Feature /
Output

Image

Kernel
Filter
Patch

Image (F)
↓
(F) Kernel (Convolving)
↓
Output Feature

$I(5 \times 5) \longrightarrow K(3 \times 3) \longrightarrow O(3 \times 3)$

$I(5 \times 5) \xrightarrow{K(3 \times 3)} O(3 \times 3)$

25 9

Loss of Info

Image :- $\underline{h} \times \underline{w} \times d \rightarrow (1,3)$

$\left. \begin{array}{c} B/W \\ Colour \end{array} \right\}$

SD $\rightarrow$ 480
FHD $\rightarrow$ 720
4K $\rightarrow$ 3096
8K $\rightarrow$
2K $\rightarrow$ ~1500

Higher Processing

Kernel Value Matrix

$$\begin{bmatrix} 0 & 1 & 2 \\ 2 & 2 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$
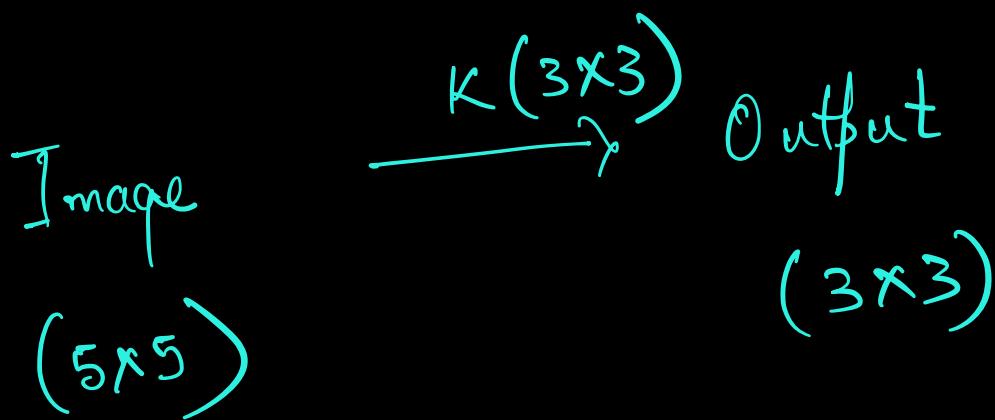
Image Matrix

$$\begin{bmatrix} 3 & 3 & 2 & 1 & 0 \\ 0 & 0 & 1 & 3 & 1 \\ 3 & 1 & 2 & 23 \\ 2 & 0 & 0 & 22 \\ 2 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$= (0 \times 3) + (1 \times 3) + (2 \times 2) \ne$

$$(2 \times 0) + (2 \times 0) + (0 \times 1) = 12$$

$$(0 \times 3) + (1 \times 1) + (2 \times 2) \; 5$$

Image $\xrightarrow{K(3 \times 3)}$ Output

(5×5) (3×3)

$(5 \times 5) \qquad K(5 \times 5) \rightarrow (1 \times 1)$

$(7 \times 7) \qquad K(7 \times 7) \rightarrow (1 \times 1)$

$(7 \times 7) \xrightarrow{K(3 \times 3)} (5 \times 5) \xrightarrow{K(3 \times 3)} 3 \times 3$

$$I \rightarrow \quad 7 \times 7$$
$$\downarrow K(3 \times 3)$$
$$5 \times 5$$
$$\downarrow K(3 \times 3)$$
$$3 \times 3$$

9×9

$\downarrow K (3 \times 3)$

7×7

$\downarrow K (3 \times 3)$

5×5

$\downarrow K (5 \times 5)$

$(\times)$

Odd Filters

99×99

$\downarrow K (3 \times 3)$

97×97

$\downarrow K (3 \times 3)$

Even (Rare)

