Convolutional Neural Networks (CNN)

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$$y[m,n] = x[m,n] * h[m,n] = \sum_j \sum_i x[i,j]h[m-i,n-j]$$

Convolution in image processing

x

4	2	9	4	7	1
3	1	5	3	2	5
8	7	1	2	6	2
6	3	0	1	8	1
1	4	1	5	7	8
2	0	9	1	3	9

*

h

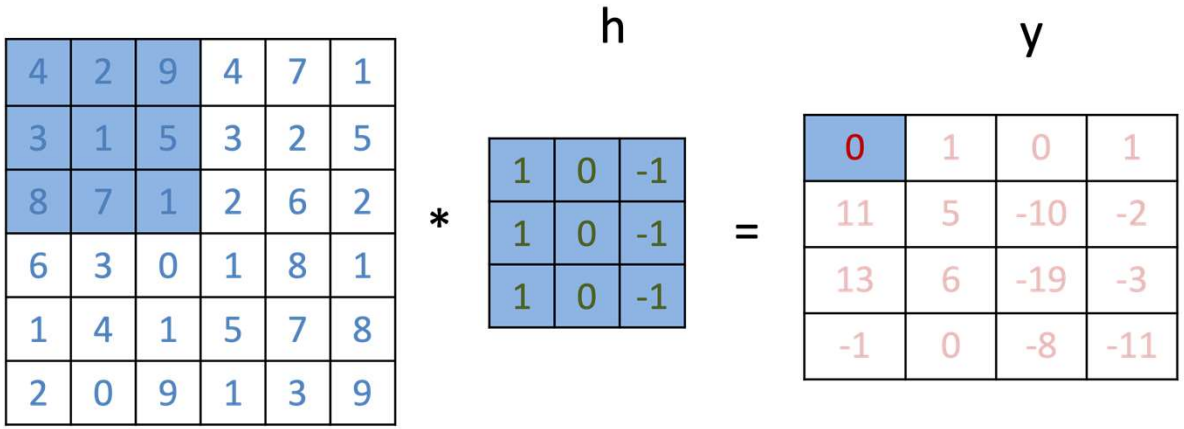
1	0	-1
1	0	-1
1	0	-1

=

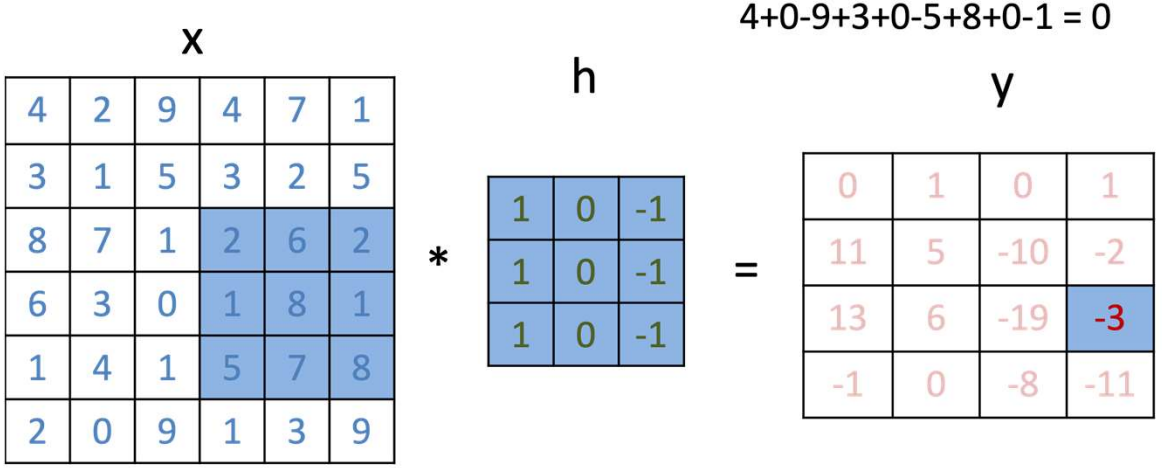
y

0	1	0	1
11	5	-10	-2
13	6	-19	-3
-1	0	-8	-11

2D convolution example

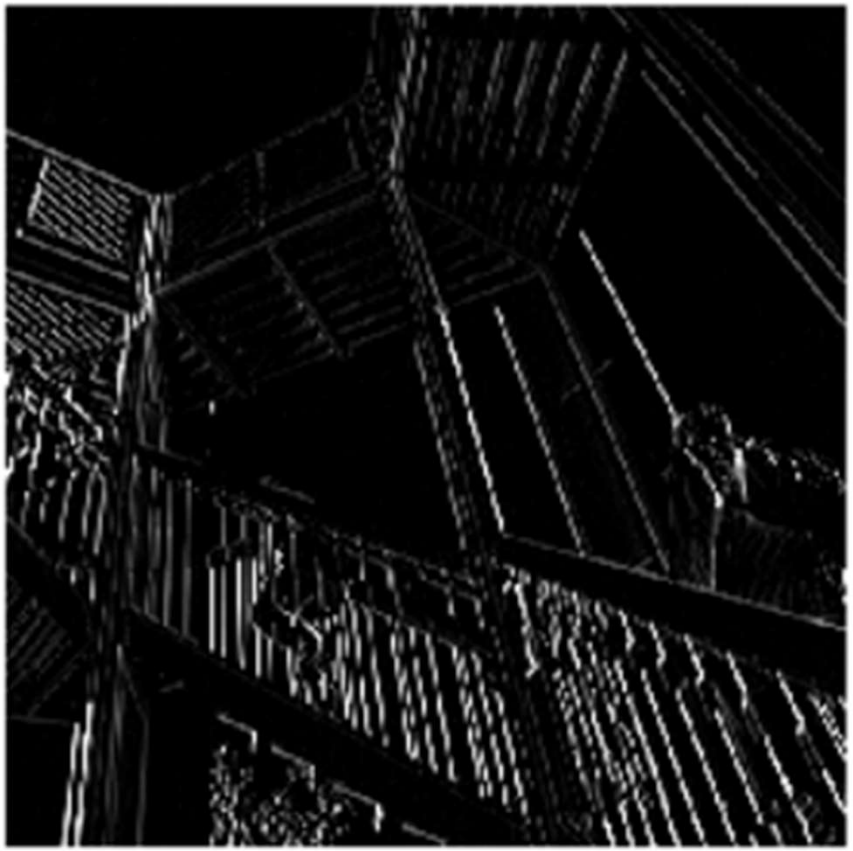


(4)(1)+(2)(0)+(9)(-1)+(3)(1)+(1)(0)+(5)(-1)+(8)(1)+(7)(0)+(1)(-1) =
4+0-9+3+0-5+8+0-1 = 0



(2)(1)+(6)(0)+(2)(-1)+(1)(1)+(8)(0)+(1)(-1)+(5)(1)+(7)(0)+(8)(-1) =
2+0-2+1+0-1+5+0-8 = -3

