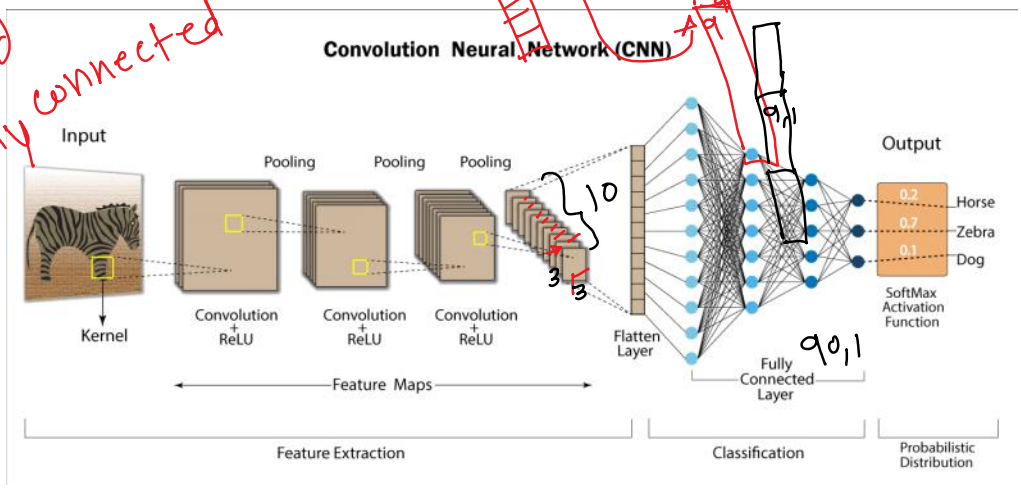
Convolution Neural Network

Thursday, October 26, 2023 10:19 PM



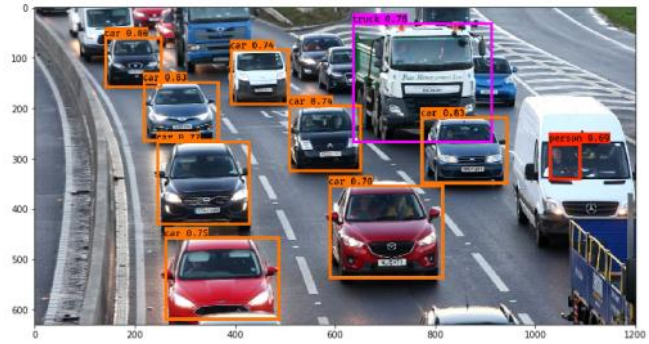
Convolution is the process involving **combination of two functions that produces the other function** as a result. In CNN's, the input image is subjected to convolution with use of filters that produces a **Feature map**.

Filters / Kernels

Filters /kernels are randomly generated vectors in the network consisting of weights and biases.

