



Introduction of Convolutional Neural Network(CNN)

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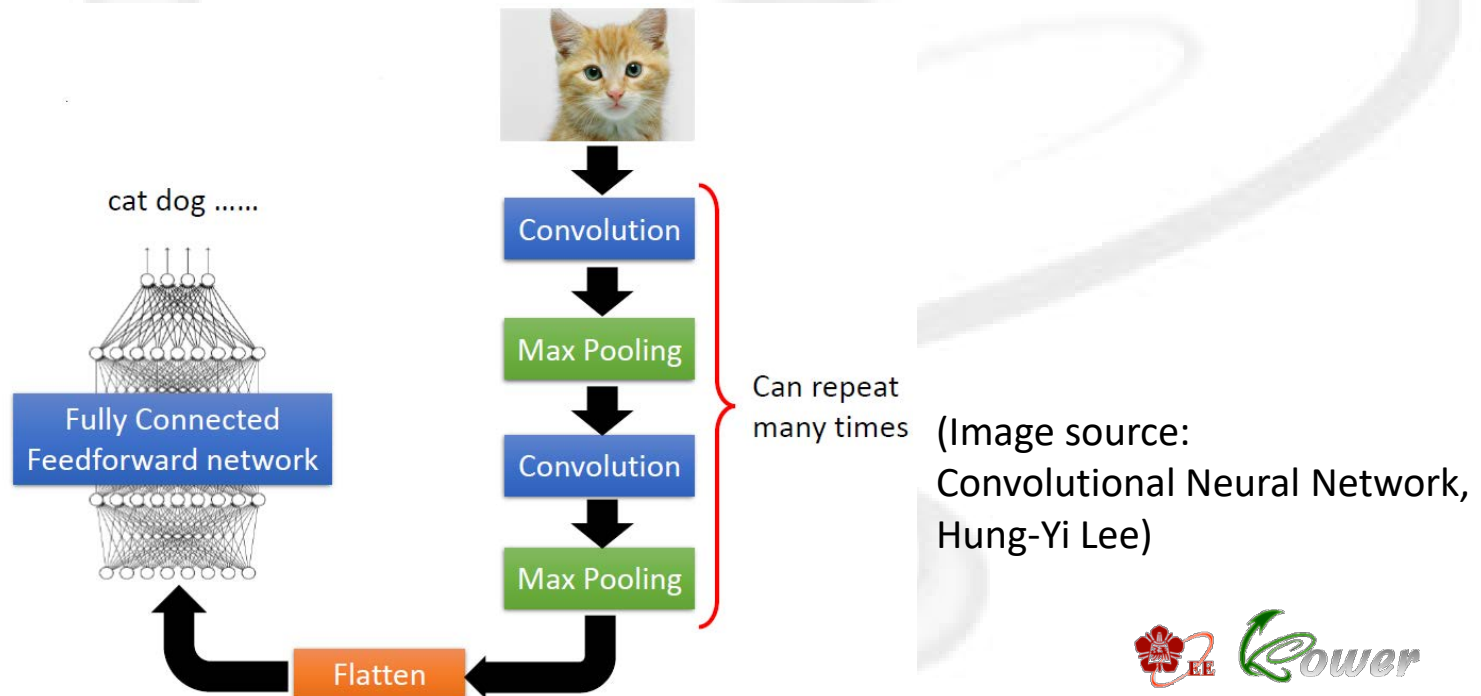
Outline

- CNN Introduction
- Convolution
- Activation Function
- Max Pooling
- Flatten
- Fully Connected

