





-1	-1	-1	-1	-1	-1
-1	-1	1	1	1	-1
-1	-1	-1	1	1	-1
-1	1	1	1	1	-1
-1	1	1	-1	-1	1
-1	-1	-1	-1	-1	-1




-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1





-1	-1	-1	-1	-1	-1
1	1	1	1	-1	-1
-1	-1	1	-1	-1	-1
-1	1	1	-1	-1	-1
-1	1	-1	-1	-1	-1
-1	1	-1	-1	-1	-1

-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1



0	0	0	0	0	0
0	0	115	210	30	0
0	6	106	82	48	0
0	40	142	240	58	6
0	228	176	10	37	11
0	3	0	0	0	0



0

0

0

0

0

0

0

0

0

0

115

210

30

0

0

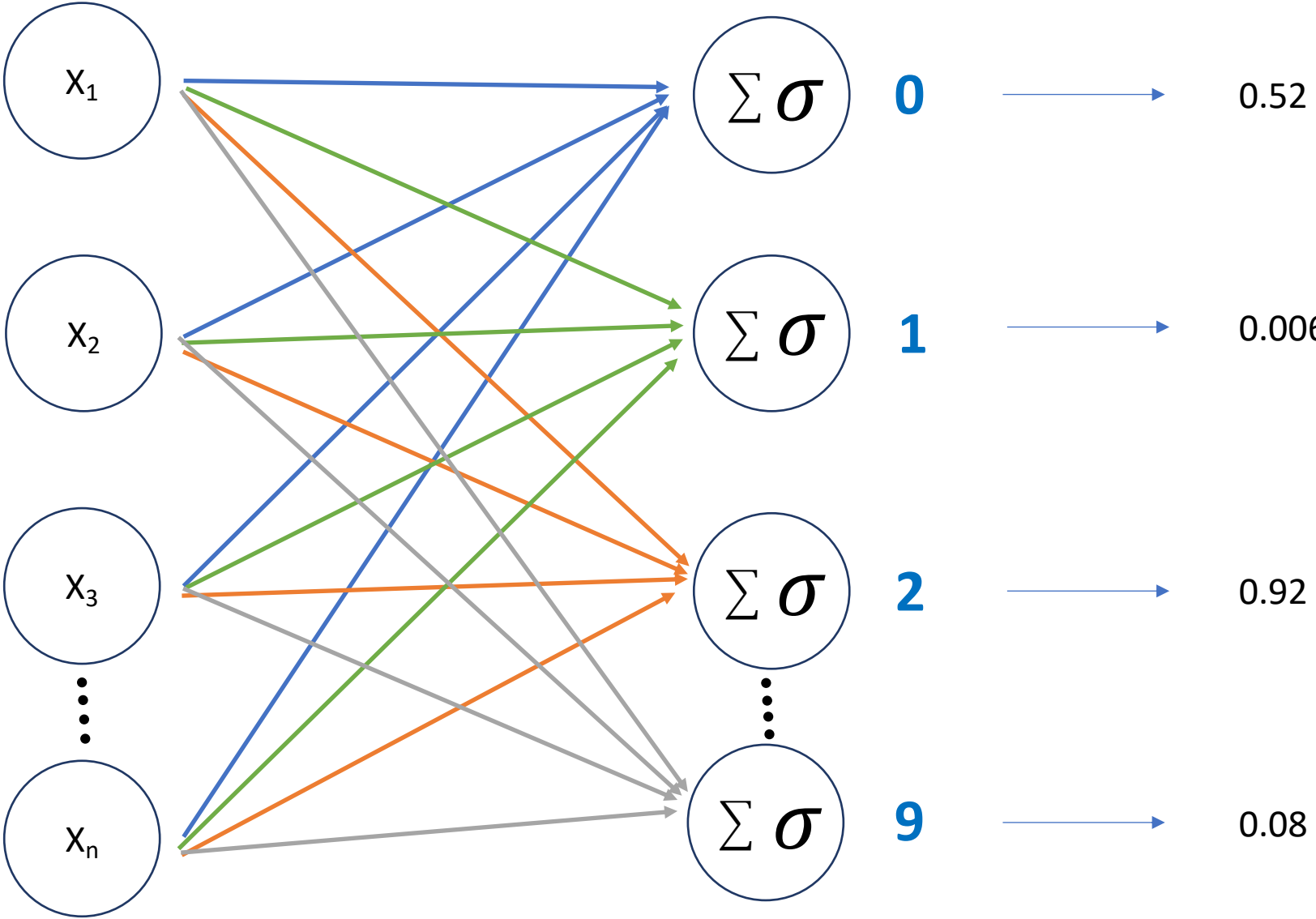
0

6

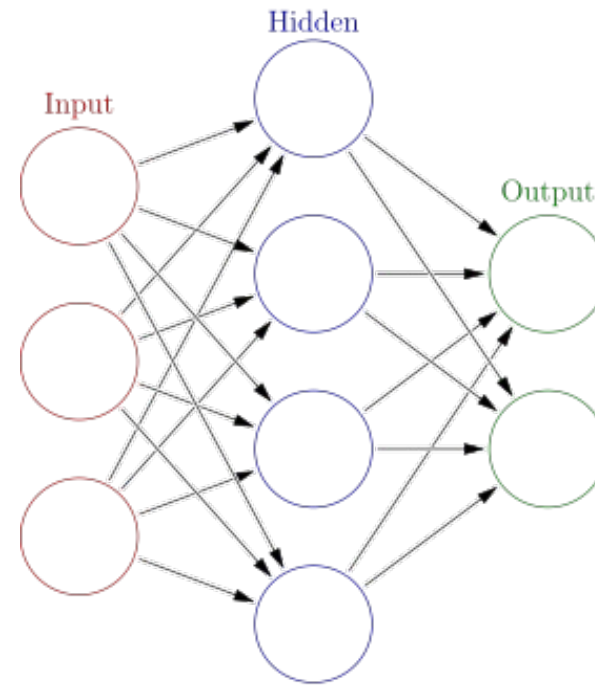
106

...

0



Neural Networks





