



ពិភាក្សាលេខាងក្រោម

SUNRISE INSTITUTE

THE CONVOLUTIONAL NEURAL NETWORK

EMBARKING ON A JOURNEY
INTO DATA SCIENCE

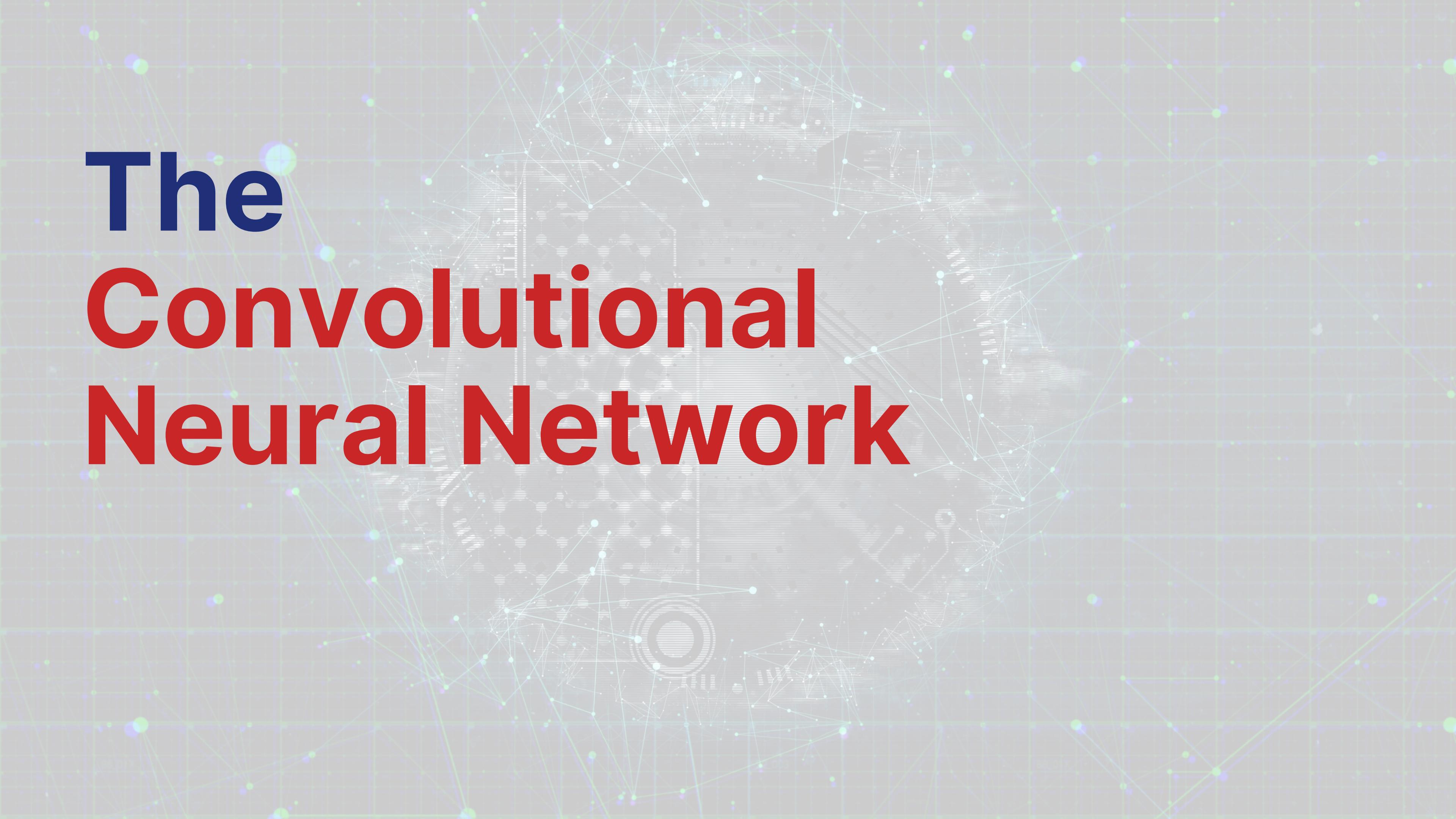
YA MANON



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

-Daniel Keys Maran

The Convolutional Neural Network



What Computer see?