95×95

$\downarrow K (5 \times 5)$

91×91

$\downarrow K (7 \times 7)$

85×85

$3 \times 3 \rightarrow \underline{2}$

$5 \times 5 \rightarrow 4$

$7 \times 7 \rightarrow 6$

Assume

$\boxed{300 \times 300} \rightarrow$ Start

Multiple Layers

Close

$\boxed{1 \times 1} \longrightarrow$ End
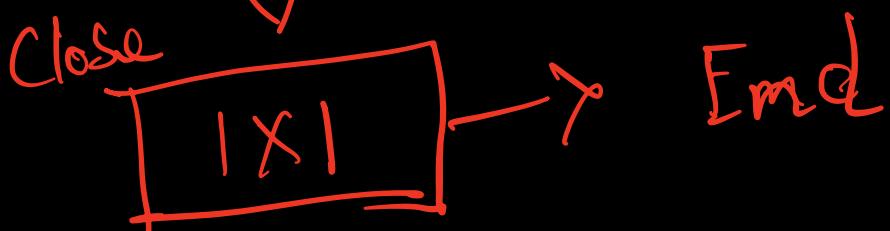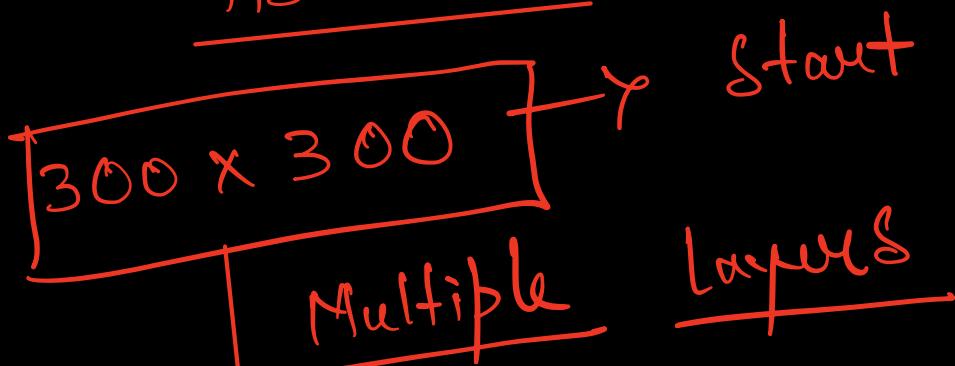
3×3

5×5

I have captured all the features

Filter/Kernel $\longrightarrow$ looking on image

$\longrightarrow$ Feature Extractor

Padding

(I) 5×5

$\downarrow$

$K (3 \times 3)$

$\downarrow$

$O (3 \times 3)$

Loss of Info

Dim Changed

Retain the dim.

5×5

$K (3 \times 3) \downarrow$ Padding

(5×5)

$K(3 \times 3)$ $\longrightarrow$ Conv

(3×3)

(100×100)

(3×3)

