

# Machine Learning, Spring 2019

## Deep Learning Part III

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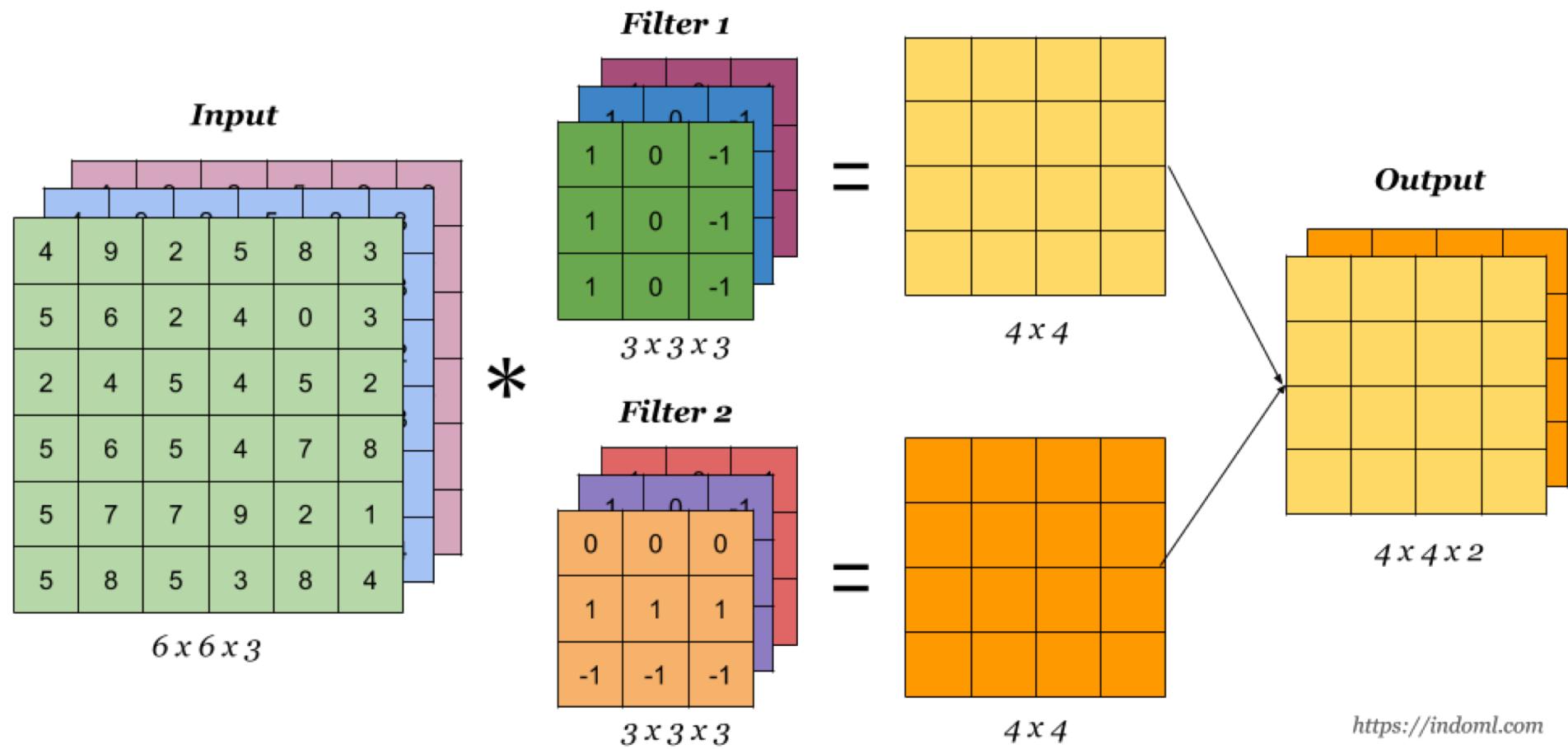
Reading Assignment: Chapter 10,11,12 & 13