CNN Introduction

CNN Introduction

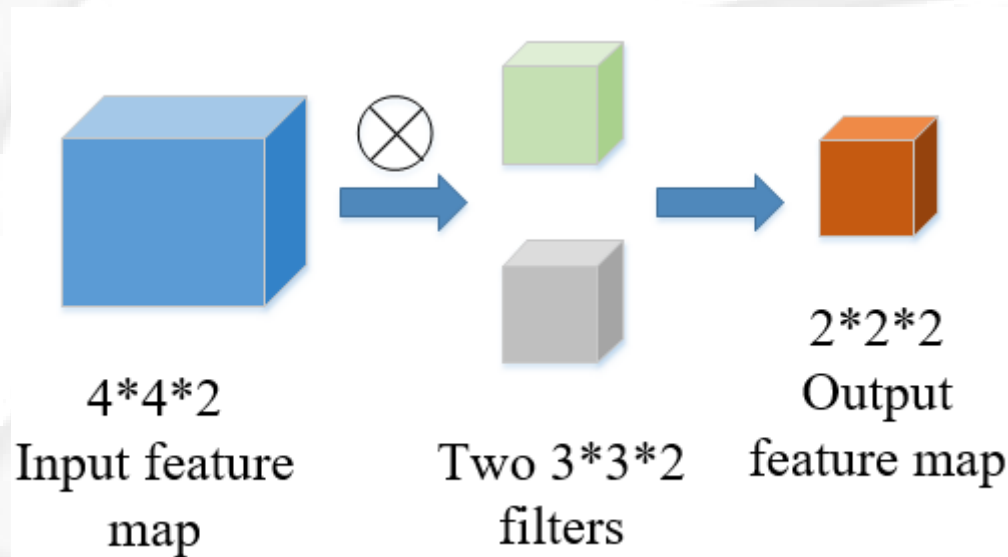
- Convolutional Neural Network (CNN) is a network structure that designed for recognize patterns from images.
- CNN is basically composed of convolution layers, pooling layers and fully connected layers.



