

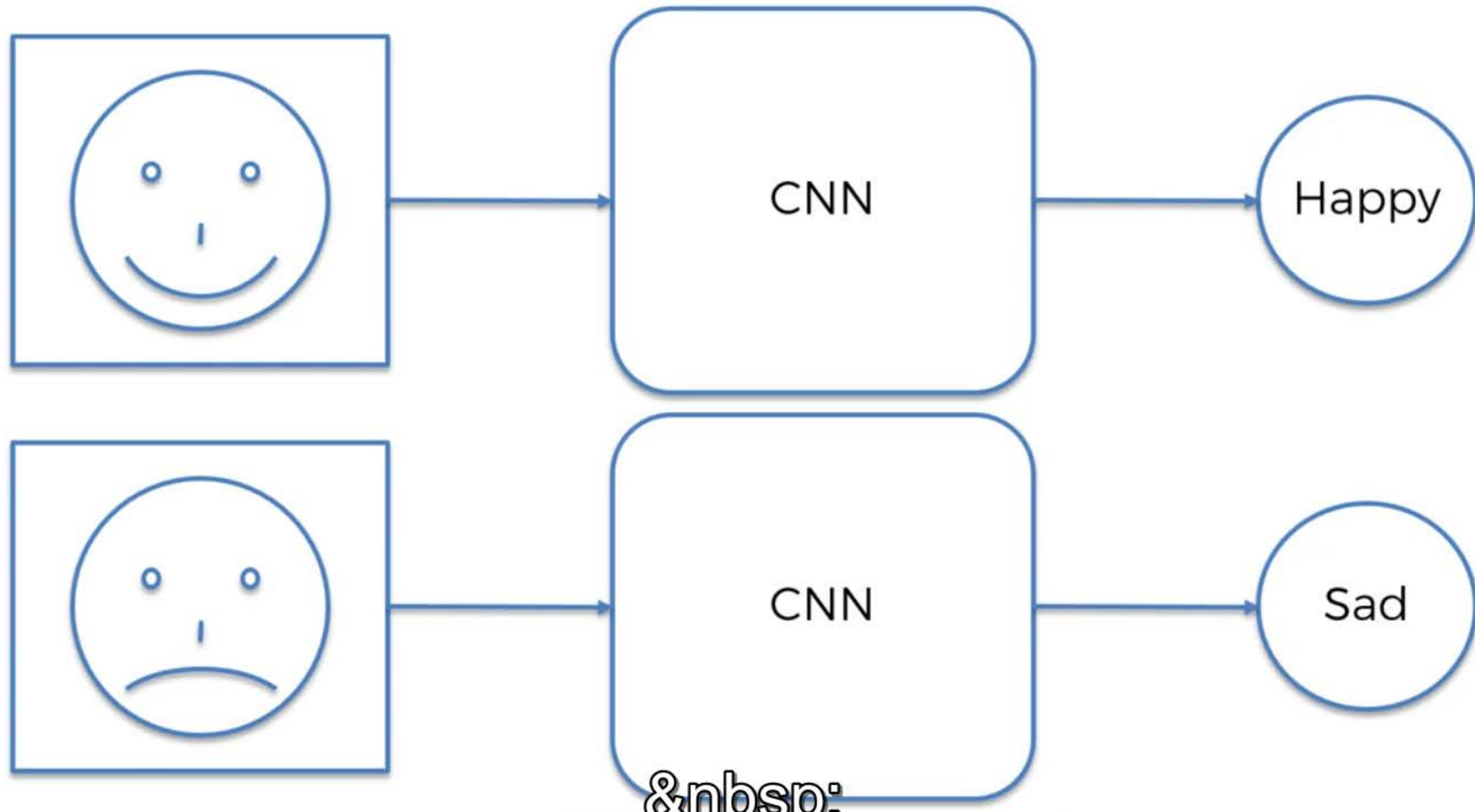
Plan of Attack

What we will learn in this section:

