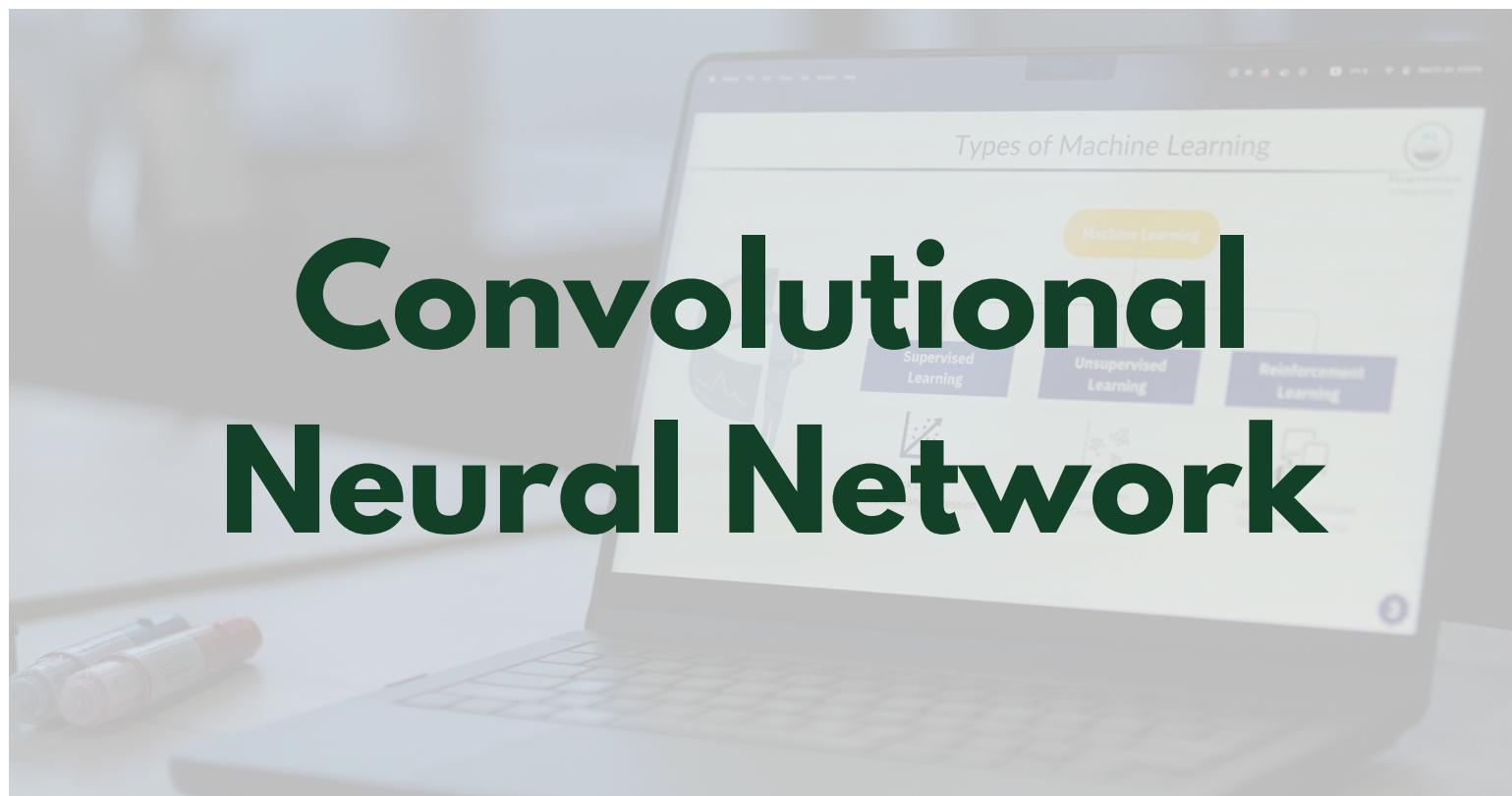




ពិភាក្សាលេខាងក្រោម

SUNRISE INSTITUTE



EMBARKING ON A JOURNEY
INTO DATA SCIENCE

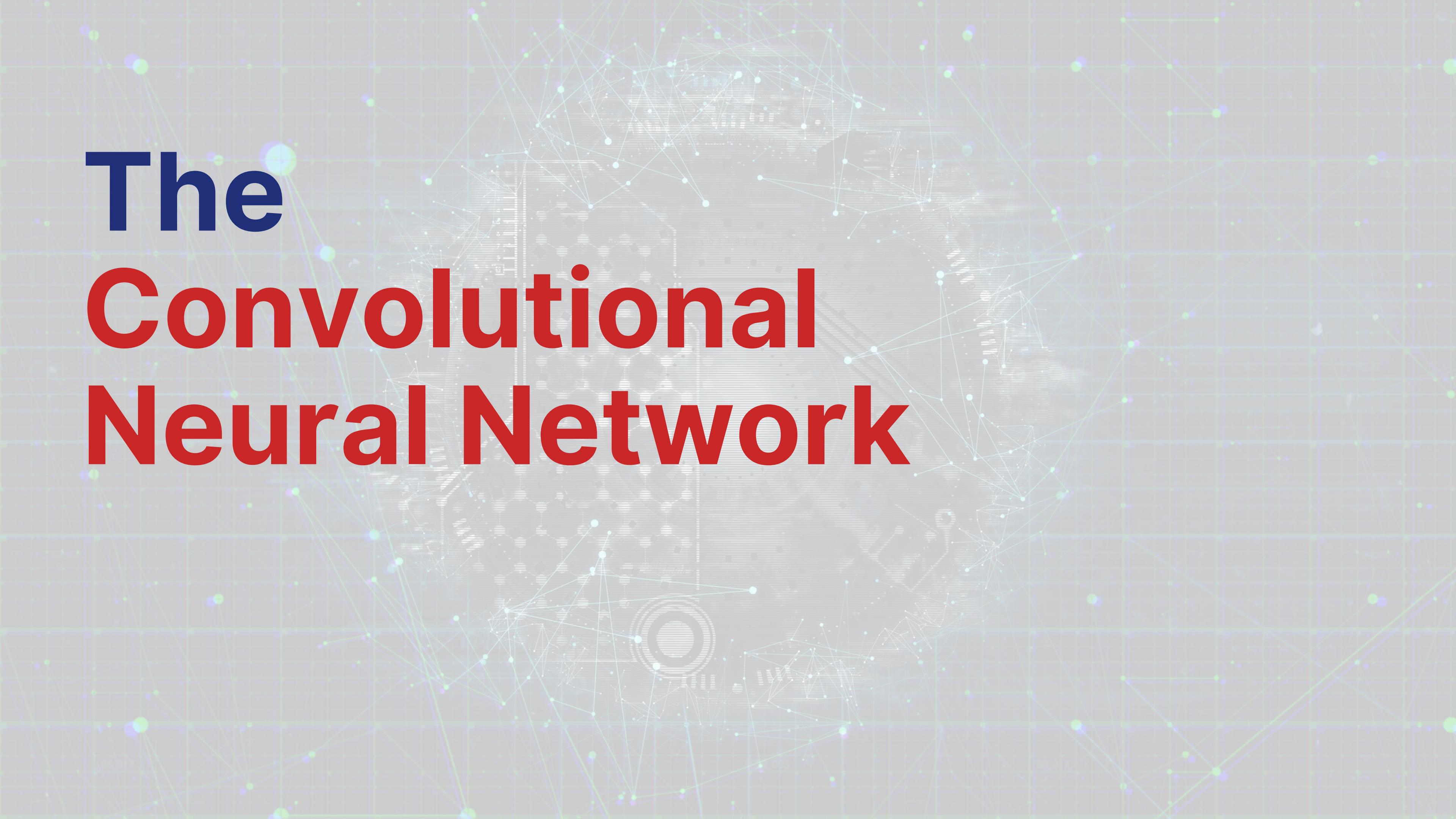
YA MANON



You can have data without information but you
cannot have information without data.

