아티스트를 위한 머신러닝 & 딥러닝

텐서플로를 활용한 딥러닝 #4

서울대학교 & V.DO / 김대식

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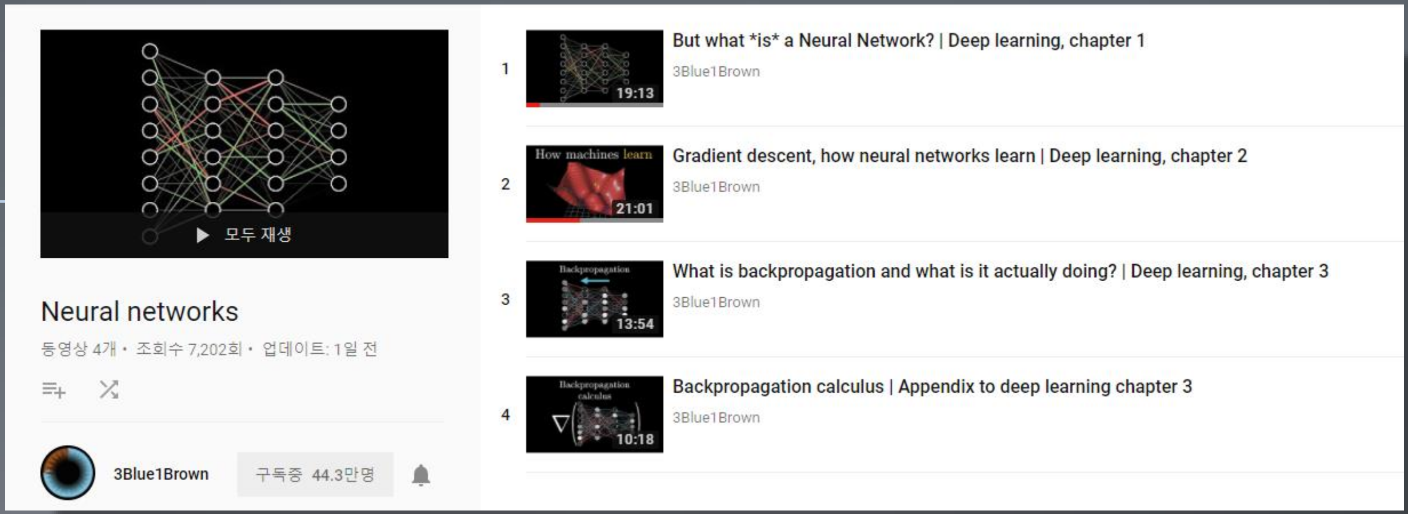
Recap

What is a Neural network ?



https://youtu.be/aircAruvnKk

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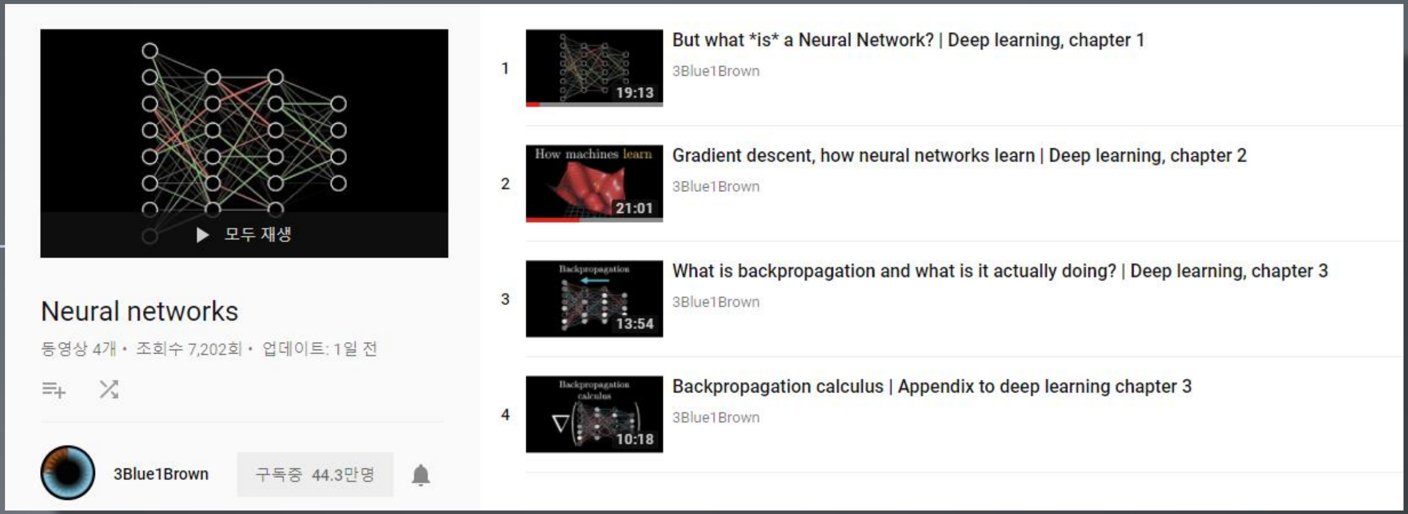
Gradient descent