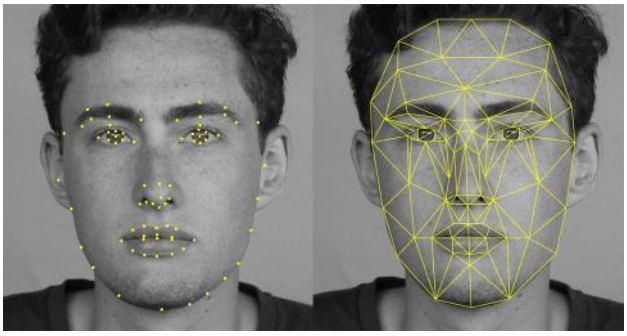
Thursday, October 26, 2023 9:14 PM

Applications of CNN



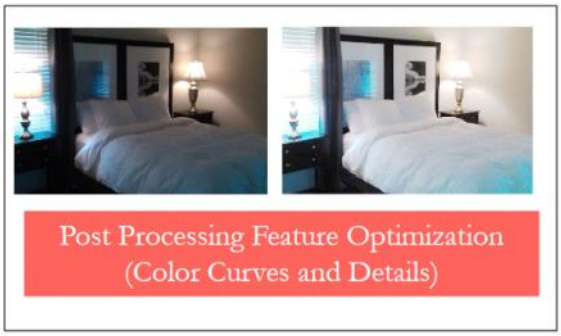
OBJECT DETECTION

SELF DRIVING CARS

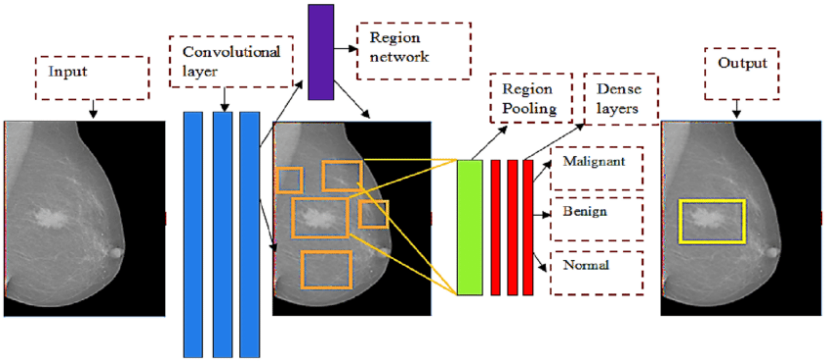


FACIAL RECOGNISTION

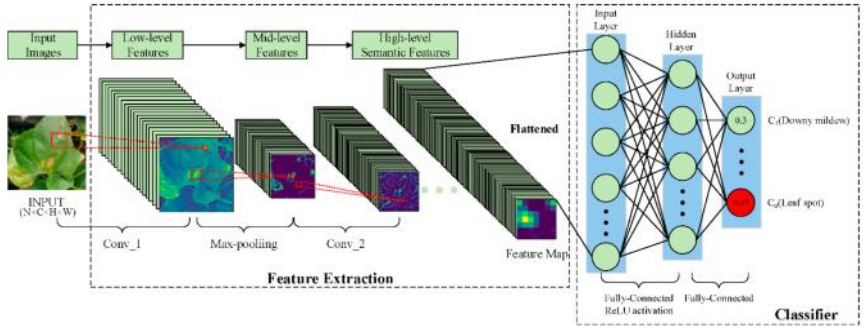
Automatic Colorization of Black and White Images