1×1

$\begin{cases} 0 & 49/50 \end{cases}$
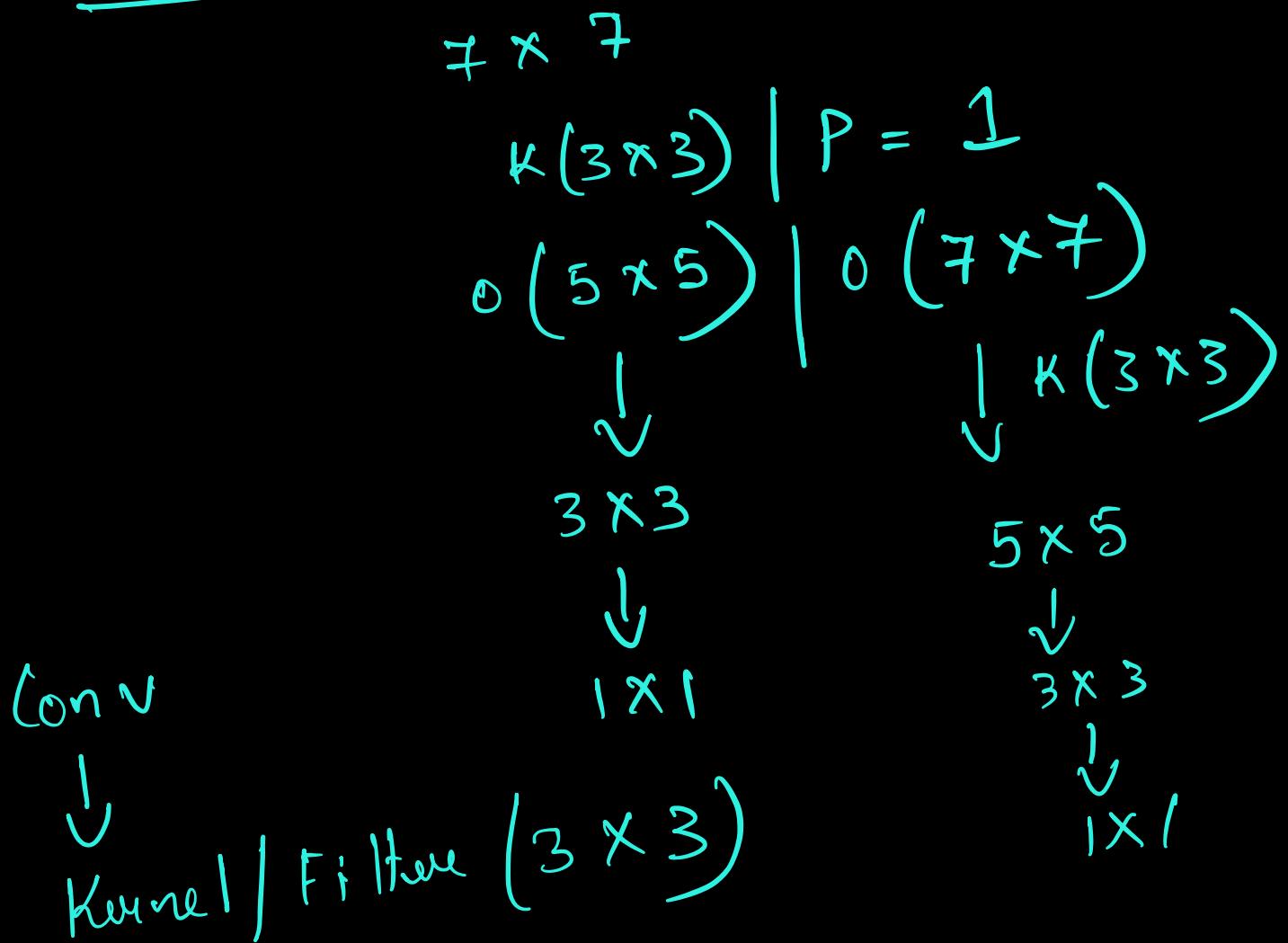
Layers

50 layers

(1000×1000)

$K(3 \times 3)$

$= \underline{500 \text{ layers}}$

(1×1)

(Max Pooling)

Padding

7×7

$K(3 \times 3) \mid P = 1$

$O(5 \times 5) \mid O(7 \times 7)$

$\mid K(3 \times 3)$

$\downarrow$

3×3

$\downarrow$

1×1

5×5

$\downarrow$

3×3

$\downarrow$

1×1

Conv

$\downarrow$

Kernel / Filter (3×3)