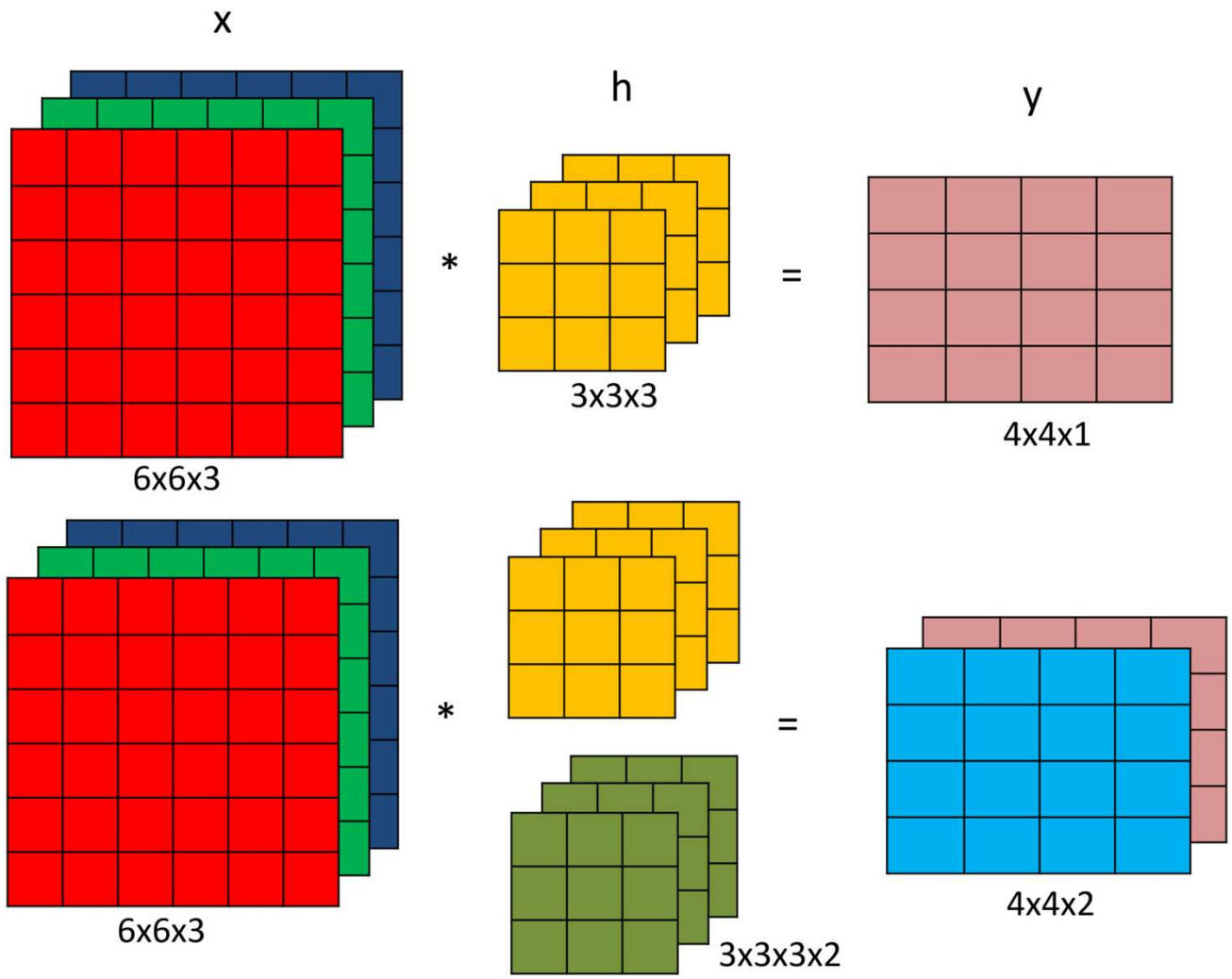
2D convolution example

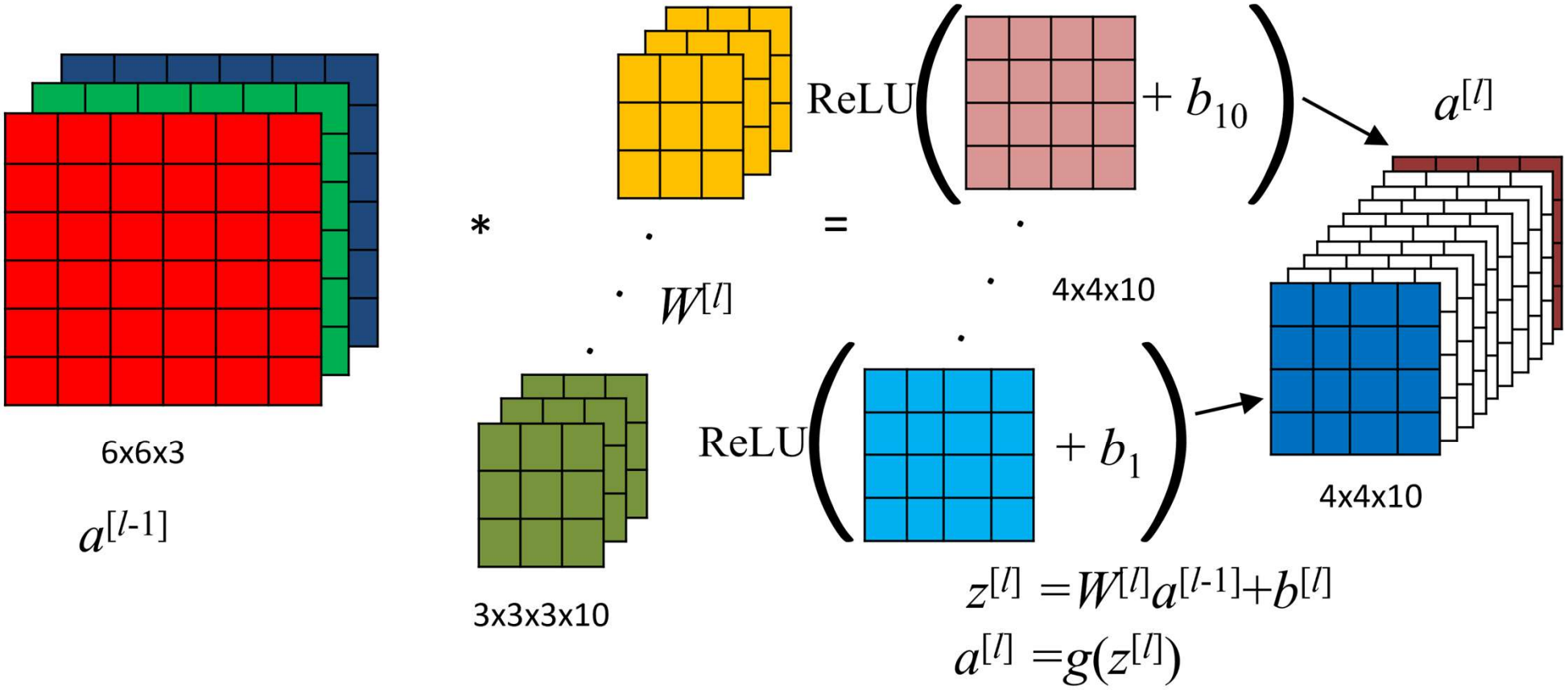


edge detection with convolution

see convolution.ipynb

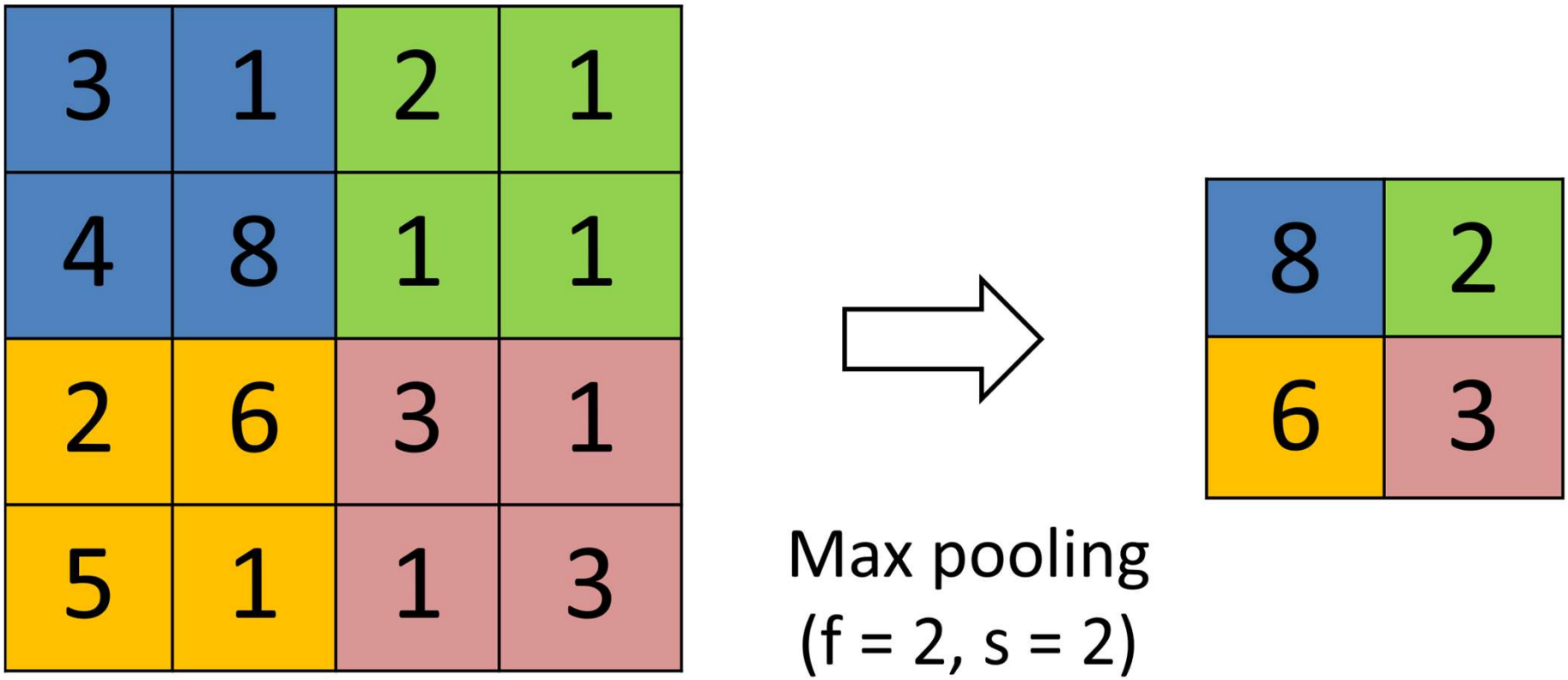
3D convolution



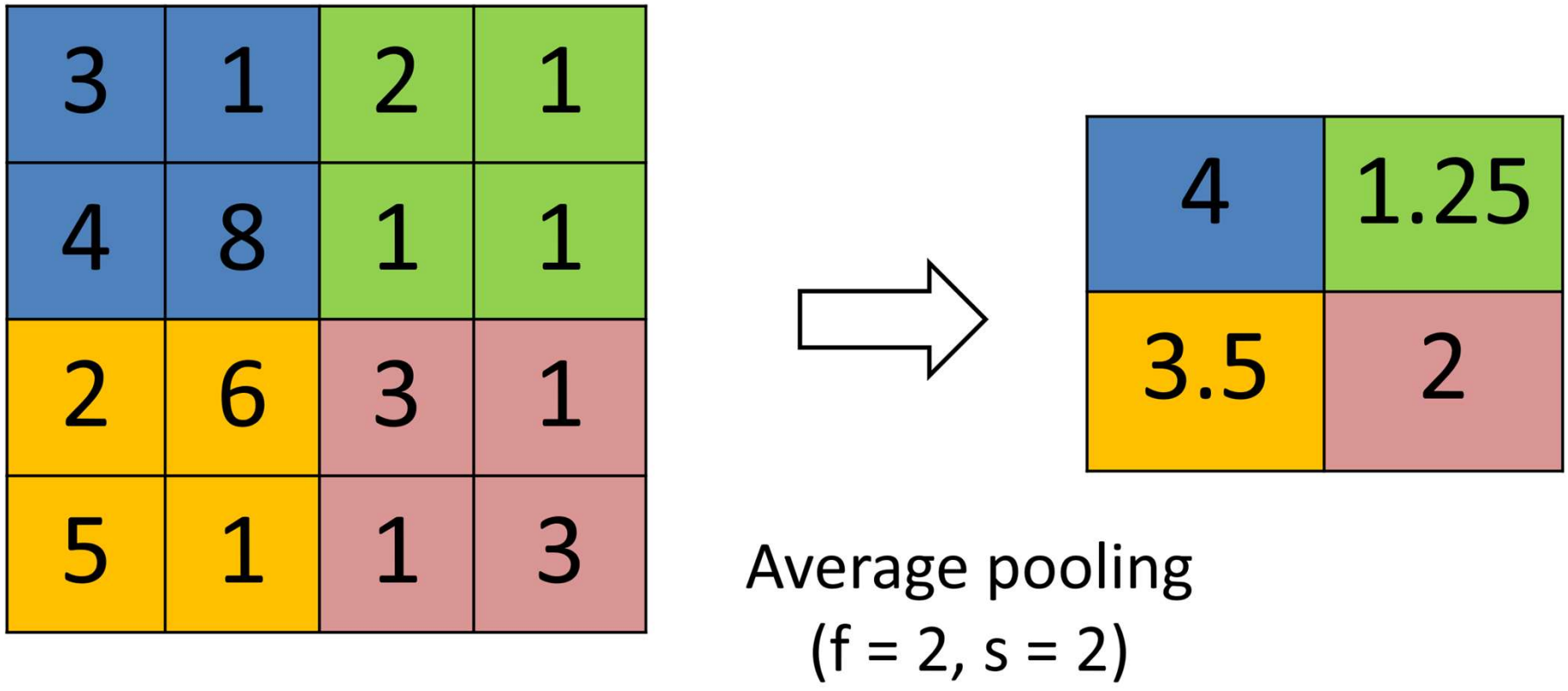


convolution layer in NN

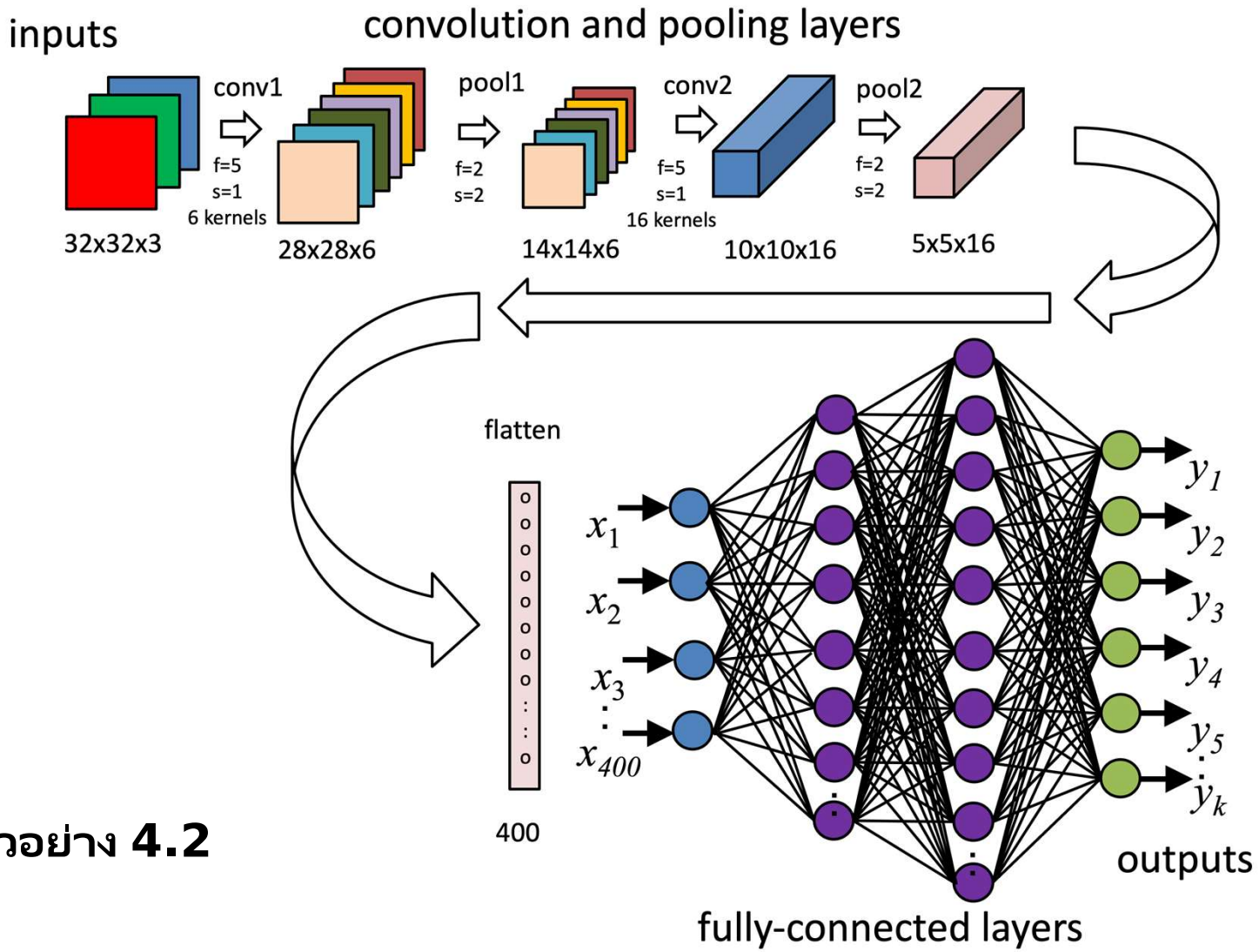
max pooling layer



average pooling layer