- What are Convolutional Neural Networks?
- Step 1 - Convolution Operation
- Step 1(b) - ReLU Layer
- Step 2 - Pooling
- Step 3 - Flattening
- Step 4 - Full Connection
- Summary

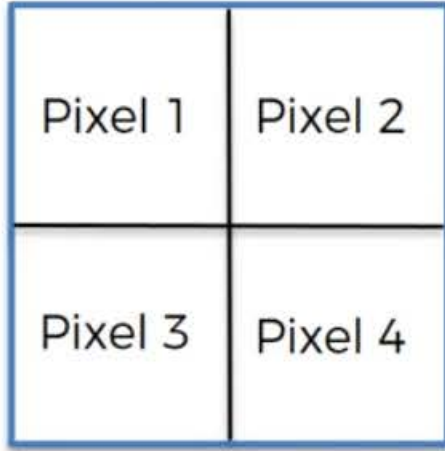
- EXTRA: Softmax & Cross-Entropy

Convolutional Neural Networks

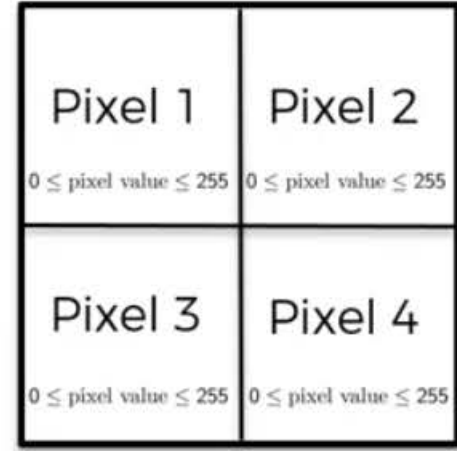