Python tutorial: <http://learnpython.org/>

TensorFlow tutorial: <https://www.tensorflow.org/tutorials/>

PyTorch tutorial: <https://pytorch.org/tutorials/>

# Convolution Neural Network

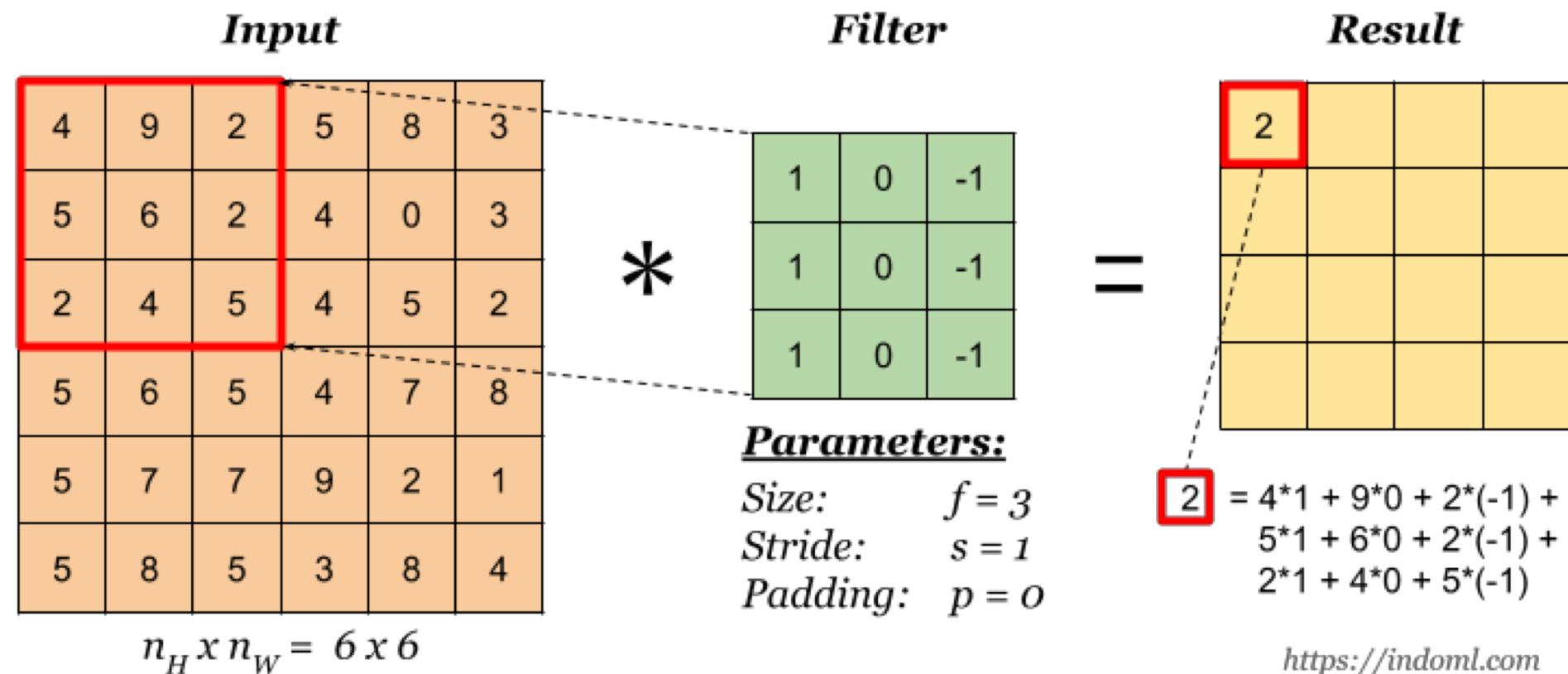


# CNN Architectures

- Basics of CNN
- Classic Networks

# CNN Basics

## Basic Convolution Operation



***Input***

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

$$n_H \times n_W = 6 \times 6$$

***Filter***

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

\*

***Result***

2	6		

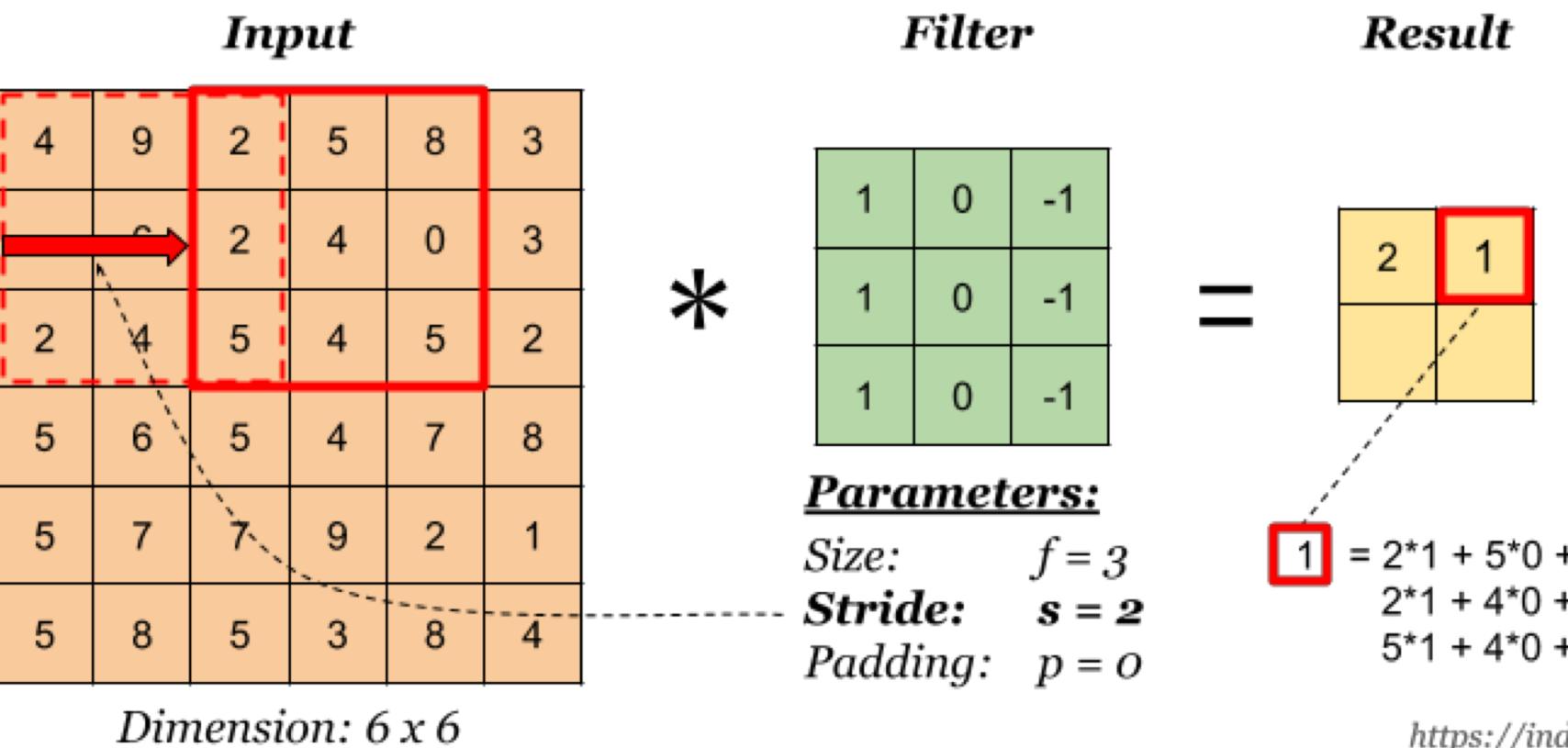
=

**Parameters:**Size:  $f = 3$ Stride:  $s = 1$ Padding:  $p = 0$ 

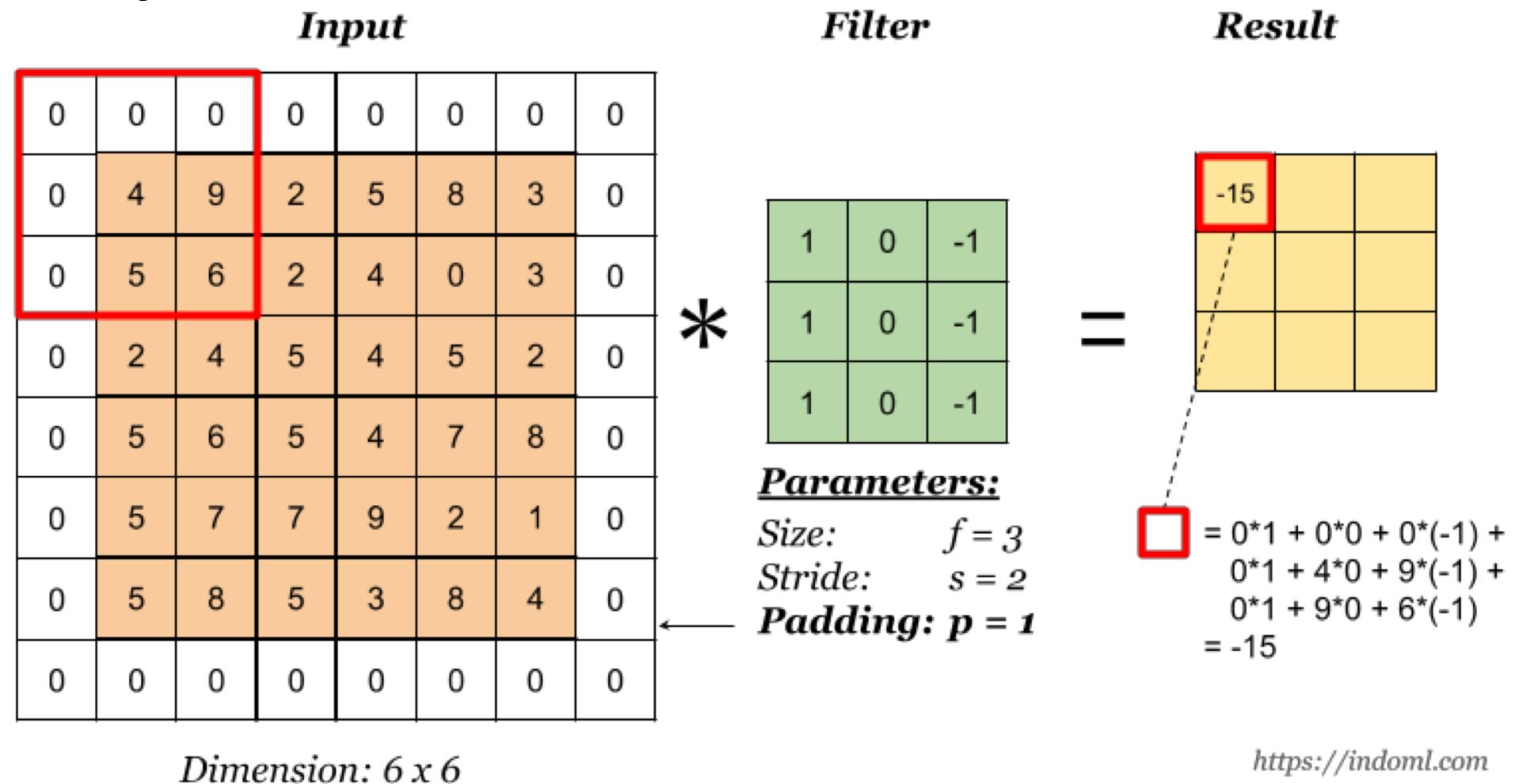
6 =  $9*1 + 2*0 + 5*(-1) +$   
 $6*1 + 2*0 + 4*(-1) +$   
 $4*1 + 5*0 + 4*(-1)$

<https://indoml.com>

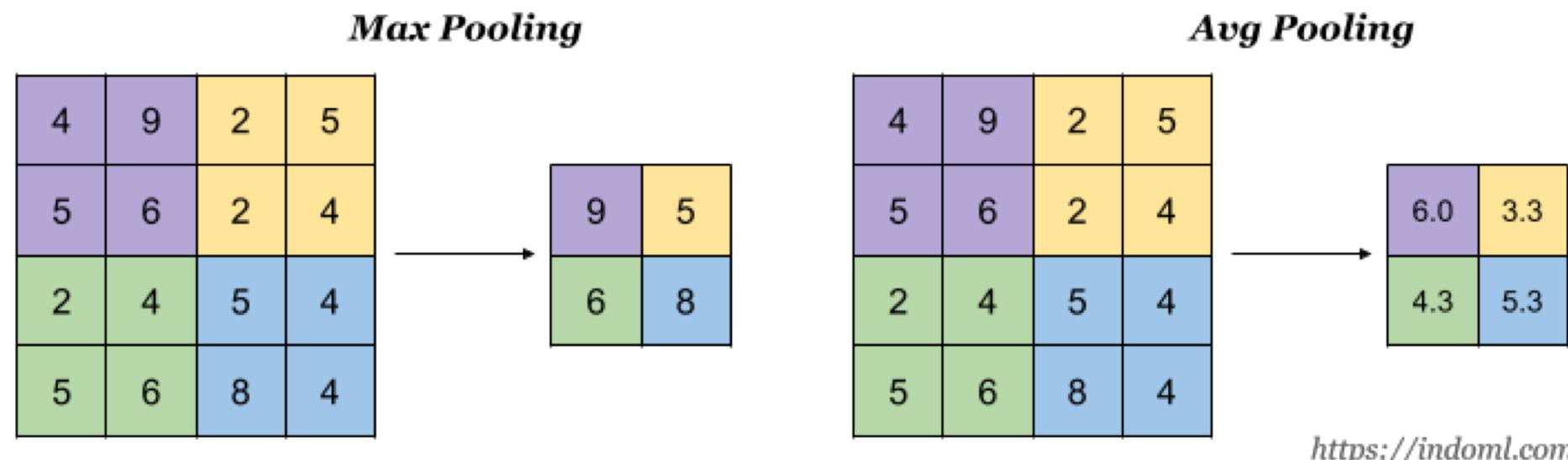
Stride:

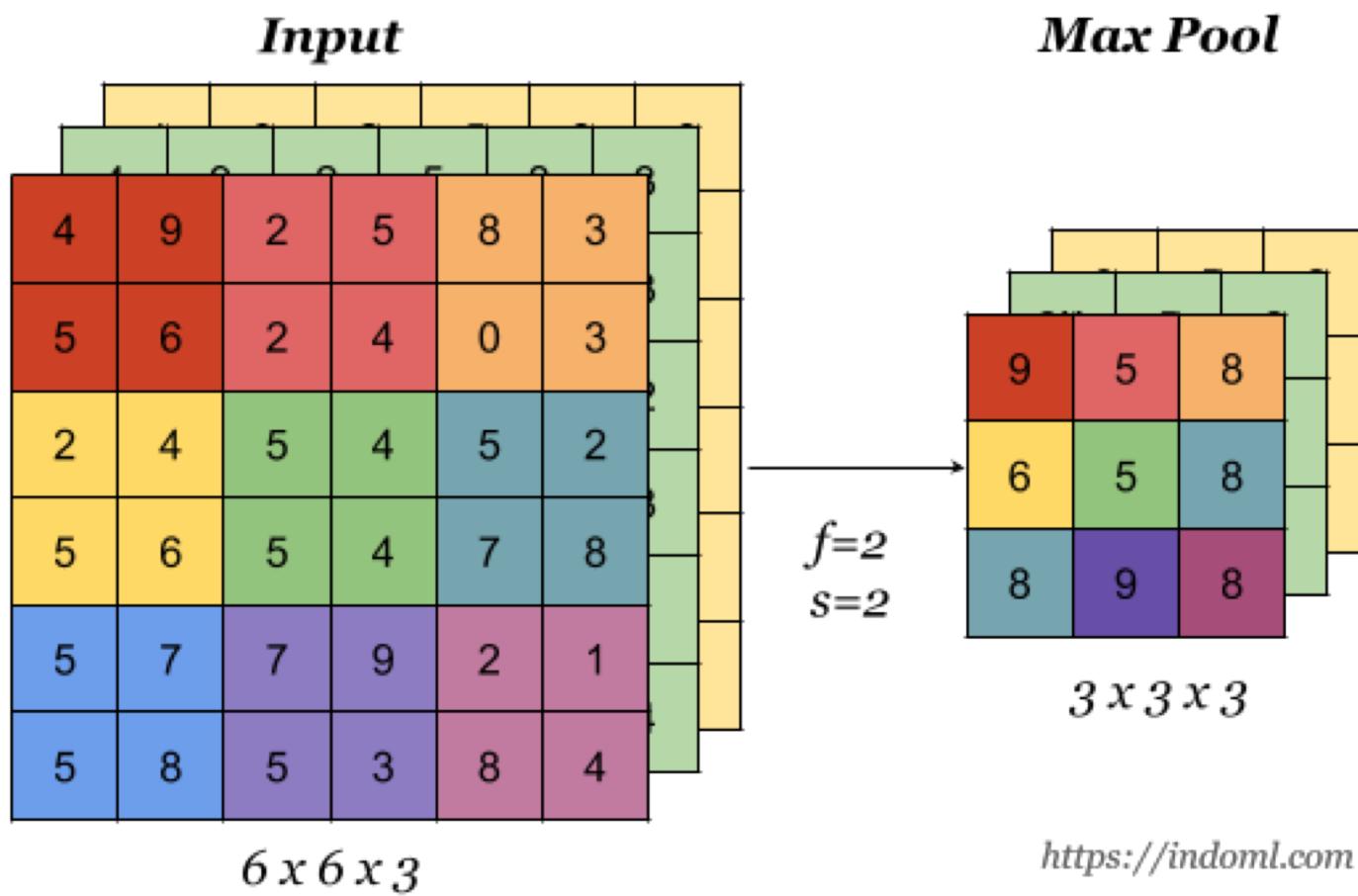


Padding:



Pooling layer:





## Softmax layer:

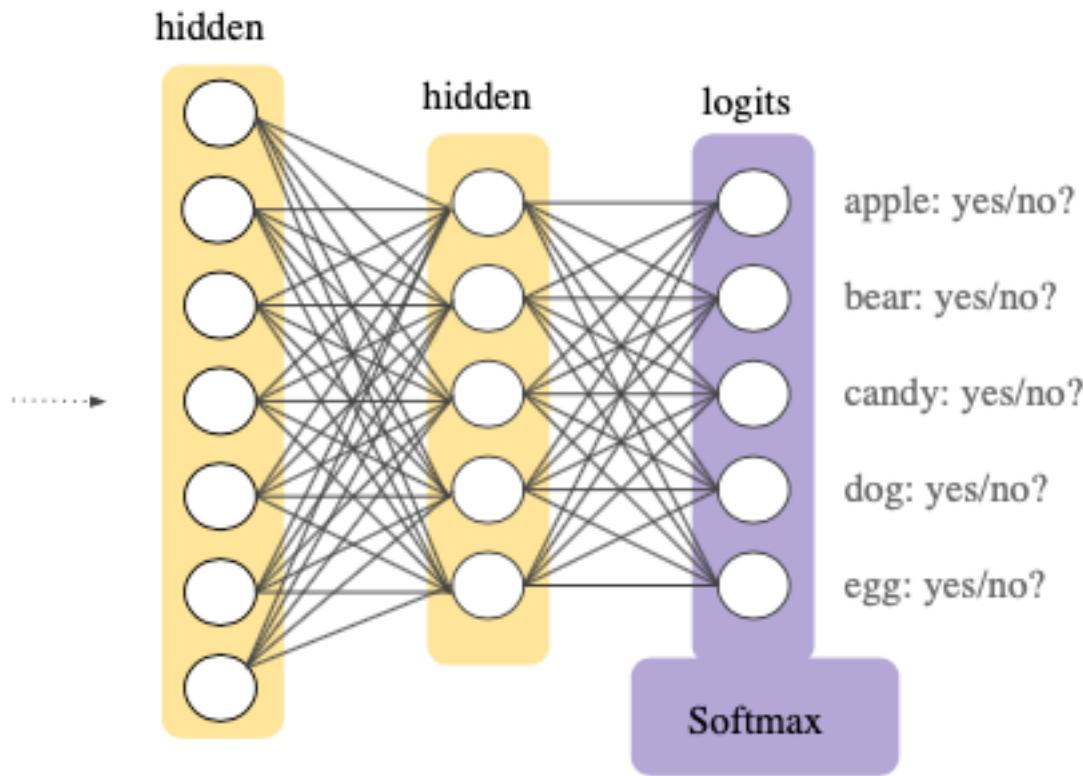
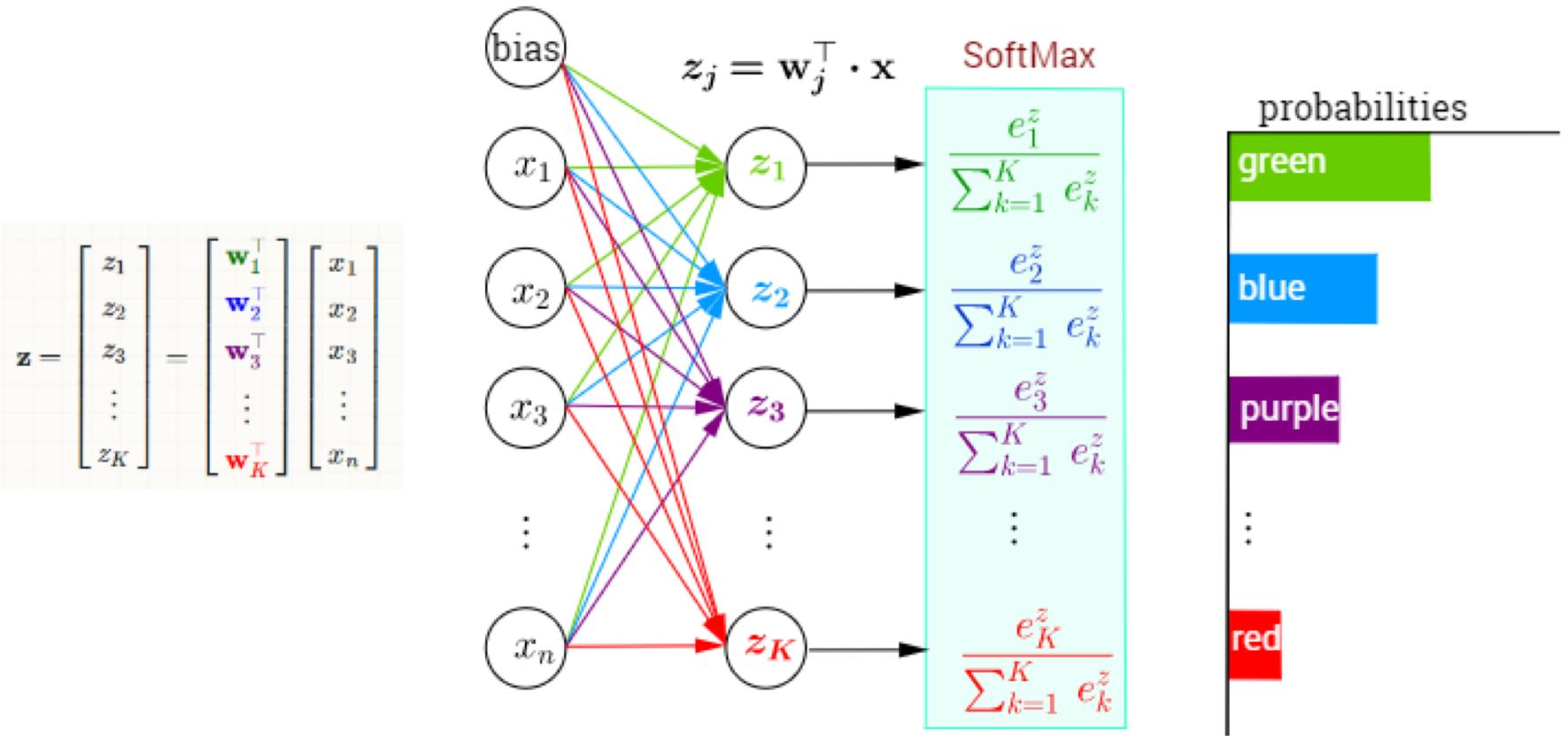
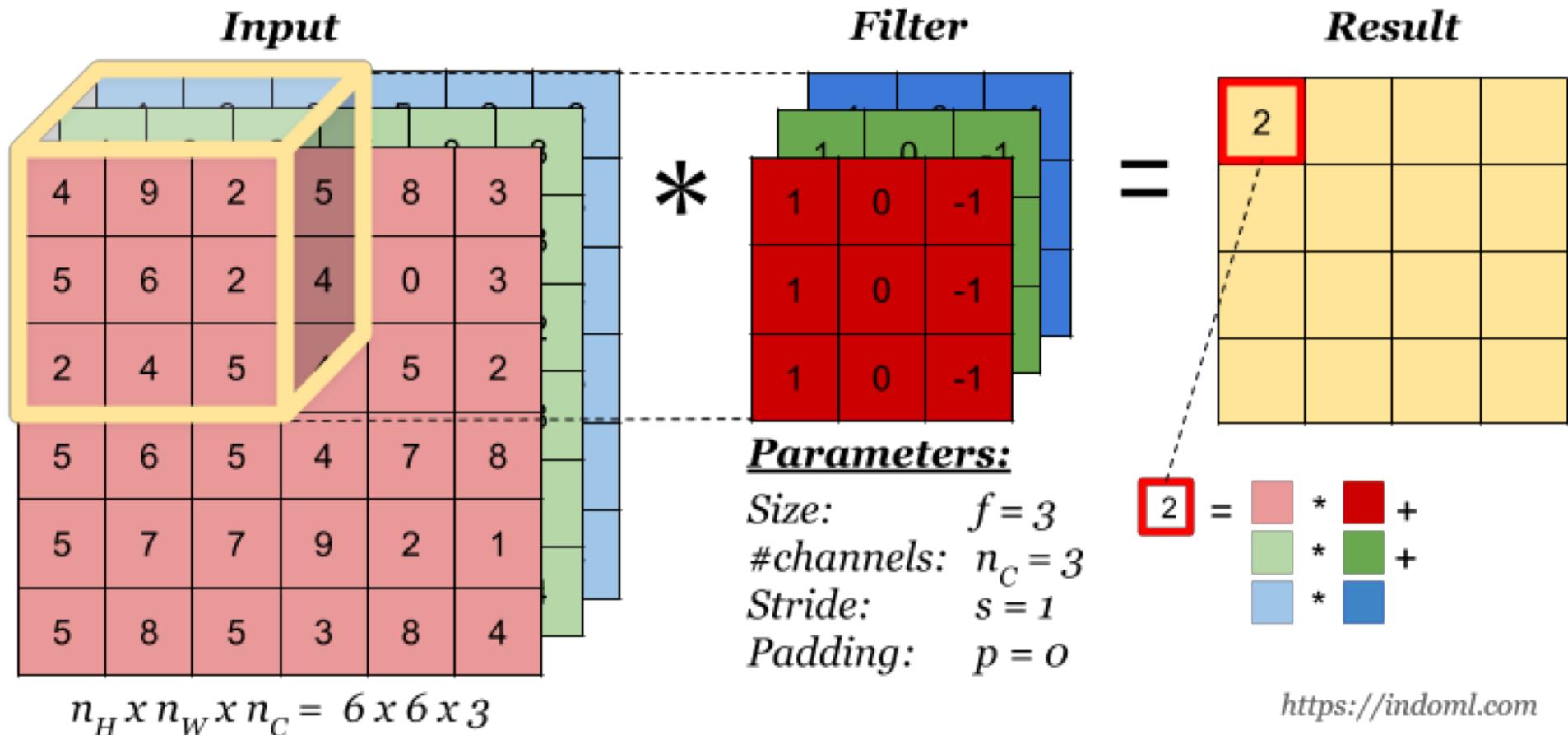