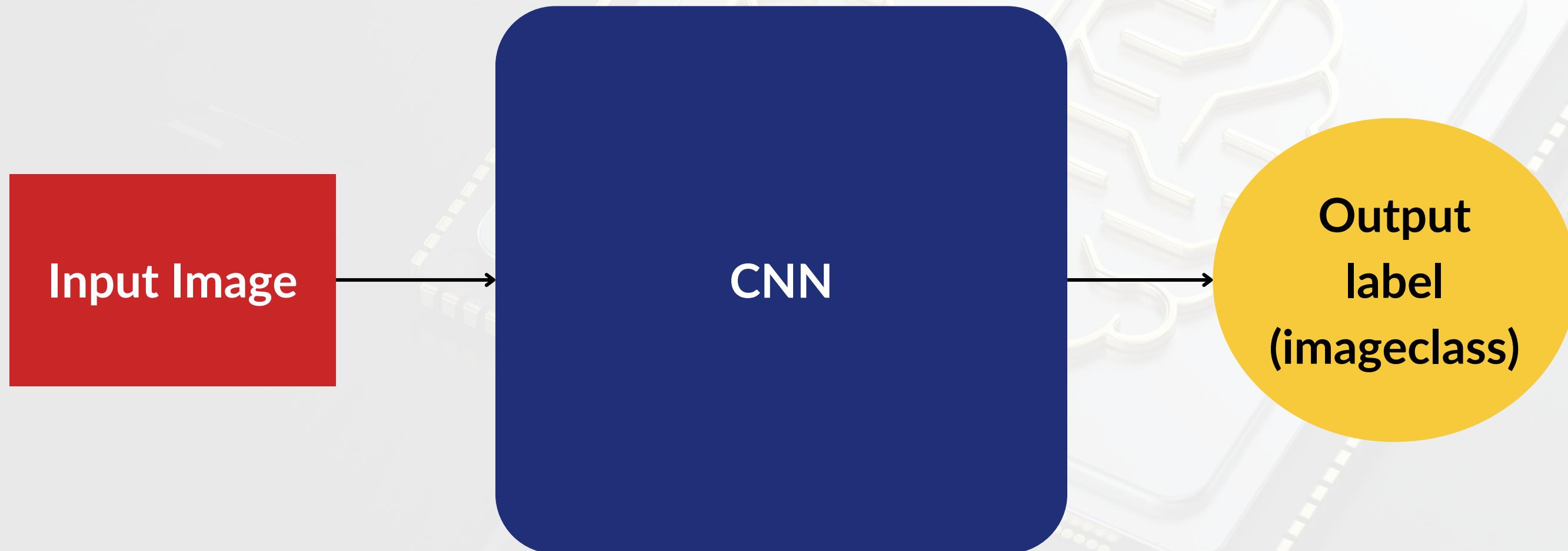
0	2	15	0	0	11	10	0	0	0	0	9	9	0	0	0	0
0	0	0	4	60	157	236	255	255	177	95	61	32	0	0	29	
0	10	16	119	238	255	244	245	243	250	249	255	222	103	10	0	
0	14	170	255	255	244	254	255	253	245	255	249	253	251	124	1	
2	98	255	228	255	251	254	211	141	116	122	215	251	238	255	49	
13	217	243	255	155	53	226	53	2	0	10	13	232	255	255	36	
16	229	252	254	49	12	0	0	7	7	0	70	237	252	235	62	
6	141	245	255	212	73	11	9	3	0	115	236	243	255	137	0	
0	87	252	250	248	215	60	0	1	121	257	255	248	144	6	0	
0	13	113	255	255	245	255	182	181	248	252	247	236	36	0	19	
1	0	5	117	251	216	241	216	247	255	241	162	17	0	7	0	
0	0	0	4	58	251	216	244	254	253	260	11	0	1	0		
0	0	4	97	255	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	2	62	255	250	125	3		
0	173	255	255	161	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	230	255	252	147	37	0	0	4	1	
0	0	5	5	0	0	0	0	14	1	0	6	6	0	0		

What Computer Sees

0	2	15	0	0	11	10	0	0	0	0	9	9	0	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	53	226	53	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	212	73	11	9	3	0	115	236	243	255	137	0	
0	87	252	250	248	215	60	0	1	121	257	255	248	144	6	0	
0	13	113	255	255	245	255	182	181	248	252	247	236	36	0	19	
1	0	5	117	251	216	241	216	247	255	241	162	17	0	7	0	
0	0	0	4	58	251	216	244	254	253	260	11	0	1	0		
0	0	4	97	255	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	2	62	255	250	125	3		
0	173	255	255	161	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	230	255	252	147	37	0	0	4	1	
0	0	5	5	0	0	0	0	14	1	0	6	6	0	0		

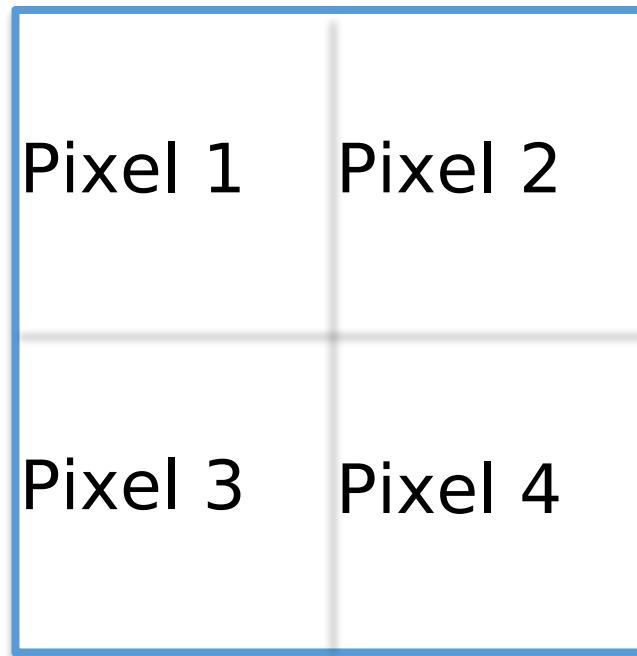
What's Convolutional Neural Networks?

CNN is a type of Deep Learning algorithm that is particularly well-suited for image recognition and precessing tasks

