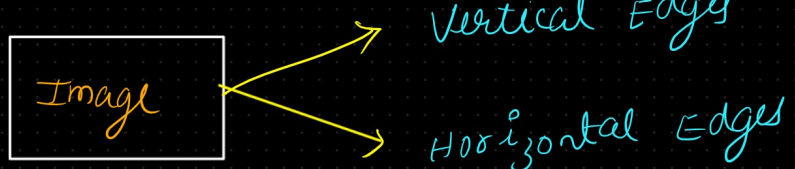
Convolutional Neural Networks (CNN)

Convolution Operation

→ Detect the edges from an Image.



6×6 → grayscale Image

3	0	1	2	7	4
1	5	8	9	3	1
2	7	2	5	1	3
0	1	3	1	7	8
4	2	1	6	2	8
2	4	5	2	3	8

6×6 Image

$*$

1	0	-1
1	0	-1
1	0	-1

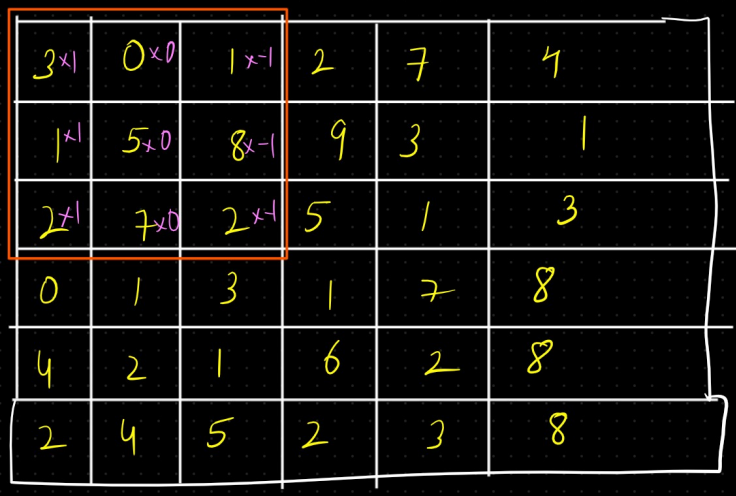
filter 3×3

[Vertical]

∴ ① 6×6 Image $*$ Filter (3×3)