-Daniel Keys Maran

The Convolutional Neural Network



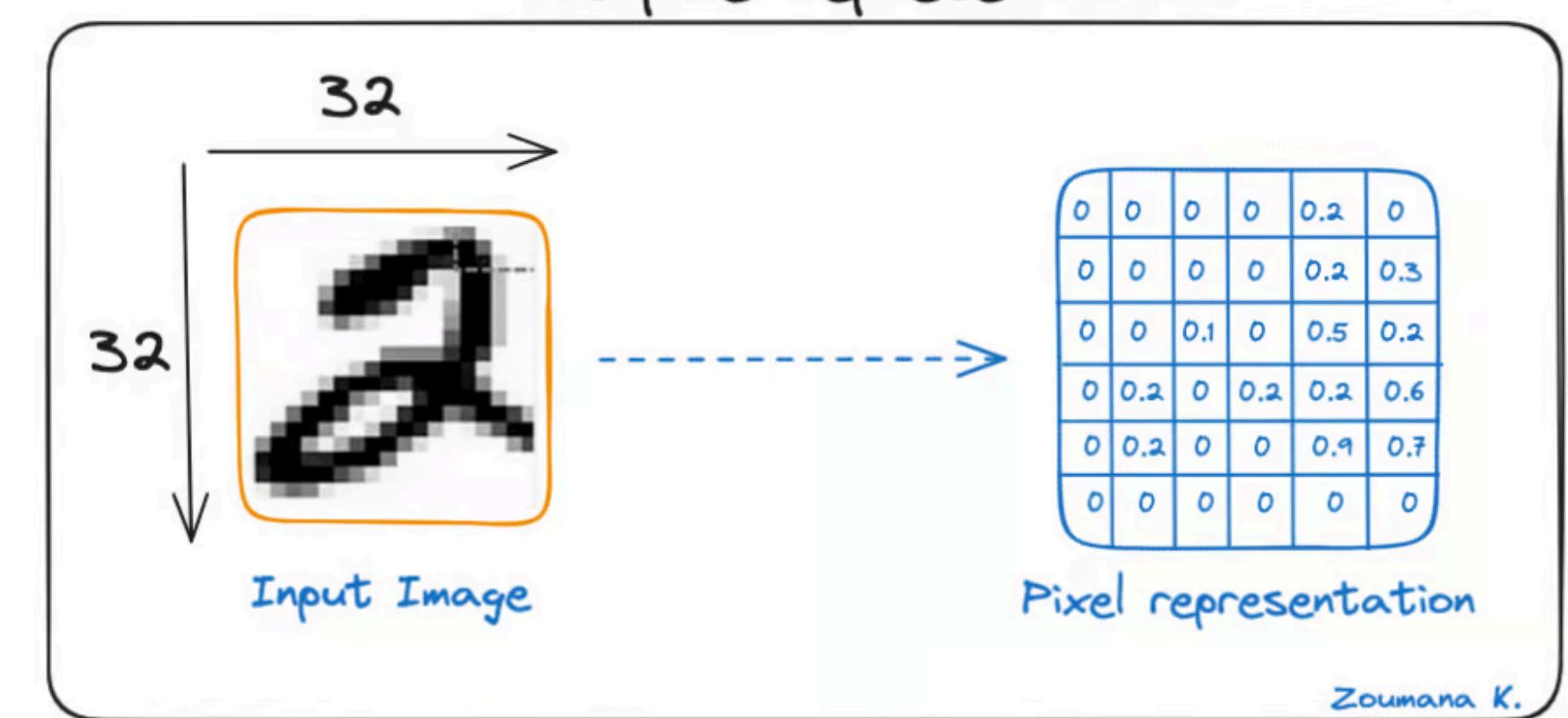
What Computer see?



What Computer Sees

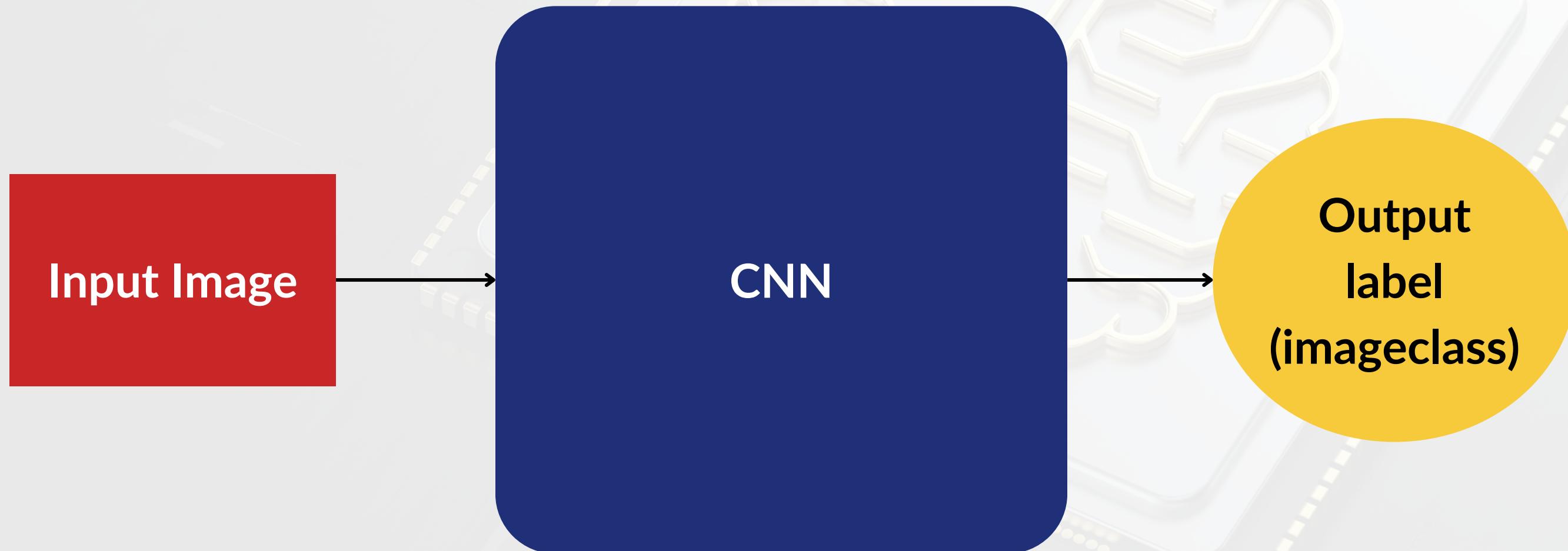
```
0 2 15 0 0 11 10 0 0 0 0 9 9 0 0 0  
0 0 0 4 60 157 236 255 255 177 95 61 32 0 0 29  
0 10 16 119 238 255 244 245 243 250 249 255 222 103 10 0  
0 14 170 255 255 244 254 255 253 245 255 249 253 251 124 1  
2 98 255 228 255 251 254 211 141 116 122 215 251 238 255 49  
13 217 243 255 155 36 226 52 2 0 10 13 232 255 255 36  
16 229 252 254 49 12 0 0 7 7 0 70 237 252 235 62  
6 141 245 255 232 25 11 9 3 0 115 236 243 255 137 0  
0 8 252 250 248 215 60 0 1 128 252 255 248 144 6 0  
0 13 113 255 255 245 255 182 181 248 252 247 208 36 0 19  
1 0 5 117 251 256 241 255 247 255 241 162 17 0 7 0  
0 0 0 4 58 251 255 246 254 253 255 120 11 0 1 0  
0 0 4 97 255 255 248 252 255 244 255 182 10 0 4  
0 22 206 252 246 251 241 100 24 113 255 245 255 194 9 0  
0 111 255 242 255 158 24 0 0 6 39 255 232 230 56 0  
0 218 251 250 137 7 11 0 0 0 2 62 255 250 125 3  
0 173 255 255 151 9 20 0 13 3 13 182 251 245 61 0  
0 107 251 241 255 230 98 55 19 118 217 248 253 255 52 4  
0 18 146 250 255 247 255 255 249 255 240 255 129 0 5  
0 0 23 113 215 255 250 248 255 248 248 118 14 12 0  
0 0 6 1 0 52 153 233 255 252 147 37 0 0 4 1  
0 0 5 5 0 0 0 0 0 14 1 0 6 6 0 0
```