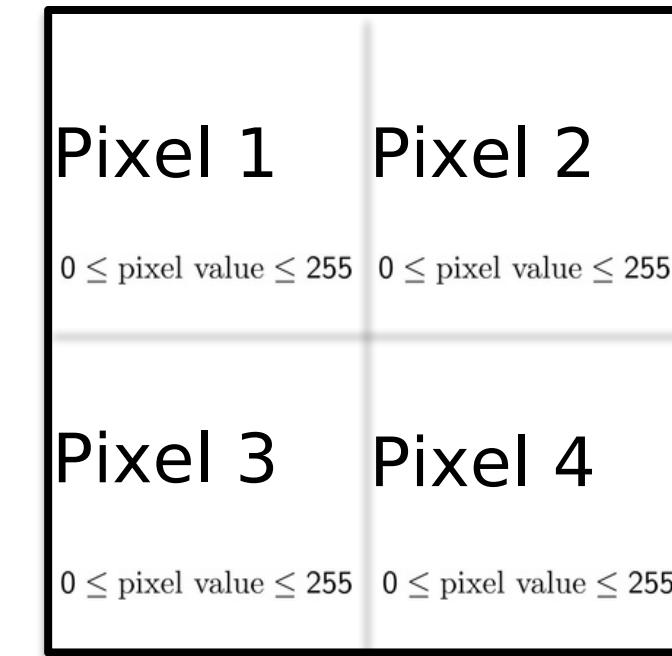


Representation by Pixel

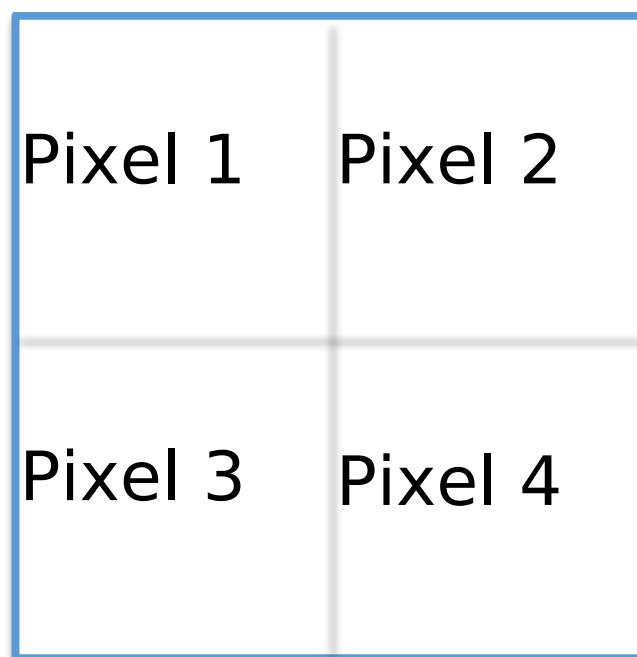
B / W Image 2x2px



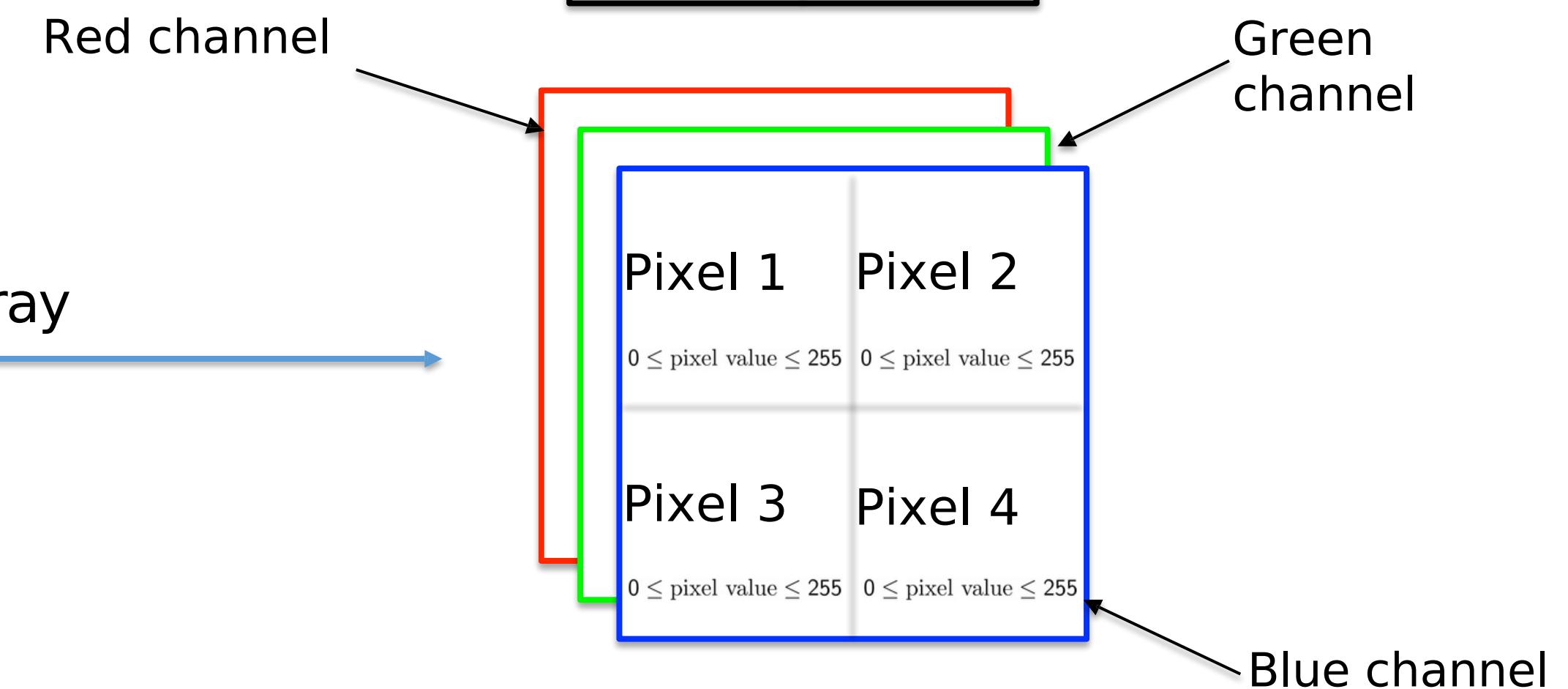
2d array