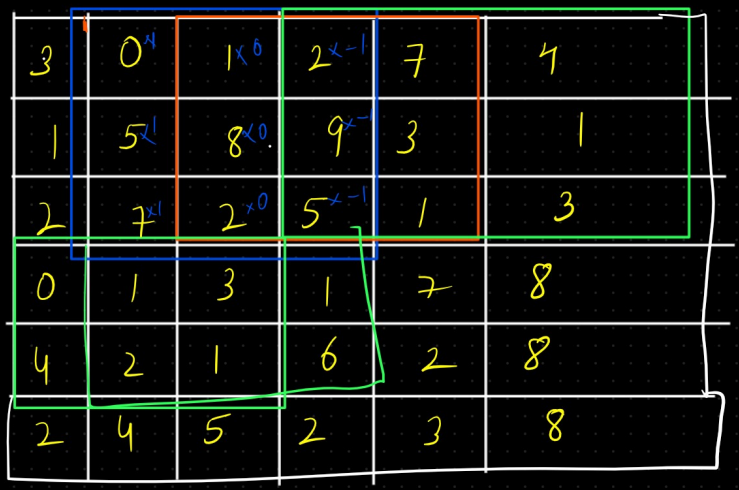
↓

4×4 Image



$= 3\times1 + 0 + 1(-1) + 1(1) + 5(0) + 8(-1) + 2(1) + 7(0) + 2(-1)$

$= 3 + 0 - 1 + 1 + 0 - 8 + 1 + 0 - 1 = -5$



Output ==== 4×4 matrix

-5	-4	0	8
-10	-2	2	3
0	-2	-4	-7
-3	-2	-3	-16

4×4

Formula: $n \times n$ (Input) $*$ $(f \times f) \rightarrow (n-f+1)(n-f+1)$

$6 \times 6 \quad * \quad (3 \times 3) \quad = \quad (6-3+1)(6-3+1)$

Horizontal $= 4 \times 4$

Vertical

1	0	-1
1	0	-1
1	0	-1

1	1	1
0	0	0
-1	-1	-1

10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0
10	10	10	0	0	0

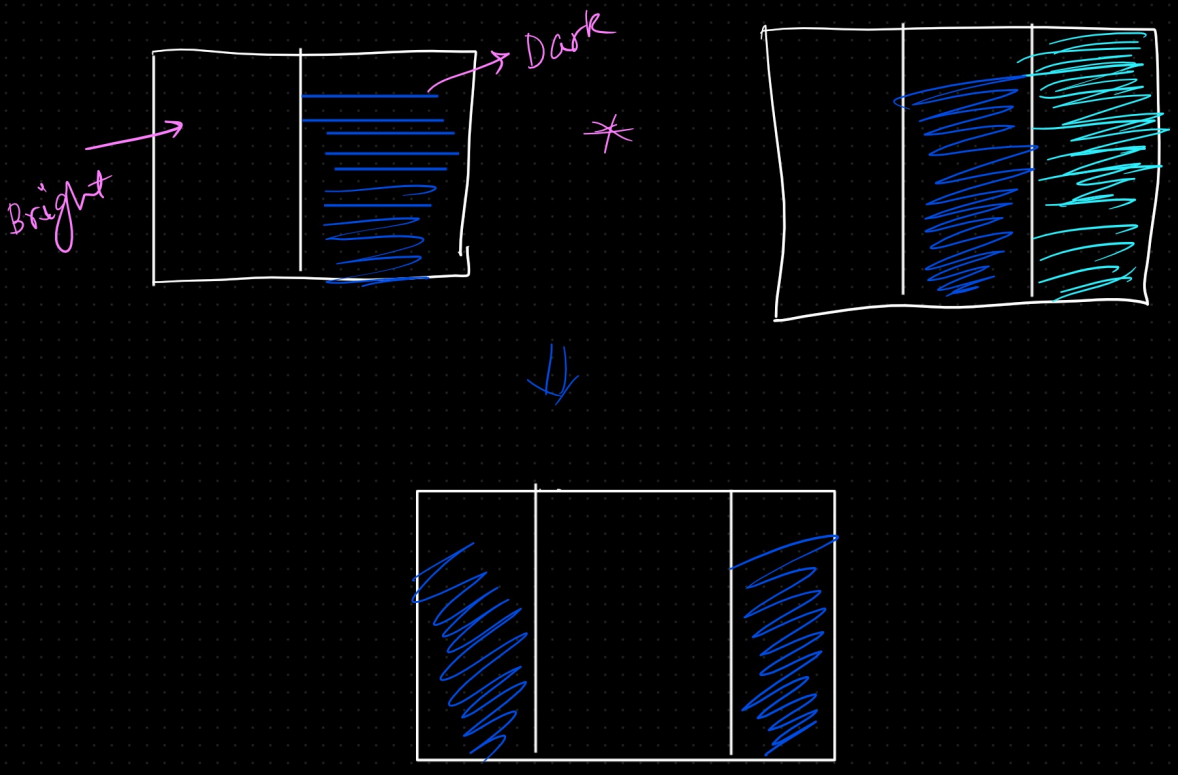
$*$

1	0	-1
1	0	-1
1	0	-1

0	30	30	0
0	30	30	0
0	30	30	0
0	30	30	0

Note:- Higher pixel → Brighter portion of the Image