CNN model example



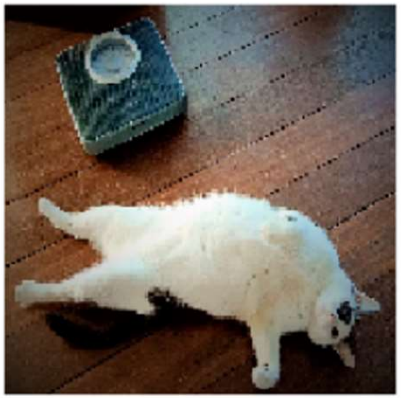
see **ตัวอย่าง 4.2**

cat/dog classification

```
[1.]
jackie.jpg is a dog
```

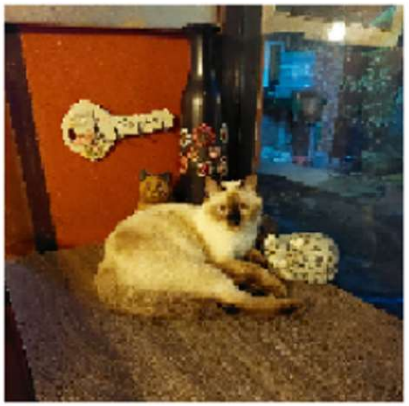
```
[1.]
maam.jpeg is a dog
```

```
[0.]
dollar_scale.jpg is a cat
```



```
[1.]
fongbeer1.jpeg is a dog
```

```
[1.]
bingzoo.jpg is a dog
```



```
[0.]
ninja_bingz.jpg is a cat
```