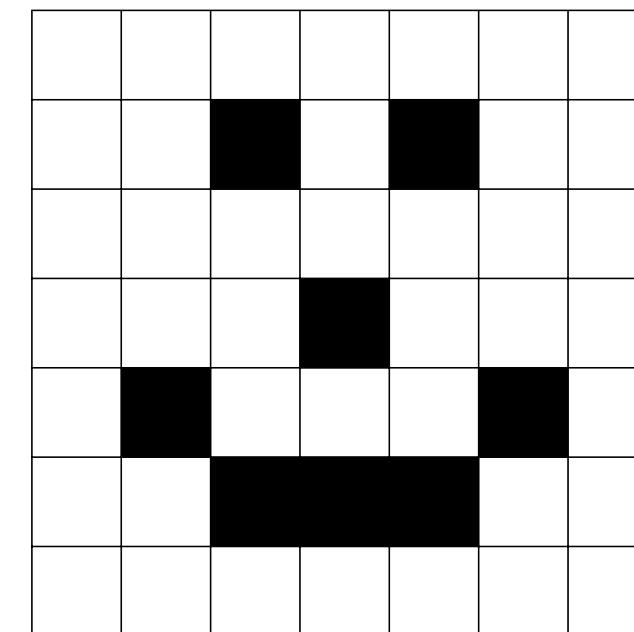
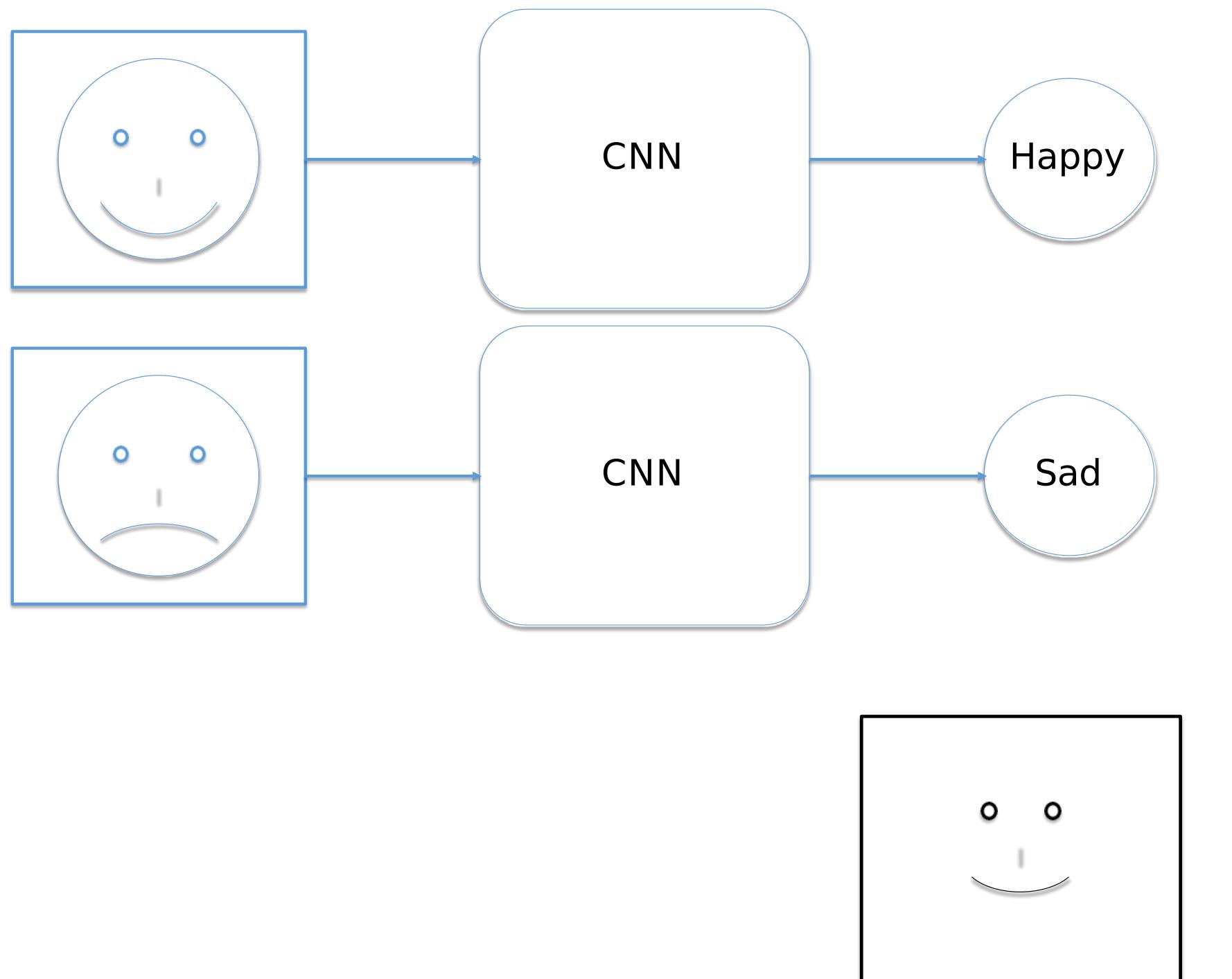
Colored Image 2x2px



3d array



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

What's Convolutional Neural Networks?