CNN Output Size Formula

$$\text{Output Size} = \left[\frac{N - F + 2P}{S} \right] + 1$$

$N \rightarrow$ Input size $(h \times w)$ $(7 \times 7, 100,)$

$F \rightarrow$ Filter / Kernel size

$P \rightarrow$ Padding

$S \rightarrow$ Stride

$I \quad 30 \times 30$ $\qquad K (3 \times 3)$ $\qquad P = 0$

$S = 1$

Floor

$$O = \left[\frac{30 - 3 + 2 \cdot 0}{1} \right] + 1$$

$O = 27 + 1$

$O = 28$

$I \quad 60 \times 60$ $\qquad K \; 7 \times 7$ $\qquad P = 0$

$S = 2$

$$O = \frac{60 - 7}{2} + 1$$

$$O = \frac{53}{2} + 1$$

$$= 26.5 + 1$$

$$= 26 + 1$$

$$= 27$$

$$60 \times 60$$

$$27 \times 27$$

$$h = w$$

$$h\,50 \quad \times w\,40 \qquad K(5 \times 5) \qquad P = 1$$

$$S = 1$$

$$h_0 = \left[\frac{50 - 5 + 2}{1} \right] + 1$$

$$= 45 + 3 = 48$$

$$w_0 = 38$$

Filter size

Input $\longrightarrow$

7×7

5×5 1

3×3 2

1×1 3

$K (3 \times 3)$

$K (5 \times 5)$

7×7

$\downarrow$

3×3 $K(3 \times 3)$

$\downarrow$

1×1

Parameters

$K(3,3)$

$= 9$