https://youtu.be/IHZwWFHWa-w

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컨볼루션 신경망
(Convolution Neural Network)

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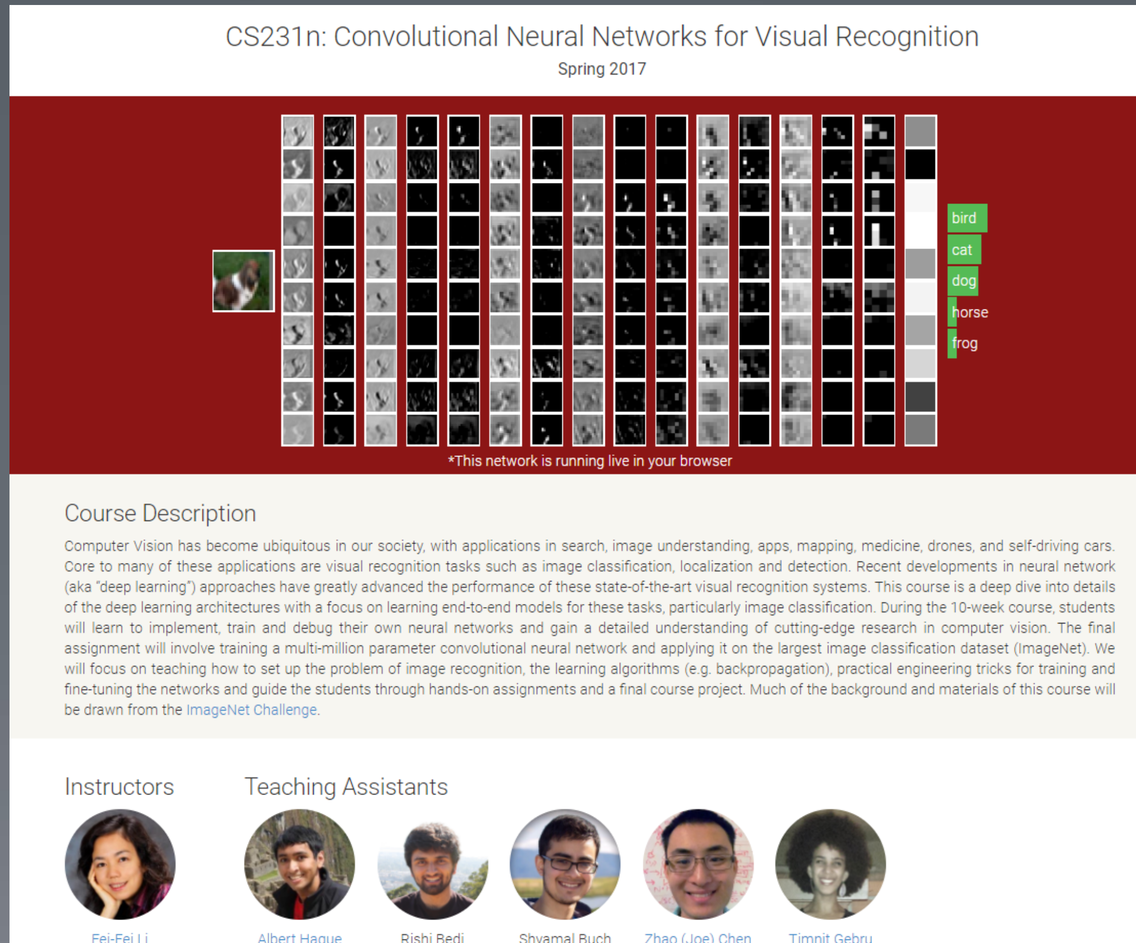