STEP 1: Convolution



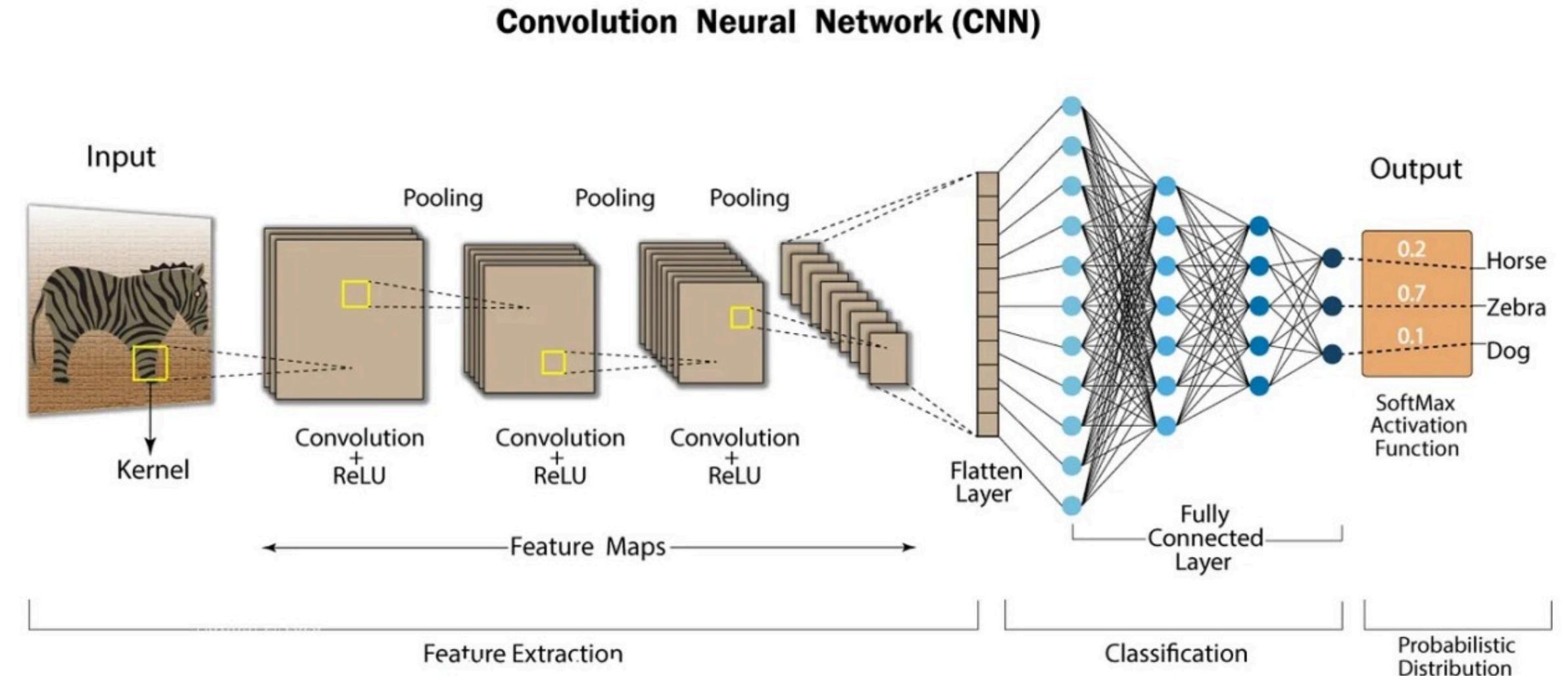
STEP 2: Max Pooling



STEP 3: Flattening



STEP 4: Full Connection



Feature Detector

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

Input
Image

Feature
Detector

Feature Detector

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

Feature Detector

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	0	1	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
1	0	0

=

0	1					

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			
1	0	0			
0	1	1			
0	0	0			

Feature
Detector

0	1	0			
1	0	0			
0	1	1			
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

Input
Image

0	0	1
0	1	0
1	0	0

=

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

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

=

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

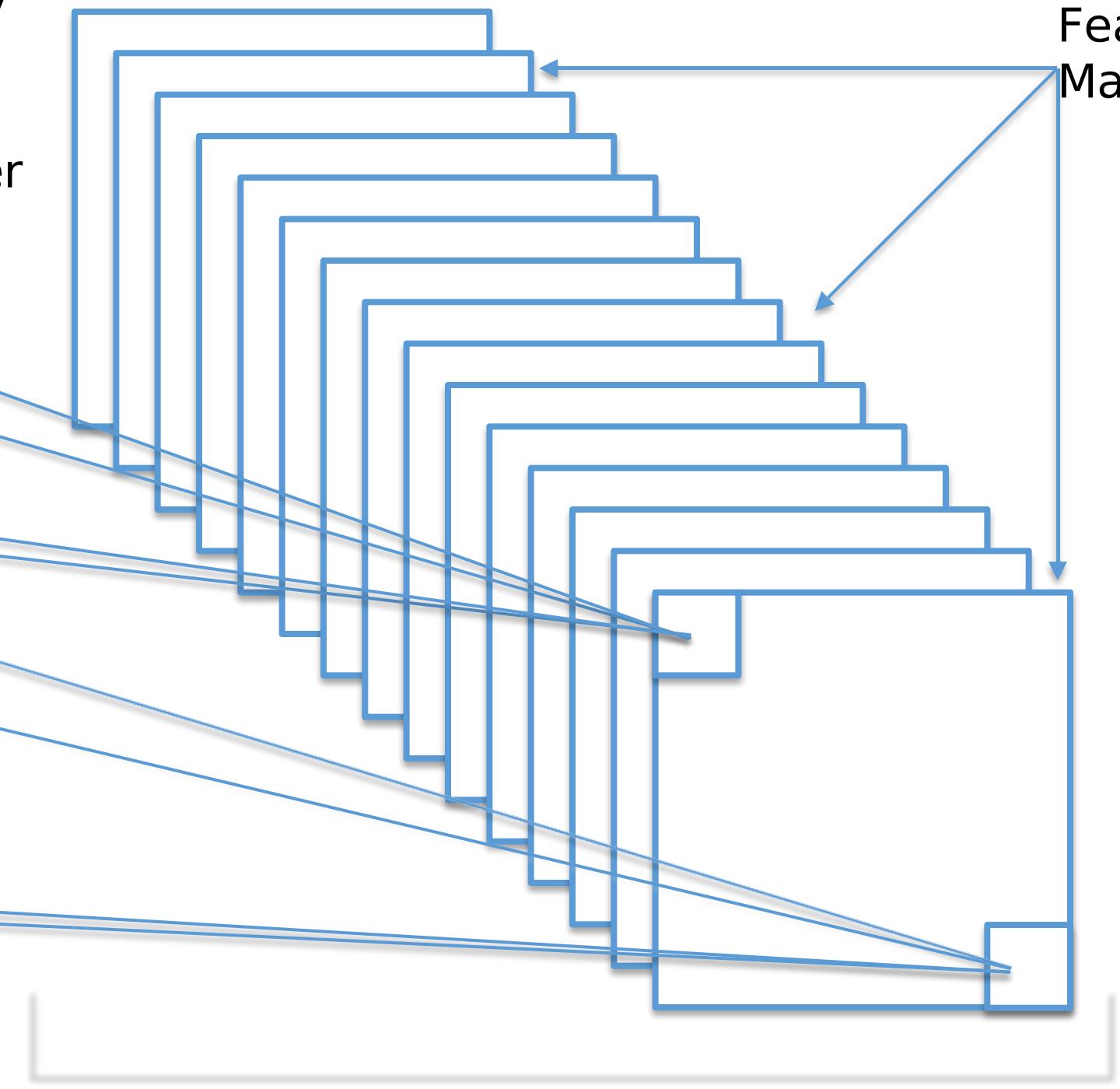
0	1	0	0	0
0	1	1	1	0
1	0	1	2	1
1	4	2	1	0
0	0	1	2	1