$K(7,7)$

$= 49$

$= 3(3 \times 3)$

$K(5,5)$

$= 25$
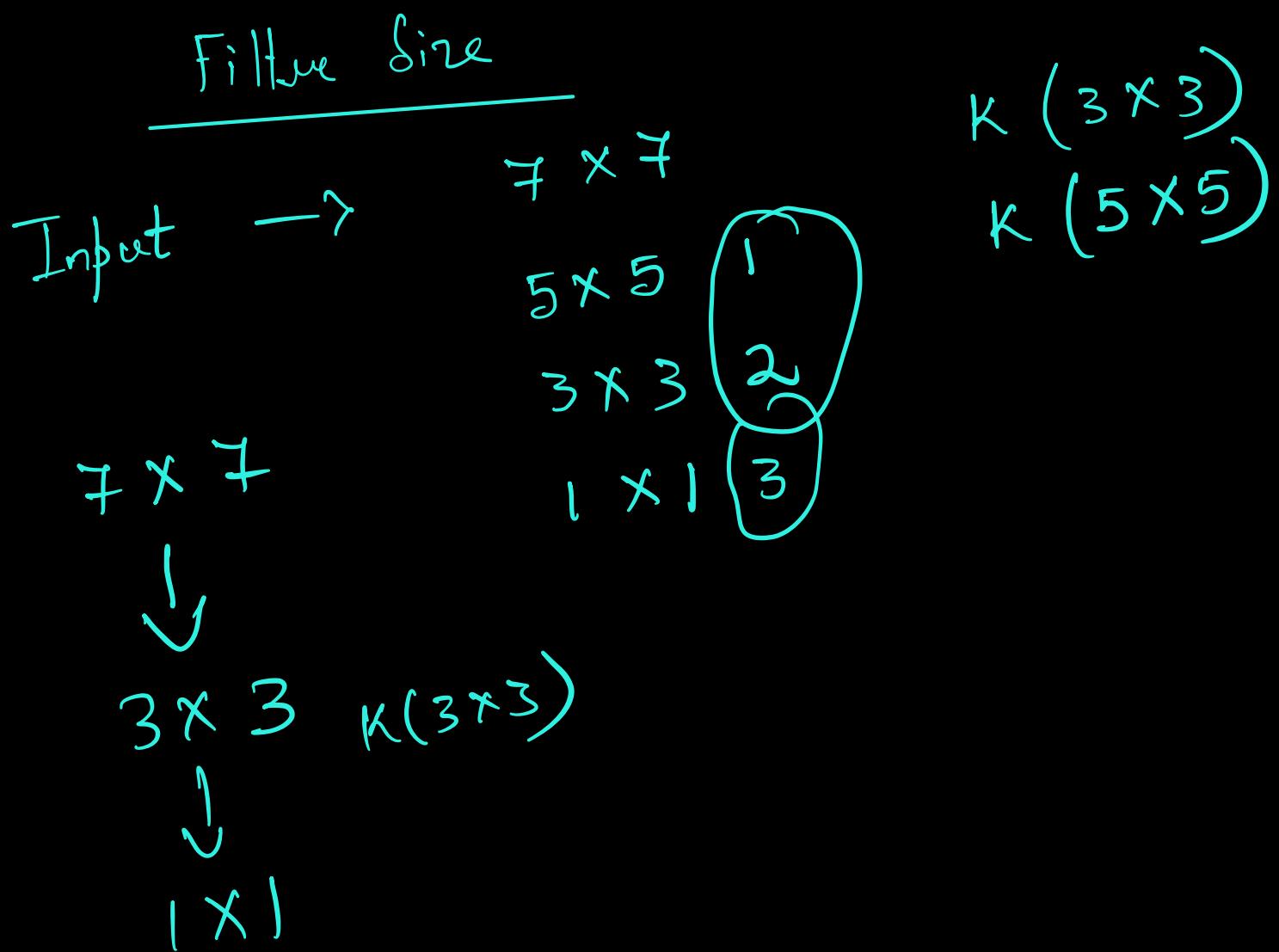
$= 2(3 \times 3)$

$k = 5 \times 5$ $k = 3$

$$I = 7 \times 7$$
$$\overline{K = 7 \times 7}$$
$$O = 1 \times 1$$

$$3 \times 3$$

$$7 \times 7$$
$$3 \left\{ \begin{array}{c} 5 \times 5 \\ 3 \times 3 \\ 1 \times 1 \end{array} \right\}$$

$$5 \times 5$$
$$2 (3 \times 3) \left\{ \begin{array}{c} 3 \times 3 \\ 1 \times 1 \end{array} \right\}$$

$$5 \times 5$$
$$= 25$$

$$2 (3 \times 3)$$
$$= 18$$
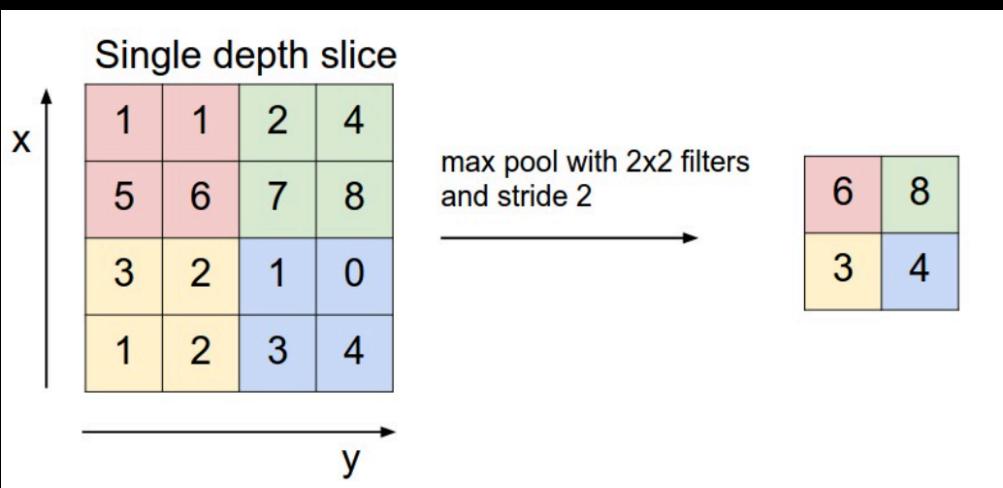
$$7 \times 7$$
$$= 3 (3 \times 3)$$
$$= 27$$

$$\left\{ \underline{\text{Less Parameters}} \right\}$$

$$80\% \binom{3,3}{} \qquad (5,5)^{20\%} (7 \times 7) \ (11 \times 11)$$

Single depth slice

1	1	2	4
5	6	7	8
3	2	1	0
1	2	3	4

max pool with 2x2 filters and stride 2 →

6	8
3	4

<u>Dim loss</u>

$I = 4 \times 4$

$O = 2 \times 2$

$= 50\%$

Info loss $= 16$ $^4/_{16} = 25\%$

<u>75% loss</u>

<u>Pooling</u>

Max, Min, Avg (Mean)