- image size = $1920 * 1080 * 3$
- First layer neurons = $1920 * 1080 * 3 = 6,220,800$
- += Hidden layer neurons
- Weights between input and hidden layer = First layer neurons * Hidden layer neurons
= around 30 million neurons

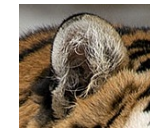




Tiger's eye?



Tiger's nose?



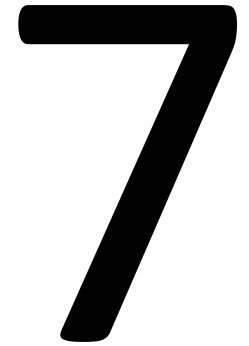
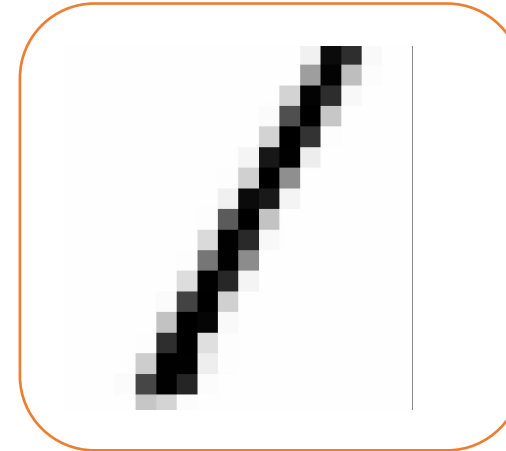
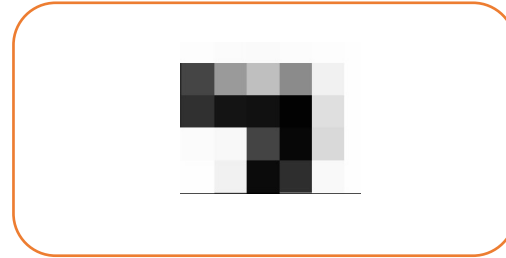
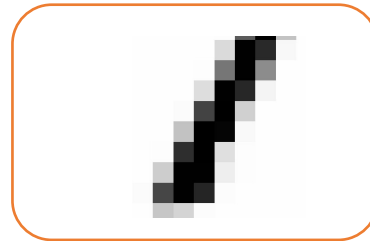
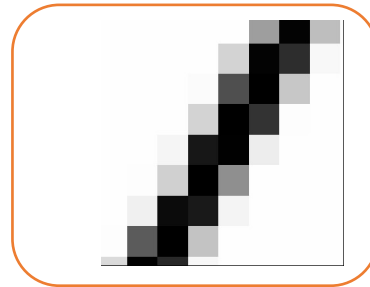
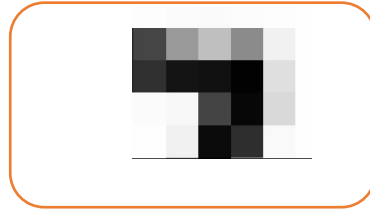
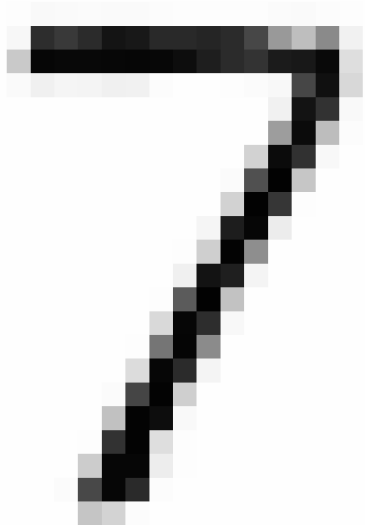
Tiger's ear?