Feature Detector

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

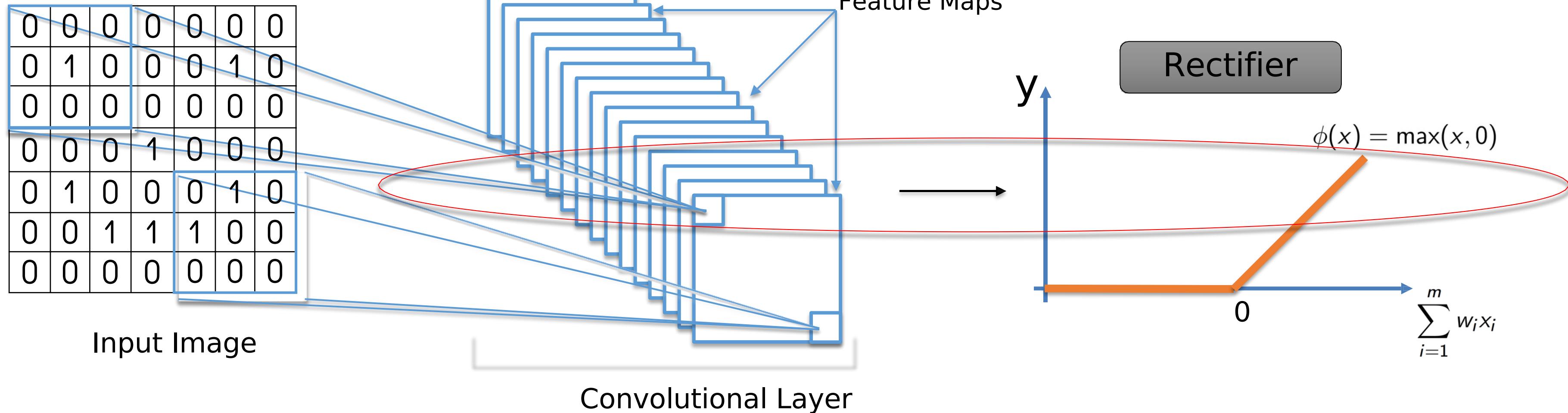
Input Image

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

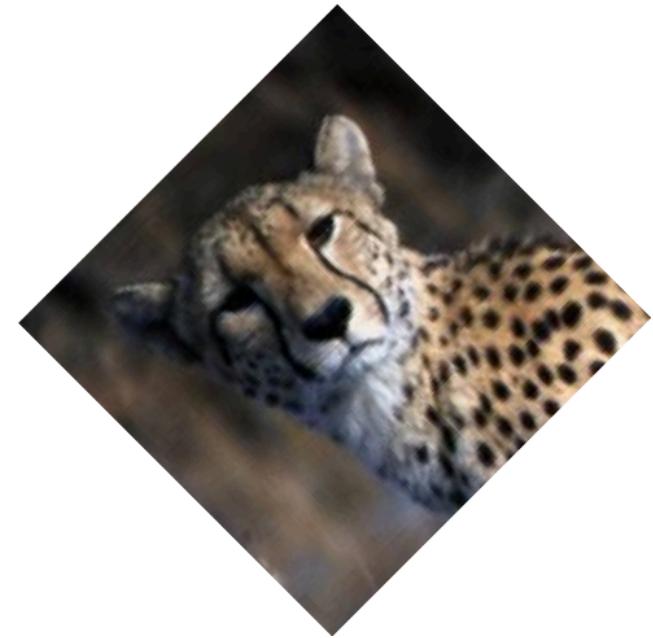