http://cs231n.stanford.edu/

Next: Convolutional Neural Networks

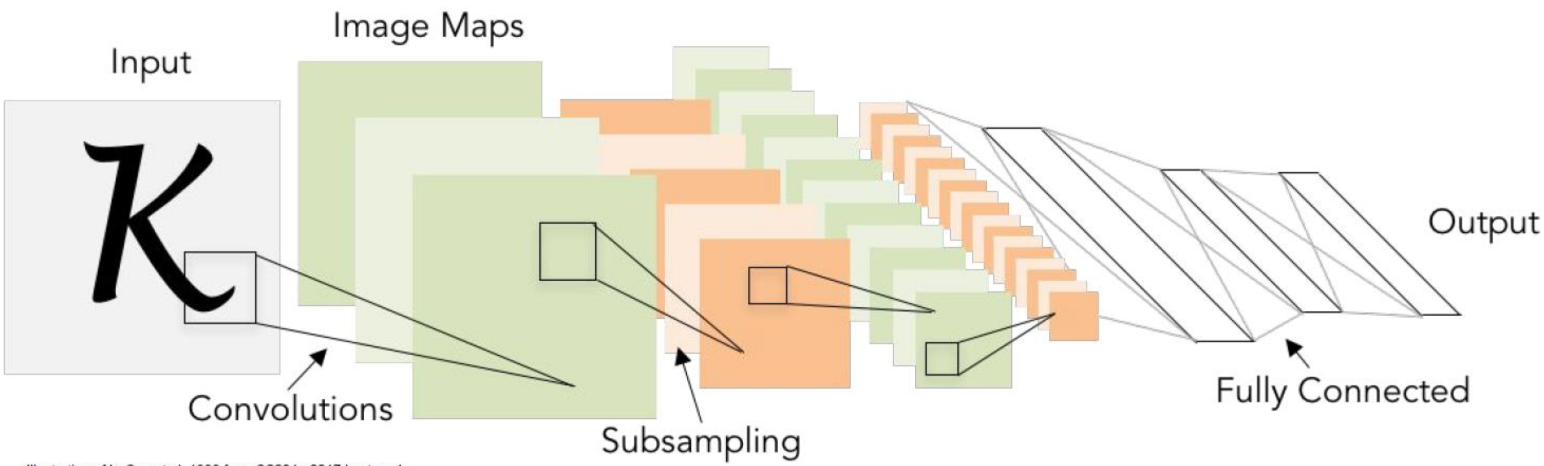
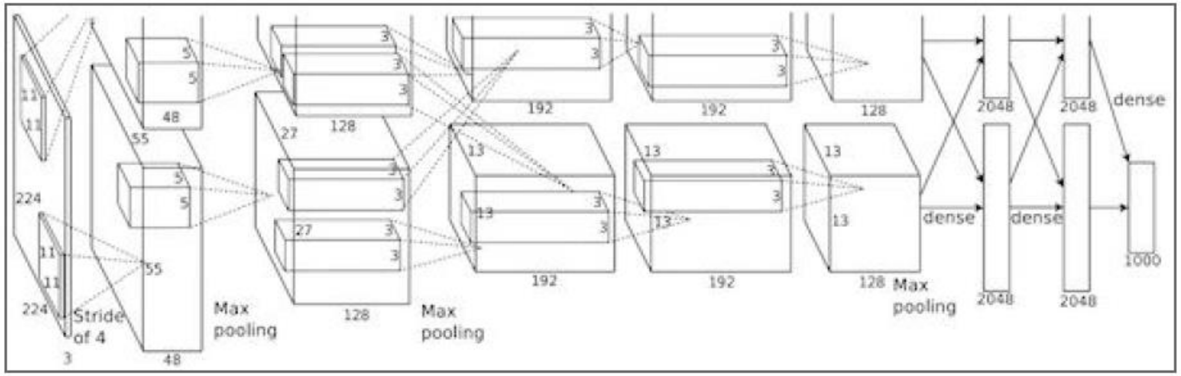