Lower pixel → Darker portion of the Image



Some commonly filters -

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

Sobel filter

3	0	-3
10	0	-10
3	0	-3

Schar filter

It puts a little more weight on the central pixels

Padding

Input: $(n \times n)$ → 6×6

Filter size: $(f \times f)$ → 3×3

Output: $(n-f+1)\ (n-f+1)$ → 4×4

Two primarily disadvantage

1 → The size of the image shrinks

2 →

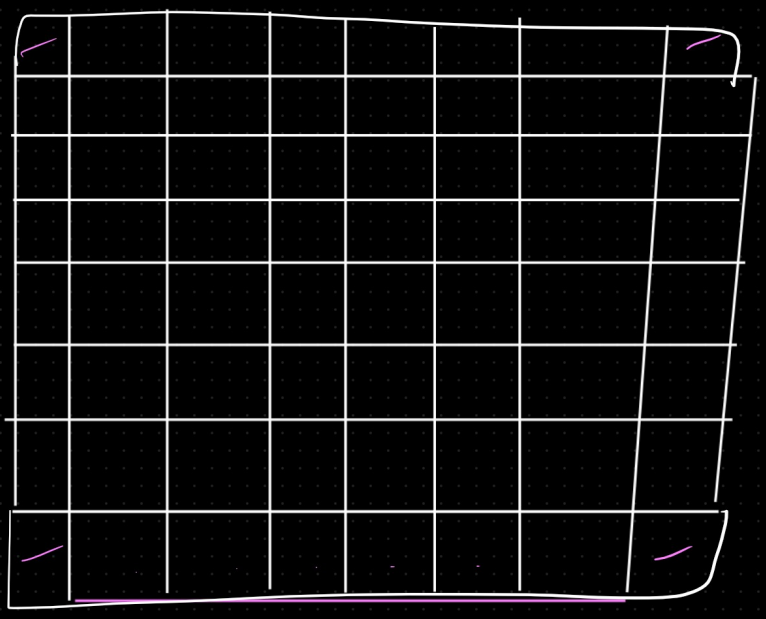
Pixels present in the corner of the image are used only a few number of times during convolution as compared to the central pixels. Hence, we do not focus too much on the corners since that can lead to information loss