Illustration of the input image and its pixel representation



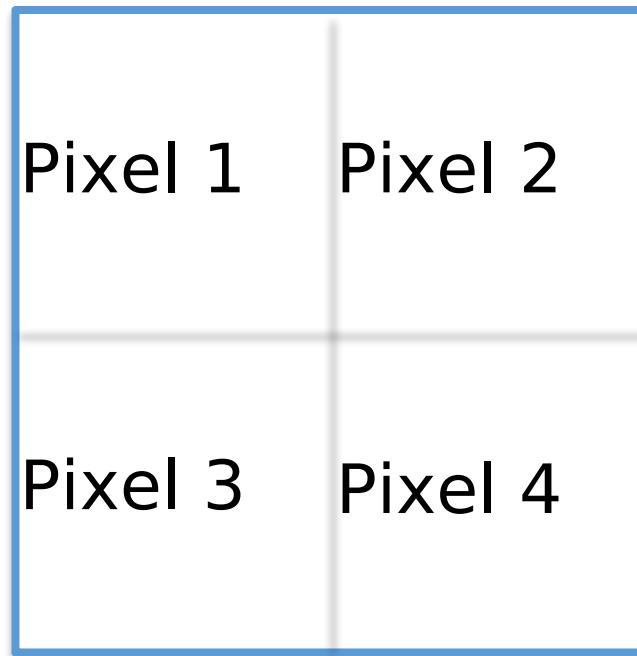
What's Convolutional Neural Networks?

CNNA also known as ConvNet, is a specialized type of deep learning algorithm mainly designed for tasks that necessitate object recognition, including image classification, detection, and segmentation.