Illustration of LeCun et al. 1998 from CS231n 2017 Lecture 1

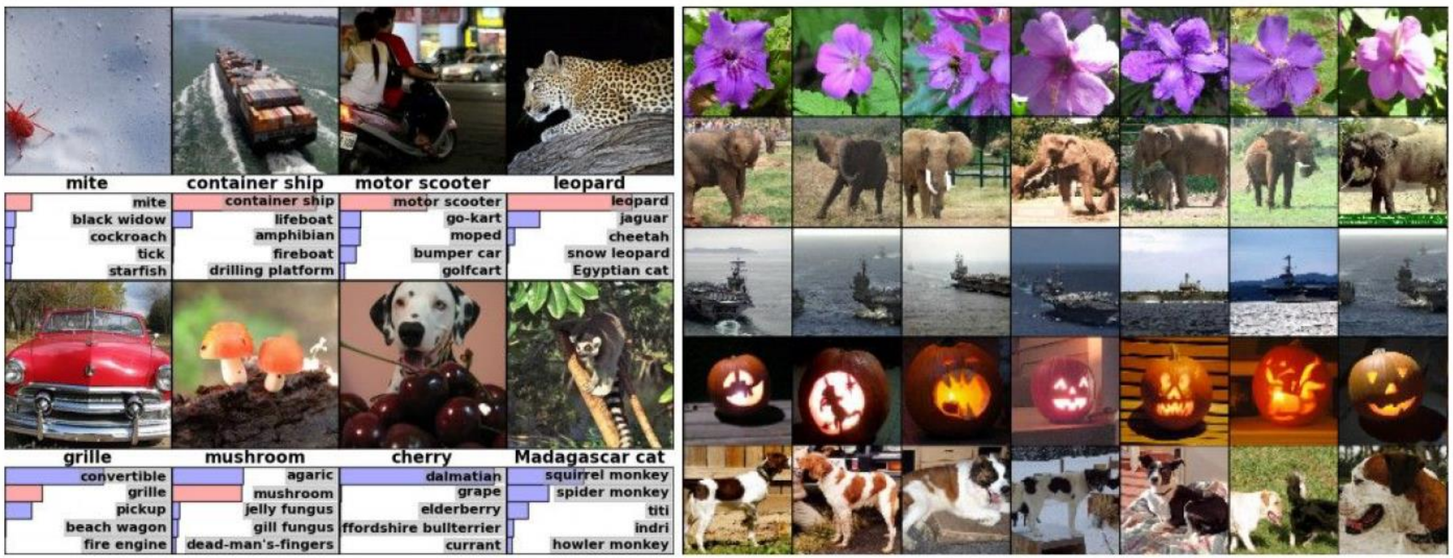
ImageNet Classification with Deep Convolutional Neural Networks
[Krizhevsky, Sutskever, Hinton, 2012]



"AlexNet"

Fast-forward to today: ConvNets are everywhere

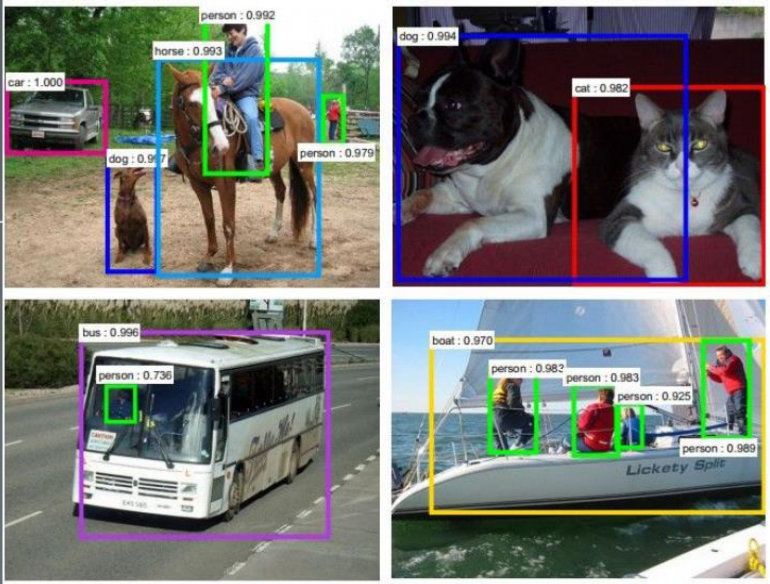
Classification Retrieval



Figures copyright Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton, 2012. Reproduced with permission.