Tiger's face?


Features

Patterns





-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1



-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1

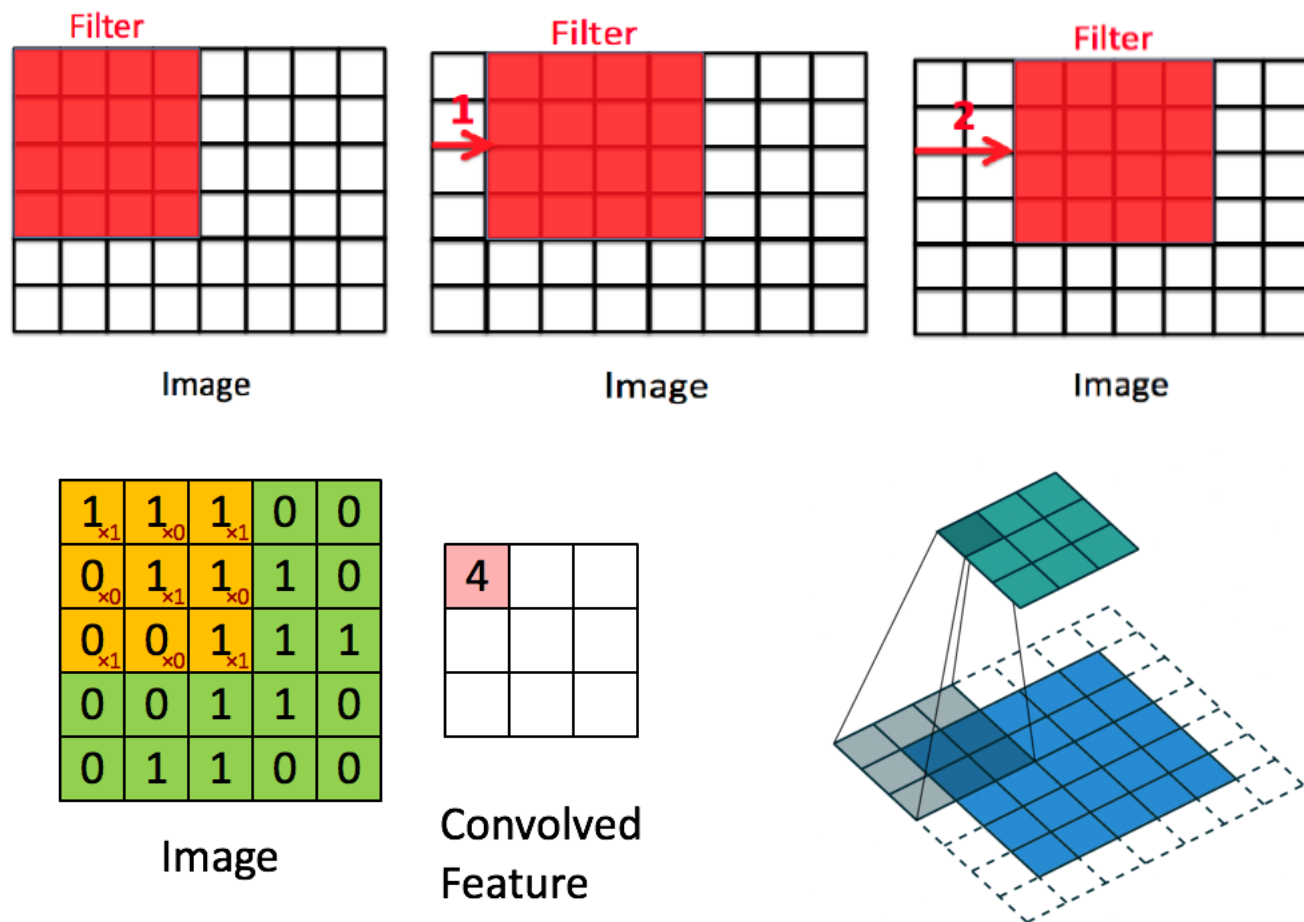
$$(-1)+(-1)+(-1)+(-1)+1+1+(-1)+(-1)+(-1)=-7$$