DNN/CNN comparision (SVHN)

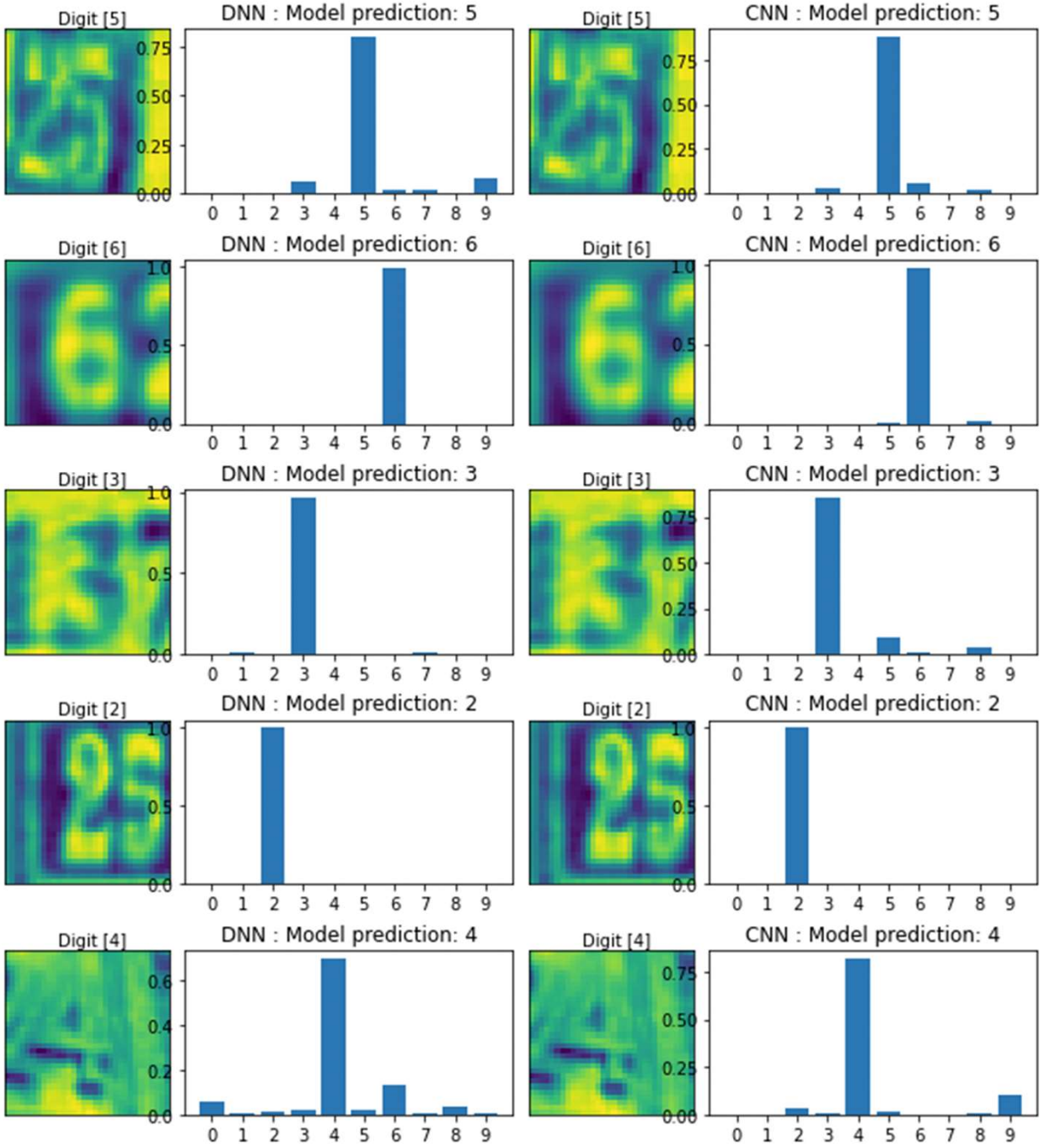
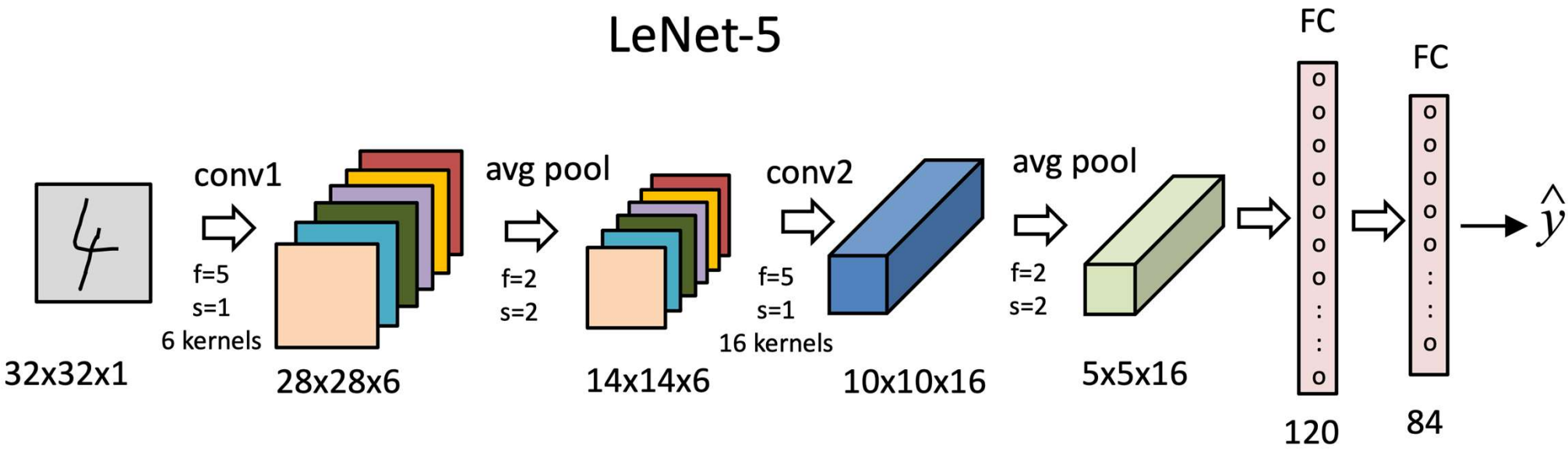