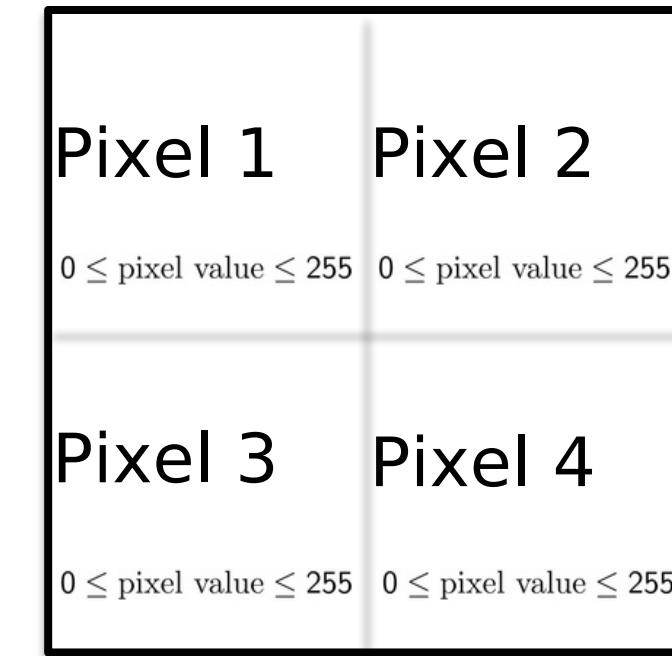


Representation by Pixel

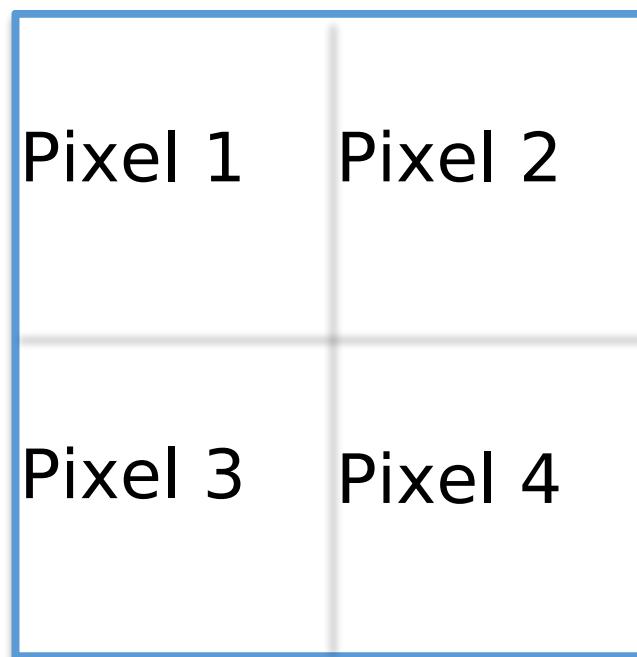
B / W Image 2x2px



2d array



Colored Image 2x2px

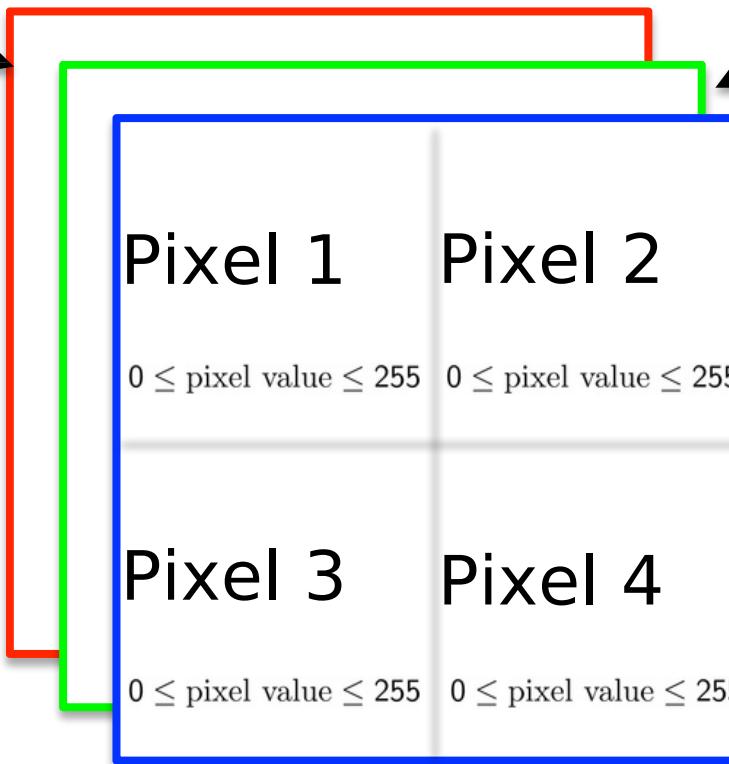


3d array

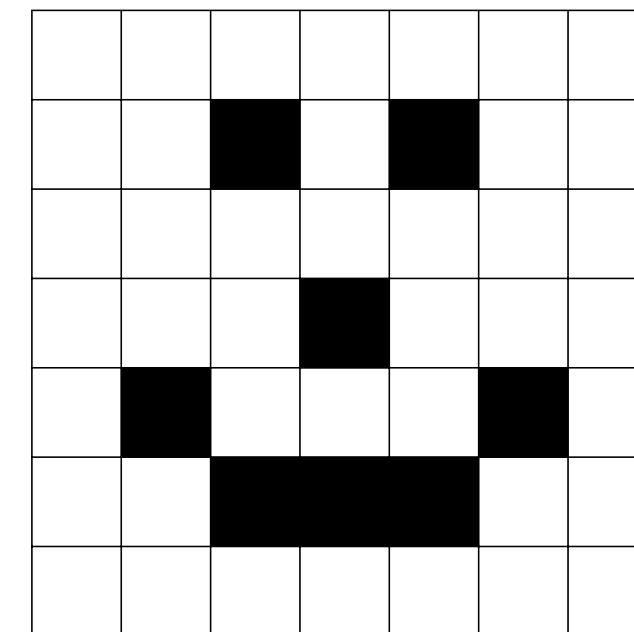
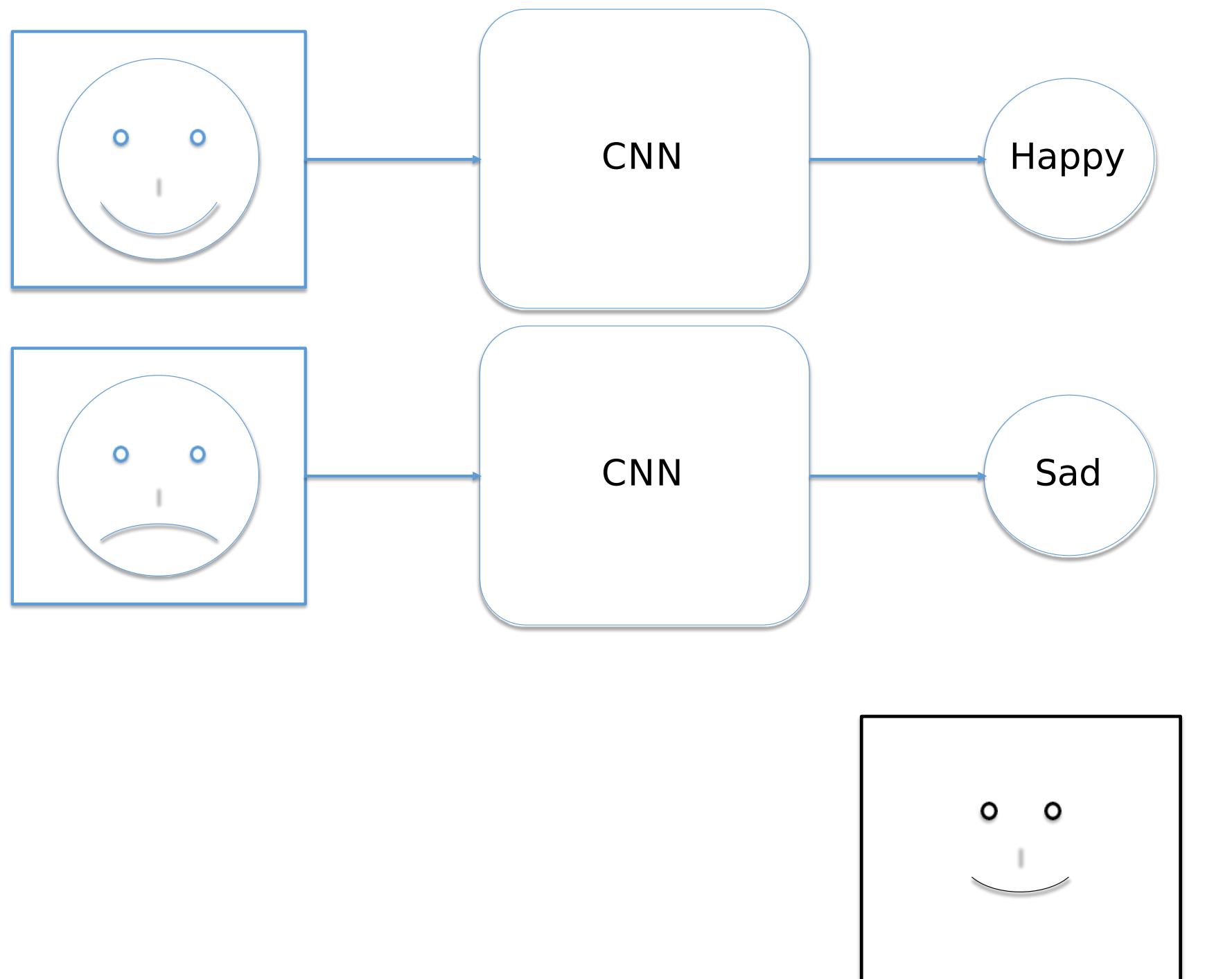
Red channel

Green
channel

Blue
channel



What's Convolutional Neural Networks?



