

Deep Learning | EX04

Convolutional Neural Networks (CNN)

800

Computer Vision | Zahra Amini

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1- Suppose the the image (a). Calculate the **output of the below model.**

↓
Conv2d(2, (3, 3), (1, 1))
Conv2d(3, (1, 1), (1, 1))
MaxPooling((2, 2), (1, 1))

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

(a)

Conv2d(n, s)

n: Number of Kernels

k: Size of Kernels

s: (stride_x, stride_y)

MaxPooling(w, h), (stride_x, stride_y))

w, h: width , height of pooling window

Initialize the kernels (weights) randomly (desired).

Use padding, for Conv2d layers.

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

Conv2d(2, (3, 3), (1, 1))

$$\text{Zero_Padding} = \frac{k-1}{2} = \frac{3-1}{2} = 1$$

Conv2d(3, (1, 1), (1, 1))

MaxPooling((2, 2), (1, 1))

Use padding, for Conv2d layers

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

Sobel Kernels

Horizontal
edge detection

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

Vertical edge
detection

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

$$\text{Output}(i, j) = \sum \sum [\text{Input}(i+k, j+l) * \text{kernel}(k, l)]$$

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

Horizontal
edge detection

$$\begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix} =$$

19	9	-9	6	-10
28	-5	-19	15	-9
19	-10	-14	21	-5
5	-4	-2	16	-3
0	-1	1	5	-1

$$O_{11} = [-1 \times 0 + 0 \times 0 + 1 \times 0 + (-2) \times 0 + 0 \times 1 + 2 \times 5 + (-1) \times 0 + 0 \times 8 + 1 \times 9] = 19$$

$$O_{12} = [-1 \times 0 + 0 \times 0 + 1 \times 0 + (-2) \times 1 + 0 \times 5 + 2 \times 8 + (-1) \times 8 + 0 \times 9 + 1 \times 3] = 9$$

$$O_{13} = [-1 \times 0 + 0 \times 0 + 1 \times 0 + (-2) \times 5 + 0 \times 8 + 2 \times 4 + (-1) \times 9 + 0 \times 3 + 1 \times 2] = -9$$

$$O_{14} = [-1 \times 0 + 0 \times 0 + 1 \times 0 + (-2) \times 8 + 0 \times 4 + 2 \times 9 + (-1) \times 3 + 0 \times 2 + 1 \times 7] = 6$$

$$O_{15} = [-1 \times 0 + 0 \times 0 + 1 \times 0 + (-2) \times 4 + 0 \times 9 + 2 \times 0 + (-1) \times 2 + 0 \times 7 + 1 \times 0] = -10$$

$$O_{21} = [-1 \times 0 + 0 \times 1 + 1 \times 5 + (-2) \times 0 + 0 \times 8 + 2 \times 9 + (-1) \times 0 + 0 \times 4 + 1 \times 5] = 28$$

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

Vertical edge
detection

*

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

-25	-29	-17	-14	-16
-6	3	15	13	5
23	28	16	7	5
13	16	10	12	17
2	1	1	7	11

Output_Layer1 --> 2 Feature Maps

19	9	-9	6	-10
28	-5	-19	15	-9
19	-10	-14	21	-5
5	-4	-2	16	-3
0	-1	1	5	-1

-25	-29	-17	-14	-16
-6	3	15	13	5
23	28	16	7	5
13	16	10	12	17
2	1	1	7	11

Conv2d(3, (1, 1), (1, 1))

$$\text{Zero_Padding} = \frac{k-1}{2} = \frac{1-1}{2} = 0$$

$$W_{\text{out}} = \left\lfloor \frac{w-m}{s} \right\rfloor + 1 = \frac{5-2}{1} + 1 = 4$$

19	9	-9	6	-10
28	-5	-19	15	-9
19	-10	-14	21	-5
5	-4	-2	16	-3
0	-1	1	5	-1

* 0.1 =

1.9	0.9	-0.9	0.6	-1
2.8	-0.5	-1.9	1.5	-0.9
1.9	-1	-1.4	2.1	-0.5
0.5	-0.4	-0.2	1.6	-0.3
0	-0.1	0.1	0.5	-0.1

