Convolutional Neural Network

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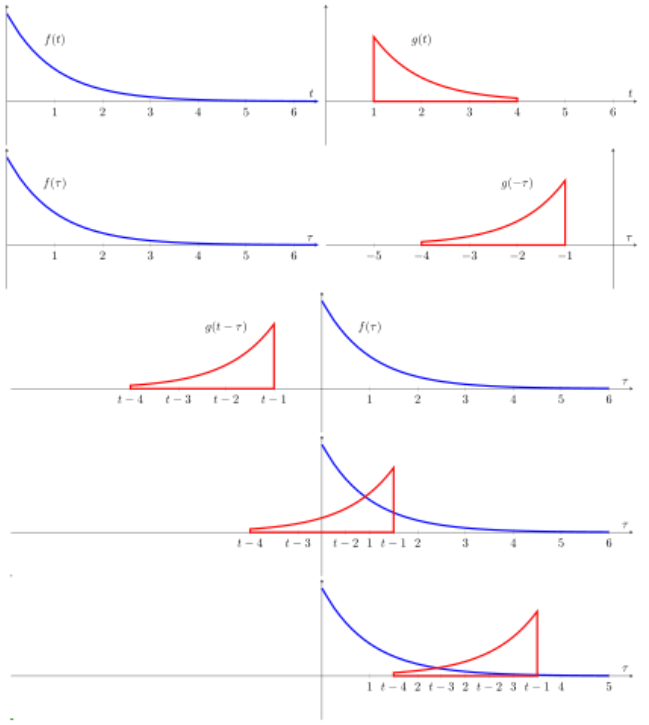
CNN