$$-7 / 9 = -0.78$$



-0.78	-0.11	-0.11	
	0.11	0.11	

Stride



Tiger's Eye Detector



Feature Map

	1	1			



Feature Map

		1		1	

Tiger's Eye Detector

Filters



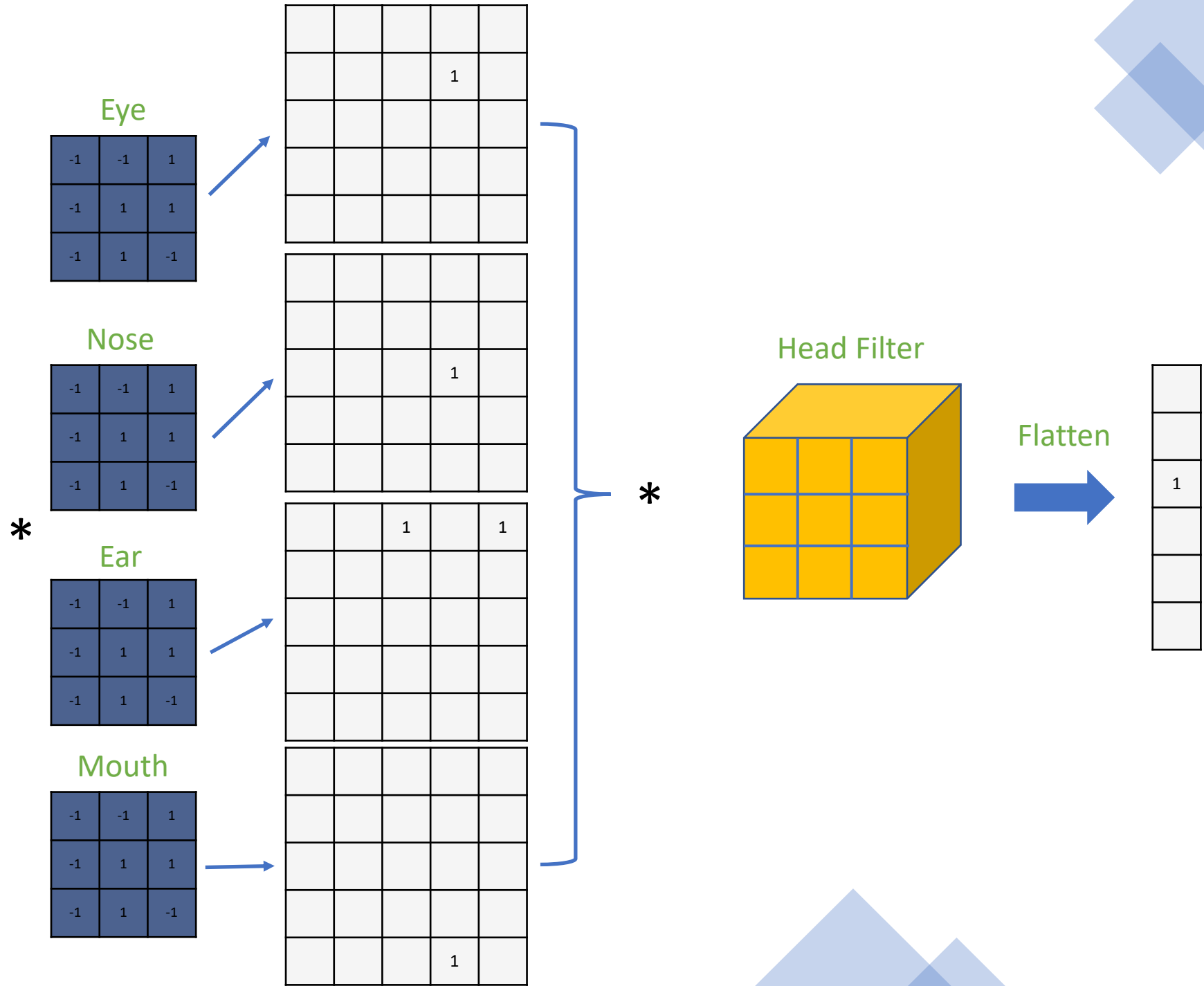
*

			-1	-1	-1	-1	-1	-1
		-1	-1	-1	-1	-1	-1	-1
-1	-1	-1	-1	-1	-1	-1	-1	-1
1	1	1	1	-1	-1	-1	-1	-1
-1	-1	1	-1	-1	-1	-1	-1	-1
-1	1	1	-1	-1	-1	-1	-1	-1