Fast-forward to today: ConvNets are everywhere

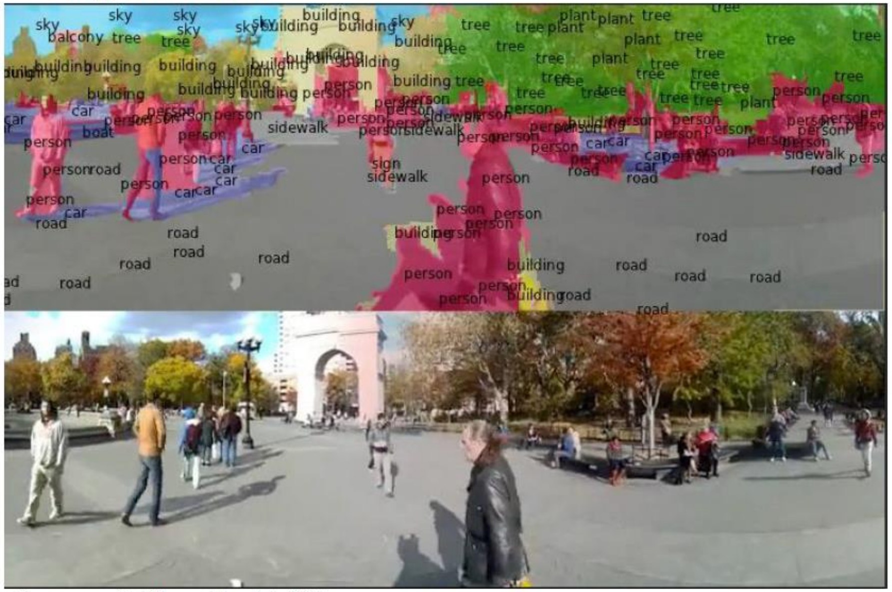
Detection



Figures copyright Shaoqing Ren, Kaiming He, Ross Girschick, Jian Sun, 2015. Reproduced with permission.

[Faster R-CNN: Ren, He, Girshick, Sun 2015]

Segmentation



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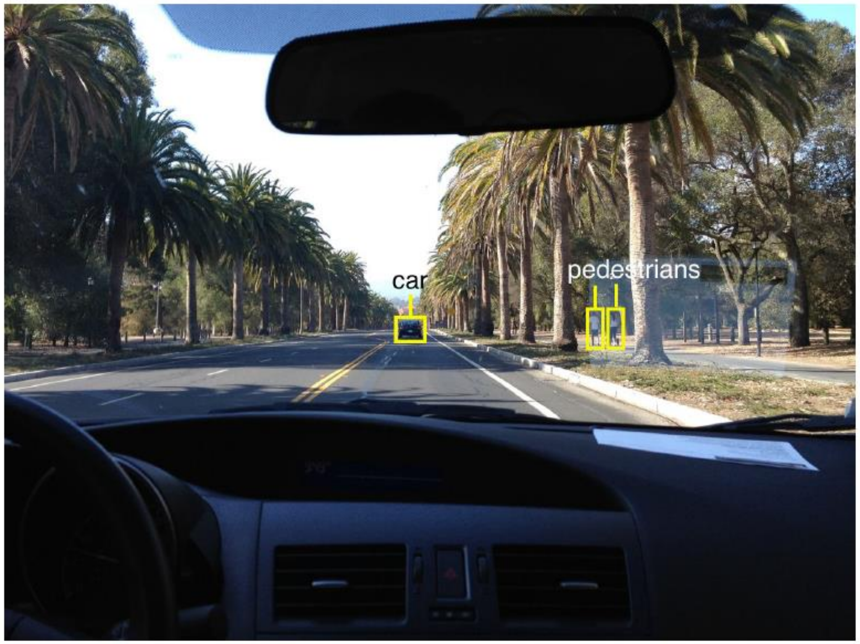
[Farabet et al., 2012]

Fast-forward to today: ConvNets are everywhere

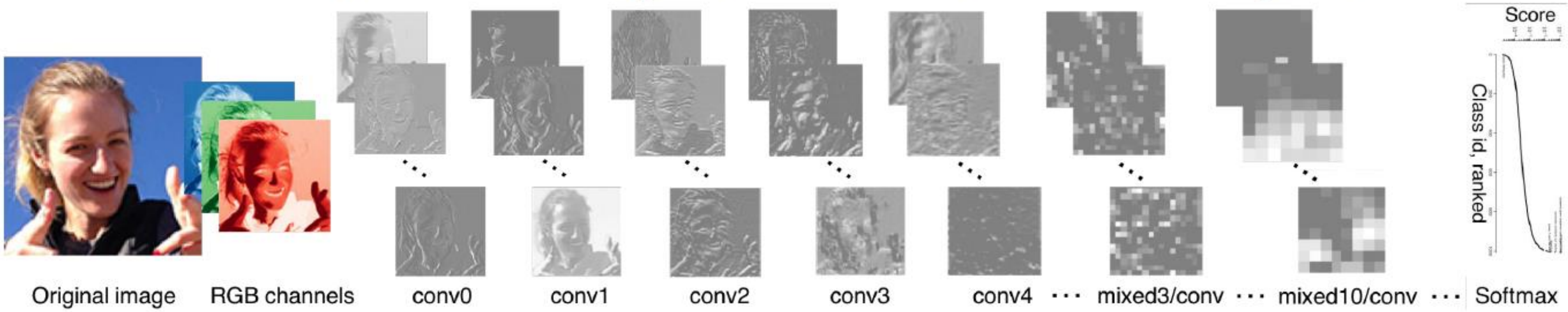


self-driving cars

NVIDIA Tesla line
(these are the GPUs on rye01.stanford.edu)