Convolutional Neural Networks

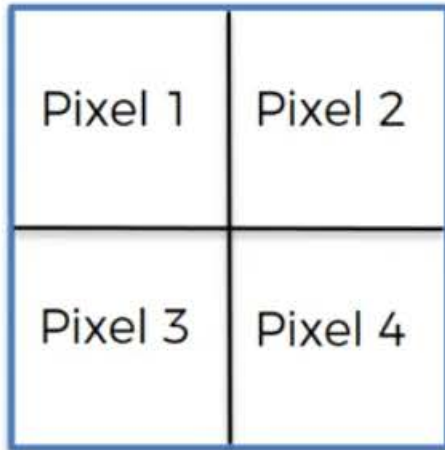
B / W Image 2x2px



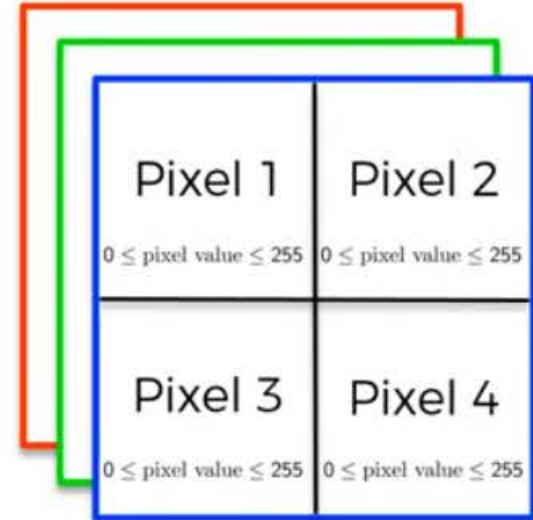
2d array



Colored Image 2x2px



3d array



STEP 1: Convolution



STEP 2: Max Pooling



STEP 3: Flattening



STEP 4: Full Connection

Step 1 – Convolution