Image source: <https://developers.google.com/machine-learning/crash-course/multi-class-neural-networks/softmax>

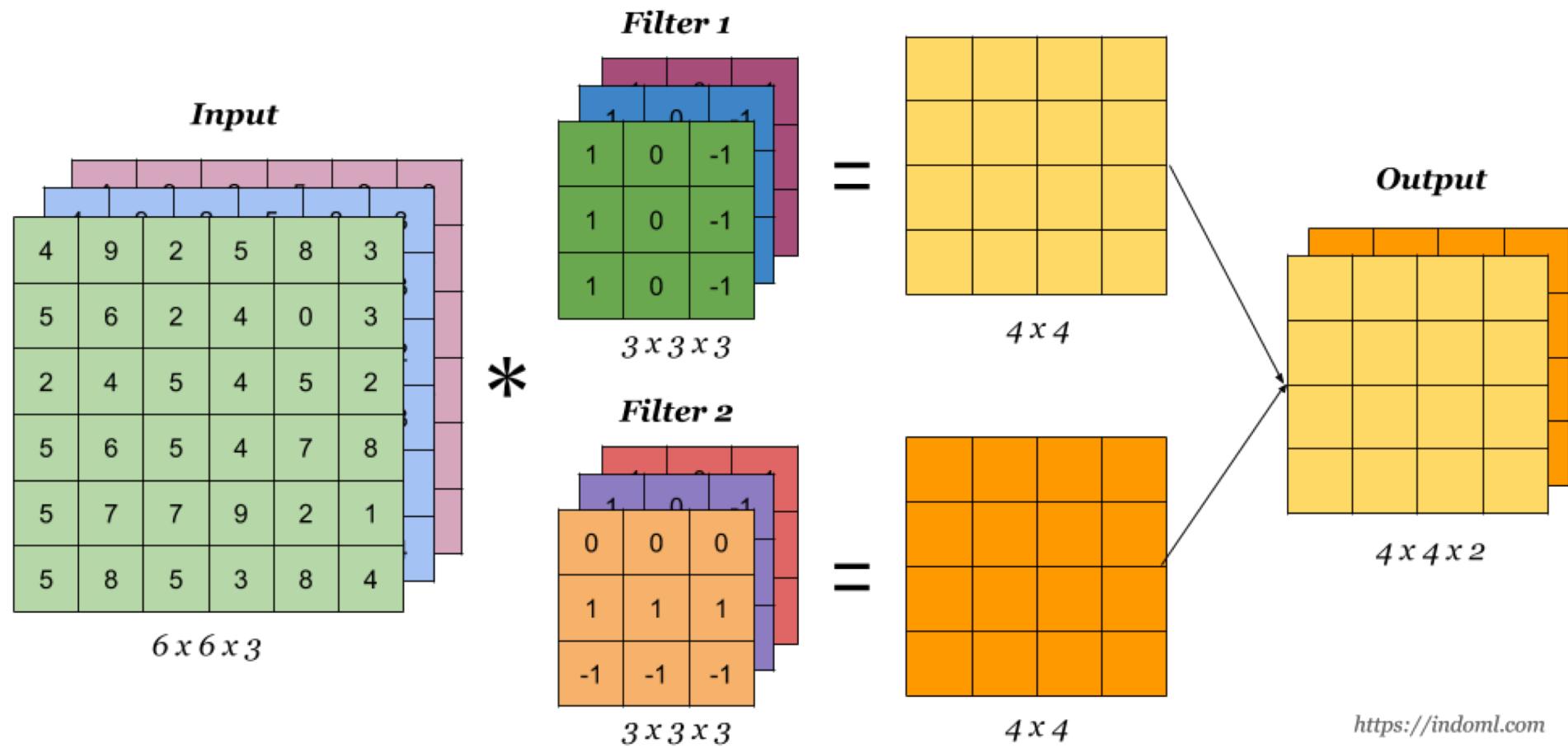


Source: <https://stats.stackexchange.com/questions/273465/neural-network-softmax-activation>