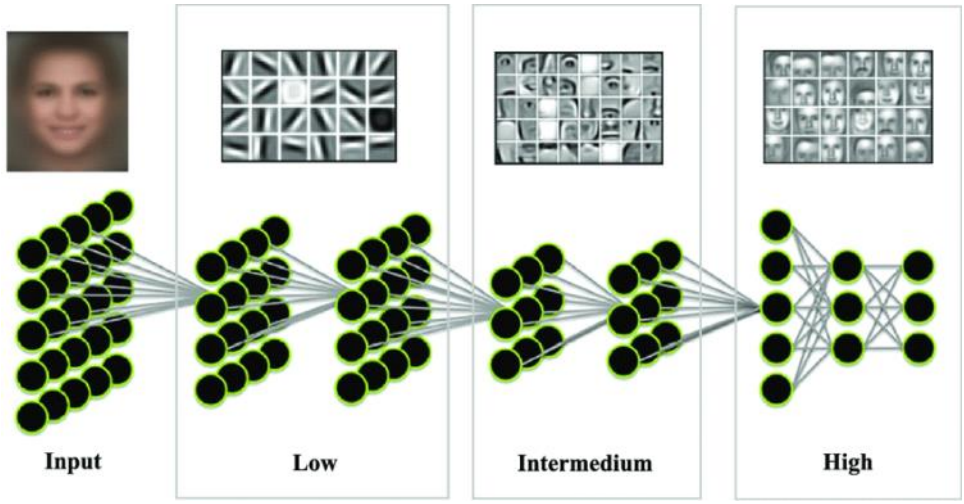
Up-scaling low-resolution images



BREAST CANCER DETECTION



LEAF DISEASE DETCTION


Input
Low
Intermedium
High

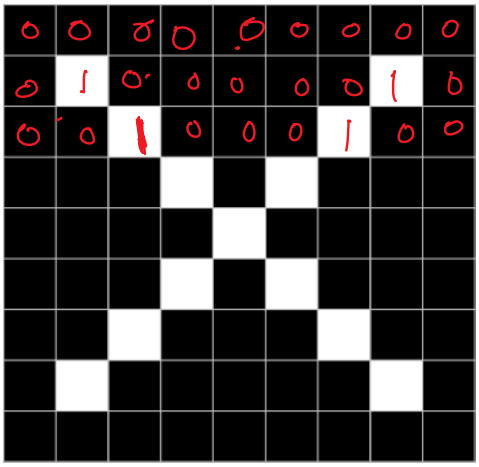
Limitations of ANN

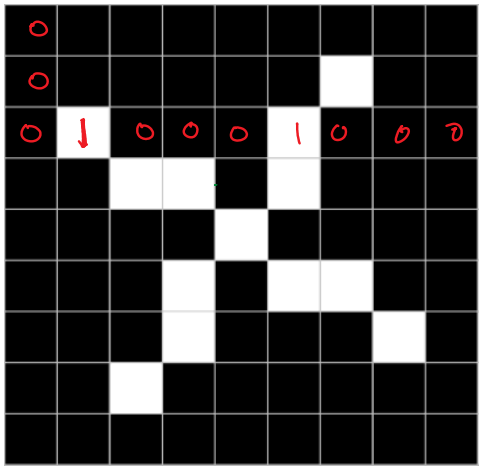
Thursday, October 26, 2023 10:24 PM

1. High Computation Cost
2. Overfitting
3. Loss of important info like spatial features

29*29=841

1920 x 1080 = 20,76,60000





-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	1	-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	-1	-1	1	-1	-1	-1	-1
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	1	-1	-1	-1	1	-1	-1

-1	-1	-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	1	-1	-1
-1	1	-1	-1	-1	1	-1	-1	-1
-1	-1	1	1	-1	1	-1	-1	-1
-1	-1	-1	-1	1	-1	-1	-1	-1
-1	-1	-1	1	-1	1	1	-1	-1
-1	-1	-1	1	-1	-1	-1	1	-1

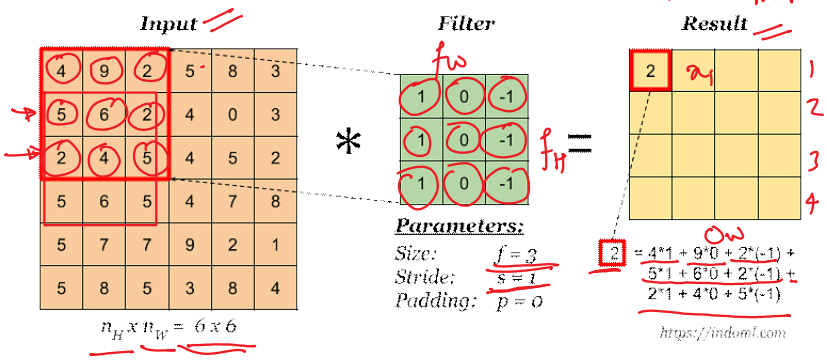
-1	-1	-1	1	-1	1	-1	-1	-1
-1	-1	1	-1	-1	-1	1	-1	-1
-1	1	-1	-1	-1	-1	-1	1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1

-1	-1	-1	1	-1	1	1	-1	-1
-1	-1	-1	1	-1	-1	-1	1	-1
-1	-1	1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1

Convolution Operations

Thursday, October 26, 2023 10:40 PM

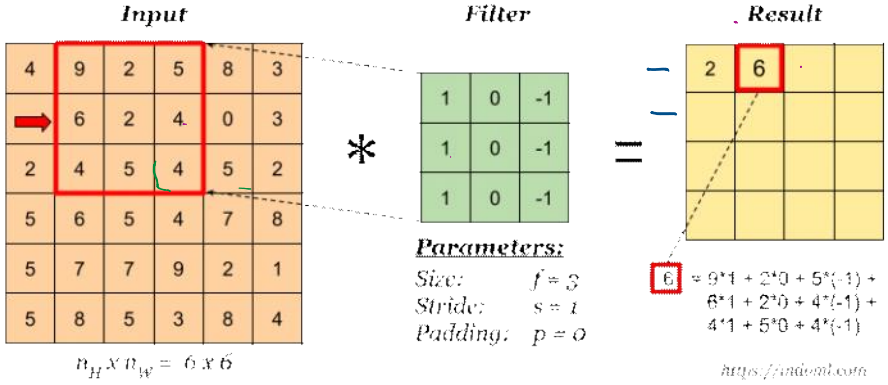
https://indoml.com/2018/03/07/student-notes-convolutional-neural-networks-cnn-introduction/