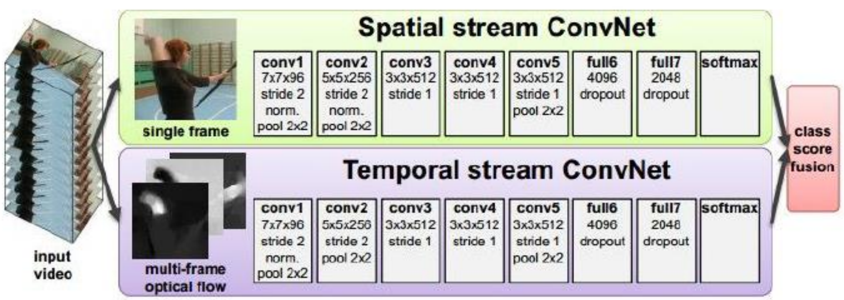
Note that for embedded systems a typical setup would involve NVIDIA Tegras, with integrated GPU and ARM-based CPU cores.

Fast-forward to today: ConvNets are everywhere



[Taigman et al. 2014]

Activations of inception-v3 architecture [Szegedy et al. 2015] to image of Emma McIntosh, used with permission. Figure and architecture not from Taigman et al. 2014.



[Simonyan et al. 2014]

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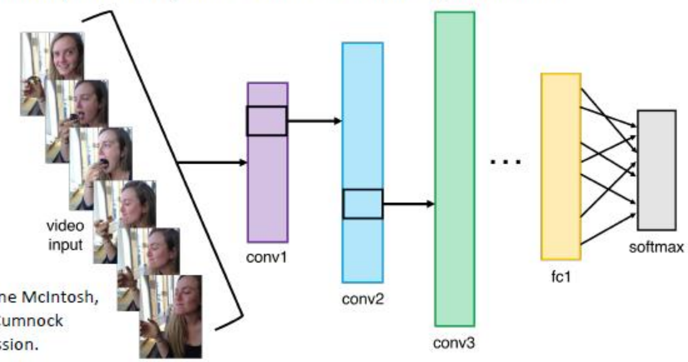


Illustration by Lane McIntosh, photos of Katie Cumnock used with permission.

Fast-forward to today: ConvNets are everywhere

[Toshev, Szegedy 2014]

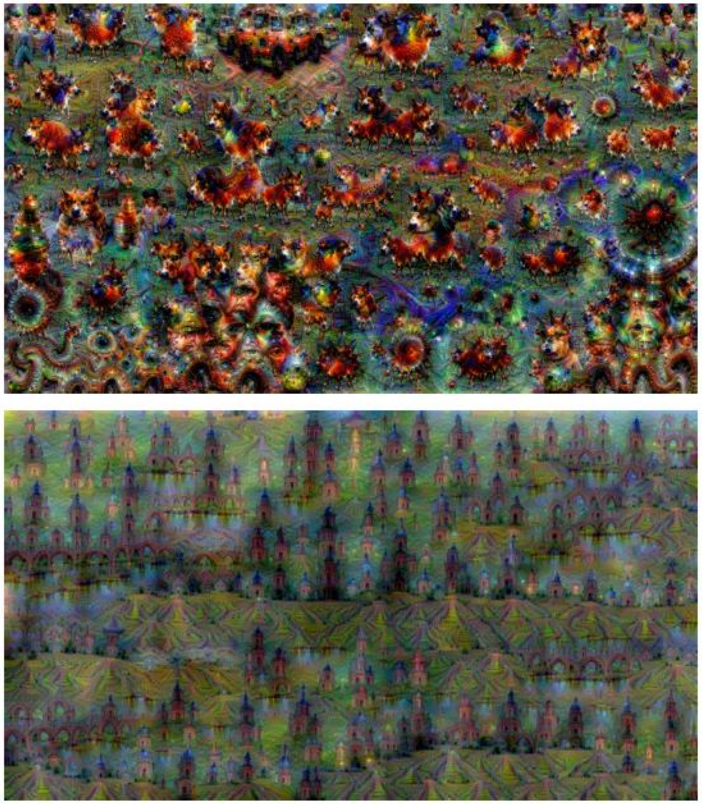
[Guo et al. 2014]

Image Captioning

[Vinyals et al., 2015]
[Karpathy and Fei-Fei, 2015]

No errors	Minor errors	Somewhat related
		
A white teddy bear sitting in the grass	*A man in a baseball uniform throwing a ball*	*A woman is holding a cat in her hand*
		
A man riding a wave on top of a surfboard	*A cat sitting on a suitcase on the floor*	*A woman standing on a beach holding a surfboard*

Captions generated by Justin Johnson using Neuraltalk2



Figures copyright Justin Johnson, 2015. Reproduced with permission. Generated using the Inceptionism approach from a blog post by Google Research.