https://cs231n.github.io/convolutional-networks/

Convolution

$$(f * g)(t) := \int_{-\infty}^{\infty} f(u)g(t-u)du$$



참고 : https://en.wikipedia.org/wiki/Convolution

CNN

CNN is Multiplication by Element

$$(f * g)(t) := \int_{-\infty}^{\infty} f(u)g(t-u)du$$

$$(f * g)(i,j) := \sum_{x=0}^{h-1} \sum_{y=0}^{w-1} f(x,y)g(i-x,i-y)$$

Filter

Spatial Smoothing Filtering

Gaussian Filter

$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

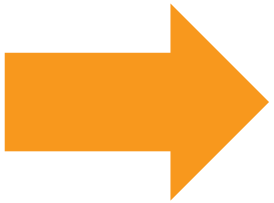
Average Filter

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

참고 : https://wjrmffldrhrl.github.io/digital9/

Filter

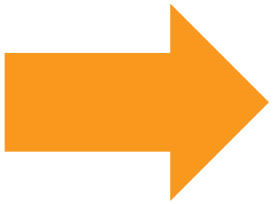
1	0	0
1	0	0
1	0	0



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

Filter

1	0	0
1	0	0
1	0	0



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

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

Edge extraction

Pooling

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

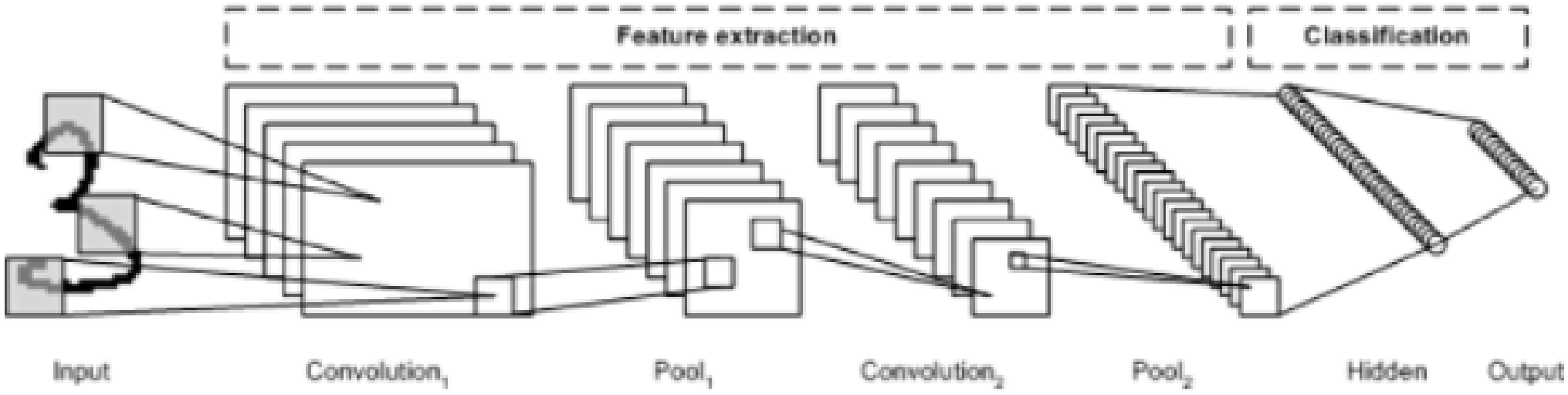
3	2	3
3	2	3
3	1	3

2x2 maxpooling

2.x	1	1.x
2.x	1.x	2
2	1	2

2x2 avgpooling

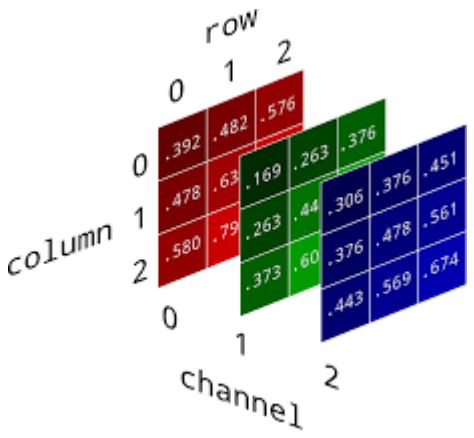
CNN Architecture



참고 : http://taewan.kim/post/cnn/

CNN Channel

What is Channel?

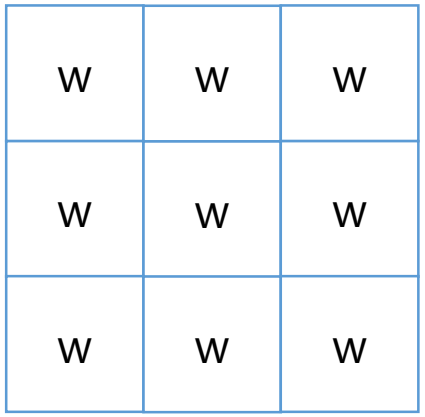


3-Channel

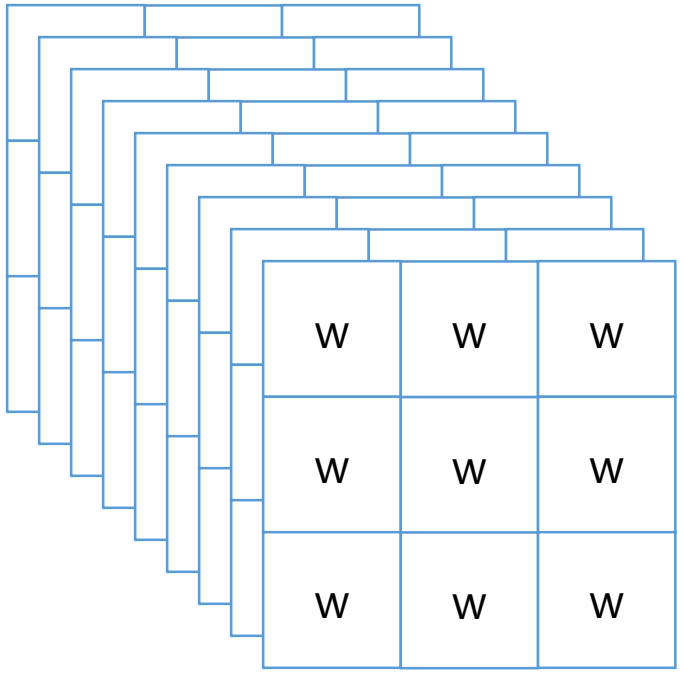
CNN Convolution Layer increases the Channel