Padding → TO overcome these issue

6×6 → original Image

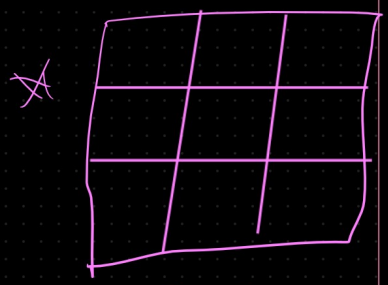
↓

padding → 8×8

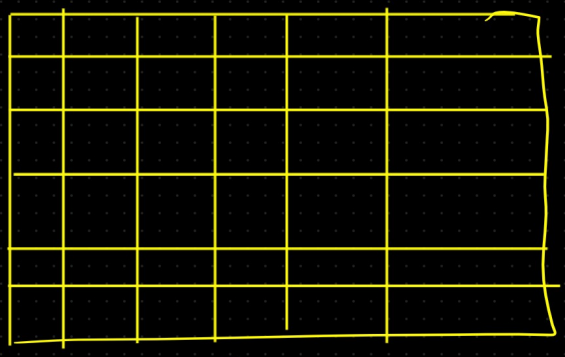


8×8

padding



3×3



6×6

Input: → n×n

padding → p

filter → f×f

Output → $(n+2p-f+1)(n+2p-f+1)$

Valid → No padding

Same → when we apply padding

Same as the input size

$$n + 2p - f + 1 = n$$

$$p = (f-1)^2$$

way we don't lose a lot of information and the image does not shrink → Same

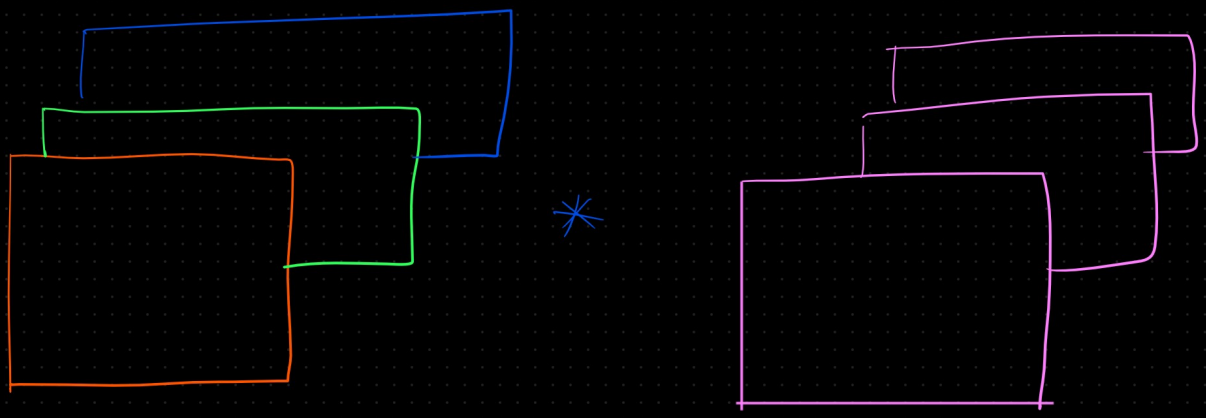
Strided Convolution

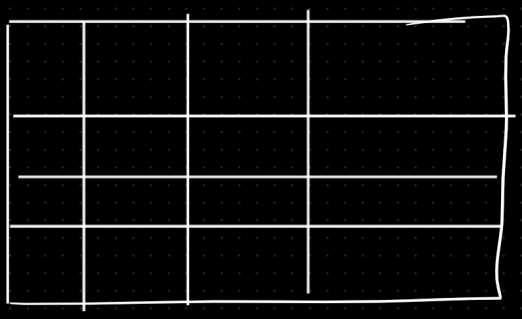
when we want to choose a step

stride = 2

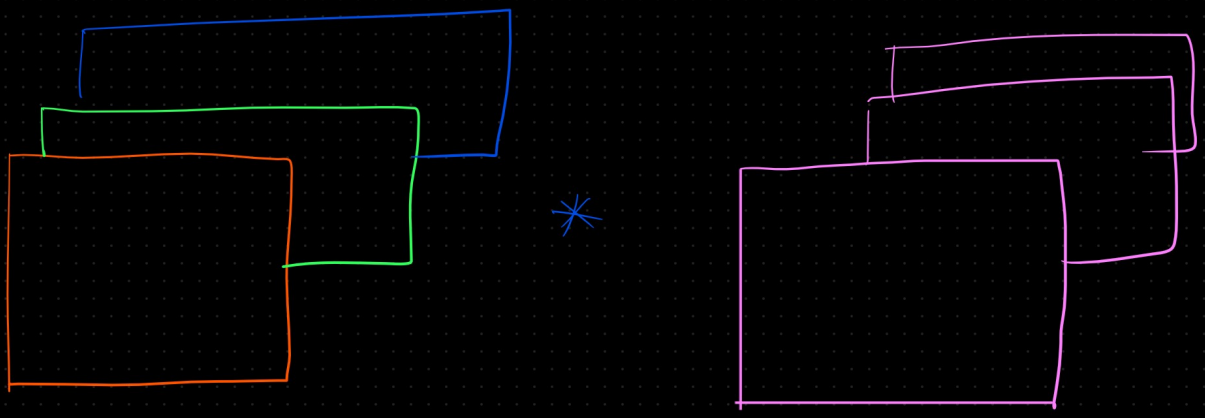
→ It will take two steps both in the horizontal and vertical separately

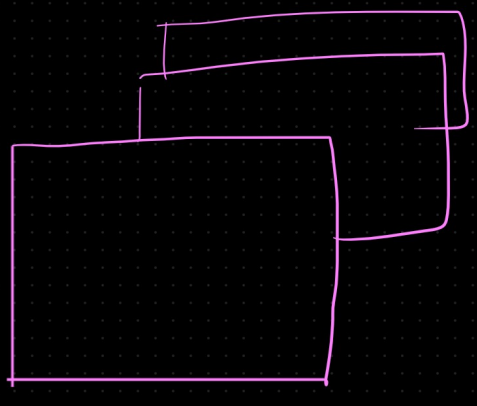
→ It helps to reduce the size of Image





Multiple filter





4×4×2