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

Key Components of a CNN

STEP 1: Convolution or feature detector



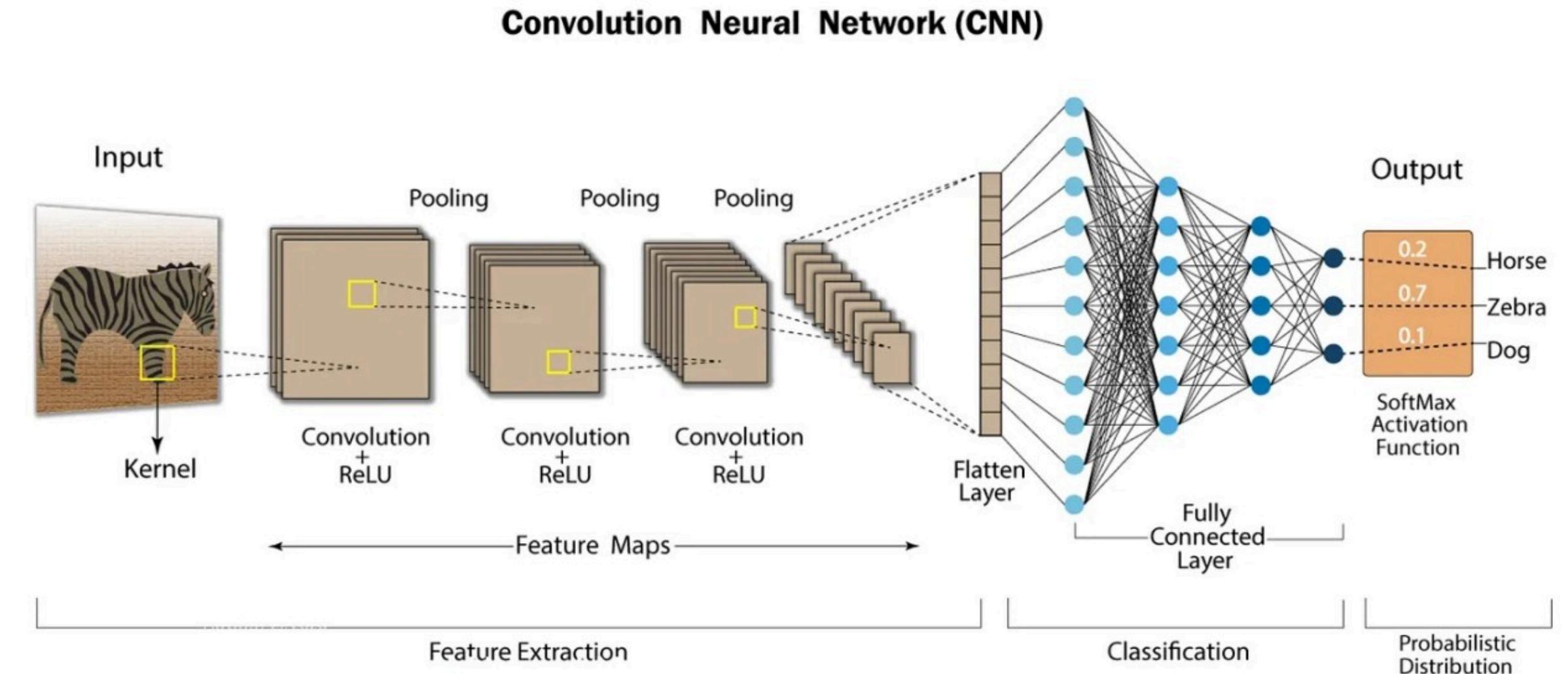
STEP 2: Max Pooling



STEP 3: Flattening



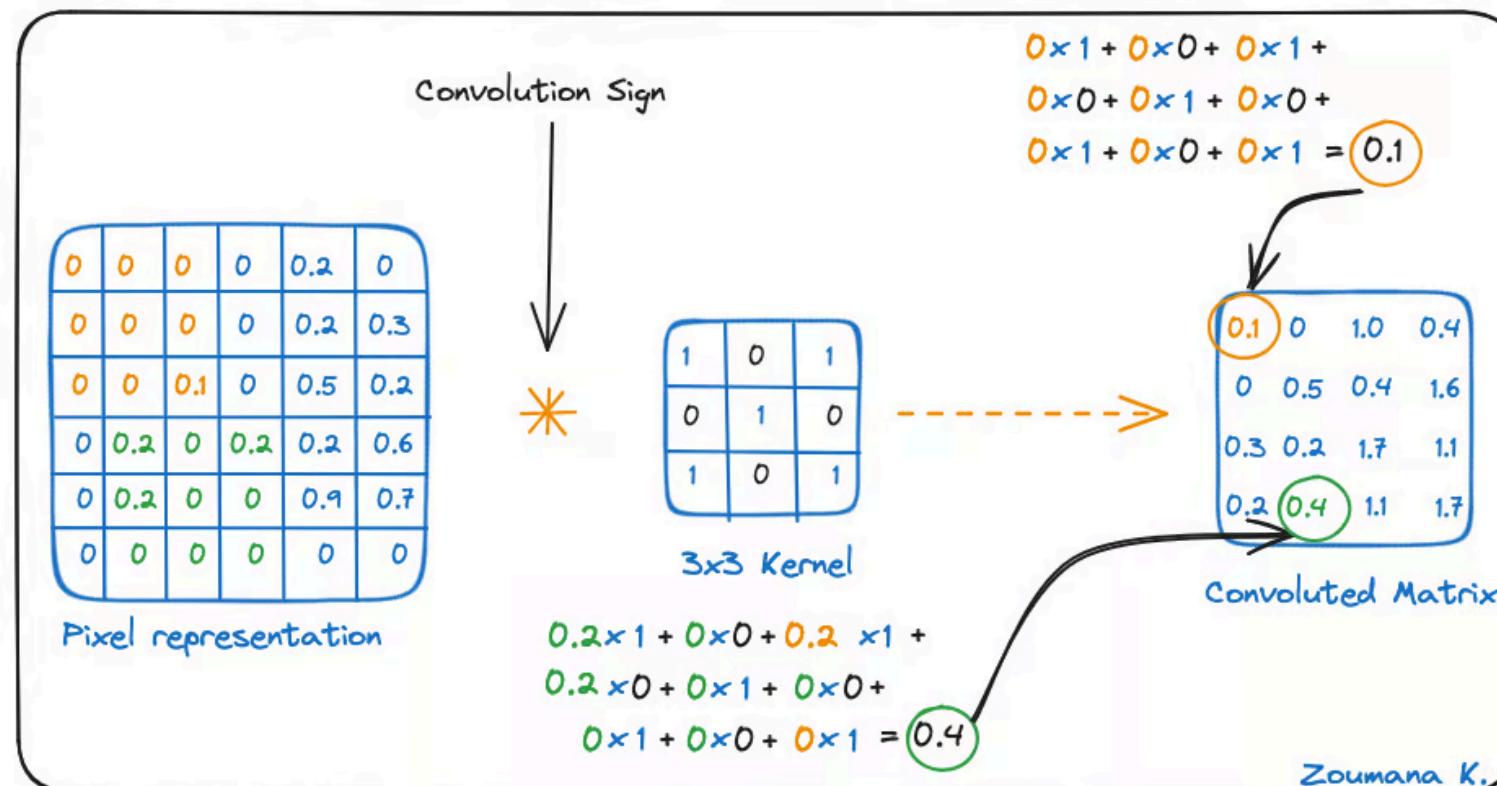
STEP 4: Full Connection



Convolution

CONVOLUTION OPERATION

Application of the convolution task using
a stride of 1 with 3×3 kernel



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

Convolution

0	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	



0	0	1
1	0	0
0	1	1



0				

Input
Image

Feature
Detector

Feature Map

Convolution

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

Input
Image

0	0	1
0	0	1
0	1	0

=

0	1					

Feature
Map

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

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

0	1	0				

0	1	0				

Feature
Detector

Feature
Map

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

Input
Image

0	0	1
0	0	1
0	1	0

=

0	1	0	0	0	0	0

Feature
Map

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

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

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

0	1	0	0	0	1	0

0	1	0	0	0	1	0

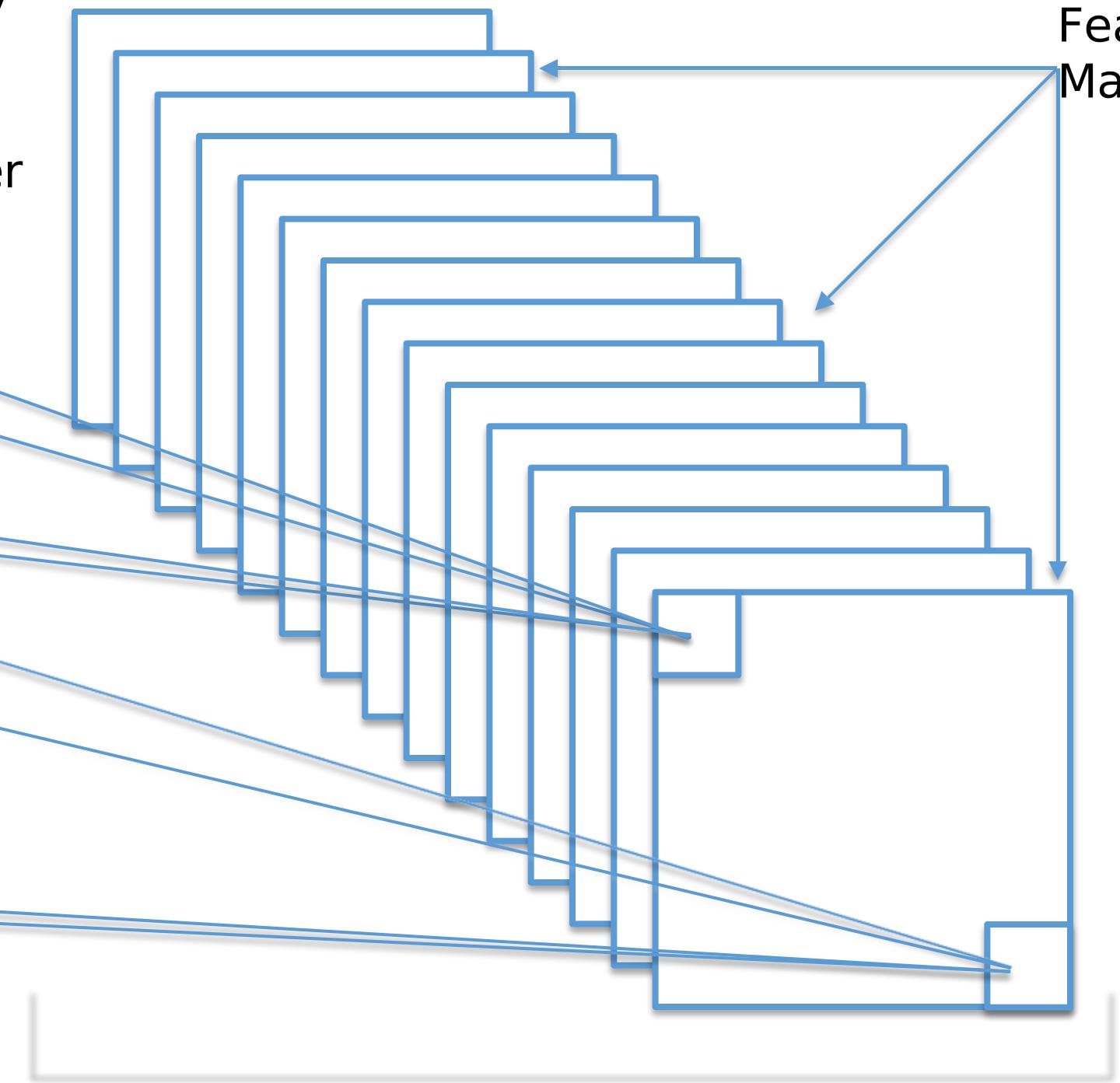
<table border="