Original image is CC0 public domain
Starry Night and Tree Roots by Van Gogh are in the public domain
Bokeh image is in the public domain
Stylized images copyright Justin Johnson, 2017;
reproduced with permission

Gatys et al, "Image Style Transfer using Convolutional Neural Networks", CVPR 2016
Gatys et al, "Controlling Perceptual Factors in Neural Style Transfer", CVPR 2017

컨볼루션 비디오

https://www.youtube.com/watch?v=KiftWz544_8

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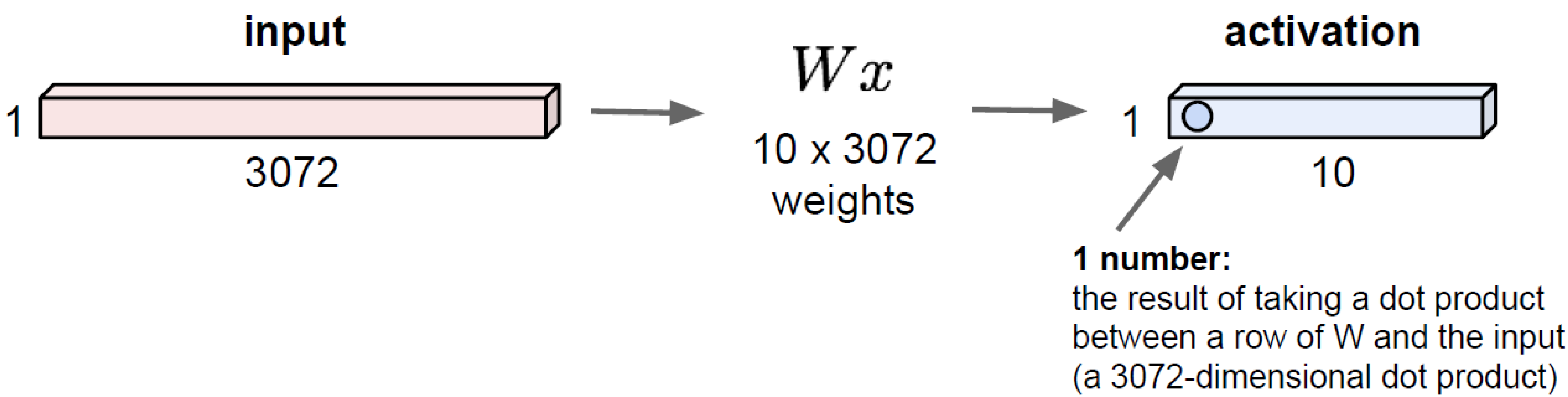
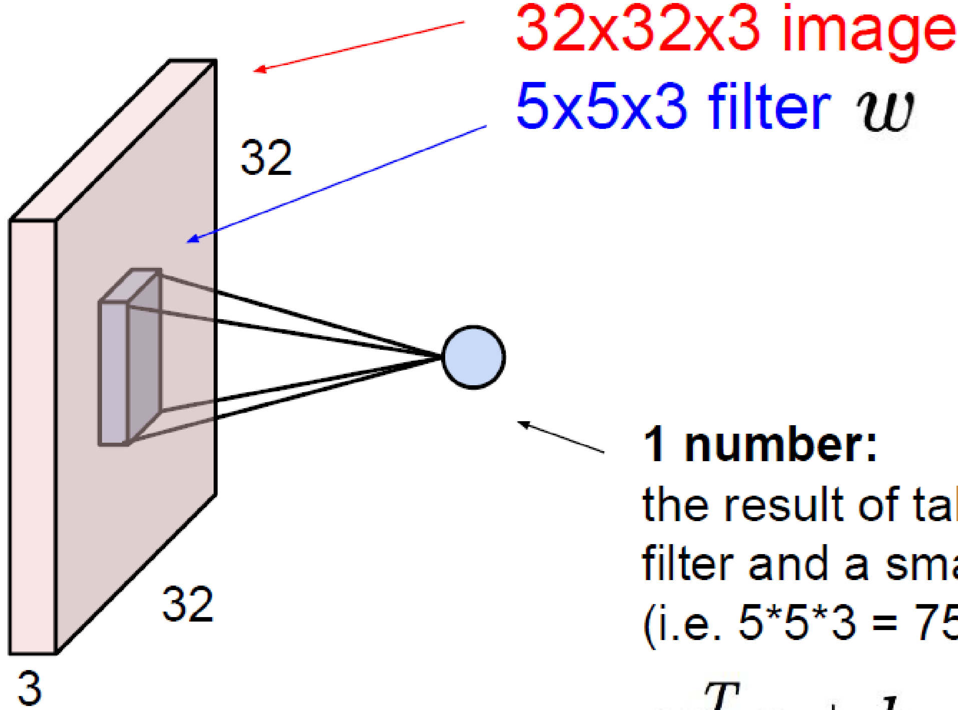
Fully Connected Layer

