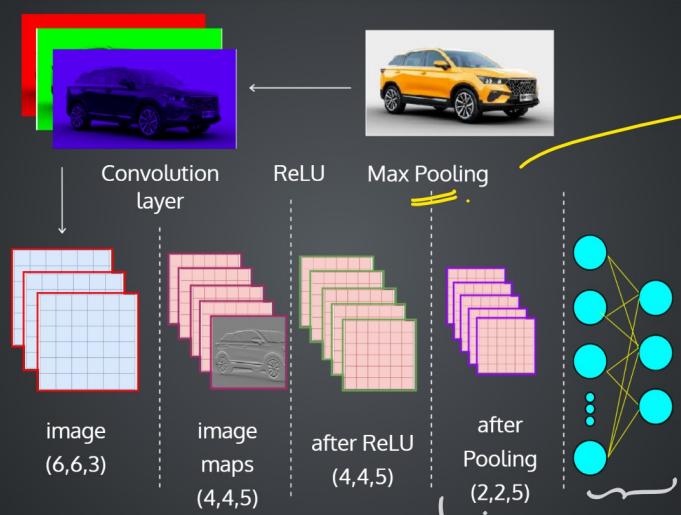
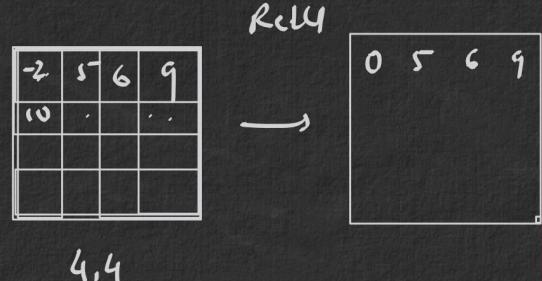
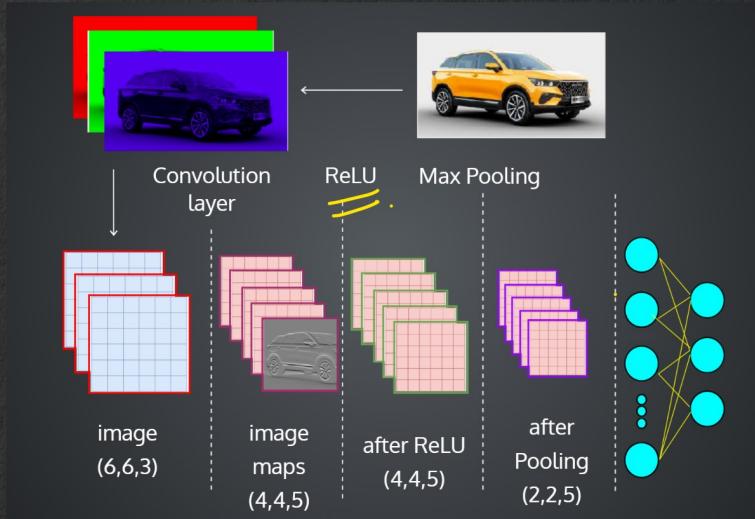
$$H_2 = \frac{6 - 3 + 2(0)}{1} + 1 = \frac{3}{1} + 1 = 4$$

$$D_2 = k$$

$$P=1$$

$$W_2 = \frac{6-3+2}{1} + 1 = \frac{6-3+2}{5} + 1 = 6$$

6,



Max Pooling, Avg. Pooling.  
Global Avg. Pooling

2	5	6	9
10	.	.	.
1	2	6	2
3	5	0	7

2	2
---	---

11	9
5	7

$$(Avg\ of\ All) = A$$

### Summary of Pooling Layer

$$\text{input image size} = W_1 \times H_1 \times D_1$$

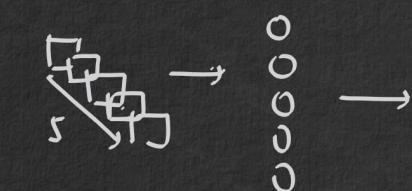
$$\text{output image size} = W_2 \times H_2 \times D_2$$

$$W_2 = \frac{(W_1 - F)}{S} + 1$$

$$H_2 = \frac{(H_1 - F)}{S} + 1$$

$$D_2 = D_1$$

- S = Stride
- F = Spatial extent



$$4, 4, 5$$

$$W_2 = \frac{4-2}{2} + 1 = \frac{2}{2} + 1 = 2$$

$$H_2 = \frac{4-2}{2} + 1 = 2$$

$$D_2 = 5 \quad (2, 2, 5)$$

$$x \xrightarrow{w} \underbrace{\Sigma \phi}_{\uparrow b} \longrightarrow y = \phi(w \cdot x + b)$$

$$\begin{array}{c} x_1 \xrightarrow{w_1} \\ x_2 \xrightarrow{w_2} \\ \downarrow b \end{array} \longrightarrow \phi \left( \underbrace{\begin{bmatrix} w_1 & w_2 \end{bmatrix}}_{\uparrow} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \right) + b = \hat{y}$$

$$\phi \left( \begin{bmatrix} w_1 \\ w_2 \end{bmatrix}^T \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + b \right) = \hat{y}$$

$$\phi (w_1 x_1 + w_2 x_2 + b) = \hat{y}$$

$x_{11}$	$x_{12}$	$x_{13}$	$x_{14}$		
$x_{21}$	$x_{22}$	$x_{23}$			
	$x_{33}$				
				$x_{44}$	

$$\begin{bmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \\ w_{33} \end{bmatrix}$$

$w$

$$\begin{array}{c} z_{11} \\ z_{12} \\ z_{13} \\ z_{14} \\ \vdots \\ z_{44} \end{array} \longrightarrow \begin{bmatrix} z_{11} & z_{12} & z_{13} & z_{14} \\ \vdots & \vdots & \vdots & \vdots \\ z_{41} & z_{42} & z_{43} & z_{44} \end{bmatrix}$$

$x$

$$z_{11} = w_{11} x_{11} + w_{12} x_{12} + w_{13} x_{13} + \dots + w_{33} x_{33} + b$$

$$= \begin{bmatrix} w_{11} & w_{12} & \dots & w_{33} \end{bmatrix} \begin{bmatrix} x_{11} \\ x_{12} \\ \vdots \\ x_{33} \end{bmatrix} + b$$

$$= \begin{bmatrix} w_{11} \\ w_{12} \\ \vdots \\ w_{33} \end{bmatrix}^T \begin{bmatrix} x_{11} \\ x_{12} \\ \vdots \\ x_{33} \end{bmatrix} + b$$

$$z = \phi \left( \underbrace{w^T \cdot x + b}_{\text{activation fn}} \right) =$$

$$w = w - \eta \frac{\partial L}{\partial w} \Big|_{w=w}$$