CNN Channel

CNN Convolution Layer increases the Channel



Filter

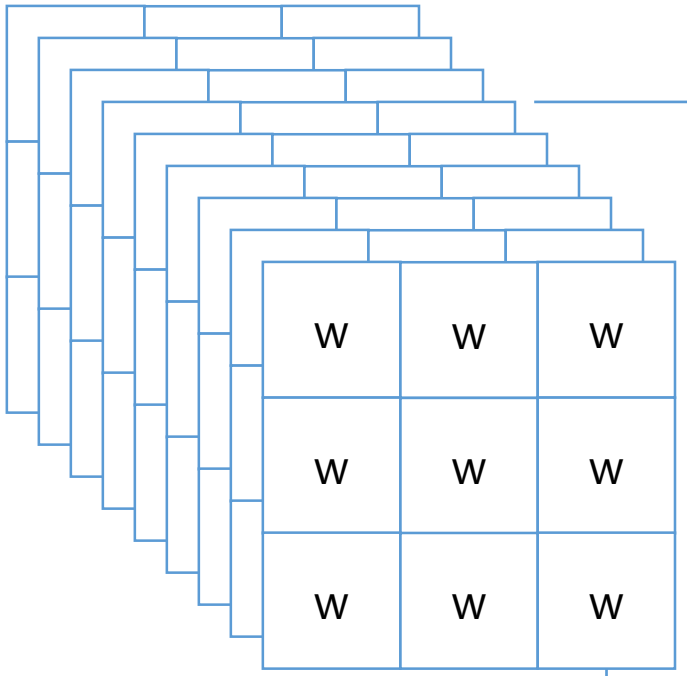


9-channel-Filter

CNN Channel

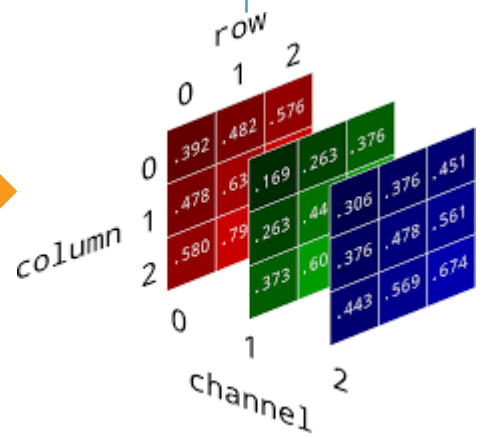
CNN Convolution Layer increases the Channel

Which one is optimized?