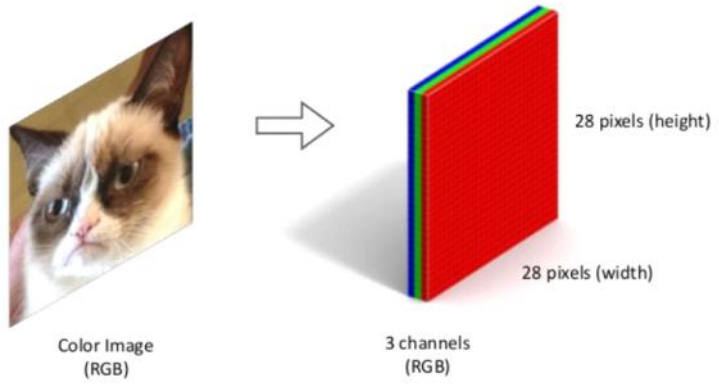


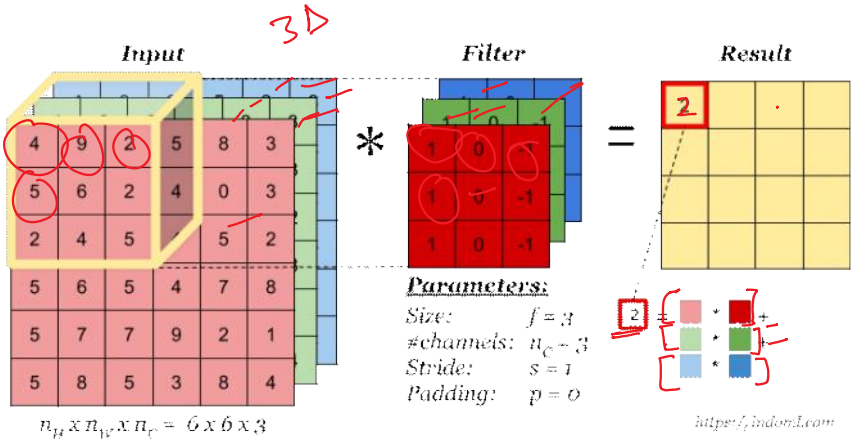
Feature map

$O_H = n_H - F_H + 1 = 6 - 3 + 1 = 4$

$O_W = n_W - F_W + 1 = 6 - 3 + 1 = 4$



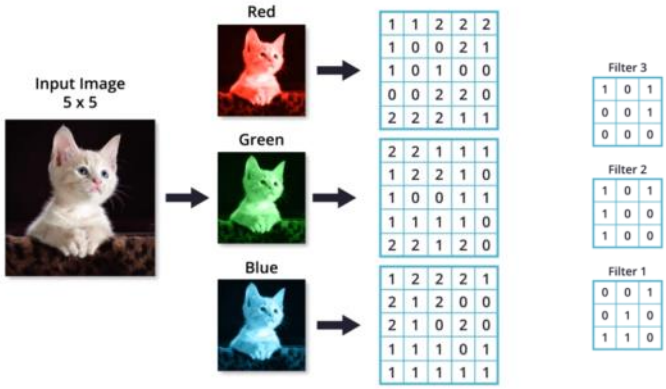


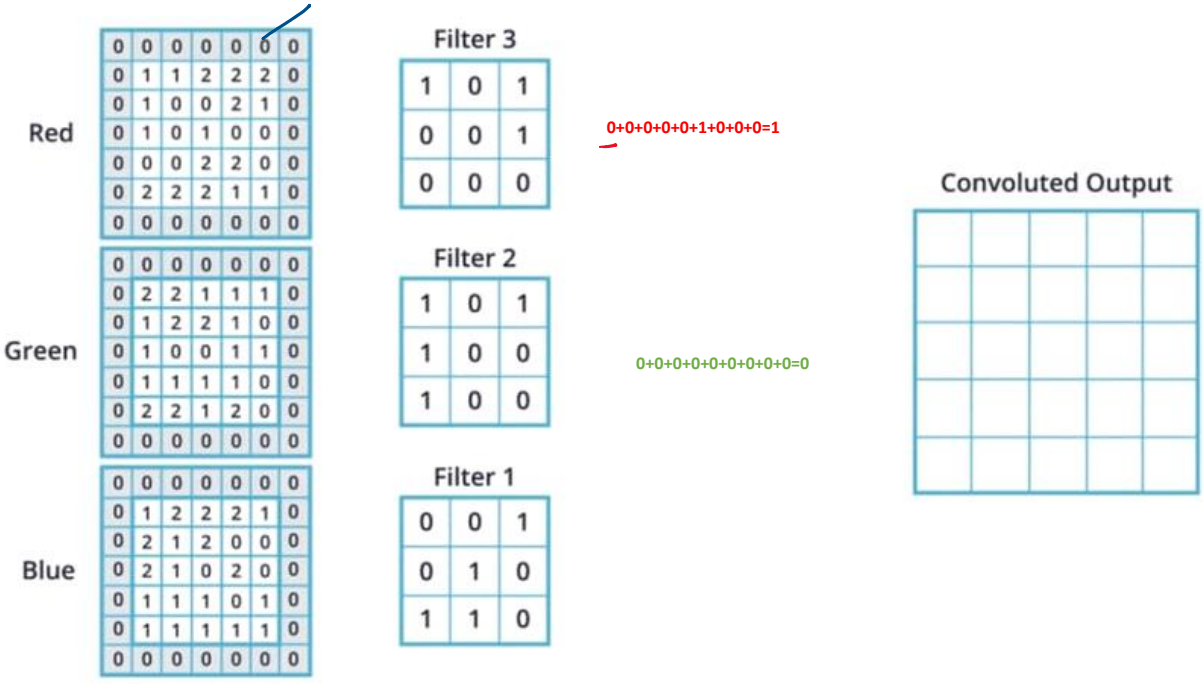


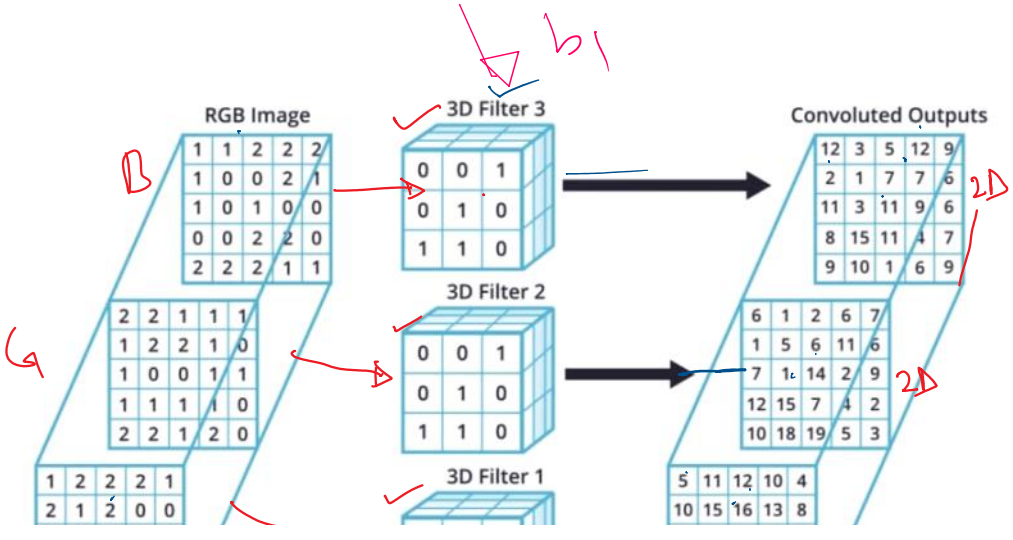
3D

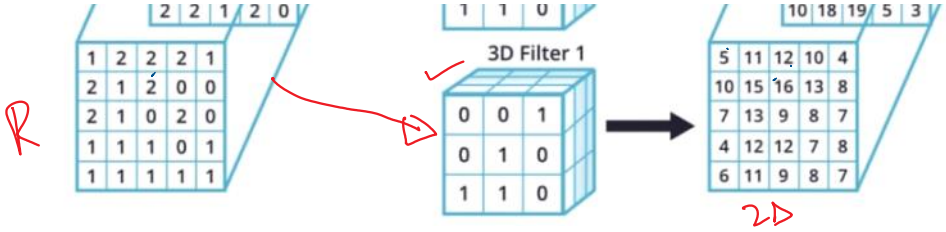
2D

$4\times1+9\times0+(2\times-1)+$
$5\times1+6\times0+2\times-1+$
$2\times1+4\times0+5\times-1+$


Input Image
5 x 5
Red
Green
Blue
Filter 3
Filter 2
Filter 1


Red
Green
Blue
Filter 3
Filter 2
Filter 1
0+0+0+0+0+1+0+0+0=1
0+0+0+0+0+0+0+0+0=0
Convoluted Output


