Tutorial 1

Monday, February 3, 2025 12:57 AM

Q1. Given the following 8x8 image, perform a forward pass through a convolutional neural network.

3	2	1	1	1	1	3	4
4	5	2	2	2	3	1	3
2	4	1	1	2	1	3	1
1	1	1	3	4	3	1	4
2	3	4	1	3	1	4	4
1	1	2	1	2	1	1	3
2	4	2	3	1	3	1	1
1	3	1	4	1	2	2	1

The description of the CNN is as follows:
Layer 1 applies two 3x3 filters using stride 2 and appropriate padding and then it uses ReLU activation. The filters are as follows:

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

Filter 1

2	1	-3
-1	0	1
0	0	-2

Filter 2

After Padding :-

0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

$\cdot$

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

Filter 1

$= 0 - 2 - 5 = -7$

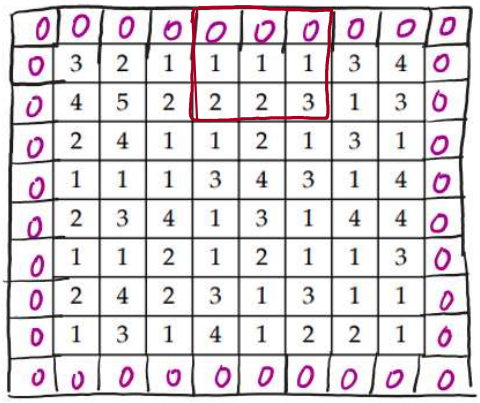
0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

$\cdot$

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

Filter 1

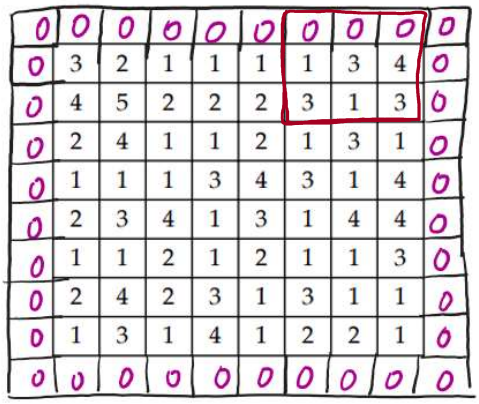
$= 0 + 2 - 1 - 5 - 2 = -6$



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

Filter 1

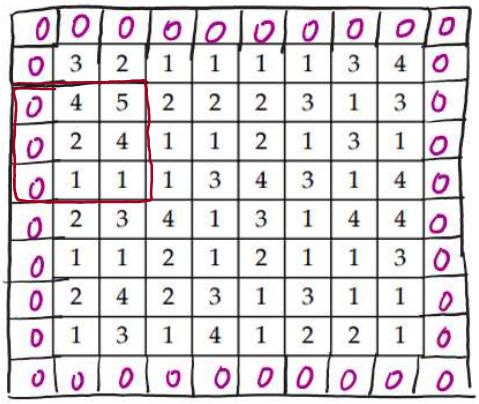
$= 0+1-1-2-3 = -5$



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

Filter 1

$= 1-4-3-3 = -9$



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

Filter 1

$= 5-4-1 = 0$

0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

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

Filter 1

$= 5+0+2+4-1-1-3$

$= 6$

0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

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

Filter 1

$= 2+0+3+1+0-1-3-3$

$= -1$

0	0	0	0	0	0	0	0	0	0
0	3	2	1	1	1	1	3	4	0
0	4	5	2	2	2	3	1	3	0
0	2	4	1	1	2	1	3	1	0
0	1	1	1	3	4	3	1	4	0
0	2	3	4	1	3	1	4	4	0
0	1	1	2	1	2	1	1	3	0
0	2	4	2	3	1	3	1	1	0
0	1	3	1	4	1	2	2	1	0
0	0	0	0	0	0	0	0	0	0

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

Filter 1

$= 3+0+3+1-1-3-4$

$= -1$

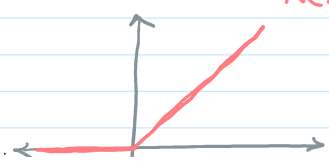
After tedious Mathematics

-7	-6	-5	-9
0	6	-1	-1
-3	4	4	0
-6	-4	-4	3

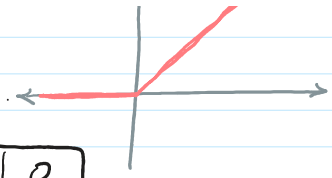
-8	-5	-6	-3
-9	-3	-9	-10
-1	-10	-1	-8
-4	-8	-3	-10

$ReLU(z) = \max(0, z)$

$R(z) = \max(0, z)$



$ReLU(z) = \max(0, z)$



0	0	0	0
0	6	0	0
0	4	4	0
0	0	0	3

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

Pooling.

0	0	0	0
0	6	0	0
0	4	4	0
0	0	0	3

6	0
4	4

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

0	0
0	0

6	0
4	4

0	0
0	0

1x1 (Average) Volumetric filter

What are we doing, Average

$$\text{New Value} = \frac{x_1 + x_2}{2}$$

$$0.5\left\{\begin{bmatrix} 6 & 0 \\ 4 & 4 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}\right\}$$

$$\begin{bmatrix} 3 & 0 \\ 2 & 2 \end{bmatrix}$$

Sigmoid

E.g 2x2 Volumetric

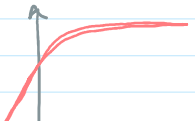
$$\begin{bmatrix} w_1 & w_2 \\ w_3 & w_4 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \end{bmatrix} \quad \begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & e \end{bmatrix}$$

$$(w_1 \cdot 1) + (w_2 \cdot 2) + (w_3 \cdot 5) + (w_4 \cdot 5)$$

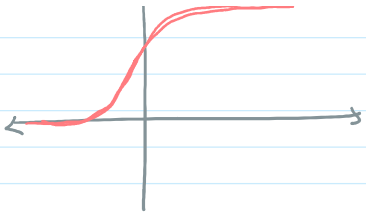
$$+$$

$$(w_1 \cdot a) + (w_2 \cdot b) + (w_3 \cdot e) + (w_5 \cdot f)$$



$$\frac{1}{1+e^{-z}}$$

Sigmoid



$\frac{1}{1+e^{-z}}$

$$\begin{bmatrix} 0.9526 & 0.500 \\ 0.8808 & 0.8808 \end{bmatrix}$$

N_1

$$\begin{bmatrix} 0.1 & 0.3 \\ 0.2 & 0.1 \end{bmatrix}$$

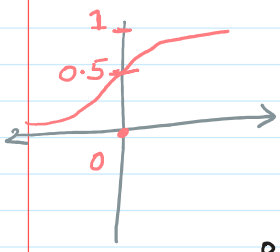
N_2

$$\begin{bmatrix} 0.3 & 0.1 \\ 0.0 & 0.5 \end{bmatrix}$$

$$z_1 = 0.1 \times 0.9526 + 0.3 \times 0.500 + 0.8808\,(0.2 + 0.1)$$
$$= 0.5095$$

$$z_2 = 0.7762$$

$z_1 = 0.5095$, $z_2 = 0.7762$



SoftMax

$$\hat{y} = \frac{e^{z_i}}{\sum_i^N e^{z_i}}$$

$$\hat{y}_1 = \frac{e^{0.5095}}{e^{0.5095} + e^{0.7762}}$$

$$= 0.3963$$

$$\hat{y}_2 = \frac{e^{0.7762}}{e^{0.5095} + e^{0.7762}}$$

$$= 0.6037$$