Step 1 - Convolution

$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau) g(t - \tau) d\tau$$

Step 1 - Convolution

0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0

Input Image



0	0	1
1	0	0
0	1	1

Feature
Detector



0				

Feature Map

Step 1 - Convolution

0	0	0	0	0	0	0
0	1	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0

Input Image



0	0	1
1	0	0
0	1	1

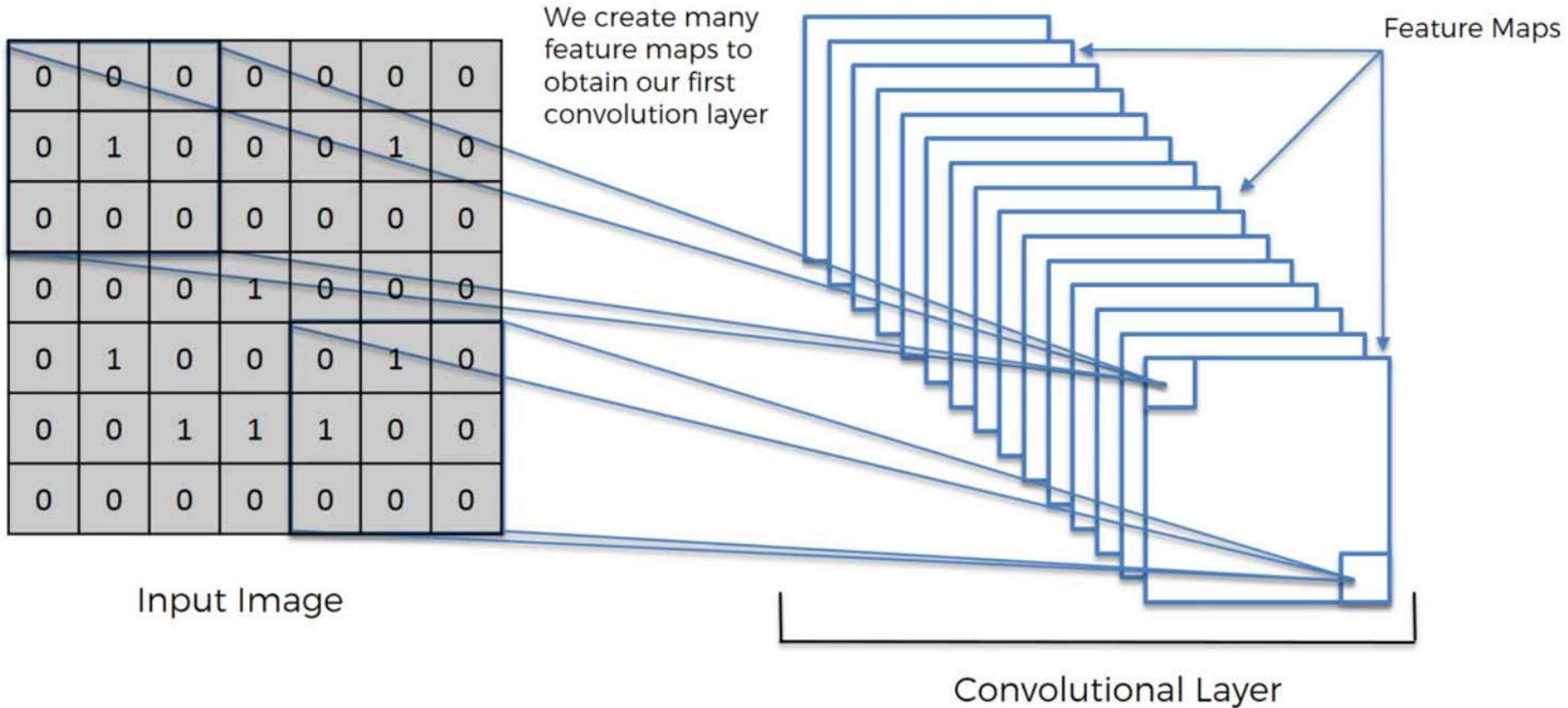
Feature
Detector



0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

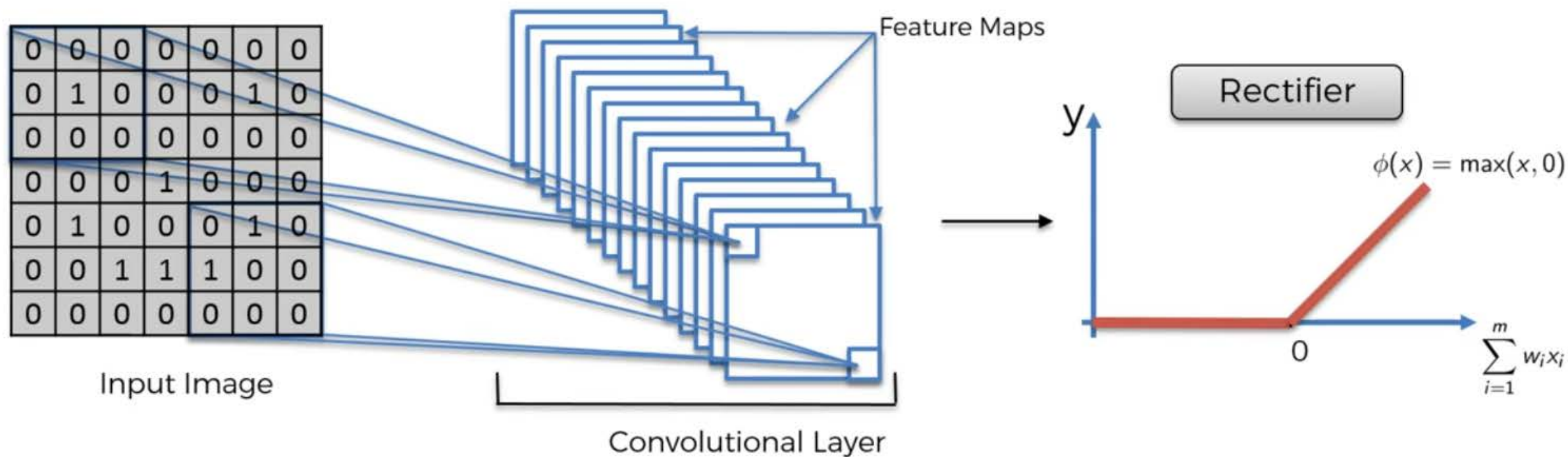
Feature Map

Step 1 - Convolution



Step 1 (B) – ReLU Layer

Step 1 (B) – ReLU Layer