RGB Image
3D Filter 3
3D Filter 2
3D Filter 1
Convoluted Outputs


3D Filter 1
0 0 1
0 1 0
1 1 0
5 11 12 10 4
10 15 16 13 8
7 13 9 8 7
4 12 12 7 8
6 11 9 8 7
1 2 2 2 1
2 1 2 0 0
2 1 0 2 0
1 1 1 0 1
1 1 1 1 1
R
2D

PADDING and STRIDES

Thursday, October 26, 2023 11:22 PM

$$O_W = \frac{n_W + 2p - f_W + 1}{S} = \frac{6 + 2(1) - 3 + 1}{1} = 6$$

$$O_H = \frac{n_H + 2p - f_H + 1}{S} = \frac{6 + 2(1) - 3 + 1}{1} = 6$$

n_W

Pixel Values

0	0	0	0	0	0	0	0
0	1	0	4	2	1	6	0
0	8	2	5	4	34	12	0
0	20	13	25	15	240	2	0
0	76	8	6	6	100	76	0
0	34	66	134	223	201	3	0
0	255	123	89	55	32	2	0
0	0	0	0	0	0	0	0

n_H

$0 + 0 + 0 + 0 + 4 + 0 + 0 + 16 + 2$

Kernel 3 x 3 Pixels

1	2	1
2	4	2
1	2	1

f_H, f_W

p = padding = 1, $S = 1$

Convoluted Image

22	27	36	313	722	576
91	110	120	522	984	576
284	257	198	755	1360	798
507	567	687	1312	1689	955
1061	1288	1496	1911	1659	702
1400	1480	1269	1249	870	279

1 2 3 4 5 6

$O_H = 6$

$O_W = 6$

$$O_W = \frac{n_W - F_W + 1}{S} = \frac{6 - 3 + 1}{2} = \frac{4}{2} = 2$$

$$O_H = \frac{n_H - F_H + 1}{S} = \frac{6 - 3 + 1}{2} = \frac{4}{2} = 2$$

n_W

Input

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

n_H

Dimension: 6 x 6

$*$

Filter

f_W

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

f_H

Parameters:

Size: $f = 3$

Stride: $s = 2$

Padding: $p = 0$

$=$

Result

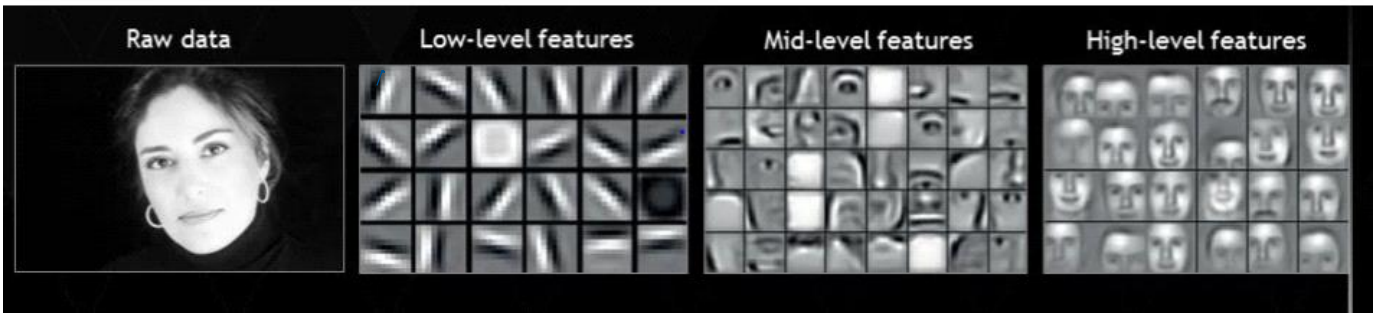
$O_W = 2$

2	1

$O_H = 2$

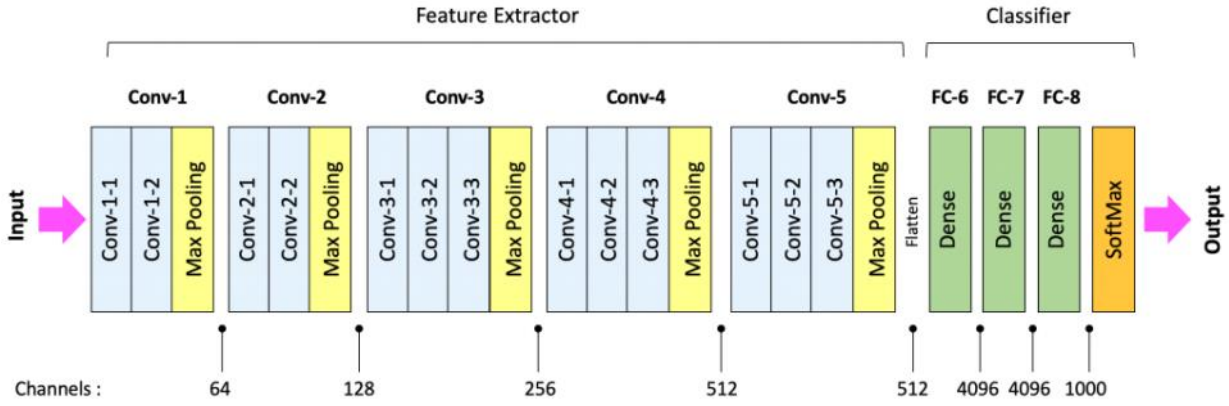
1 = 2*1 + 5*0 + 3*(-1) + 2*1 + 4*0 + 3*(-1) + 5*1 + 4*0 + 2*(-1)