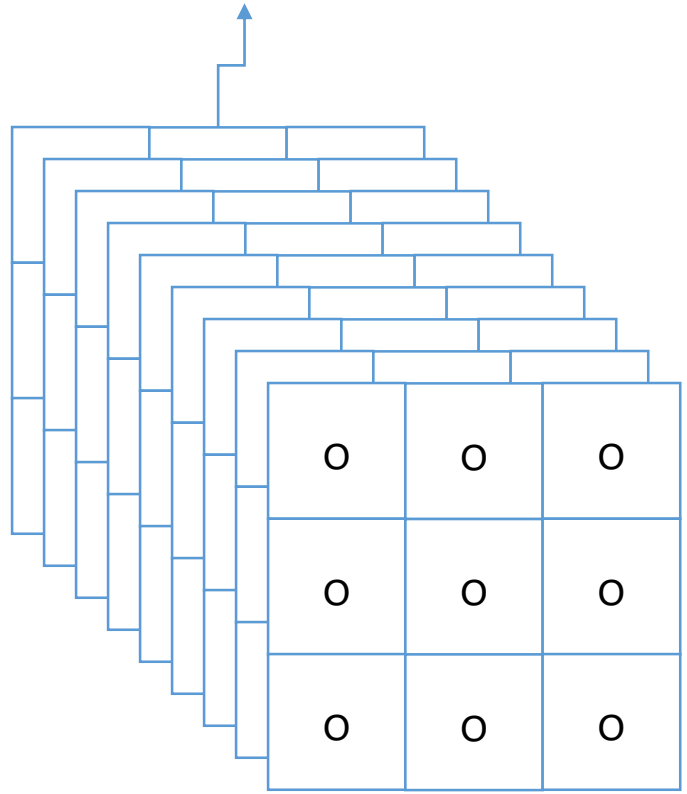


9-channel-Filter

Conv



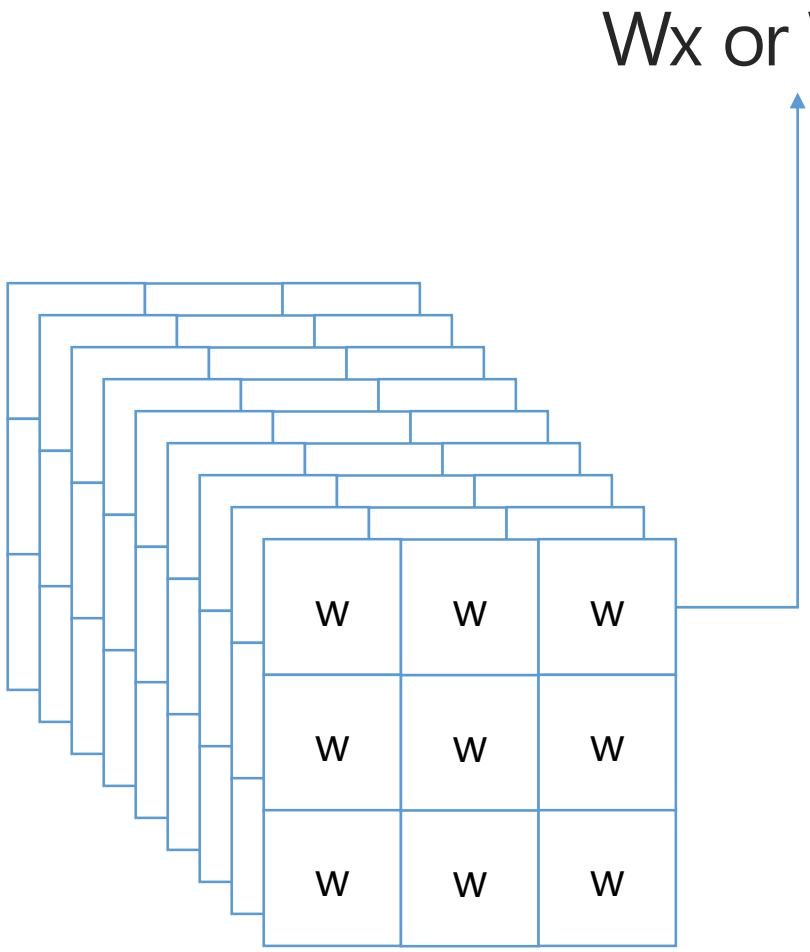
3-Channel Image



9-channel-Image

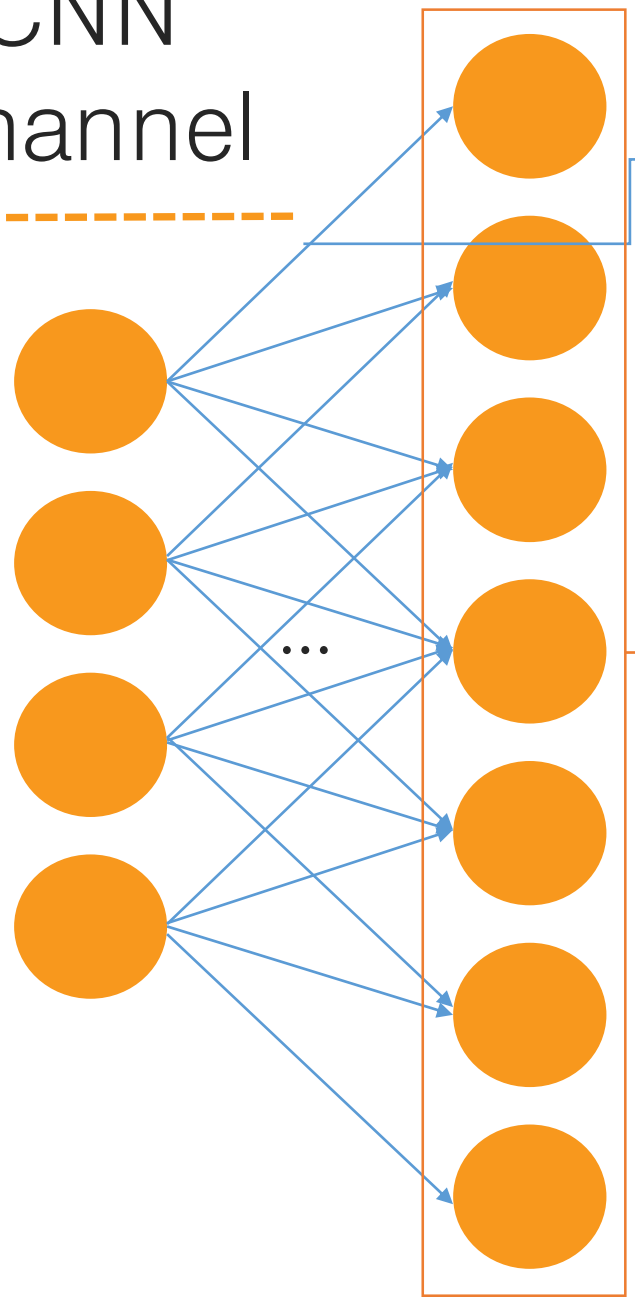
3-depth

CNN Channel



9-channel-Filter

CNN Channel



Weight

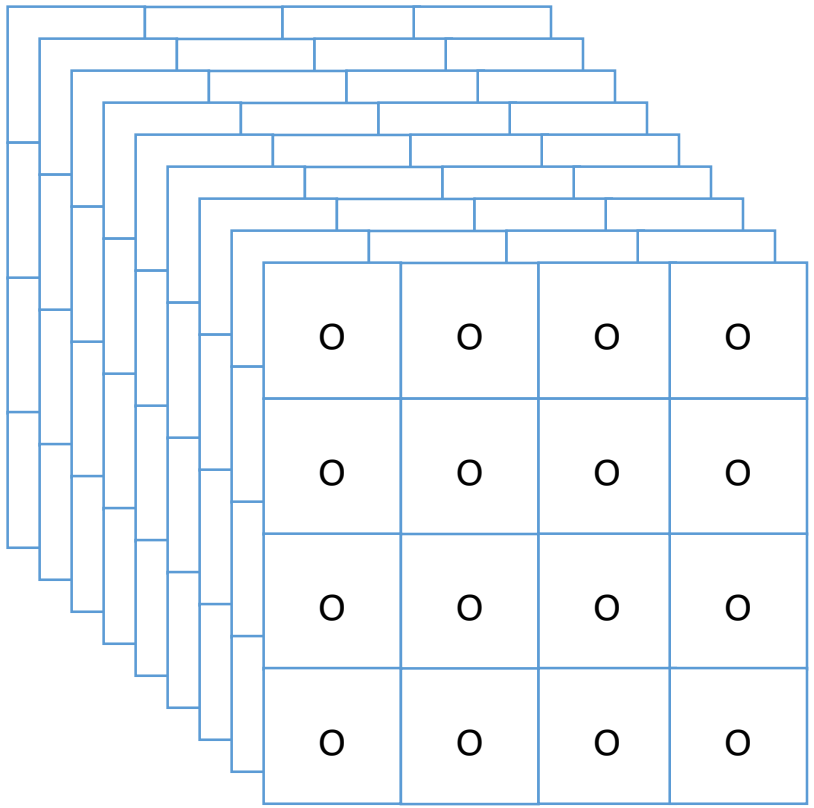
w	w	w
w	w	w
w	w	w

Filter