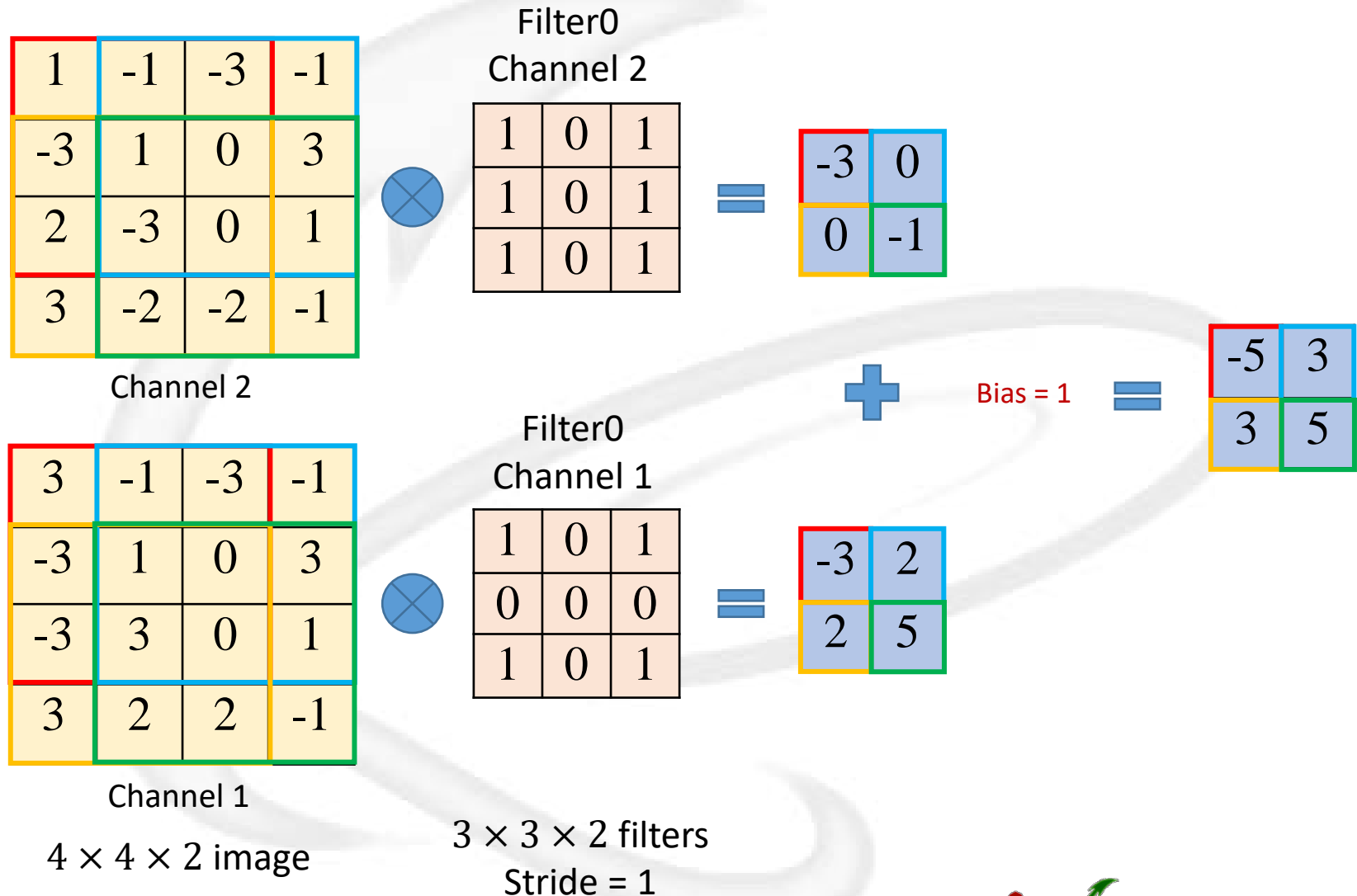
Convolution

Convolution (1/3)

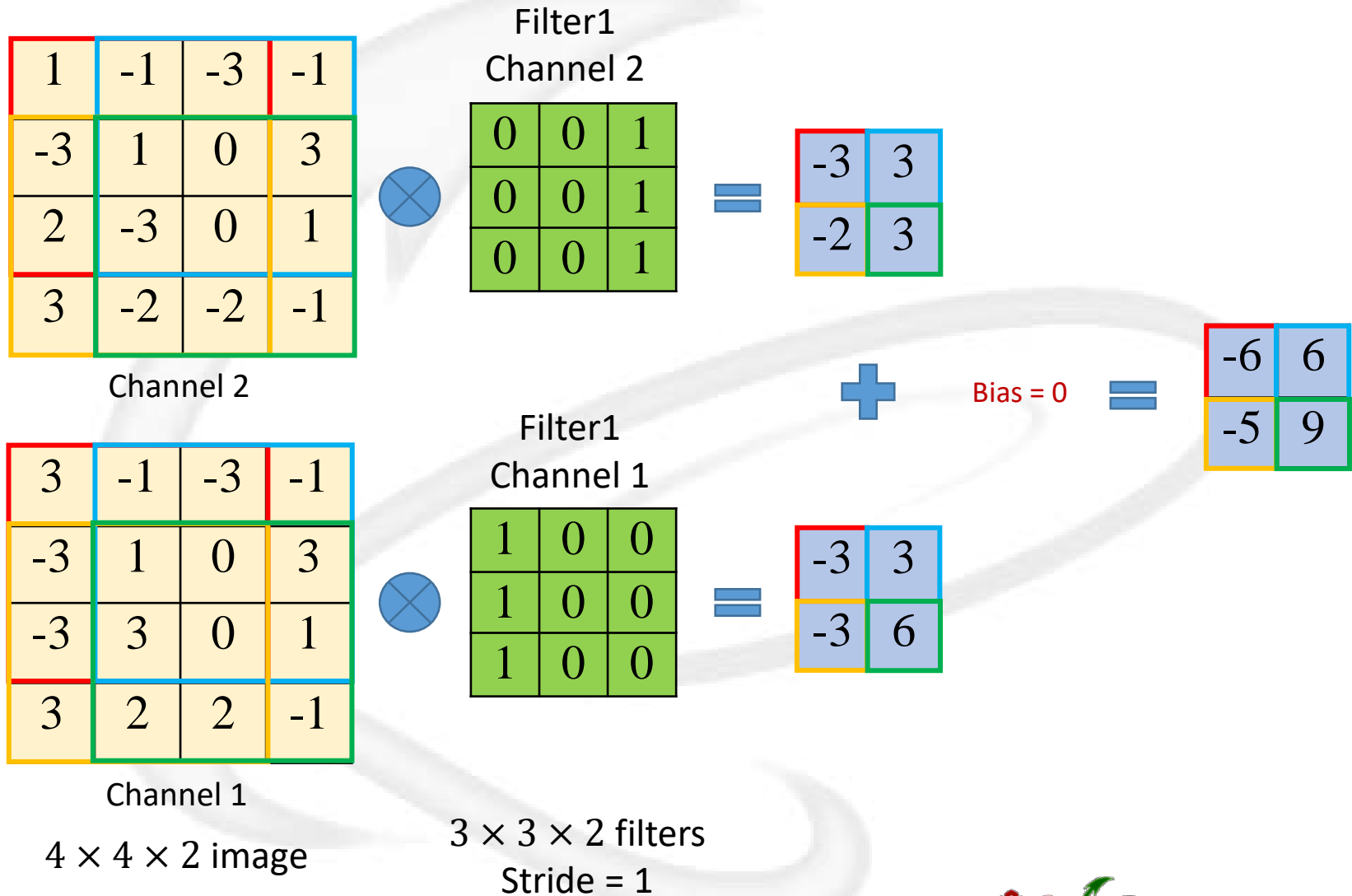
- Find the certain features in the image.
- Each filter represents a specific feature.
- The output of convolutional layer is called feature map.