ពិភាក្សាល័យ
SUNRISE INSTITUTE

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

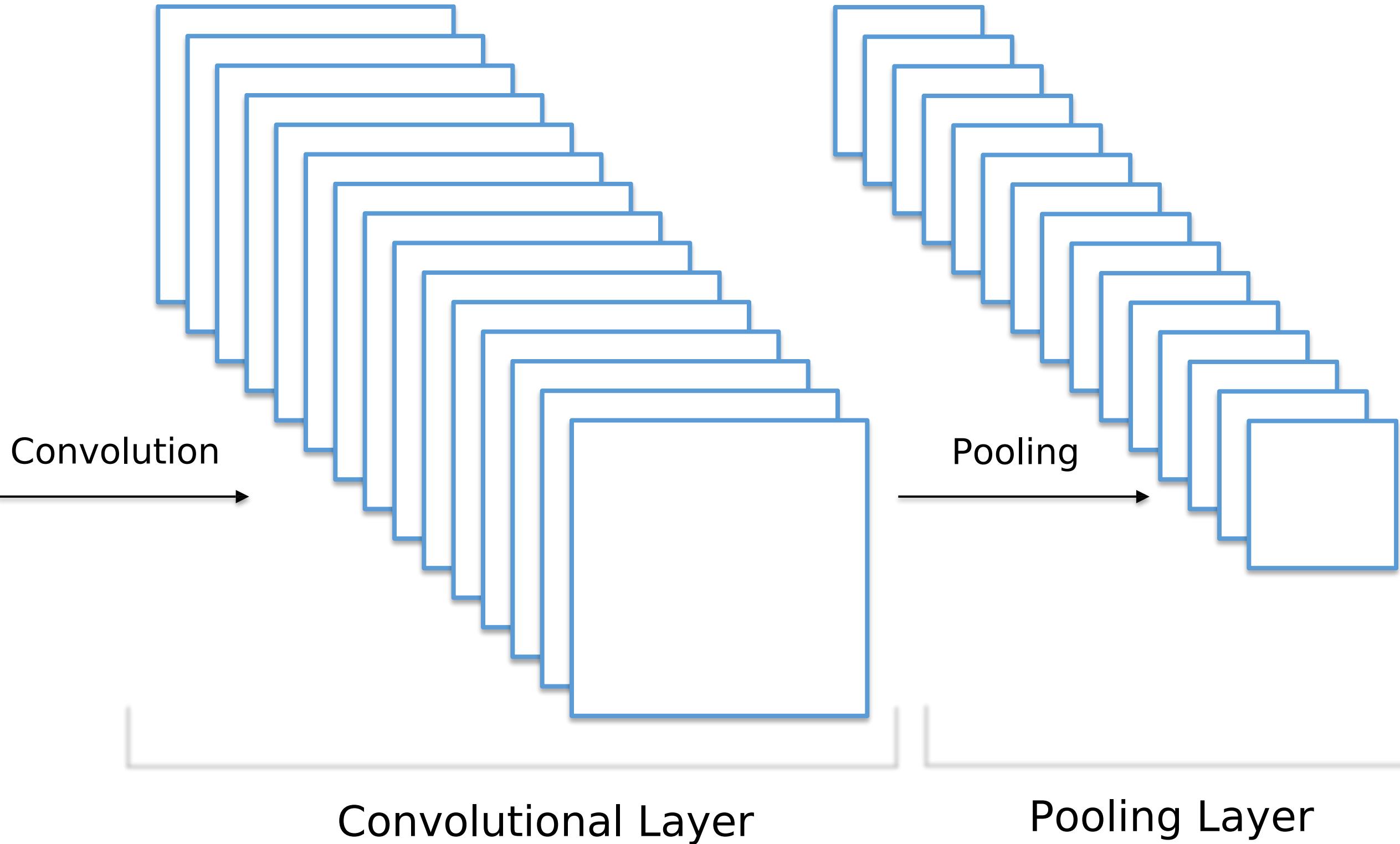
1	1	0
4	2	1
0	2	1

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