-1	1	-1	-1	-1	-1	-1	-1	
-1	1	-1	-1	-1	-1			

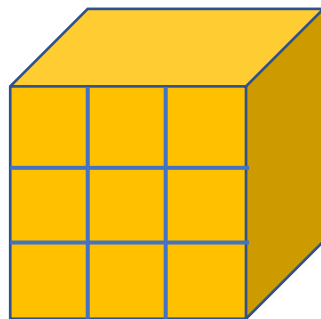
=

Feature Maps

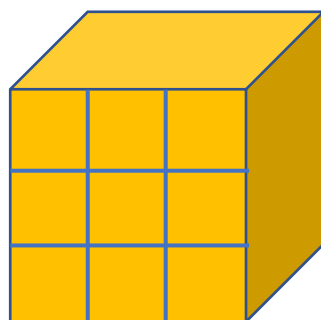
		1			1			
						1		
	1							



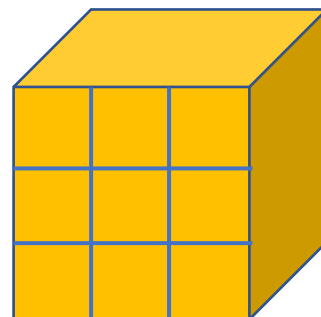
Head Filter



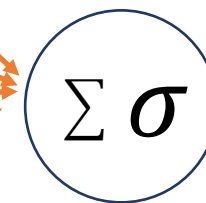
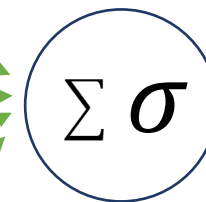
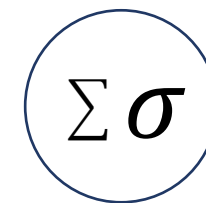
Body Filter