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

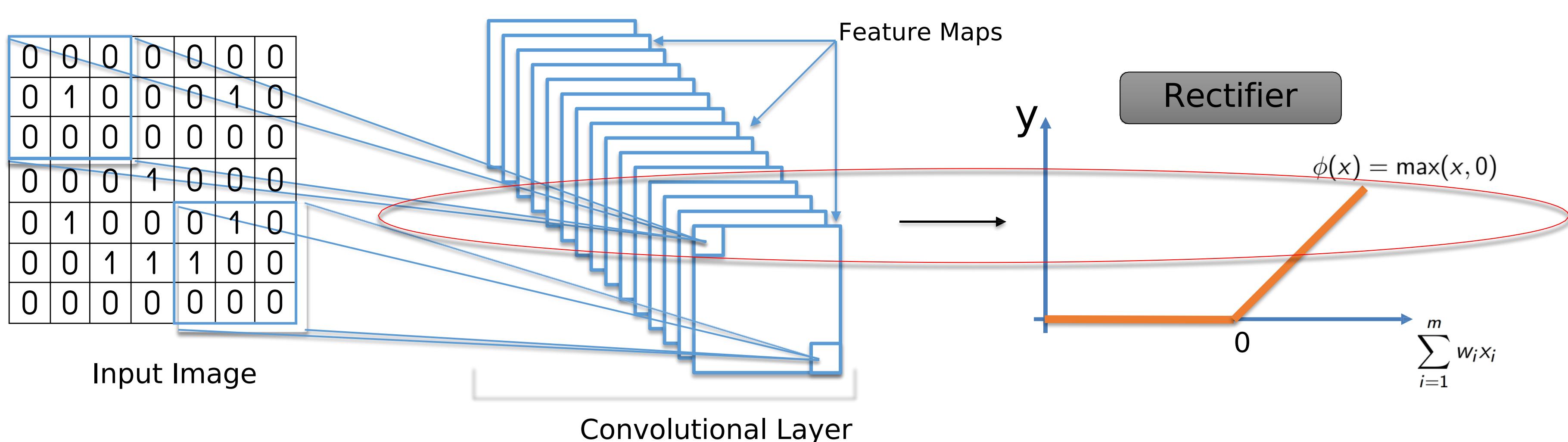
Input Image

We create many feature maps to obtain our first convolution layer



Convolutional Layer

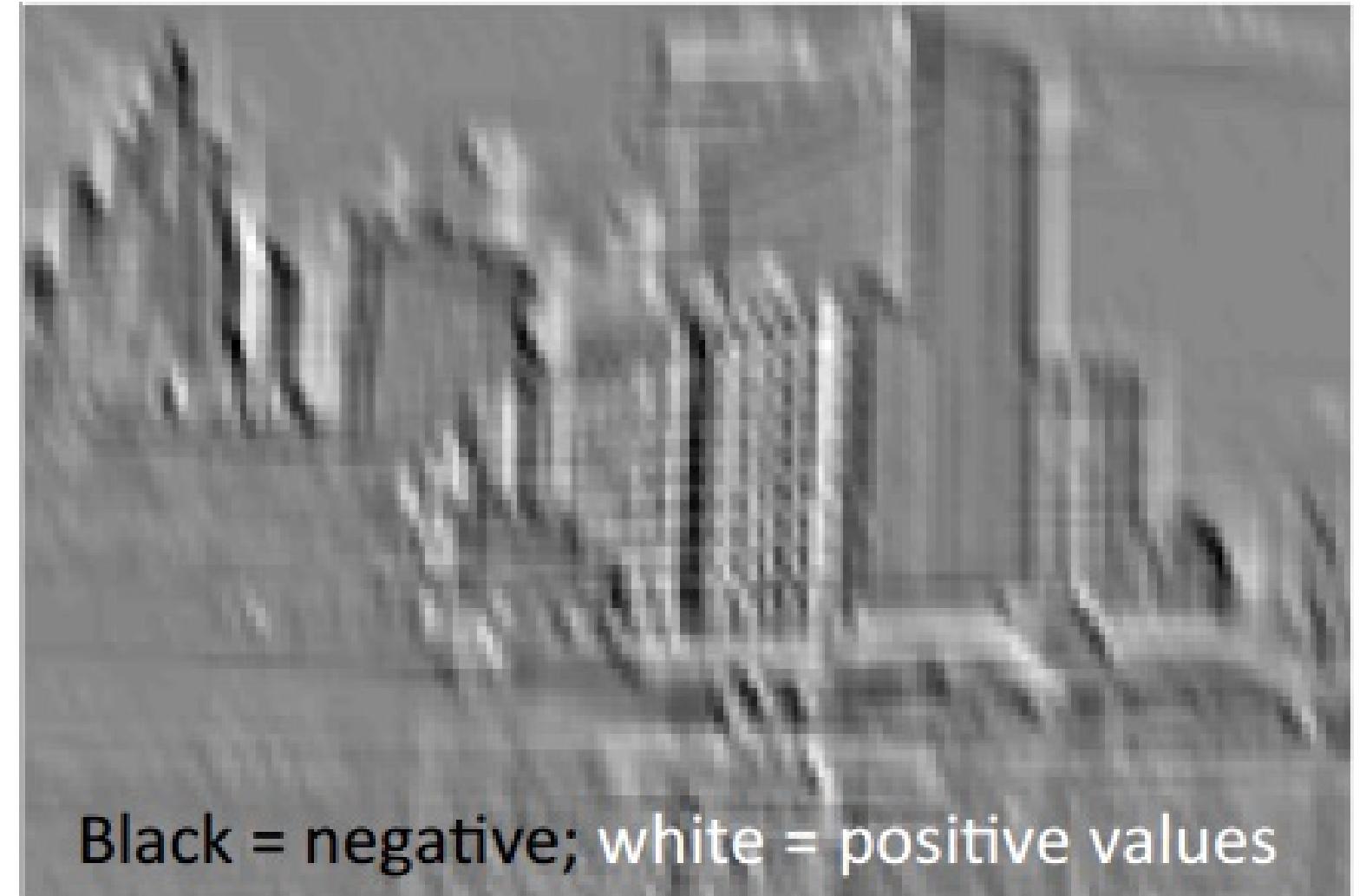
Rectified Linear Units



Rectified Linear Units



Using Feature
Detector



Black = negative; white = positive values

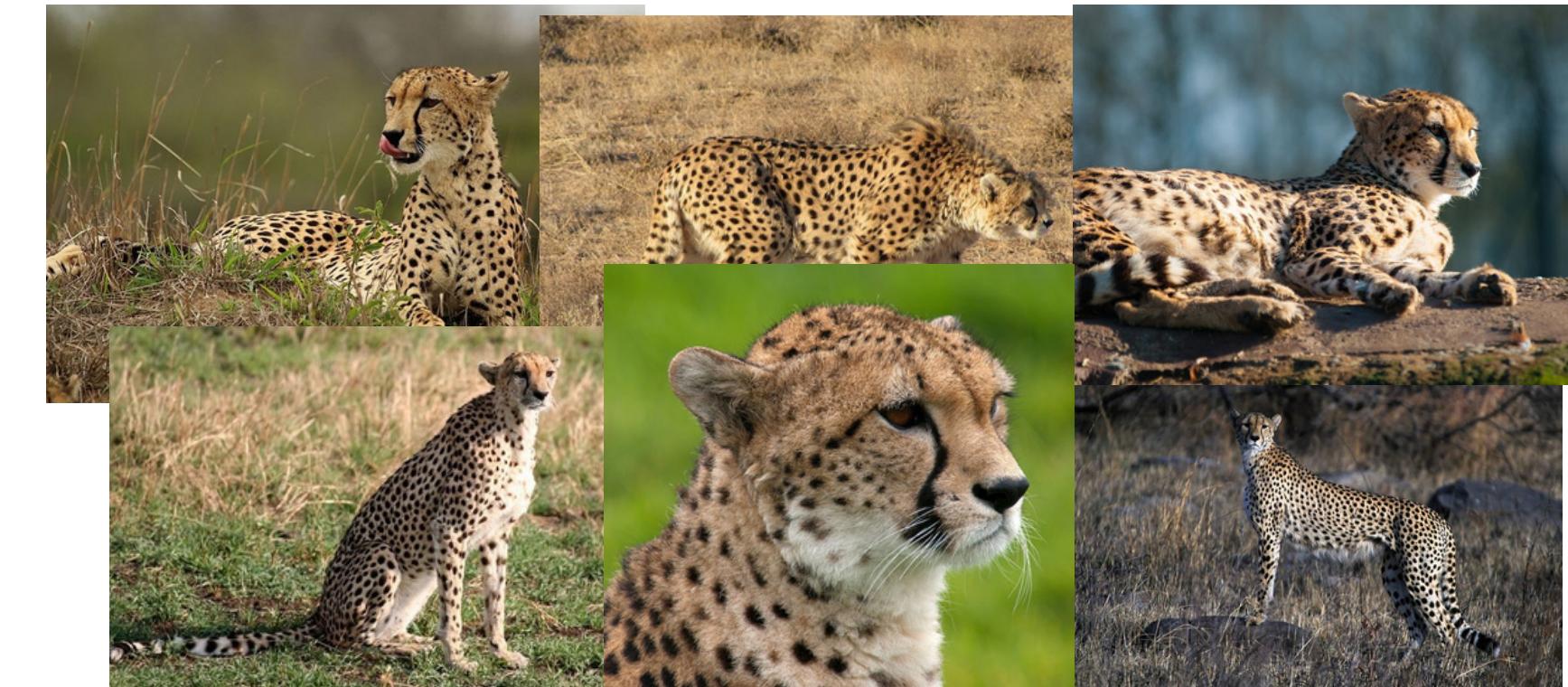
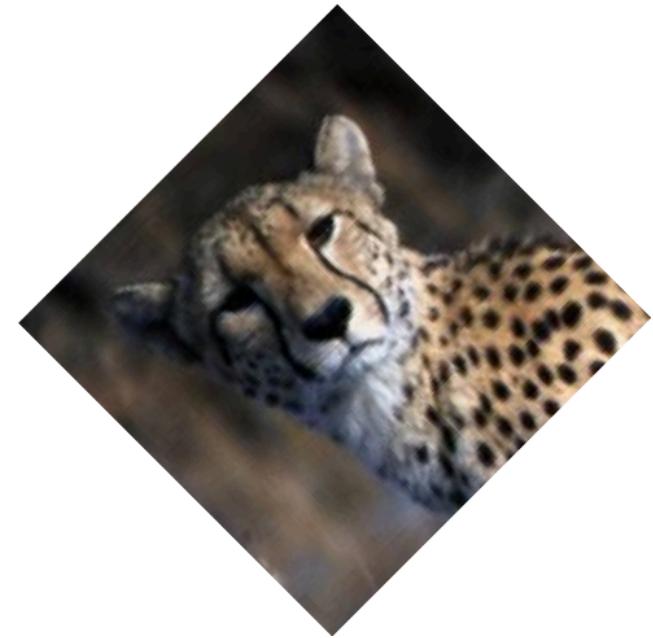