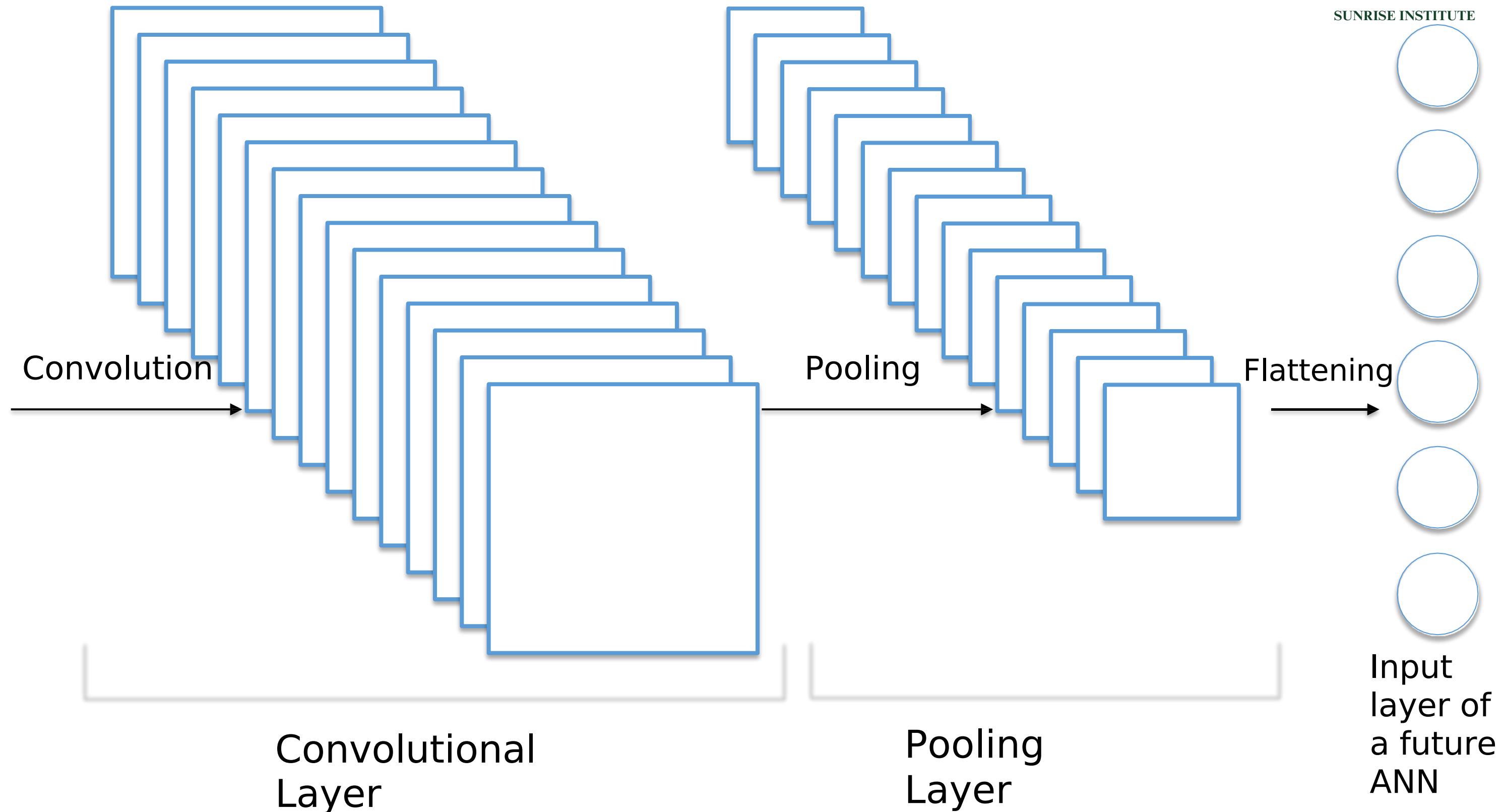


1
1
0
4
2
1
0
2
1

Flentenning

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

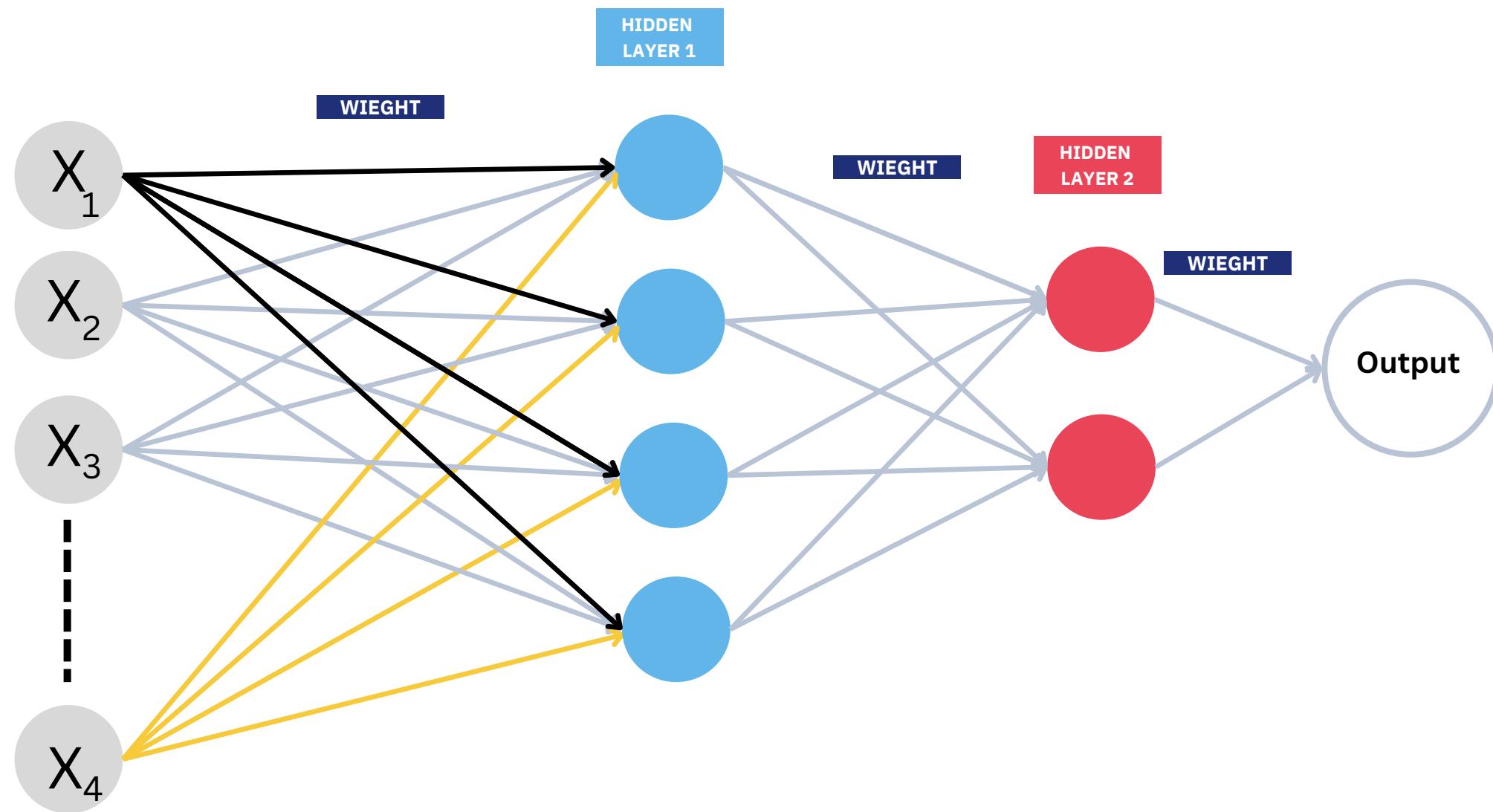


Full Connection

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