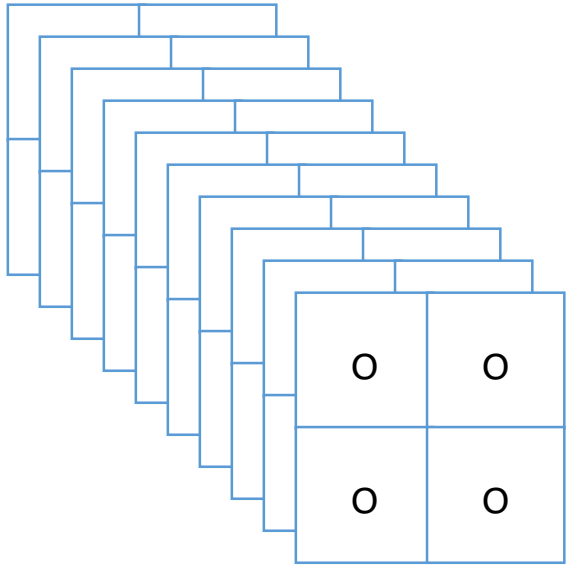
N-Channel Image

Pooling

Same Channel



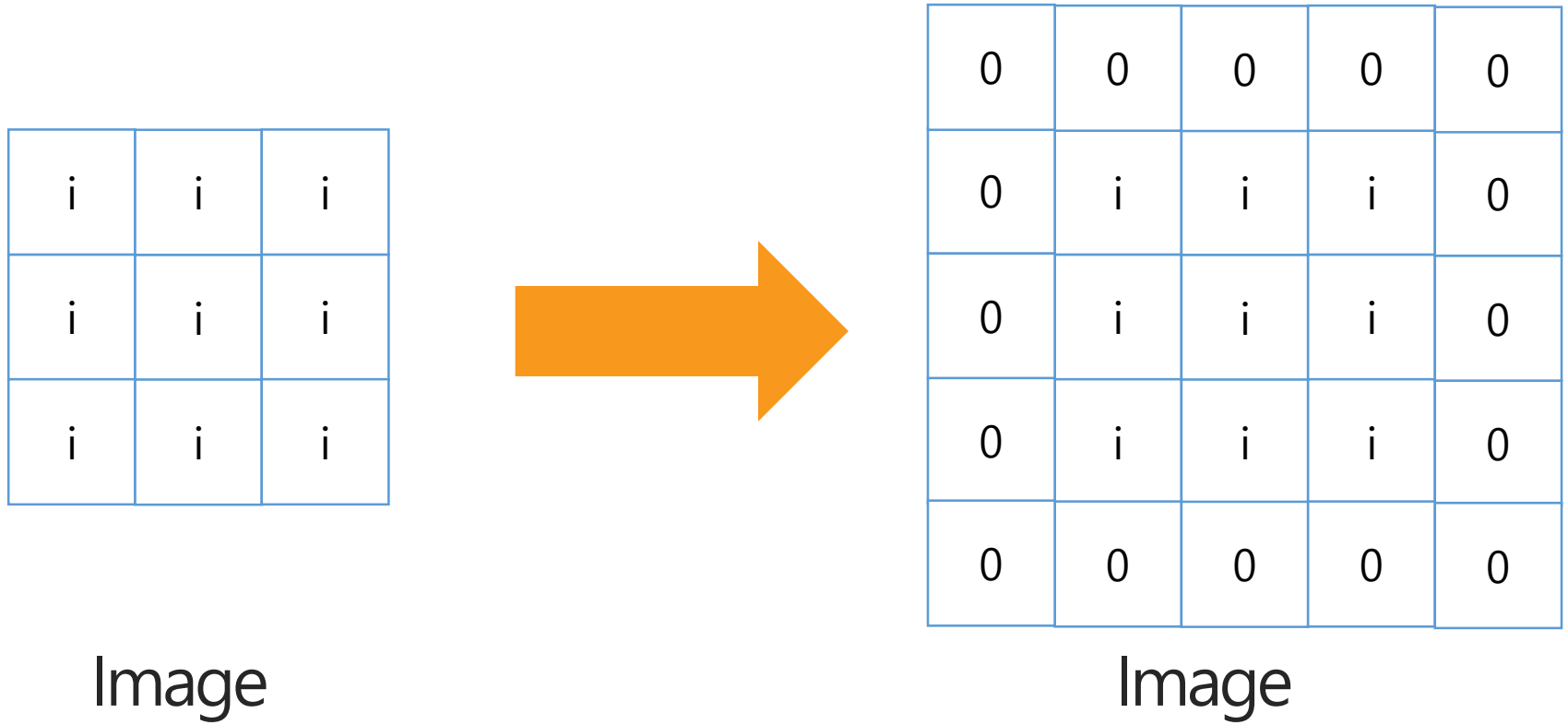
9-channel-Image



9-channel-Image

Padding

Same Channel



Image

Image

Output Size

Quiz : (480X640)-Image =>
Convolution Filter (5X5), Stride =5, Padding= 5

Output Size?

Output Size

Output Size : (N-F) / Stride +1

i	i	i	i	i	i	i
i	i	i	i	i	i	i
i	i	i	i	i	i	i
i	i	i	i	i	i	i
i	i	i	i	i	i	i
i	i	i	i	i	i	i
i	i	i	i	i	i	i

F	F	F
F	F	F
F	F	F

o	o	o
o	o	o
o	o	o

No padding, stride=2

(3, 3)

Output Size

Quiz : (480X640)-Image 3-Channel =>
Convolution Filter (5X5), Stride =5, Padding= 5
Channel=>9

Output Channel?

Output Size

9

Filter

Dilation?