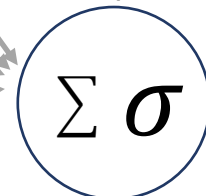
Feet Filter



Flatten



⋮

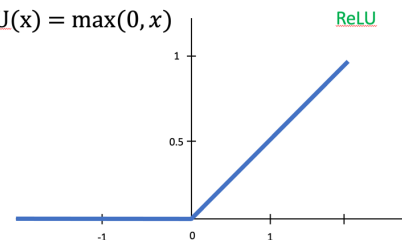


-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1



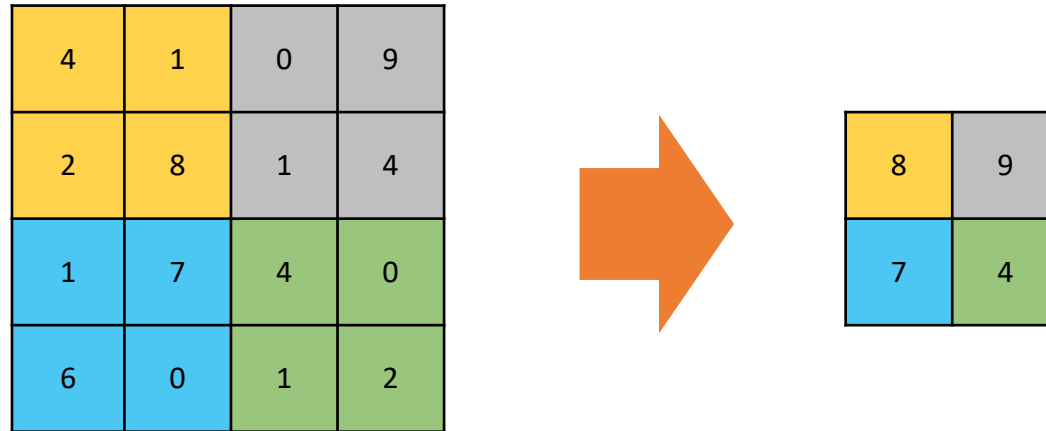
-0.78	-0.11	-0.11	1
	0.11	0.11	

$$\text{ReLU}(x) = \max(0, x)$$



0	0	0	1
	0.11	0.11	

(Max) Pooling



2 by 2 filter with stride = 2

-1	-1	-1	-1	-1	-1
-1	1	1	1	1	-1
-1	-1	-1	1	-1	-1
-1	-1	-1	1	-1	-1
-1	1	1	-1	-1	-1
-1	-1	1	-1	-1	-1



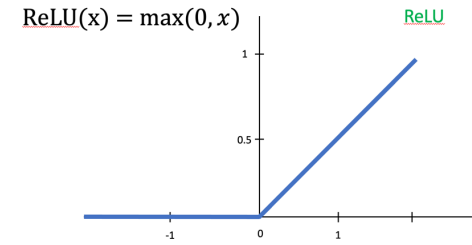
-0.78	-0.11	-0.11	1
	0.11	0.11	



0	0	0	1
	0.11	0.11	




0.11	0.11
0.33	0



Max
Pooling



Benefits of Pooling

- Reduces dimensions and computation
 - Reduces overfitting with less parameters
- 



Eye

-1	-1	1
-1	1	1
-1	1	-1

Nose

-1	-1	1
-1	1	1
-1	1	-1

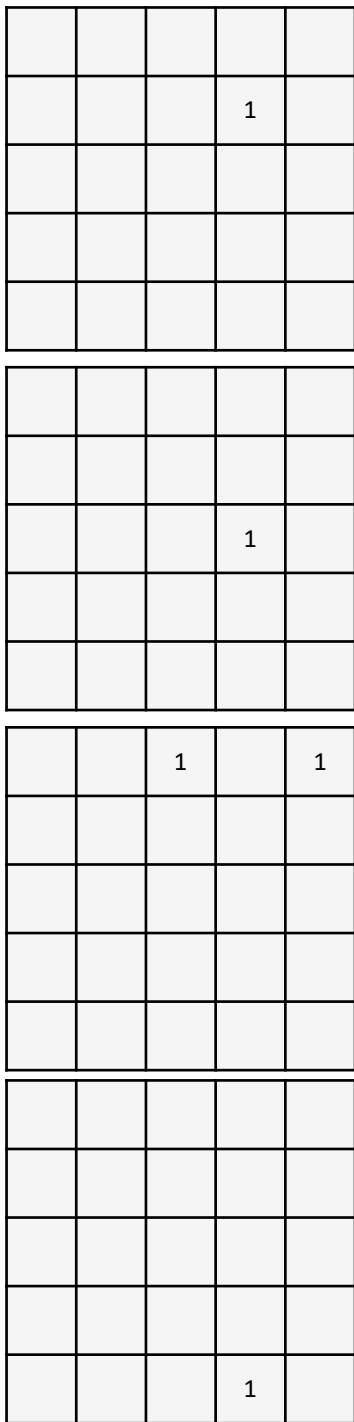
Ear

-1	-1	1
-1	1	1
-1	1	-1

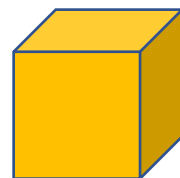
Mouth

-1	-1	1
-1	1	1
-1	1	-1

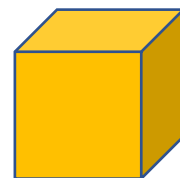
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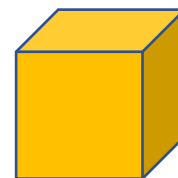
Pooling