# CNN on Volume (Tensors)

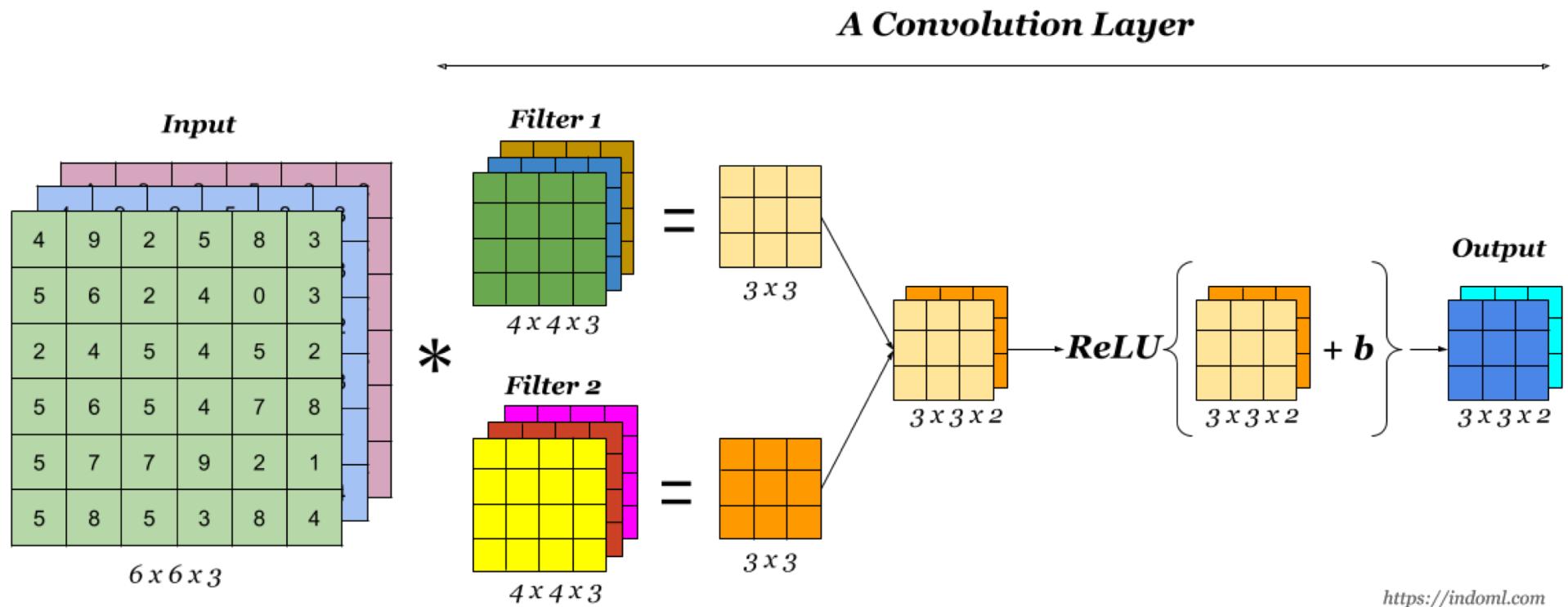


# Multiple Filters

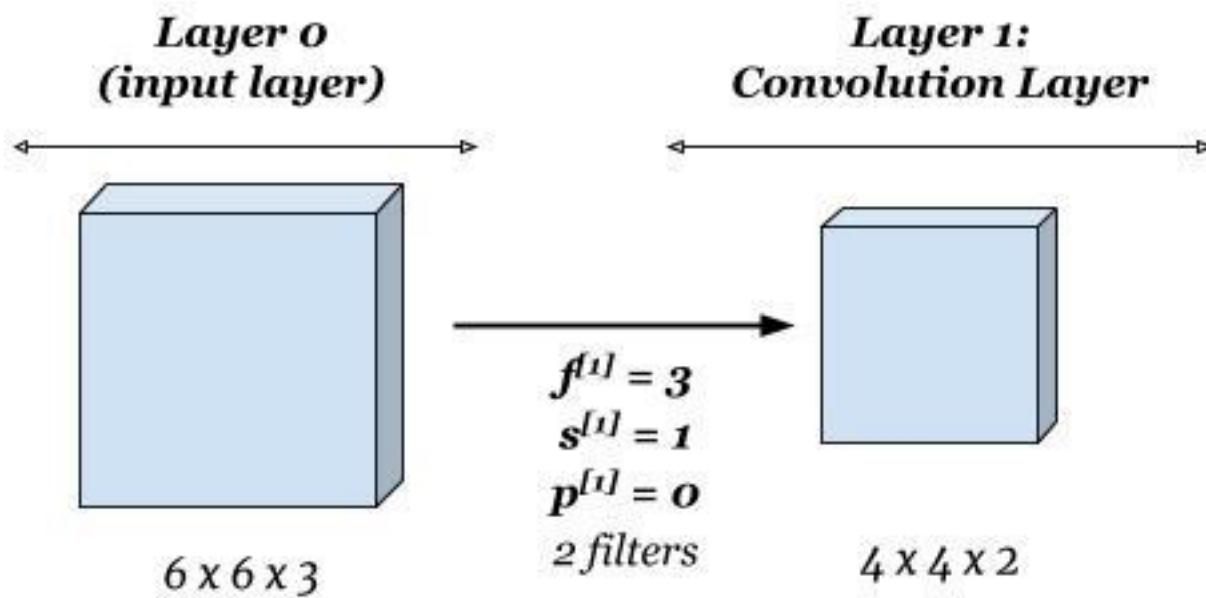


<https://indoml.com>

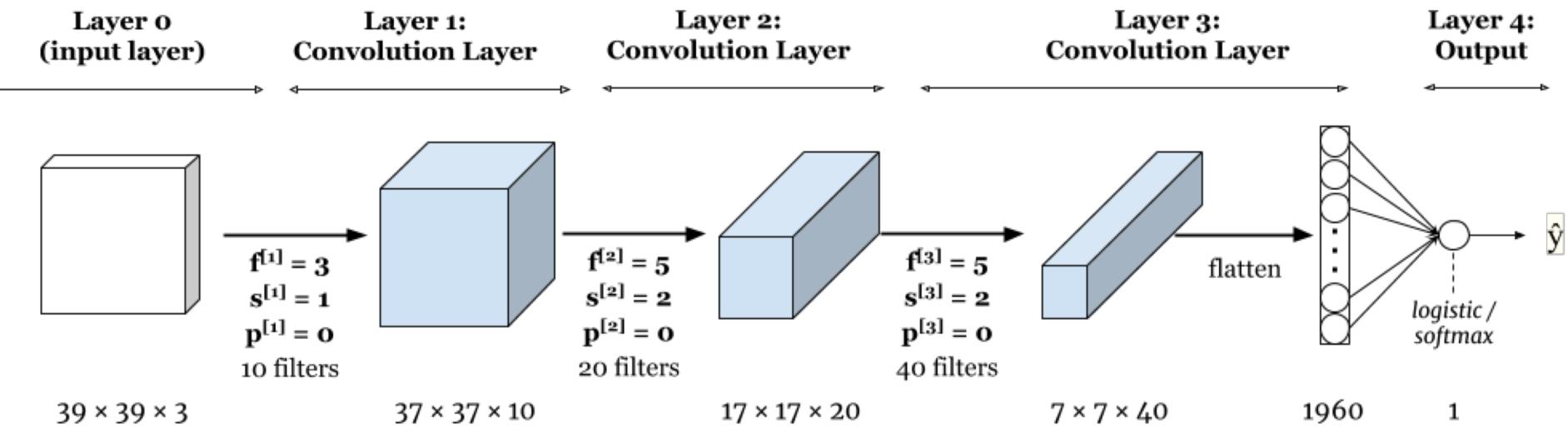
# One Layer Representation



# Shorthand Representation

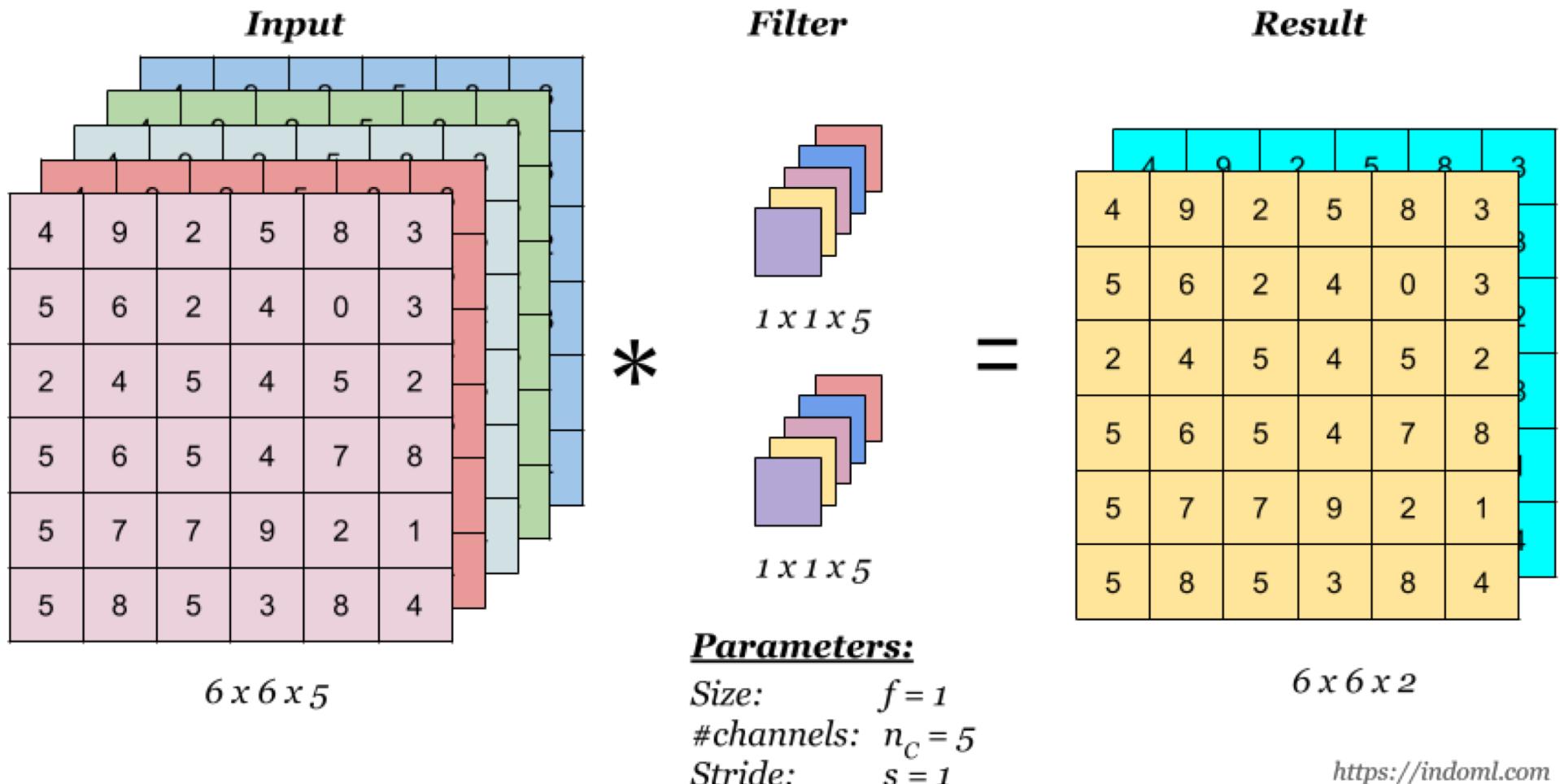


# Sample Network Structure

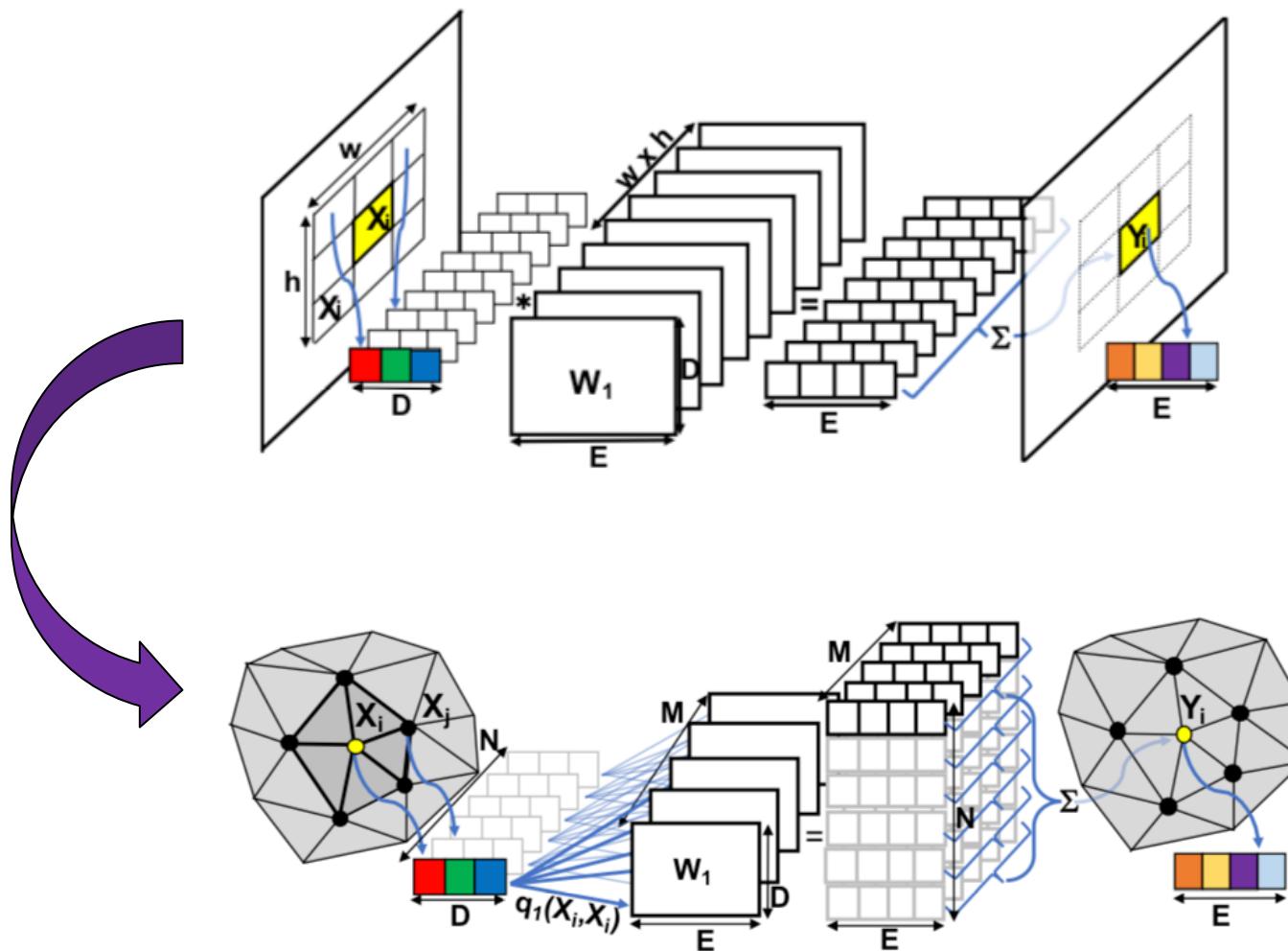