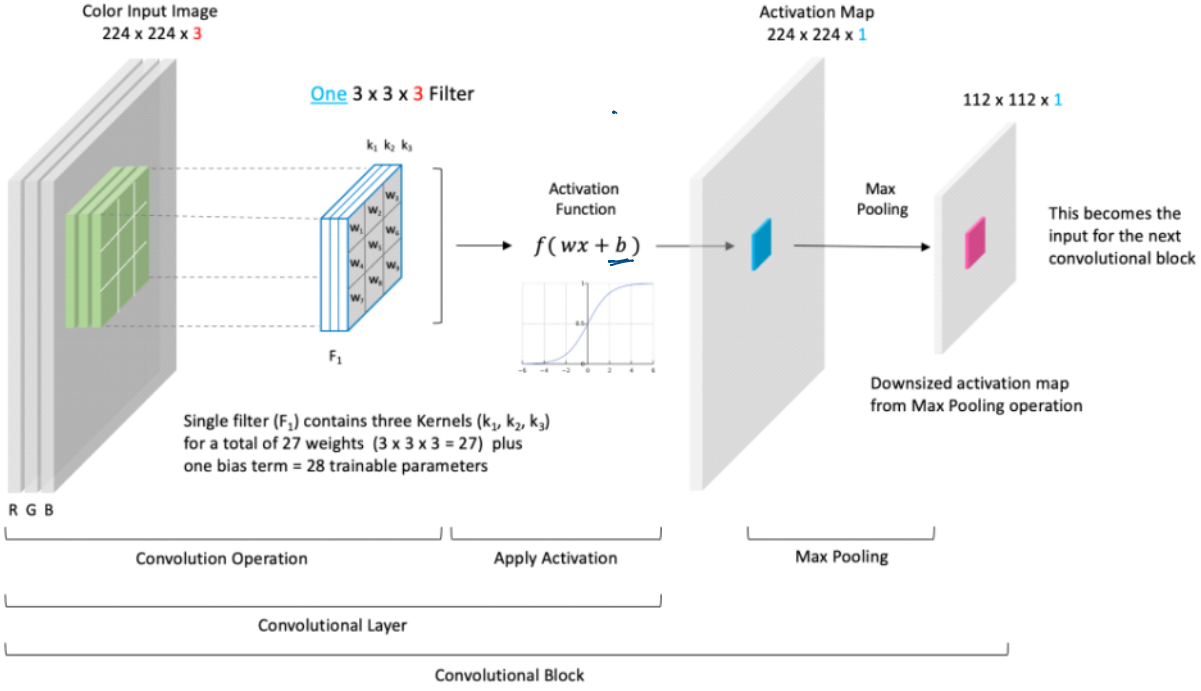
https://indoml.com


Raw data
Low-level features
Mid-level features
High-level features

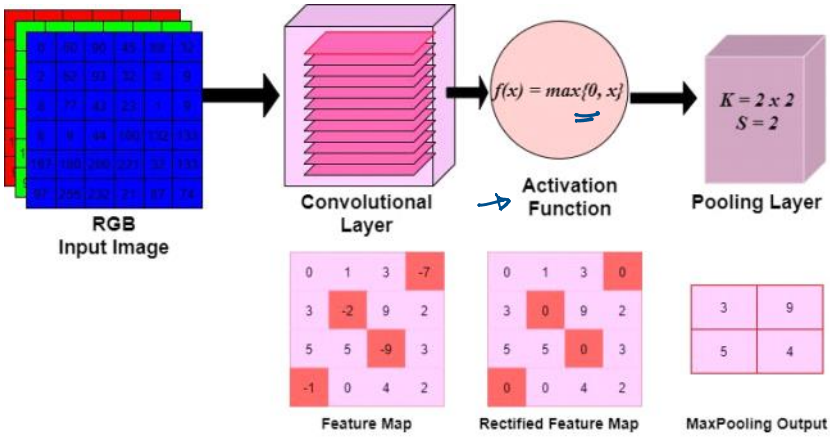
Max or Average Pooling

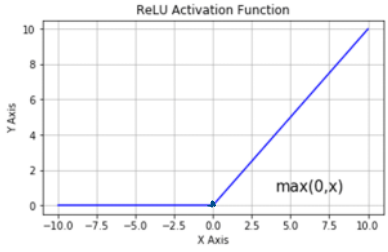
Thursday, October 26, 2023 11:35 PM



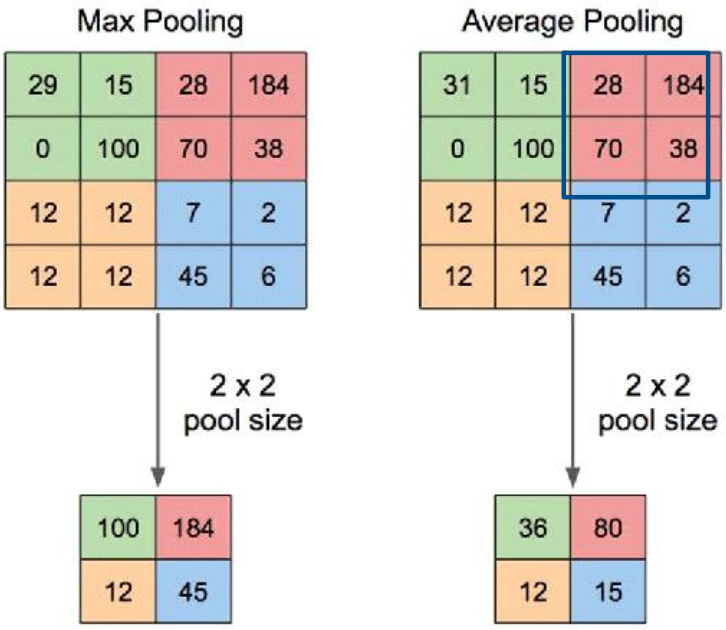


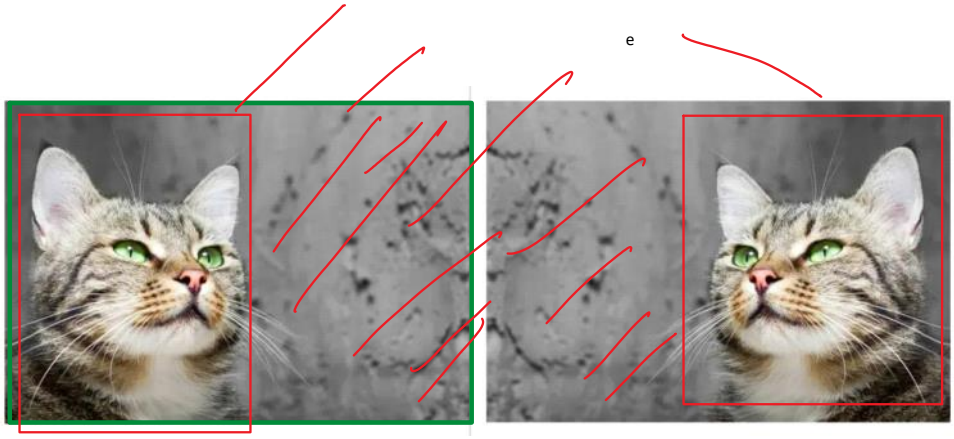
2





Activation map


Max Pooling
29 15 28 184
0 100 70 38
12 12 7 2
12 12 45 6
2 x 2
pool size
100 184
12 45
Average Pooling
31 15 28 184
0 100 70 38
12 12 7 2
12 12 45 6
2 x 2
pool size
36 80
12 15



Before Flattening

Thursday, October 26, 2023 11:38 PM