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Rectified Linear Units



Max Pooling



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



Pooled Feature Map

Max Pooling

strides

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

Pool size

Max Pooling



Feature Map

Pooled Feature Map

Max Pooling

strides

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

Pool size

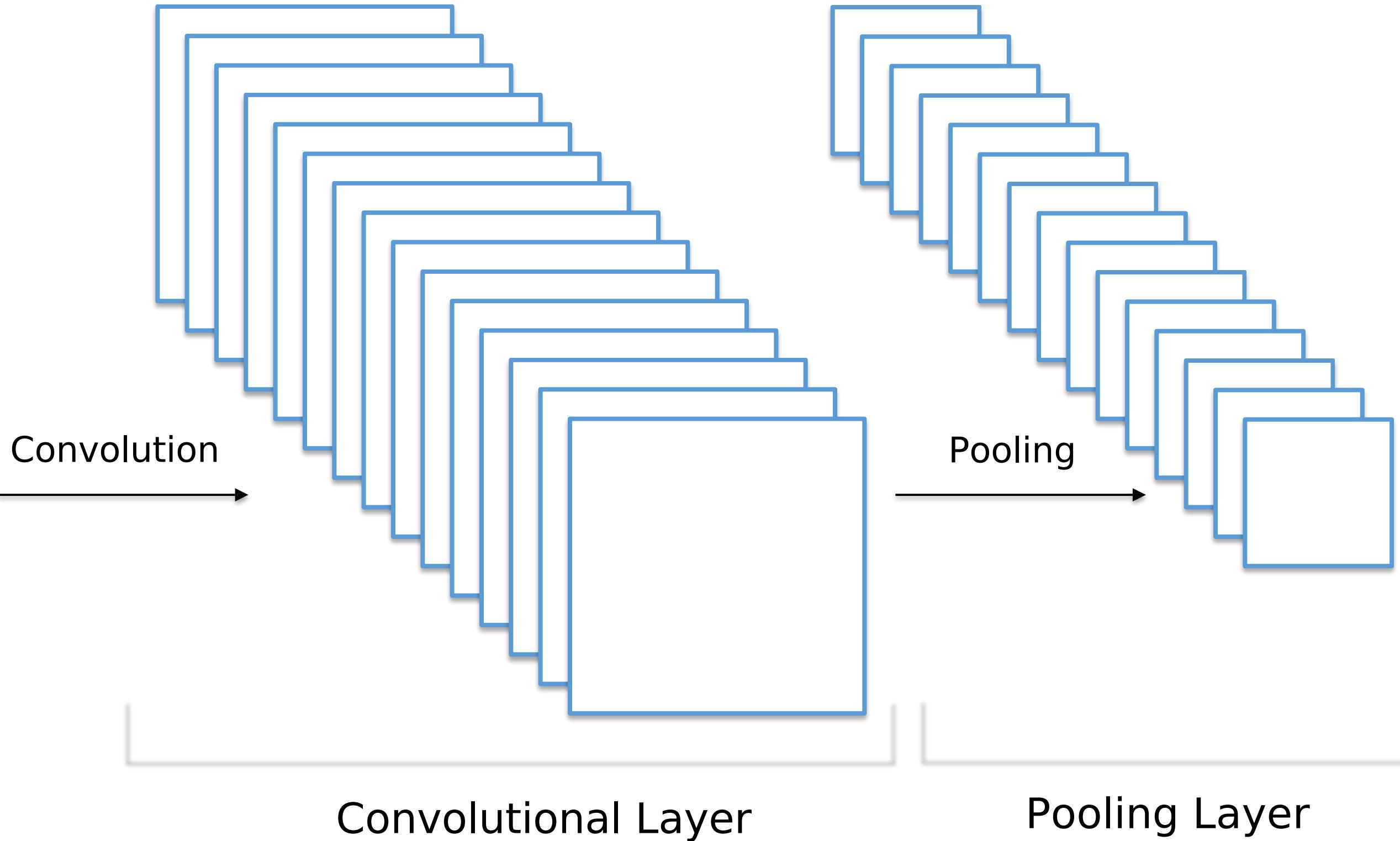
1	1	0
4	2	1
0	2	1

Pooled Feature Map

Max Pooling

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