image augmentation

CNN case study

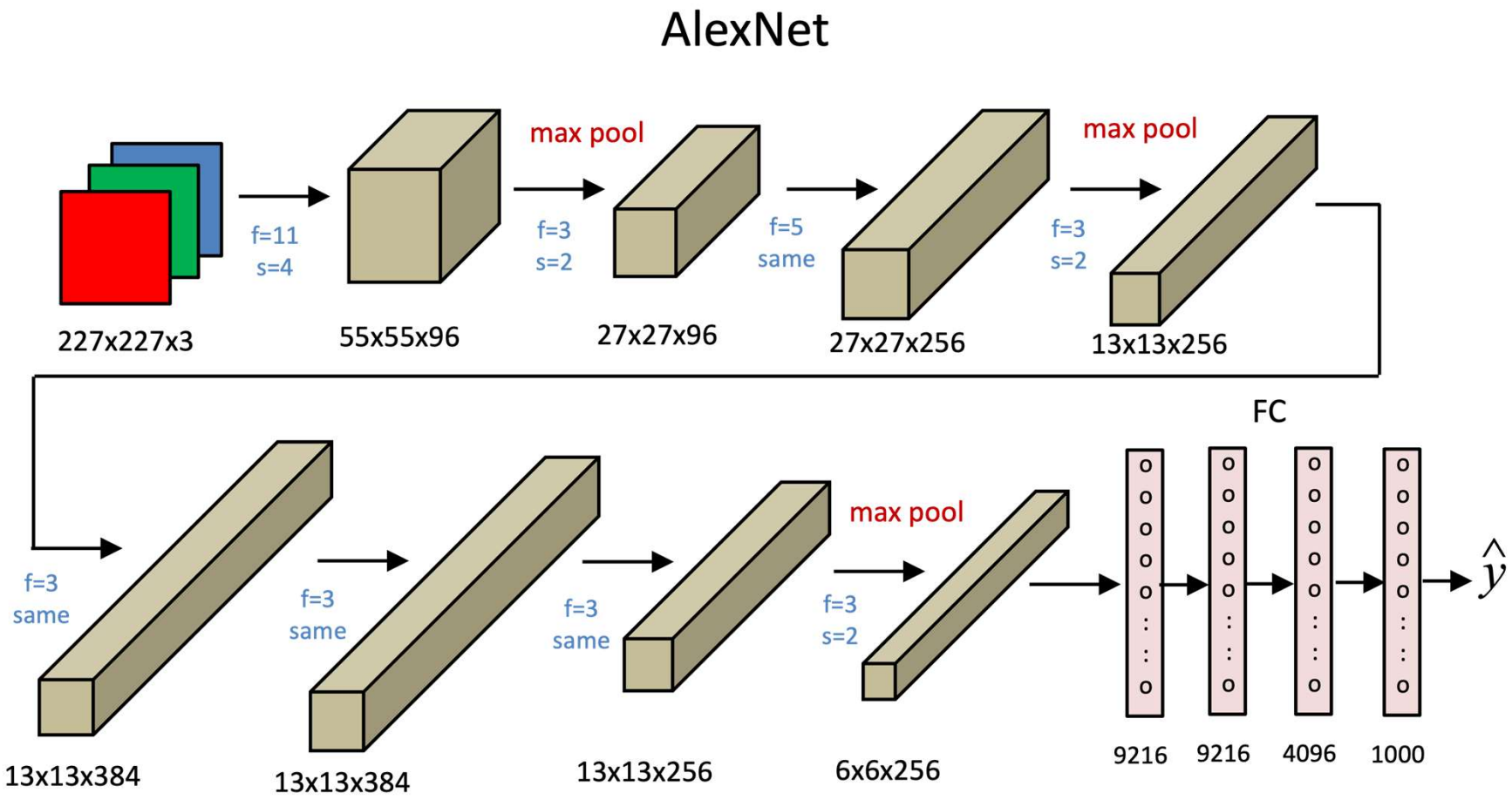
LeNet-5
AlexNet
VGG-16
ResNets
Inception model

LeNet-5



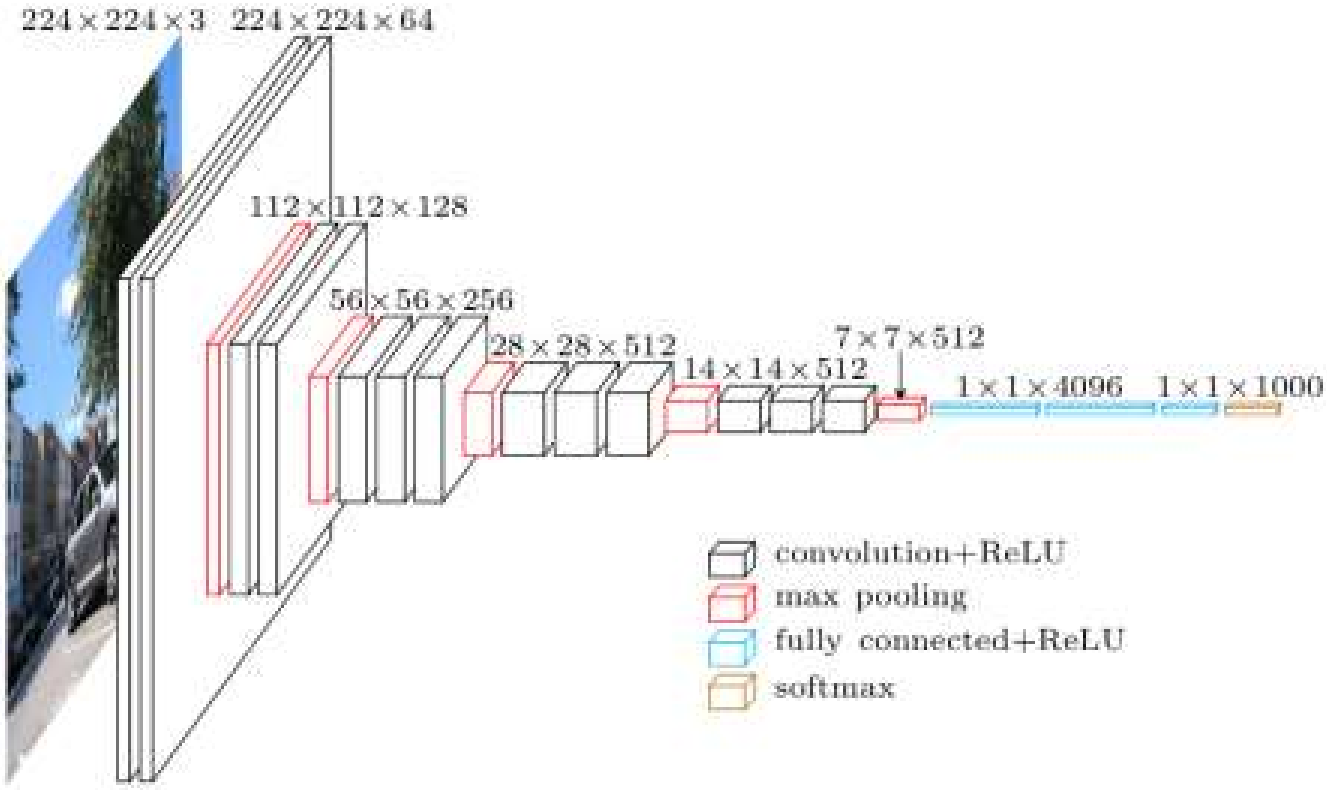
LeCun, Y.; Boser, B.; Denker, J. S.; Henderson, D.; Howard, R. E.; Hubbard, W. & Jackel, L. D. (1989). Backpropagation applied to handwritten zip code recognition. Neural Computation, 1(4):541-551.

AlexNet



Krizhevsky, Alex; Sutskever, Ilya; Hinton, Geoffrey E. (2017-05-24). "ImageNet classification with deep convolutional neural networks"

