Convolution of Matrices

GENERAL ASSEMBLY

Convolution

X (the 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	9

$*$

W (the filter)

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

$=$

Pass the **filter** over the **image** and compute the element-wise dot product to get the results.

Convolution

X (the 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	9

$*$

W (the filter)

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

$=$

Pass the **filter** over the **image** and compute the element-wise dot product to get the results.

Convolution

X (the 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	9

*

W (the filter)

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

=

-5			

```
3*1 + 0*0 + 1*-1 +
1*1 + 5*0 + 8*-1 +
2*1 + 7*0 + 2*-1 = -5
```


Convolution

X (the 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	9

$*$

W (the filter)

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

$=$

-5			

We then slide the **filter** across the **image** to the next pixel and repeat the process.

Convolution

X (the 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	9

*

W (the filter)

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

=

-5	-4		

```
0*1 + 1*0 + 2*-1 +
5*1 + 8*0 + 9*-1 +
7*1 + 2*0 + 5*-1 = -4
```


Convolution

X (the 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	9

*

W (the filter)

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

=

-5	-4	0	

```
1*1 + 2*0 + 7*-1 +
8*1 + 9*0 + 3*-1 +
2*1 + 5*0 + 1*-1 = 0
```


Convolution

X (the 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	9

*

W (the filter)

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

=

-5	-4	0	8

```
2*1 + 7*0 + 4*-1 +
9*1 + 3*0 + 1*-1 +
5*1 + 1*0 + 3*-1 = 0
```


Convolution

X (the 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	9

$*$

W (the filter)

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

$=$

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

And so on until completion...

What does this actually do for us?

X (the image)

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

$*$

W (the filter)

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

$=$

What does this actually do for us?

X (the image)

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

$*$

W (the filter)

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

What does this actually do for us?

X (the image)

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

$*$

W (the filter)

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

$=$

What does this actually do for us?

X (the image)

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

$*$

W (the filter)

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

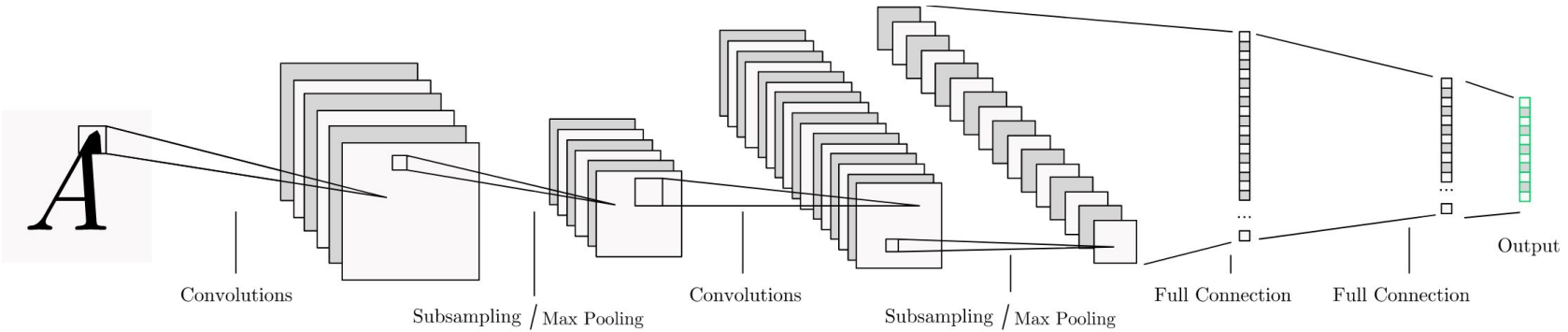
$=$

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

Edge Detection!

Source: https://aishack.in/tutorials/image-convolution-examples/

CNNs in the World



Source: https://hako.github.io/dissertation/figures/figure_5.svg