Convolution (2/3)



Convolution (3/3)



Padding

Padding (1/2)

- A method to keep the feature map size same after the convolution process.
- Common method: Zero-Padding

$$\begin{bmatrix} 1 & -1 & -3 & -1 \\ -3 & 1 & 0 & 3 \\ 2 & -3 & 0 & 1 \\ 3 & -2 & -2 & -1 \end{bmatrix} \otimes \begin{bmatrix} 1 & 0 & 1 \\ 1 & 0 & 1 \\ 1 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -3 & 0 \\ 0 & -1 \end{bmatrix}$$

Padding (2/2)

0	0	0	0	0	0
0	1	-1	-3	-1	0
0	-3	1	0	3	0
0	2	-3	0	1	0
0	3	-2	-2	-1	0
0	0	0	0	0	0



1	0	1
1	0	1
1	0	1

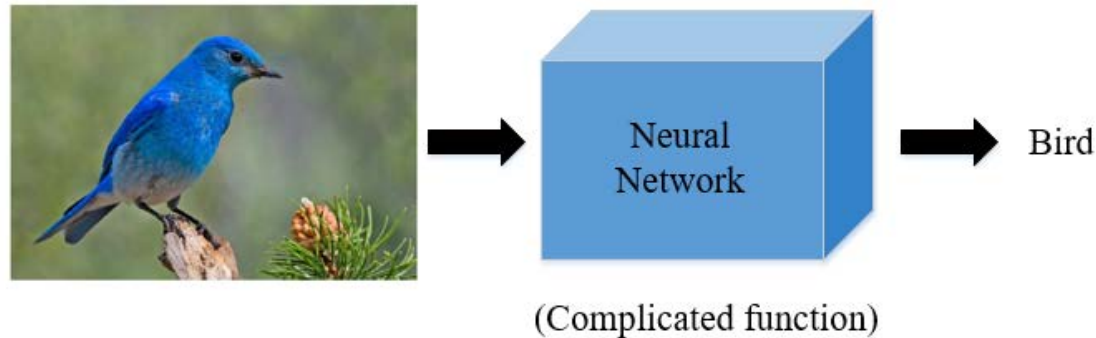


0	-5	2	-3
-3	-3	0	-3
-4	0	-1	-2
-5	3	-5	-2

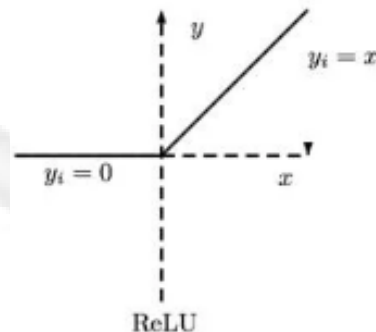
Activation Function

Activation Function (1/2)