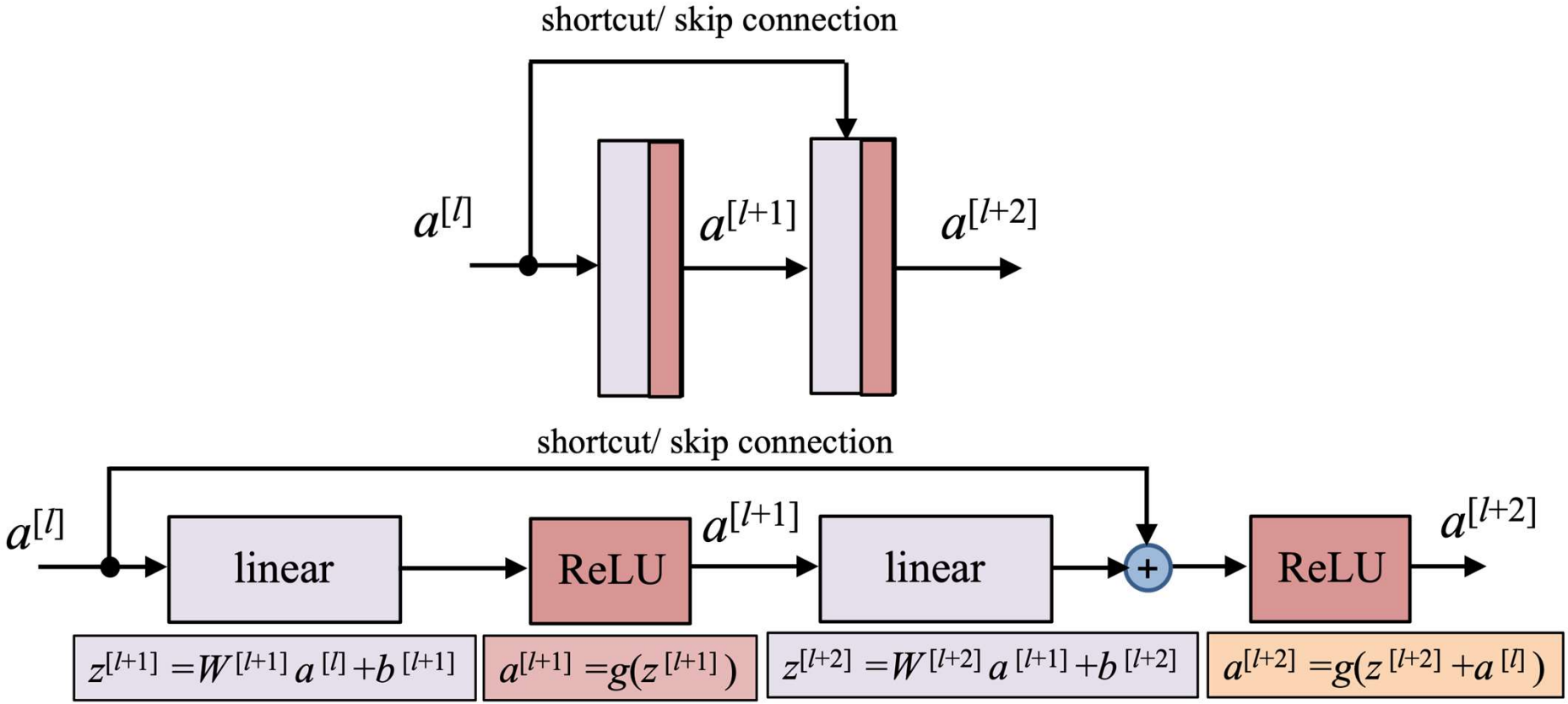
VGG-16



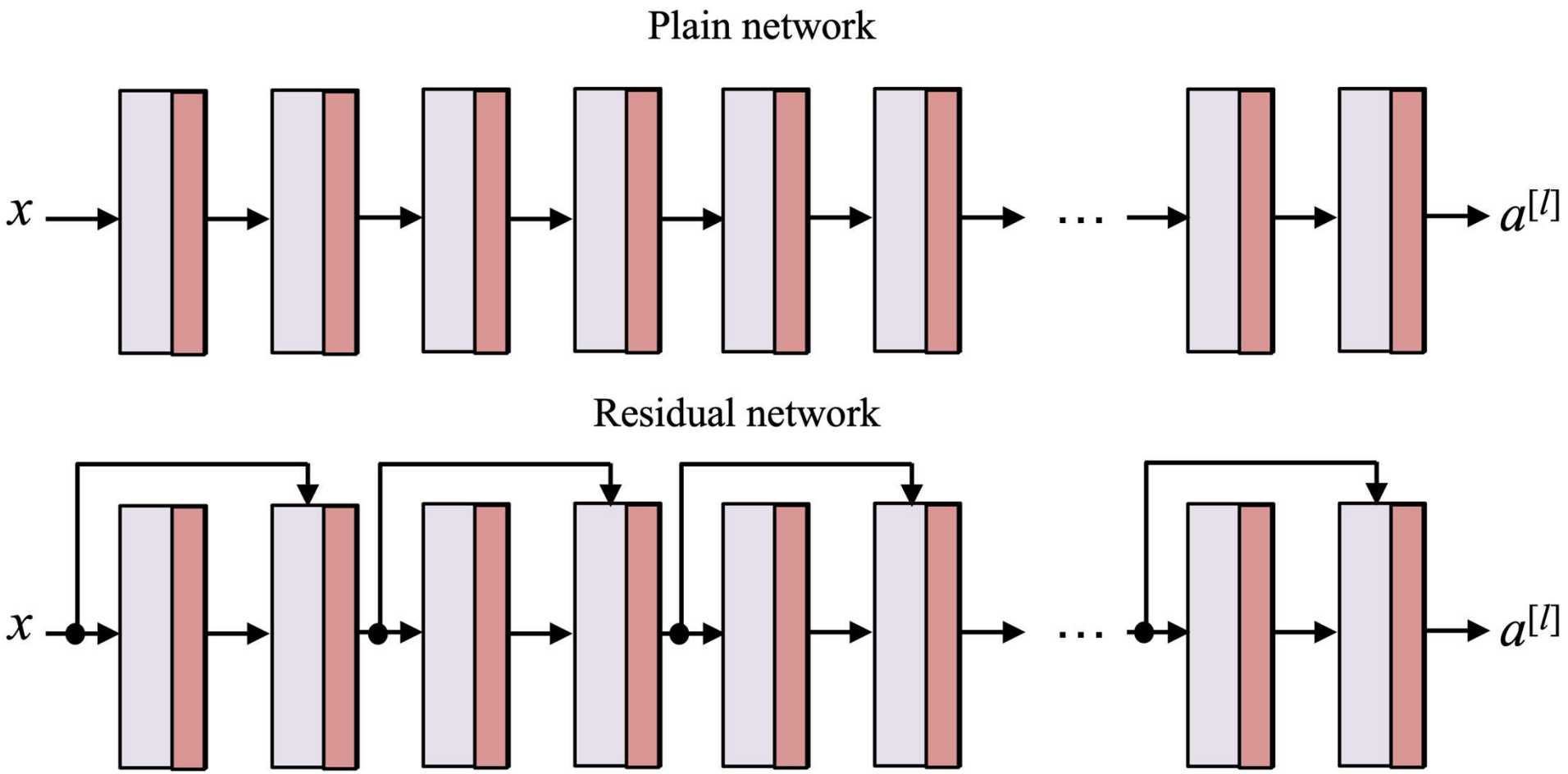
•Simonyan Sisserman. Very deep convolution networks for large-scale image recognition. 2015.

ResNets

He, K; Zhang X; Ren S.; Sun J.; Deep residual learning for image recognition. CVPR. 2015.