F	0	F	0	F
0	0	0	0	0
F	0	F	0	F
0	0	0	0	0
F	0	F	0	F

(3,3) Conv => Dilation=2

(5,5) Filter

CNN BackPropagation

1	1	0
1	1	0
1	0	0

Image

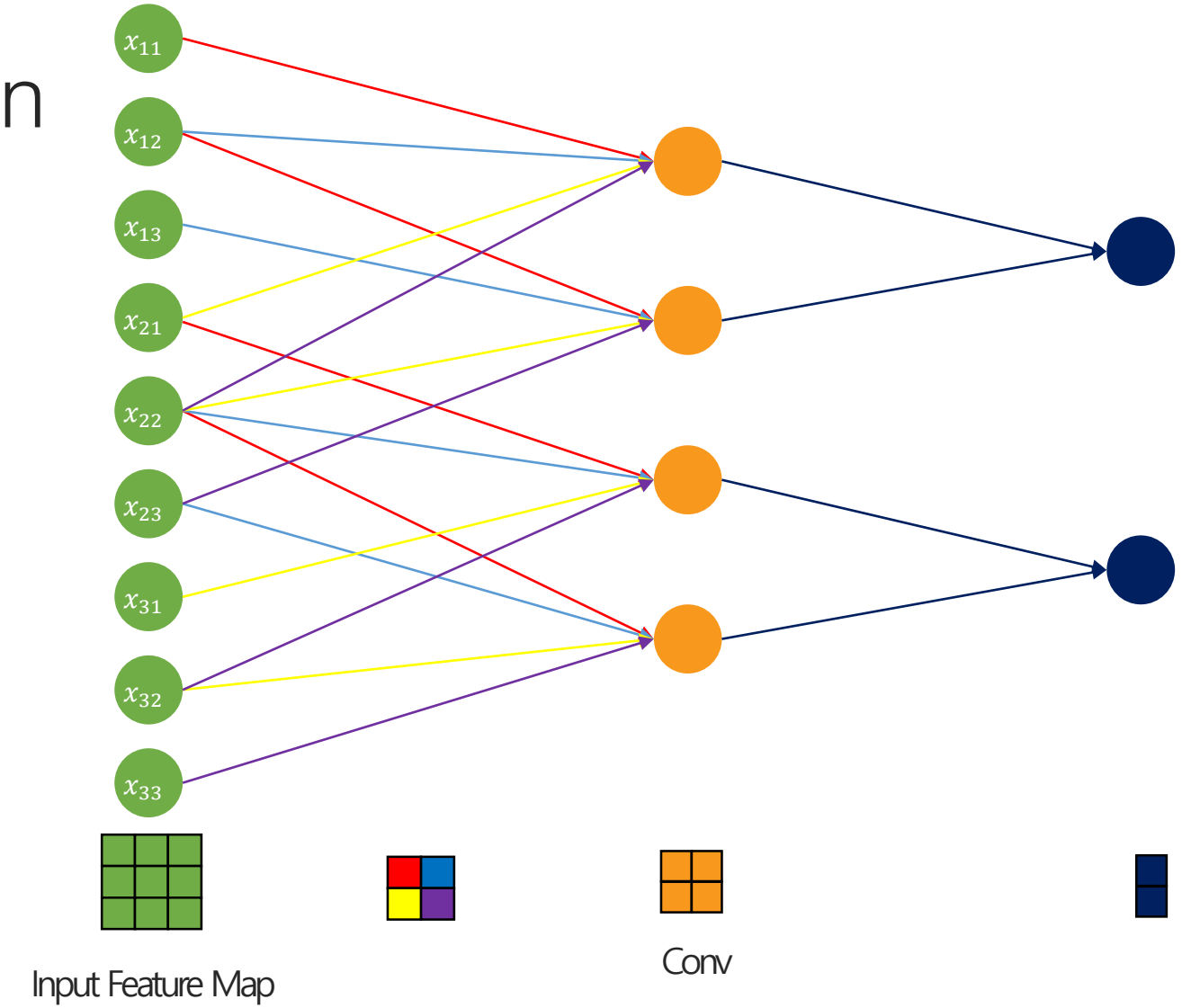
w_{11}	w_{12}
w_{21}	w_{22}

2X32Kernel

$w_{11} + w_{12} + w_{21} + w_{22}$	$w_{11} + w_{21}$
$w_{11} + w_{12} + w_{21}$	w_{11}