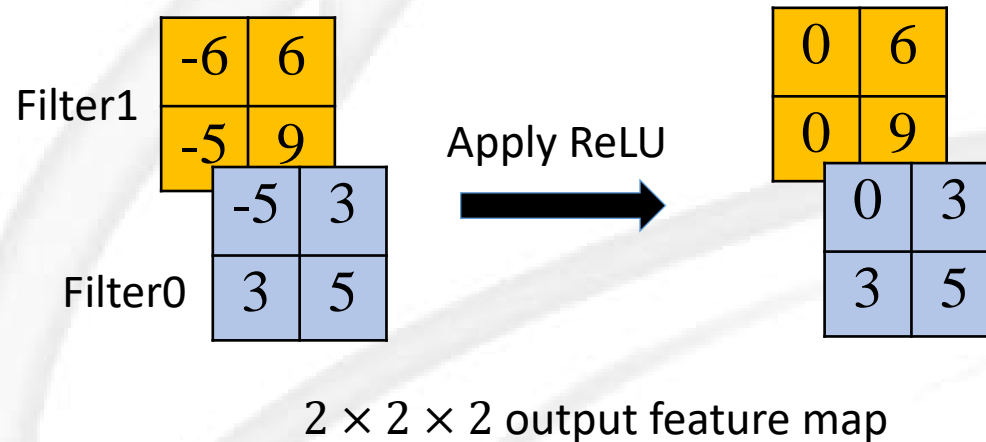
- Because neural networks usually imitate complicated mathematic functions, we need to add non-linear functions to increase complexity.



- One of the popular activations is Rectified linear units (ReLU).



Activation Function (2/2)



Max Pooling

Max Pooling (1/2)

- Subsampling the image will not change the object.
- Less parameters for neural network to learn.



subsampling



(Image source:
Convolutional Neural Network,
Hung-Yi Lee)

Convolution

(28*28*6)

Max Pooling

(14*14*6)

Convolution

(12*12*6)

Max Pooling

(6*6*6)

Max Pooling (2/2)

Stride = 2

3	-1	-3	-1
-3	1	0	-3
-3	-3	0	1
3	-2	-2	-1

(1)

3

3	-1	-3	-1
-3	1	0	-3
-3	-3	0	1
3	-2	-2	-1

(2)

3	0
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3	-1	-3	-1
-3	1	0	-3
-3	-3	0	1
3	-2	-2	-1

(3)

3	0
3	

3	-1	-3	-1
-3	1	0	-3
-3	-3	0	1
3	-2	-2	-1

(4)