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# 1\*1 Convolutions



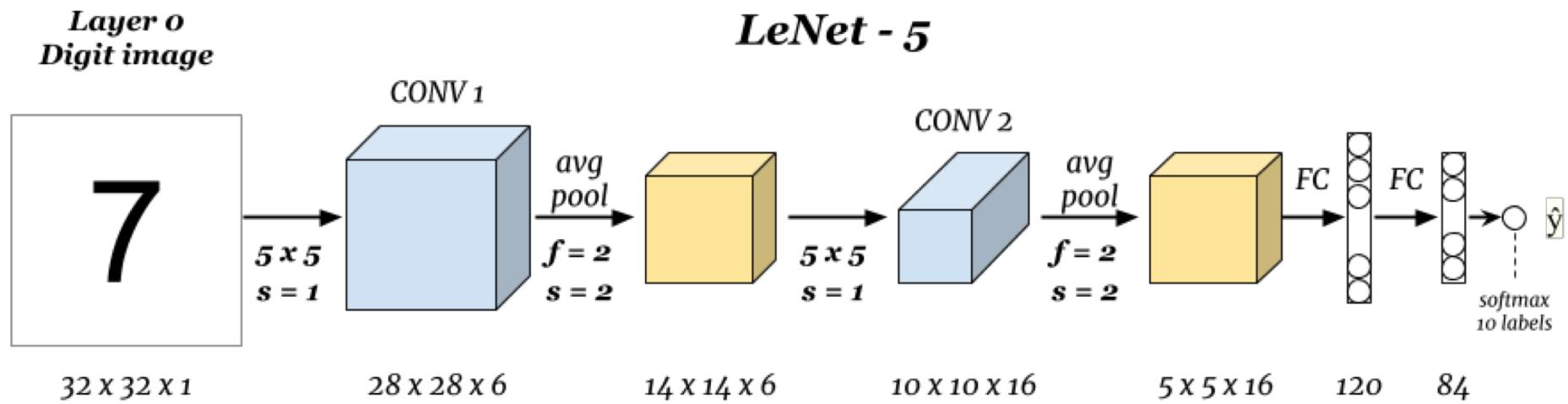
# Generalize the CNN



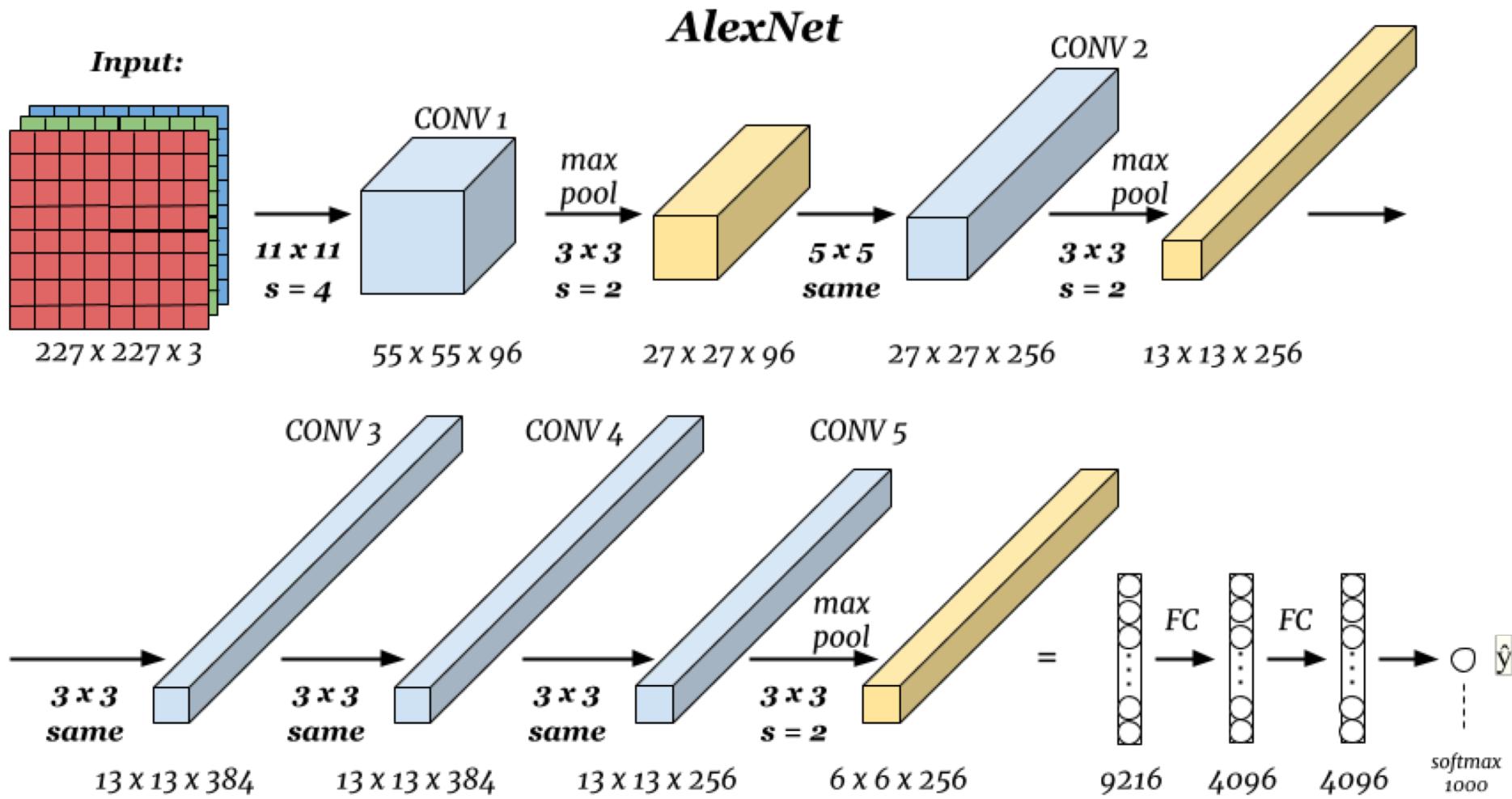
# Classic Networks

- LeNet
- AlexNet
- VGG Net
- ResNet
- GooLeNet

# LeNet

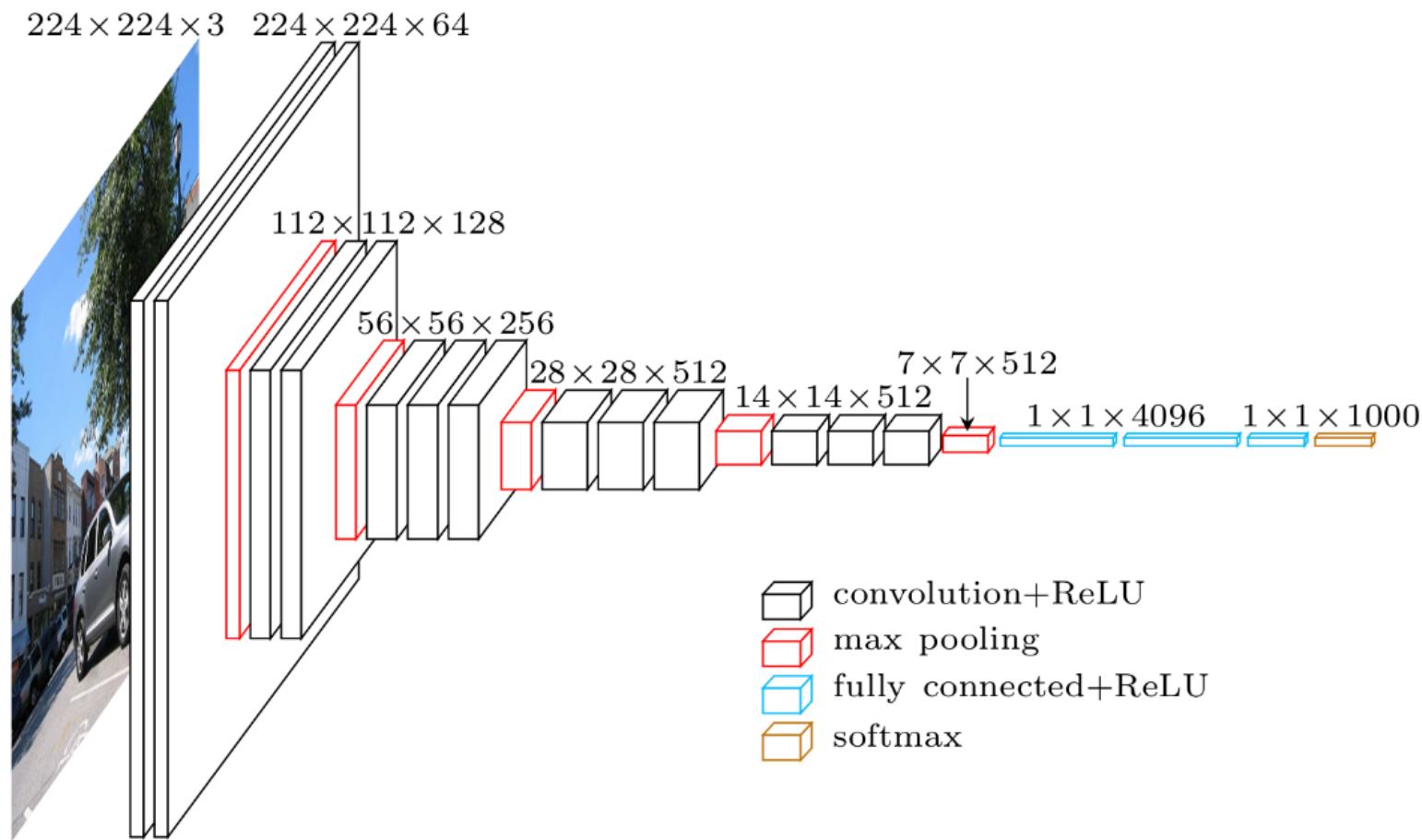