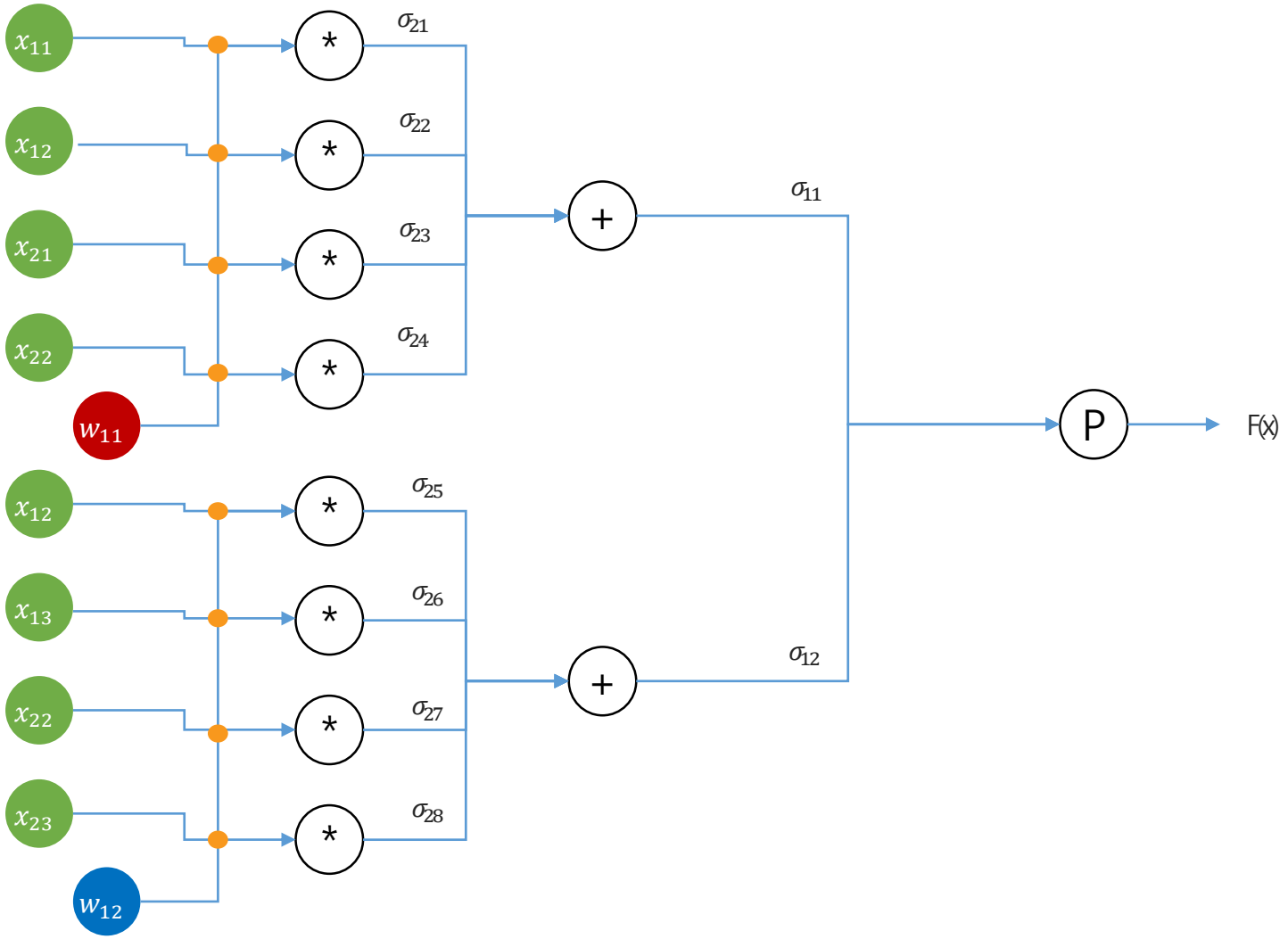
Convolved Feature

CNN BackPropagation



출처 : https://ratsgo.github.io/deep%20learning/2017/04/05/CNNbackprop/

CNN BackPropagation



Output Size

$$f(x) = maxpool(\sigma_{11}, \sigma_{12})$$

$$\sigma_{11}=\sigma_{21}+\sigma_{22}+\sigma_{23}+\sigma_{24}$$

$$\sigma_{12}=\sigma_{25}+\sigma_{26}+\sigma_{27}+\sigma_{28}$$

$$\sigma_{21}=x_{11} * w_{11}$$

$$\sigma_{22}=x_{12} * w_{11}$$

$$\sigma_{23}=x_{21} * w_{11}$$

$$\sigma_{24}=x_{22} * w_{11}$$

$$\sigma_{25}=x_{12} * w_{12}$$

$$\sigma_{26}=x_{13} * w_{12}$$

$$\sigma_{27}=x_{22} * w_{12}$$

$$\sigma_{28}=x_{23} * w_{12}$$

$$\frac{\partial \sigma_{21}}{\partial w_{11}} = x_{11}$$

$$\frac{\partial \sigma_{22}}{\partial w_{11}} = x_{12}$$

$$if(\sigma_{11} > \sigma_{12})$$

$$\frac{\partial f(x)}{\partial \sigma_{11}} = 1, \frac{\partial f(x)}{\partial \sigma_{12}} = 0$$

$$\frac{\partial \sigma_{1n}}{\partial \sigma_{2n}} = 1$$

$$\frac{\partial f(x)}{\partial w_{11}} = x_{11} + x_{12}+x_{21}+x_{22}$$

감사합니다

THANK YOU