Flentenning

1	1	0
4	2	1
0	2	1

Pooled Feature Map

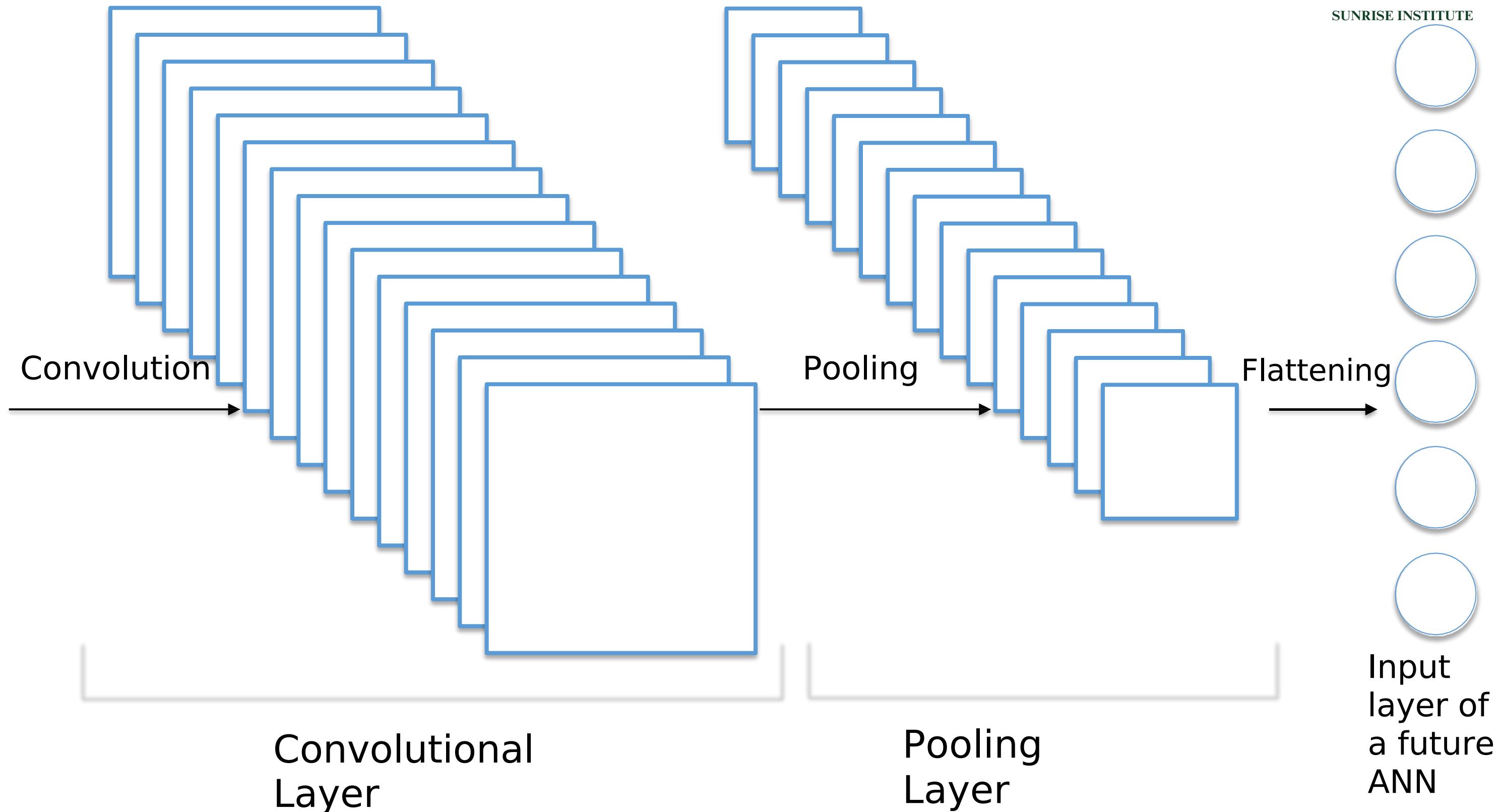
Flattening



1
1
0
4
2
1
0
2
1

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

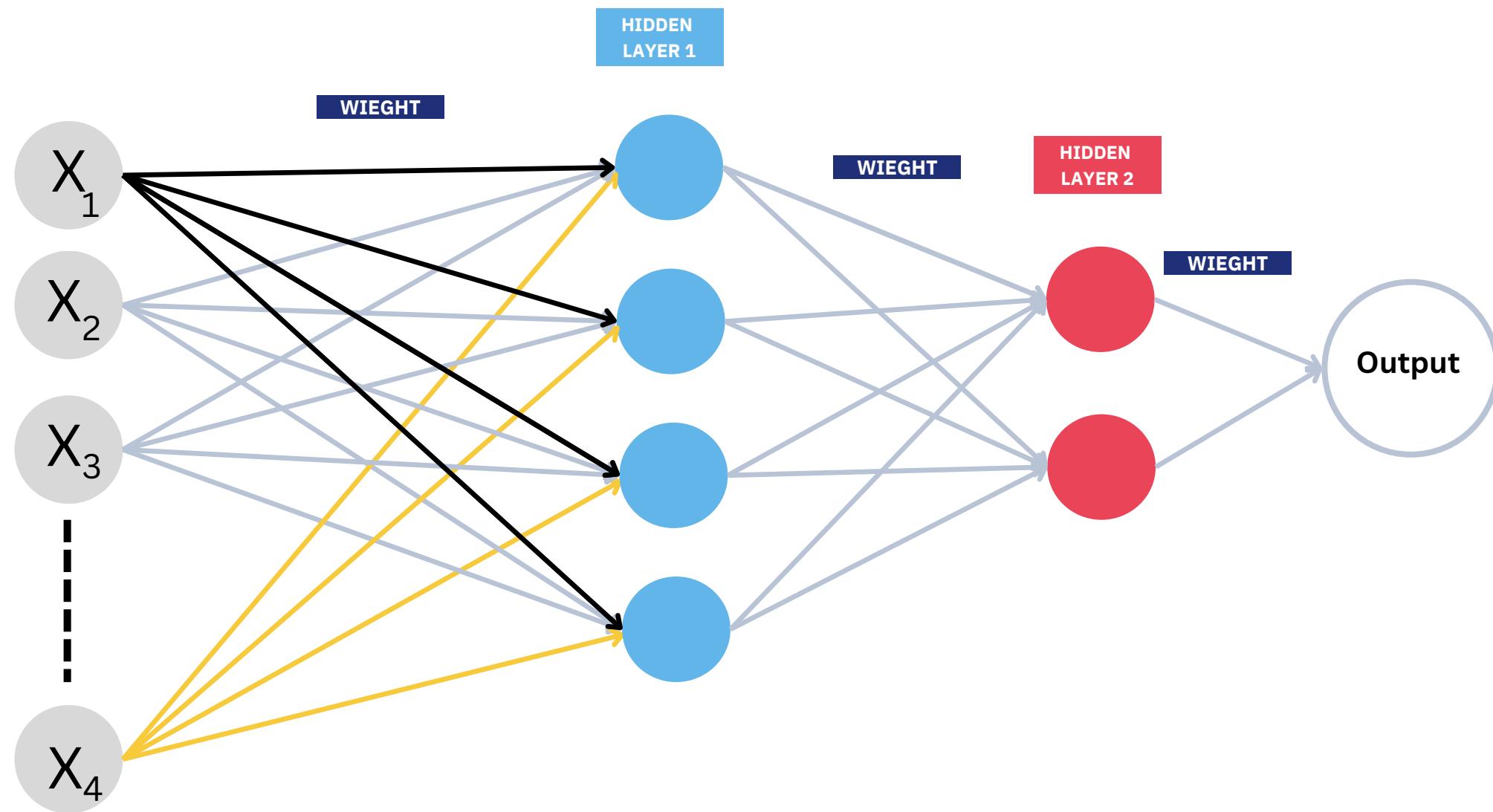


Full Connection

Input:

- 2d mage
- Vector of pixel values

- **Fully Connected**
- Connect neuron in hidden layer to all neurons in input layer
- No spatial information
- And many, many parameters!



Summary

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