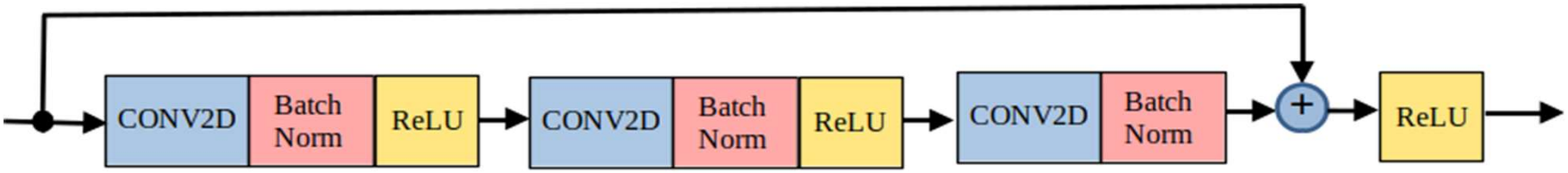
Residual block



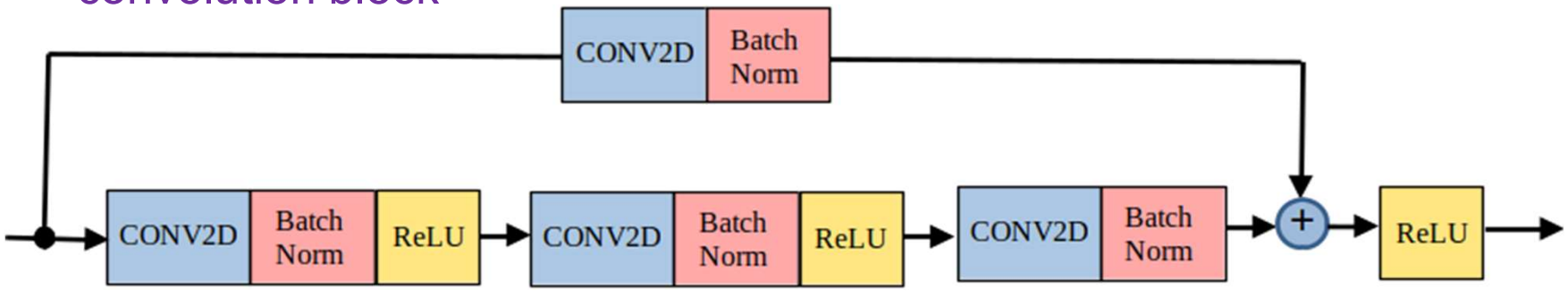
Plain v.s. residual network

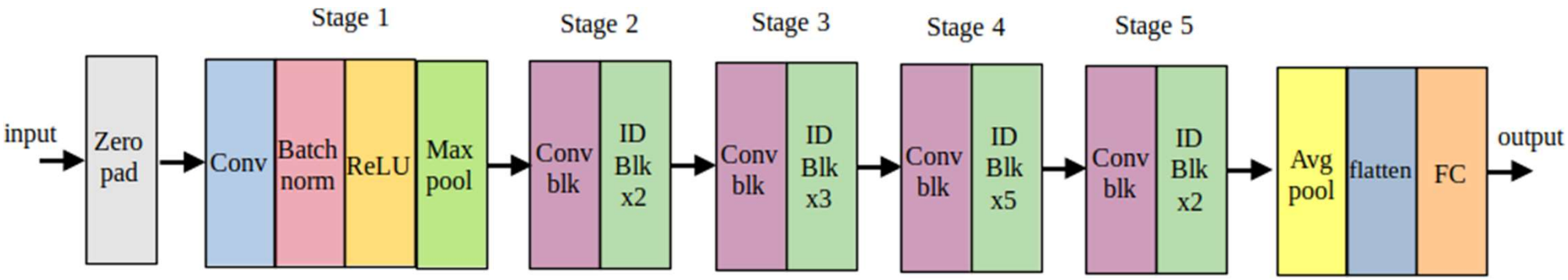
construct ResNets in TensorFlow

identity block



convolution block



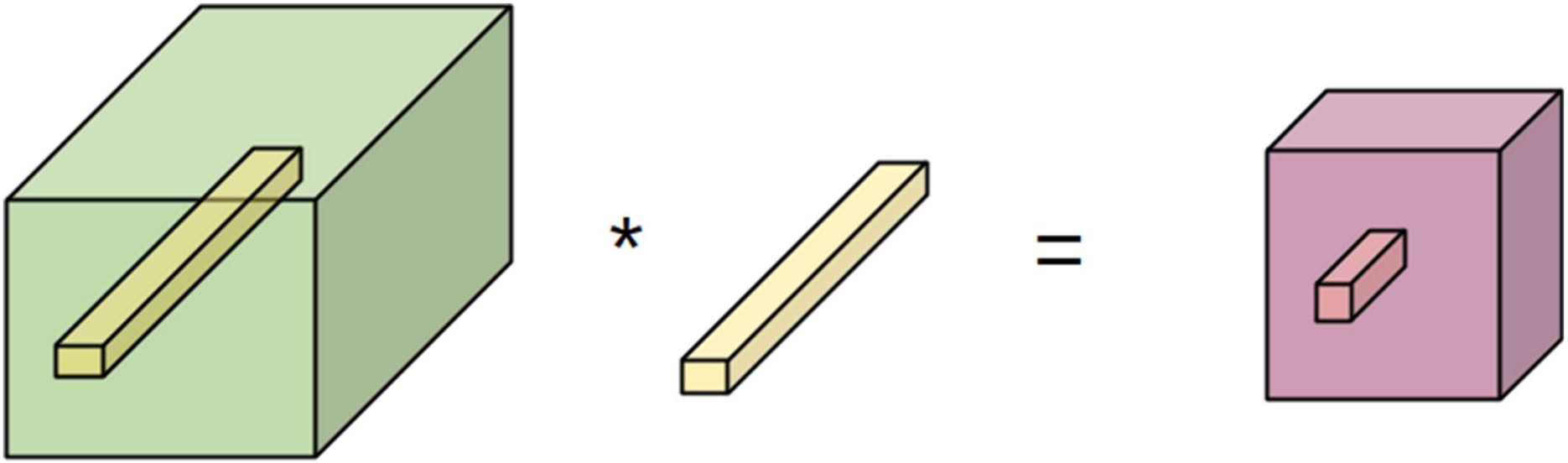


ResNet50 model

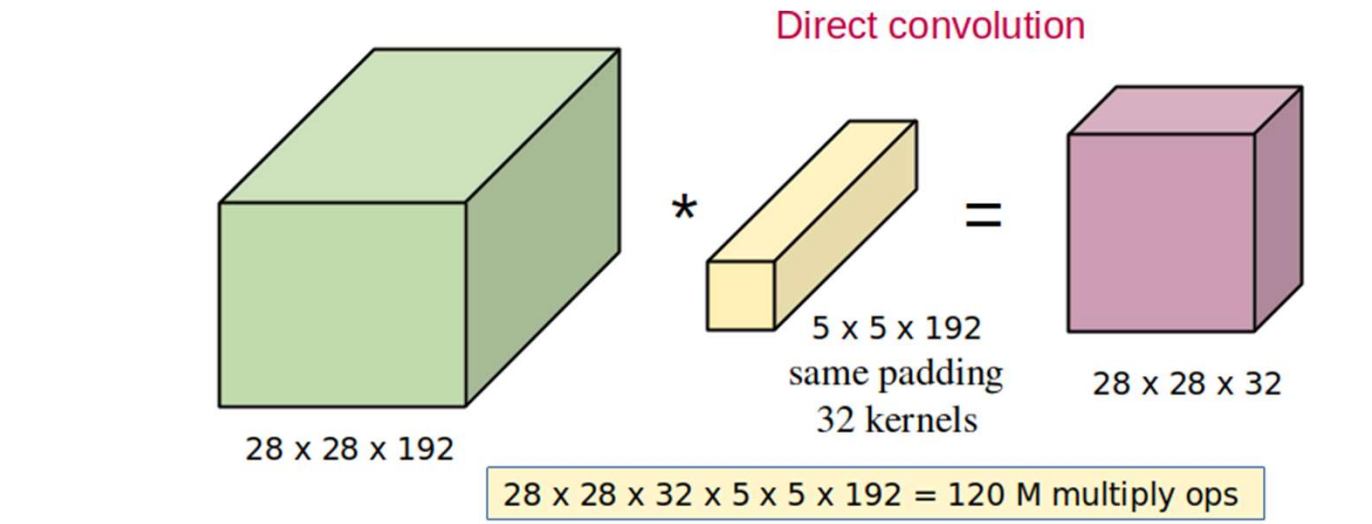
Inception model

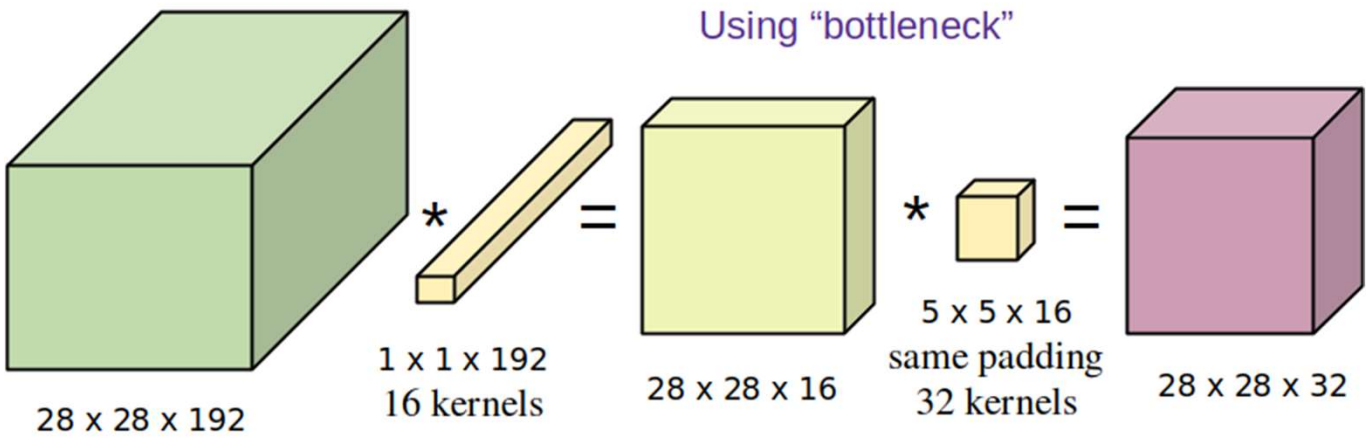
Szegedy et al. Going deeper with convolutions. 2014.