# AlexNet

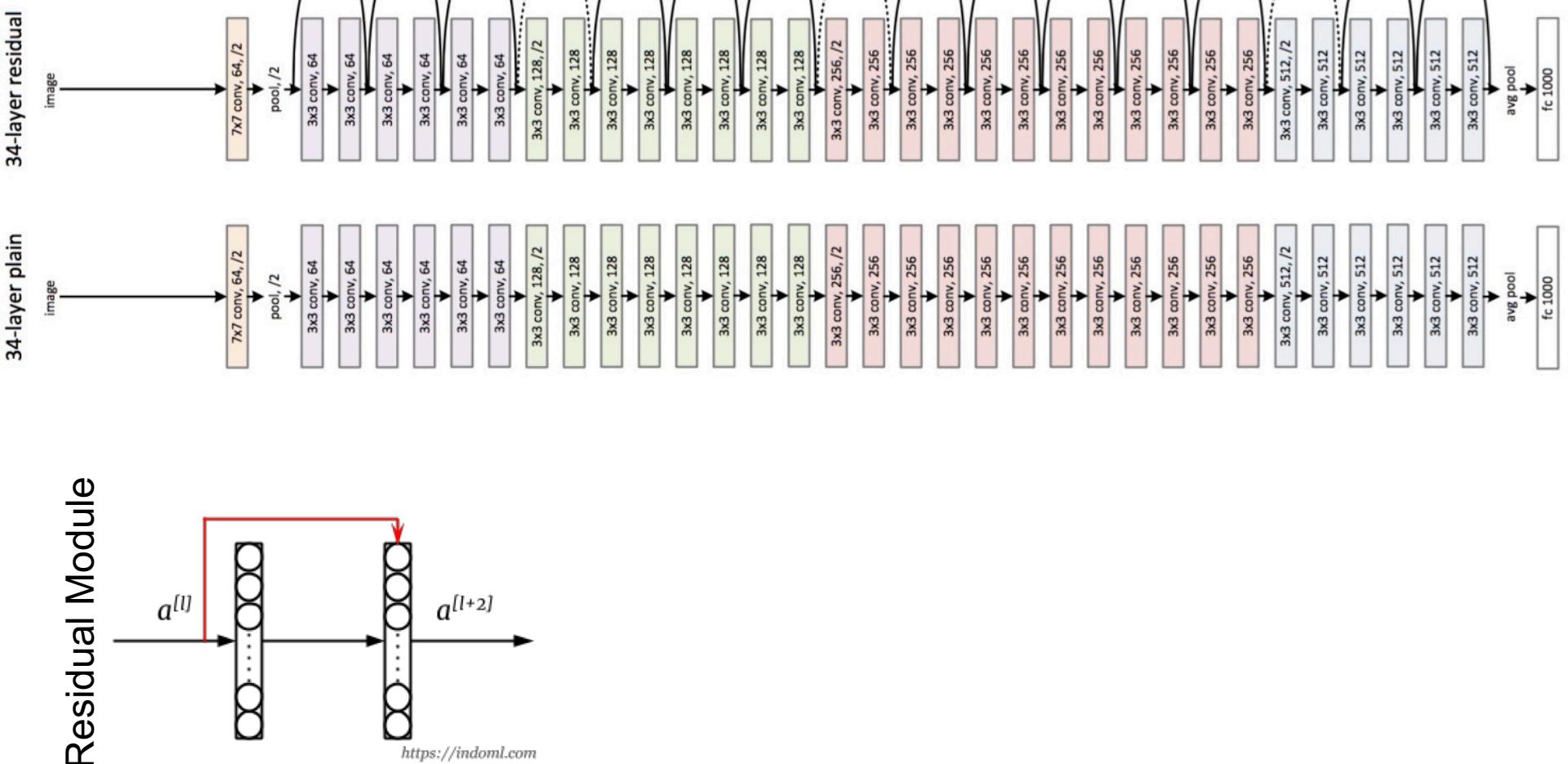


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# VGG-16

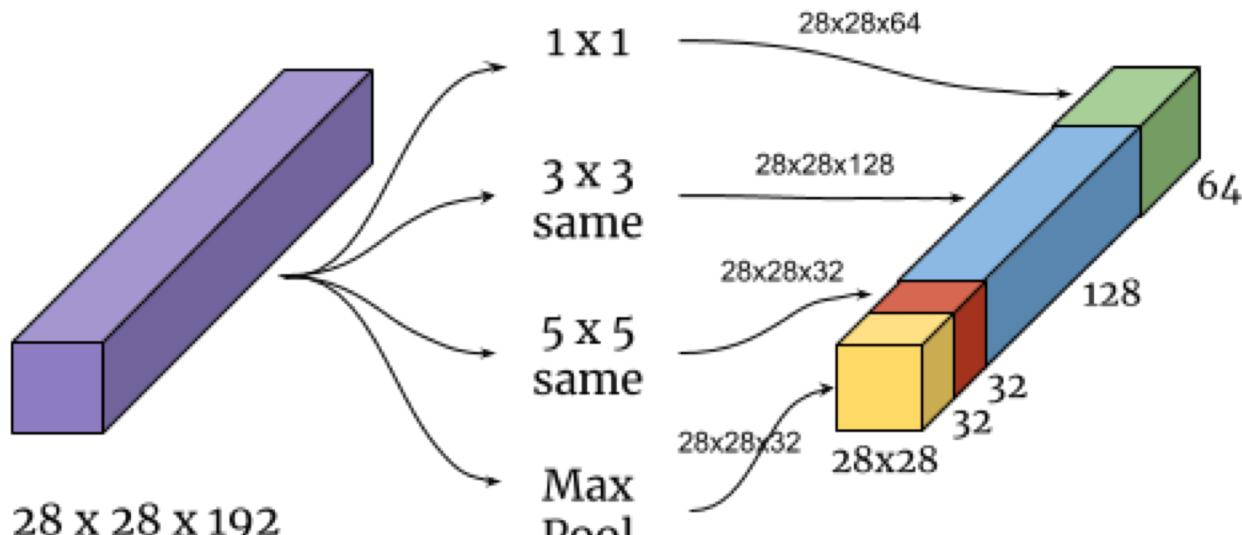


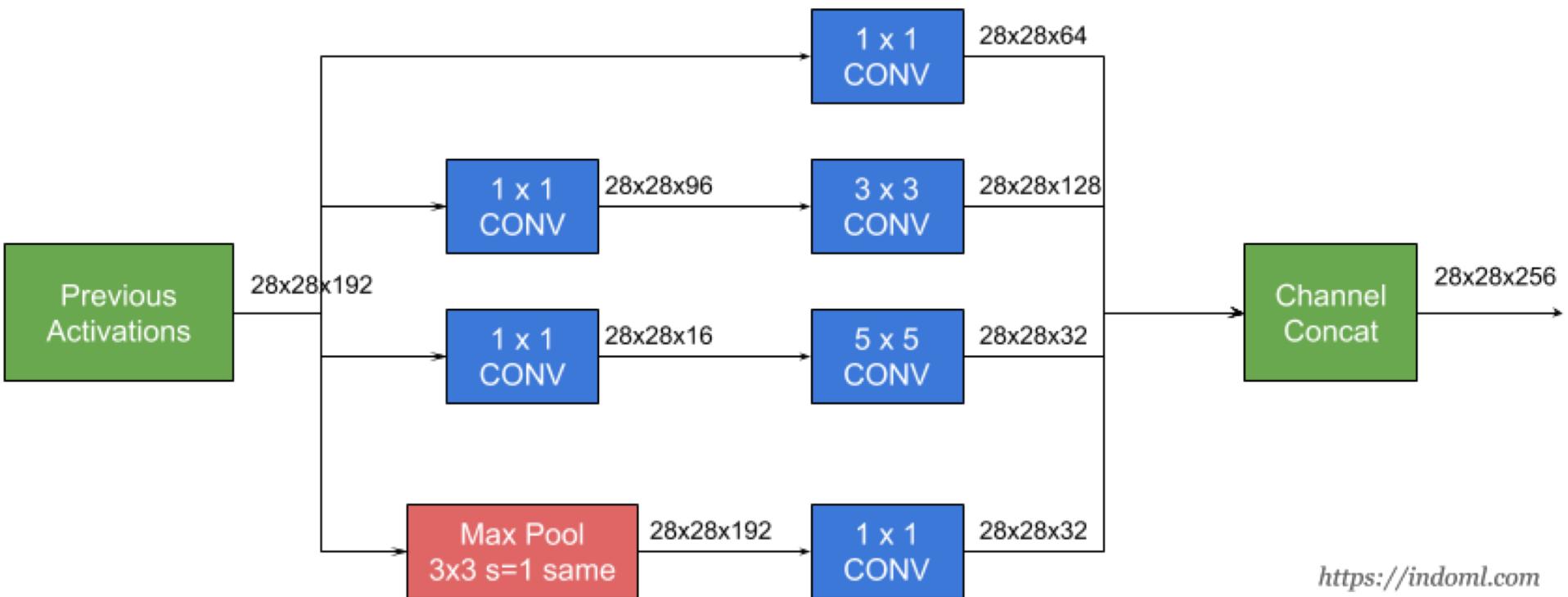
# ResNet



# GoogLeNet

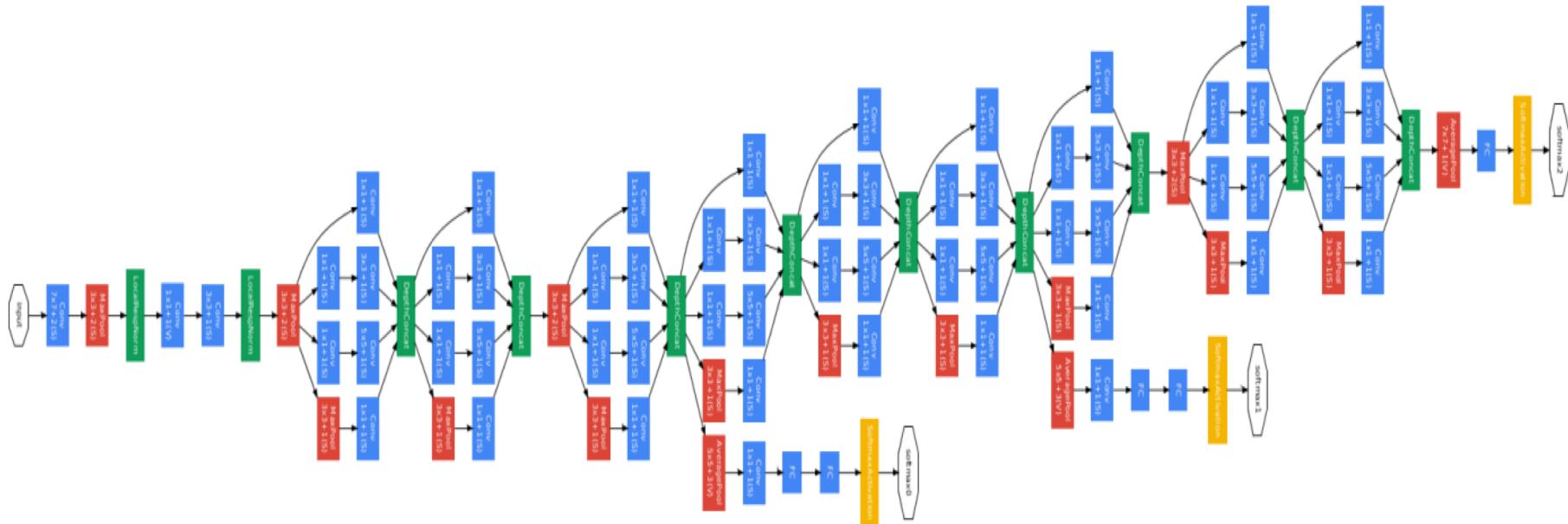
## Inception Module





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# GoogLeNet:



# Summary of Networks

Year	CNN	Developed by	Place	Top-5 error rate	No. of parameters
1998	LeNet(8)	Yann LeCun et al			60 thousand
2012	AlexNet(7)	Alex Krizhevsky, Geoffrey Hinton, Ilya Sutskever	1st	15.3%	60 million
2014	GoogLeNet(19)	Google	1st	6.67%	4 million
2014	VGG Net(16)	Simonyan, Zisserman	2nd	7.3%	138 million
2015	ResNet(152)	Kaiming He	1st	3.6%	