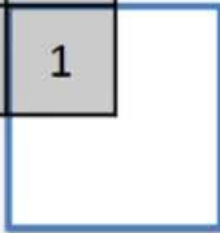
Step 2 – Max Pooling

Step 2 - Max Pooling



Step 2 - Max Pooling

0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1



Feature Map

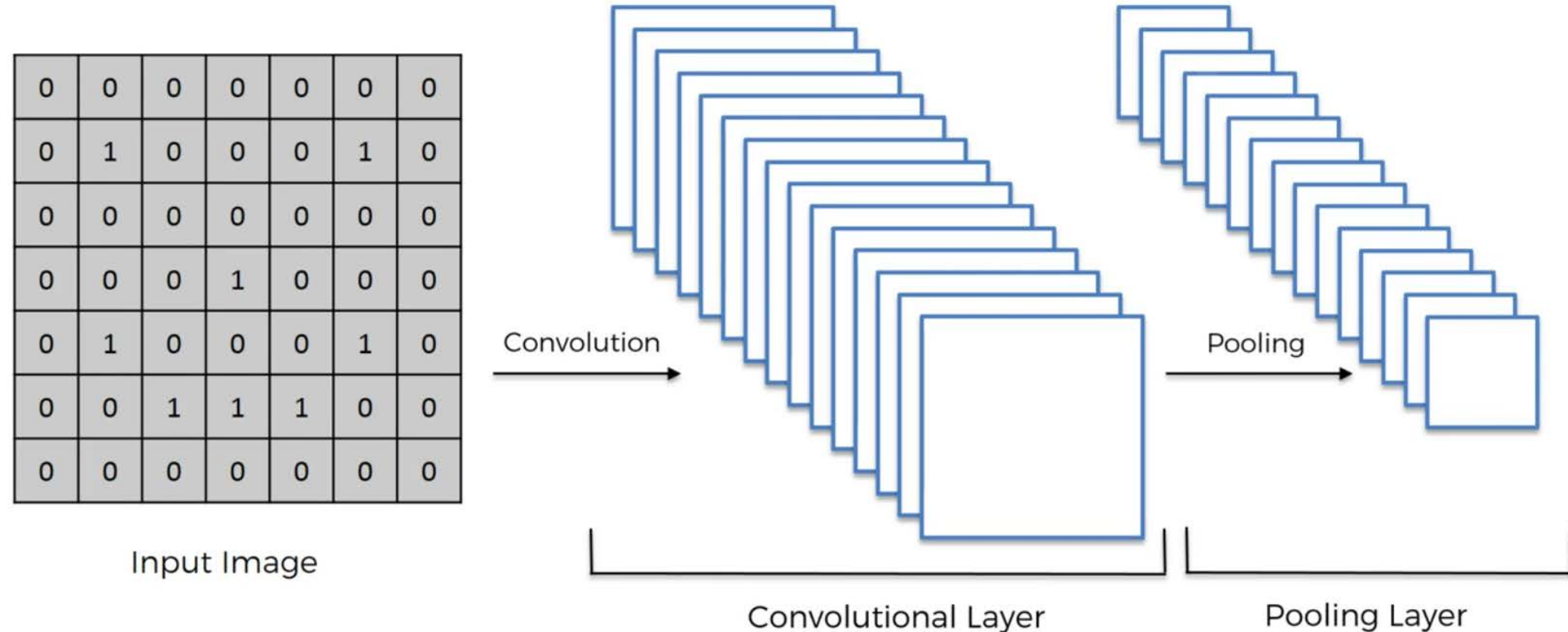
Max Pooling



1	1	0
4	2	1
0	2	1

Pooled Feature Map

Step 2 - Max Pooling