Head Filter



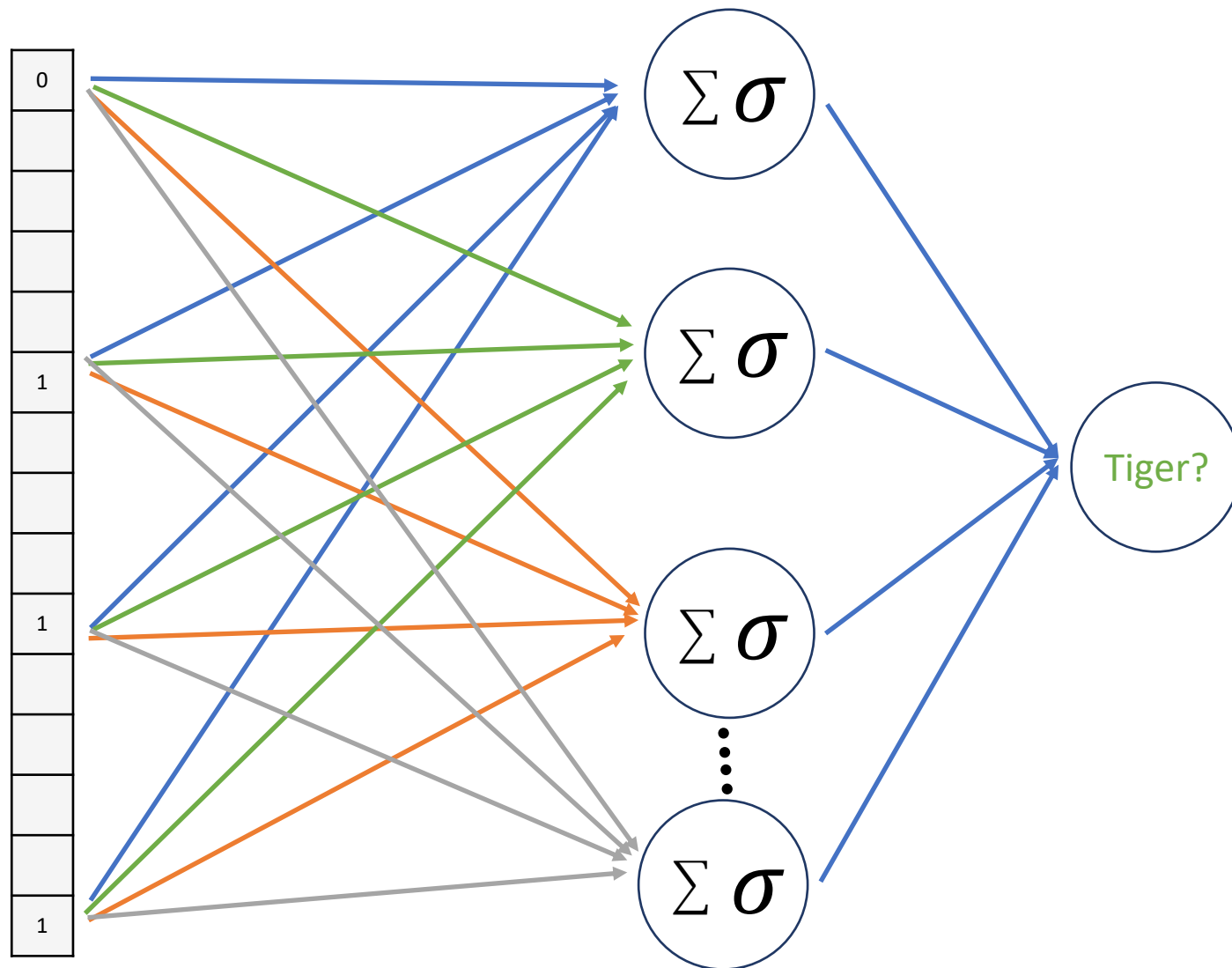
Pooling



Flatten



0
1
1
1





Any Questions?