Max-Pool 2D →

2.8	0.9	1.5	1.5
2.8	-0.5	2.1	2.1
1.9	-0.2	2.1	2.1
0.5	0.1	1.6	1.6

19	9	-9	6	-10
28	-5	-19	15	-9
19	-10	-14	21	-5
5	-4	-2	16	-3
0	-1	1	5	-1

* 0.2 =

3.8	1.8	-18	12	-2
5.6	-1	-38	3	-18
3.8	-2	-2.8	42	-1
1	-0.8	-0.4	3.2	-0.6
0	-0.2	0.2	1	-0.2

Max-Pool 2D →

5.6	1.8	3	3
5.6	-1	42	42
3.8	-0.4	42	42
1	0.2	3.2	32

19	9	-9	6	-10
28	-5	-19	15	-9
19	-10	-14	21	-5
5	-4	-2	16	-3
0	-1	1	5	-1

* 0.3 =

5.7	2.7	-2.7	1.8	-3
8.4	-1.5	-5.7	4.5	-2.7
5.7	-3	-42	63	-15
1.5	-1.2	-0.6	48	-0.9
0	-0.3	0.3	1.5	-0.3

Max-Pool 2D →

84	27	45	45
84	-15	63	63
57	-06	6.3	63
1.5	03	48	48

-25	-29	-17	-14	-16
-6	3	15	13	5
23	28	16	7	5
13	16	10	12	17
2	1	1	7	11

$$\star \boxed{0.1}$$

-25	-29	-17	-14	-16
-6	0.3	15	13	0.5
23	28	16	0.7	0.5
13	1.6	1	12	1.7
0.2	0.1	0.1	0.7	1.1

Max-Pool 2D

0.3	1.5	1.5	13
28	28	16	1.3
2.8	28	16	17
1.6	16	1.2	17

-25	-29	-17	-14	-16
-6	3	15	13	5
23	28	16	7	5
13	16	10	12	17
2	1	1	7	11

$$\star \boxed{0.2}$$

-5	-5.8	-34	-28	-32
-12	0.6	3	26	1
46	56	32	14	1
2.6	3.2	2	24	3.4
04	02	0.2	14	22

Max-Pool 2D

0.6	3	3	26
56	56	32	26
56	56	32	34
32	32	24	3.4

-25	-29	-17	-14	-16
-6	3	15	13	5
23	28	16	7	5
13	16	10	12	17
2	1	1	7	11

$$\star \boxed{0.3}$$

-7.5	-8.7	-51	-42	-48
-1.8	0.9	45	3.9	15
6.9	8.4	4.8	2.1	15
3.9	4.8	3	3.6	51
0.6	0.3	0.3	2.1	33

Max-Pool 2D

0.9	4.5	45	3.9
8.4	84	48	3.9
8.4	84	4.8	51
4.8	4.8	3.6	5.1

28	09	1.5	1.5
28	-05	2.1	2.1
19	-02	21	21
05	01	1.6	1.6

2.8
0.9
1.5
1.5
2.8
-0.

5.6	1.8	3	3
56	-1	42	42
38	-04	42	42
1	02	3.2	3.2

5
2.1
2.1
1.9
-0.
2
2.1

84	27	45	45
84	-15	63	63
57	-06	6.3	63
1.5	03	48	4.8

2.1
0.5
0.1
1.6
1.6
5.6
1.8
3.0
3.0
5.6
-1.
0
4.2
4.2

0.3	1.5	1.5	1.3
28	28	16	1.3
2.8	28	16	17
1.6	16	1.2	17

3.8
-0.

0.6	3	3	26
56	56	32	26
56	56	32	34
32	32	24	3.4

4
4.2
4.2
1.0
0.2

0.9	4.5	45	3.9
8.4	84	48	3.9
8.4	84	4.8	51
4.8	4.8	3.6	5.1

3.2
3.2
. . .

Flatten →