Step 3 – Flattening

Step 3 - Flattening

1	1	0
4	2	1
0	2	1

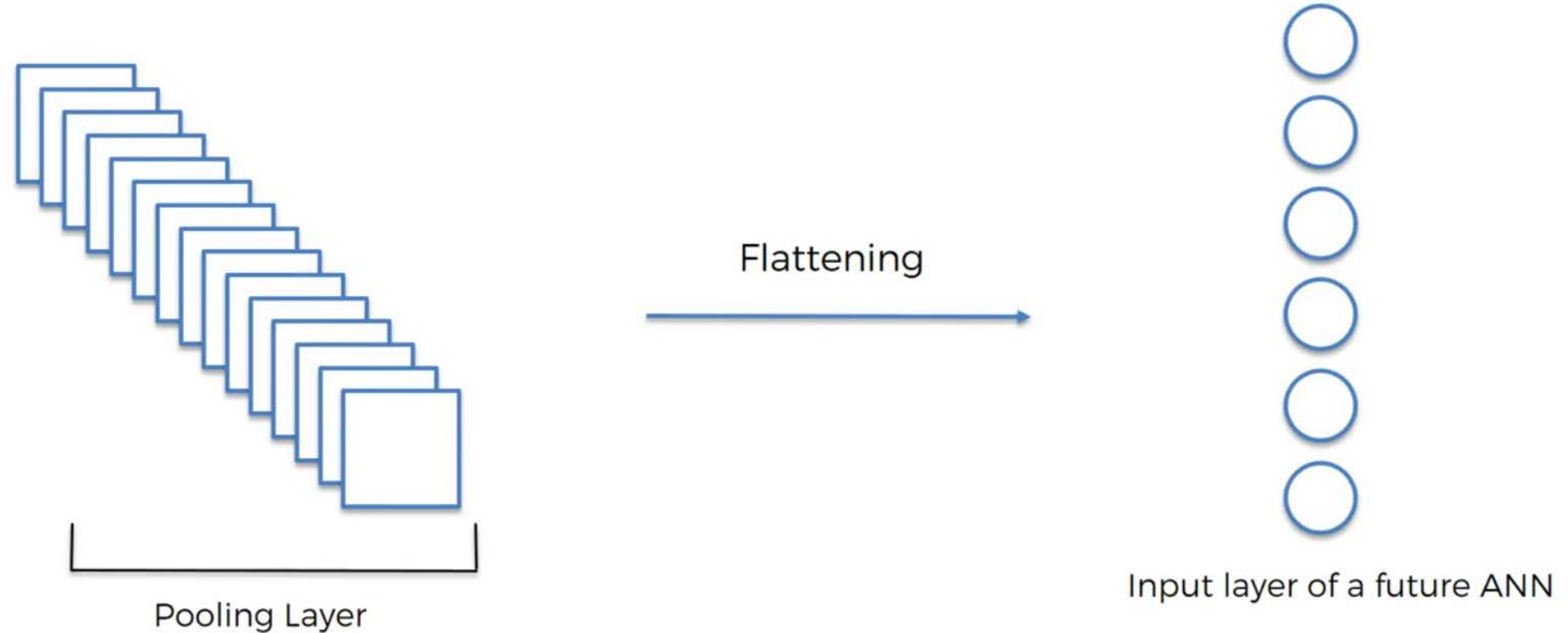
Pooled Feature Map

Flattening

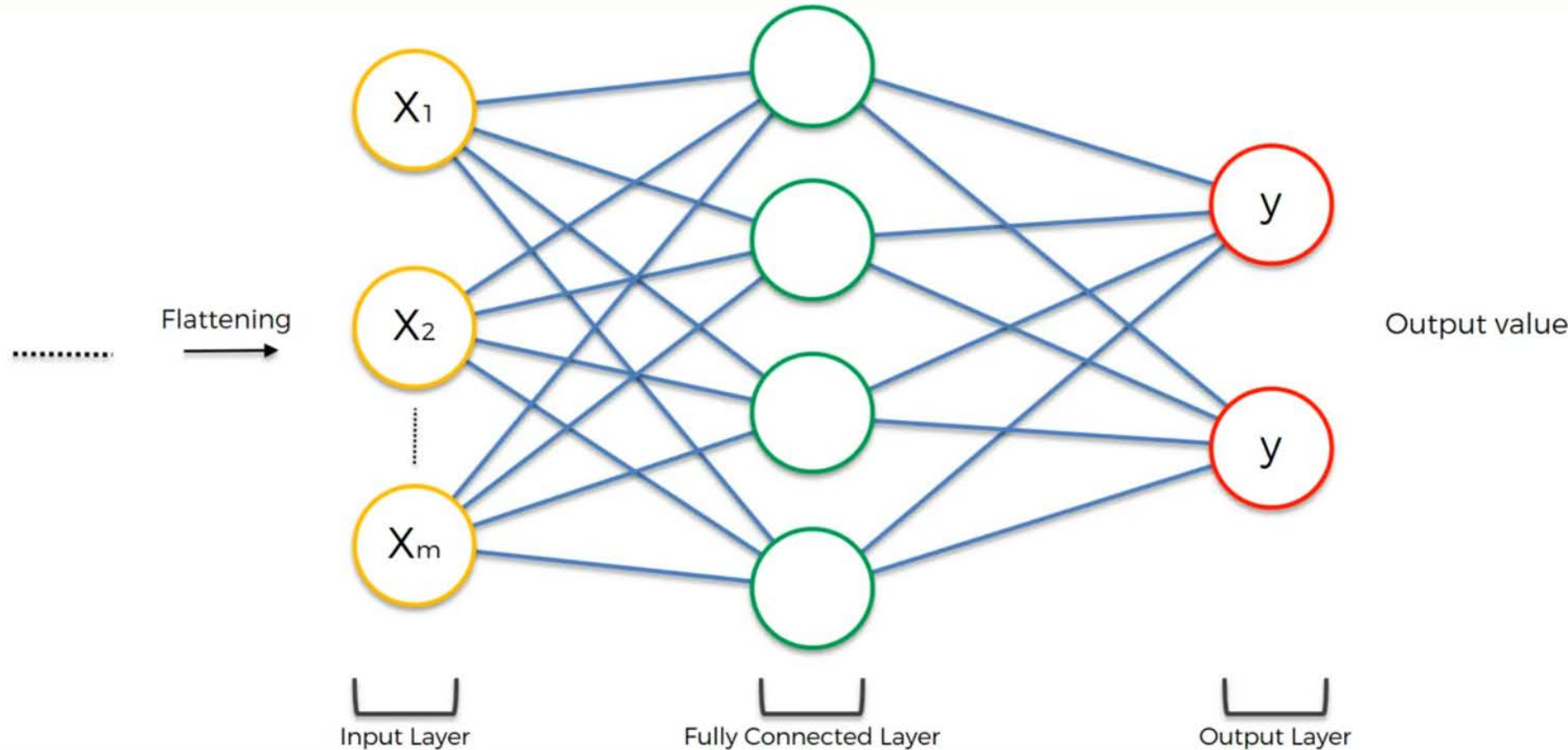


1
1
0
4
2
1
0
2
1

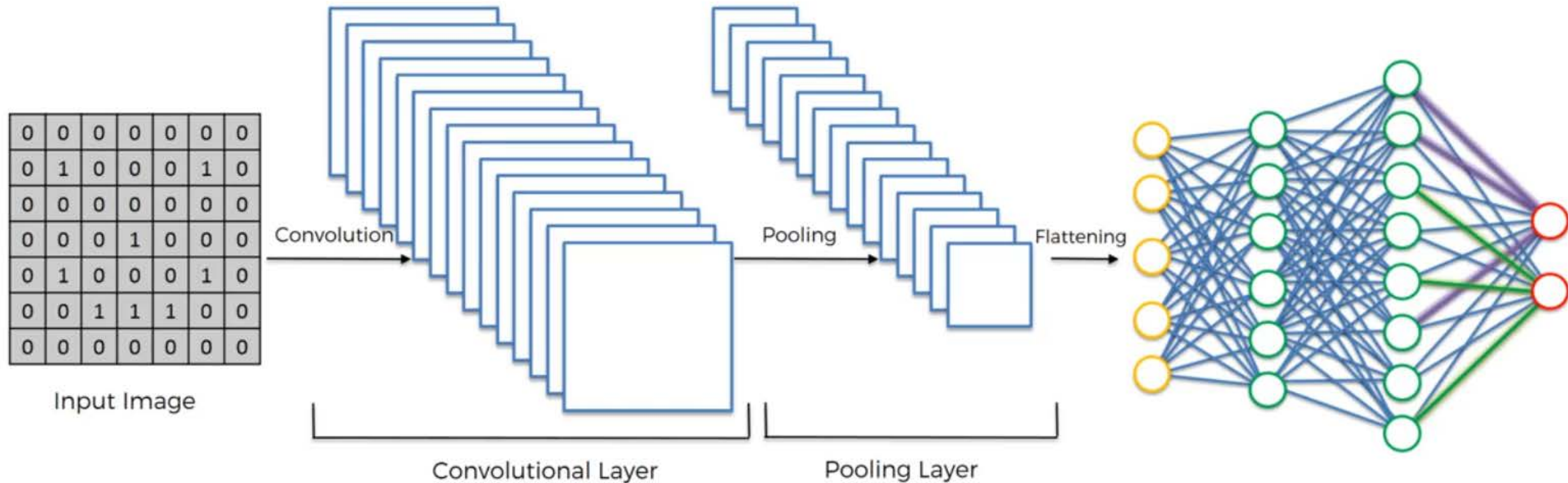
Step 3 - Flattening



Step 4 - Full Connection



Summary



Softmax & Cross-Entropy