Convolution using 1x1 kernel

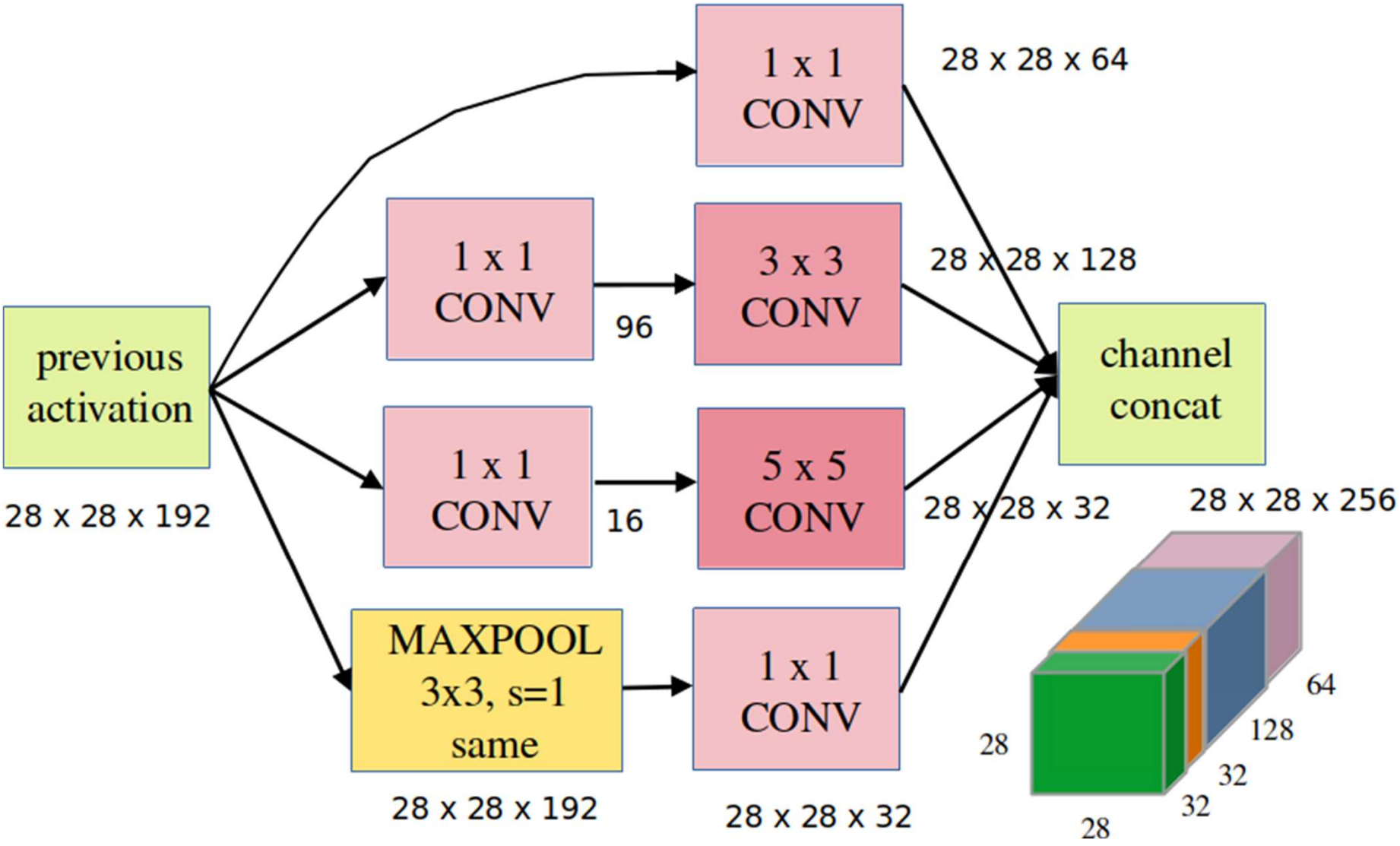


Implement “bottleneck” with 1x1 convolution

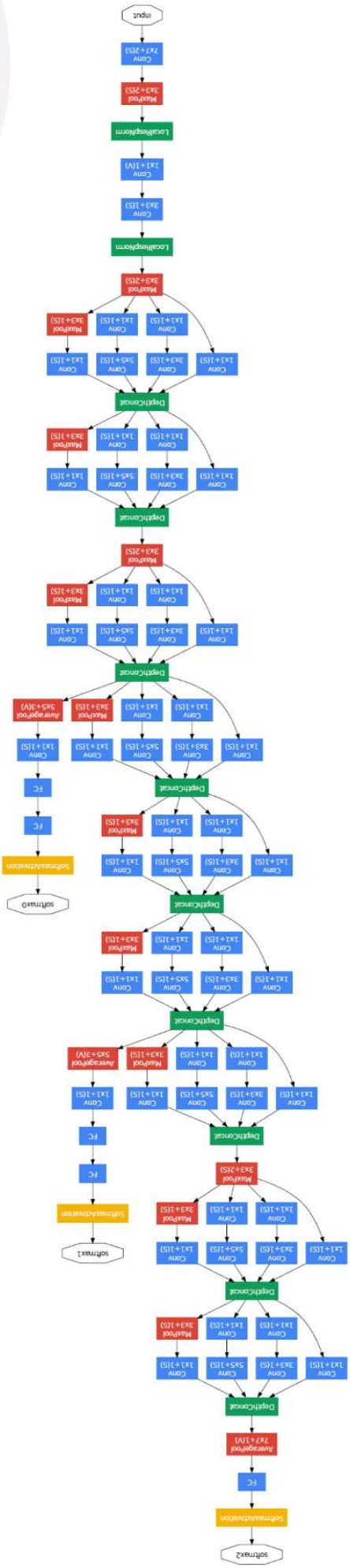


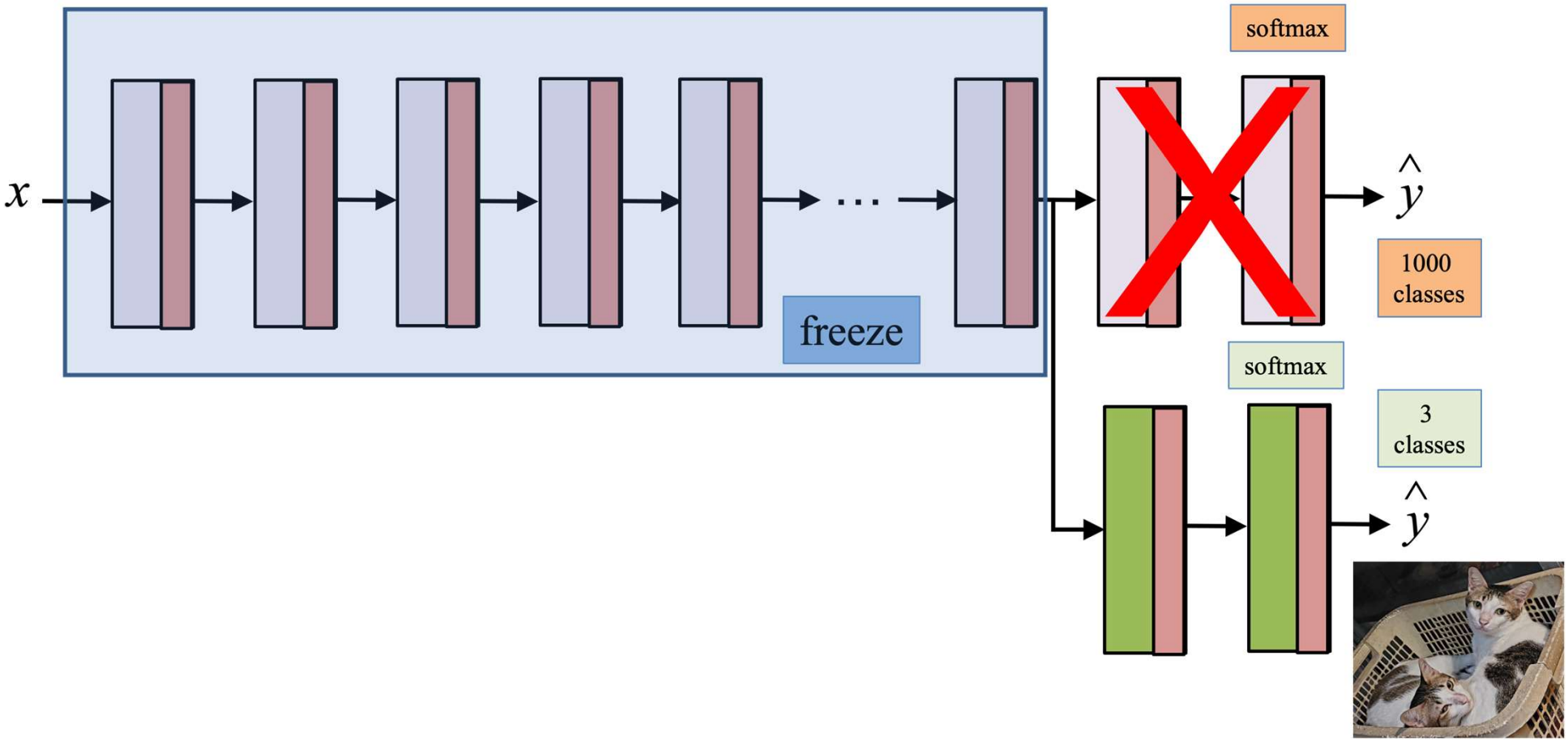


Inception module



googlenet





transfer learning