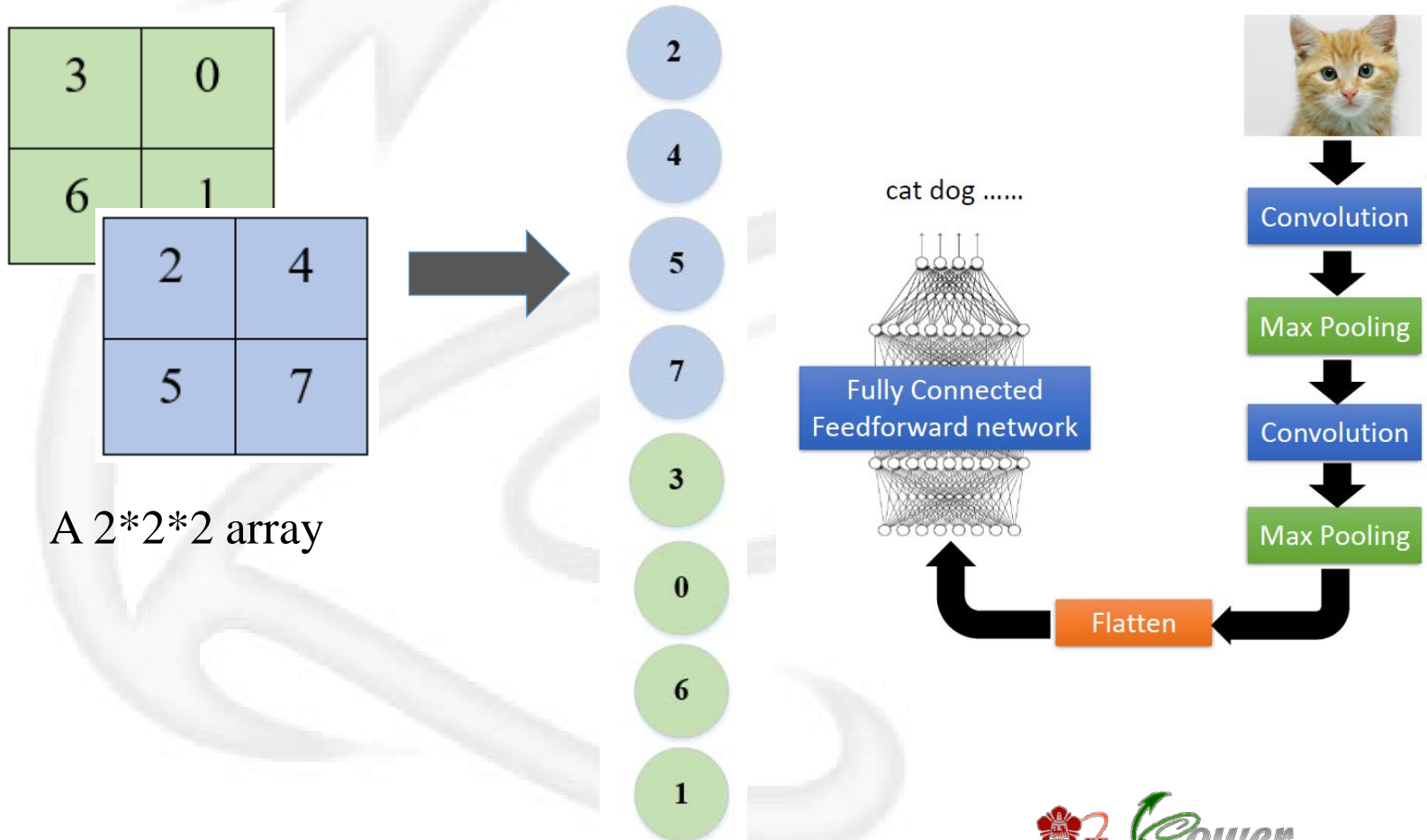
3	0
3	1



Flatten

Flatten

- Flatten the three-dimensional array into one dimensional array. (Row major)