Why ?   <u>Dimension Loss</u>

<u>Pure Conv</u>

100×100
$= 50$ layers

<u>Con + Max</u>
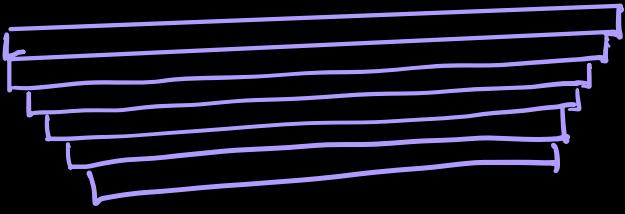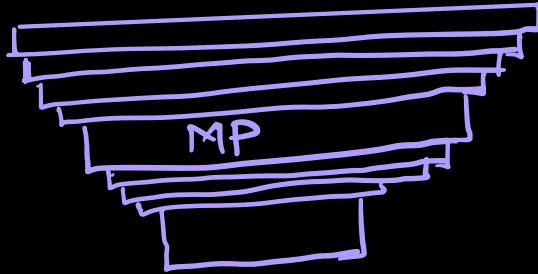
100×100

$\overset{2}{0}$

100 × 100
98 × 98
96 × 96
94 × 94
92 × 92
90 × 90

MP

100 × 100
98 × 98
96 × 96
94 × 94
47 × 47
45 × 45
43 × 43
41 × 41
20 × 20

50 Layer

lessue than
50

Stride → Skip
(2)

$N = 100$, $F = 3$, $S = 1$

$$\left\{ (1 \times 1) \right.$$

$$\left\{ \begin{array}{l} 2 \times 2 \\ 3 \times 3 \quad 4 \times 4 \\ 5 \times 4 \end{array} \right\}$$

$$. I (4 \times 4) \quad (2, 2)$$

$$K (2, 2)$$

$$K (4, 4) \longrightarrow |X| \longleftarrow$$

3×3

2×2
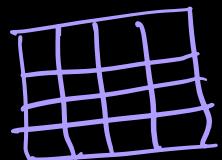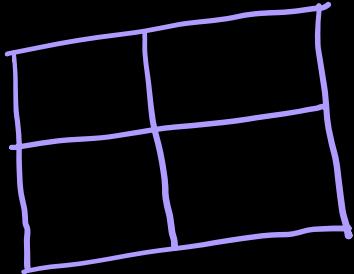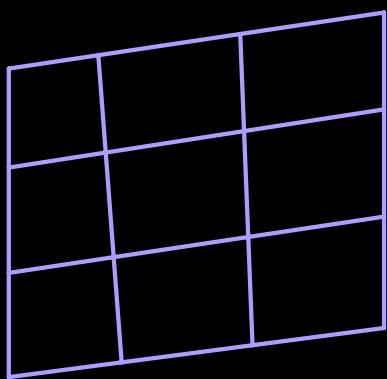
<u>Symmetry Issue</u>

Dimensions

$K(3, 3)$ No of Filters   , P , S

Size 2^2 (8, 16, 32, 64)

Filter $\longrightarrow$ Feature Extraction

More Filter $\longrightarrow$ More Feature Extraction

32 Filters $\longrightarrow$ 32 Features

64 Filters $\longrightarrow$ 64 Features

(3×3) 64   (5×5) 128

Input   (30 × 30 × 3)

Conv 1, $\quad$ K(3×3), $\quad$ No of Filters = $\dfrac{16}{32}$, $\quad$ P = 0 $\quad$ S = 1

$$I = 30 \times 30 \times 3$$

$$\text{Conv} = 28 \times 28 \times 16$$

$$\text{Conv} = 26 \times 26 \times 32$$

$$\text{I layer} = 30 \times 30 \times \boxed{3}$$

Depth
↓
Channels
↓
Feature
Map
↓
Feature
Output

$$\underline{\text{Kernel High}}$$

$\underline{\text{In}\boxed{\text{crease}}\text{ in Params}}$

$$30, 30 \qquad 7 \times 7$$

$$= \qquad \dfrac{N - K + 2P}{1}$$

$$30 - \boxed{7} + 0$$
$$=$$
$$= \quad 23$$