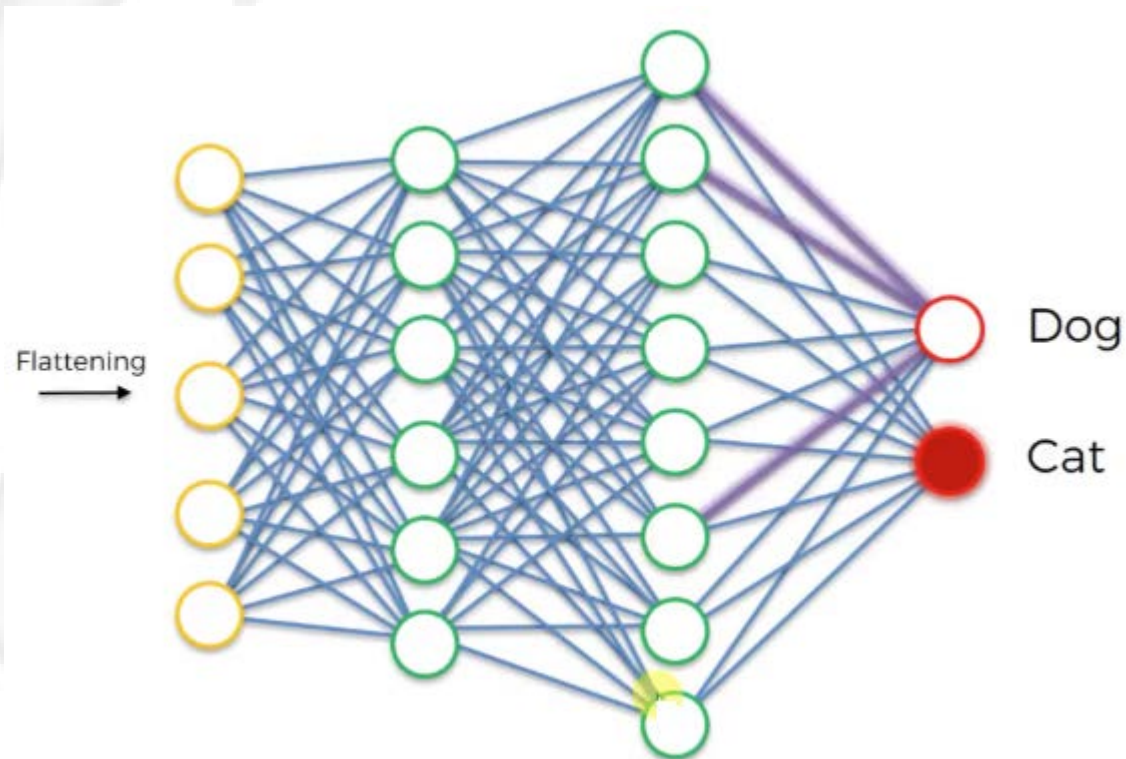


A 2*2*2 array

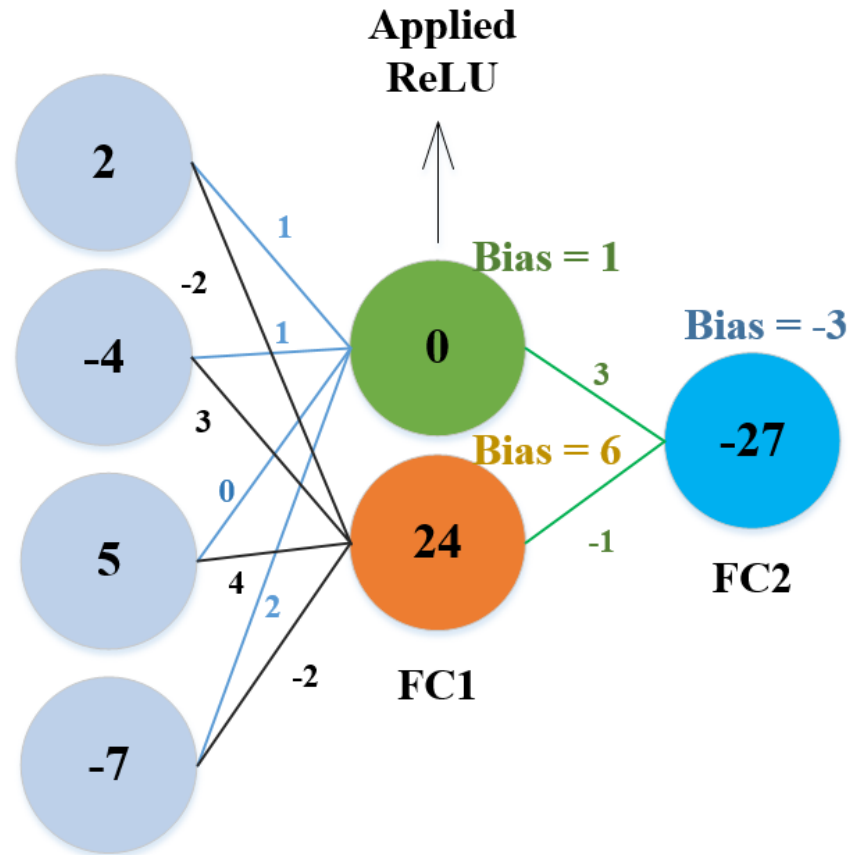
Fully Connected

Fully Connected (1/2)

- ❑ The main function of fully connected layer is to classify objects.
- ❑ Usually, there are activation functions applied in fully connected layers.



Fully Connected (2/2)



$$2*1+(-4)*1+5*0+(-7)*2+1 = -15$$

$$R(-15) = 0$$

$$2*(-2)+(-4)*3+5*4+(-7)*(-2)+6 = 24$$

$$R(24) = 24$$

$$0*3+24*(-1)+(-3) = -27$$