32x32x3 image -> stretch to 3072 x 1



Convolution Layer

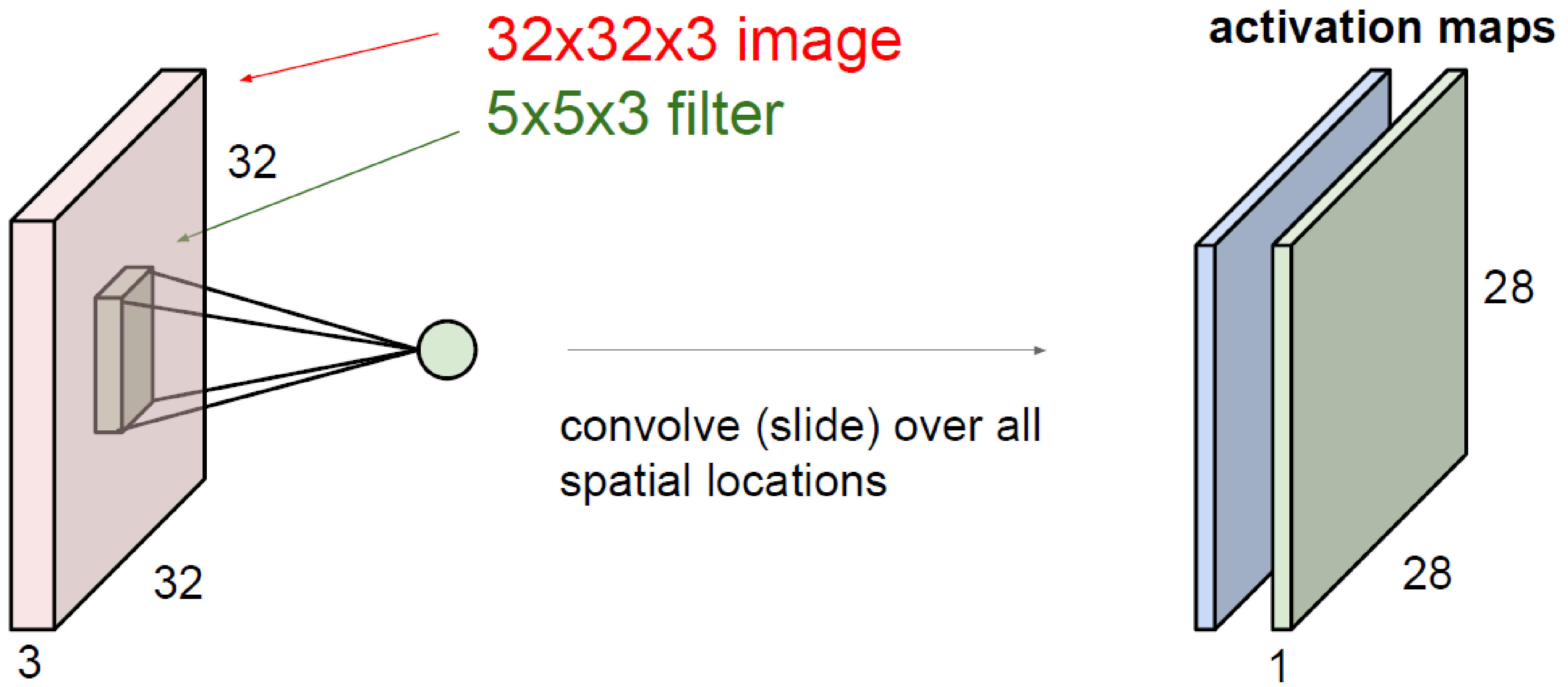


1 number:
the result of taking a dot product between the filter and a small 5x5x3 chunk of the image (i.e. 5*5*3 = 75-dimensional dot product + bias)

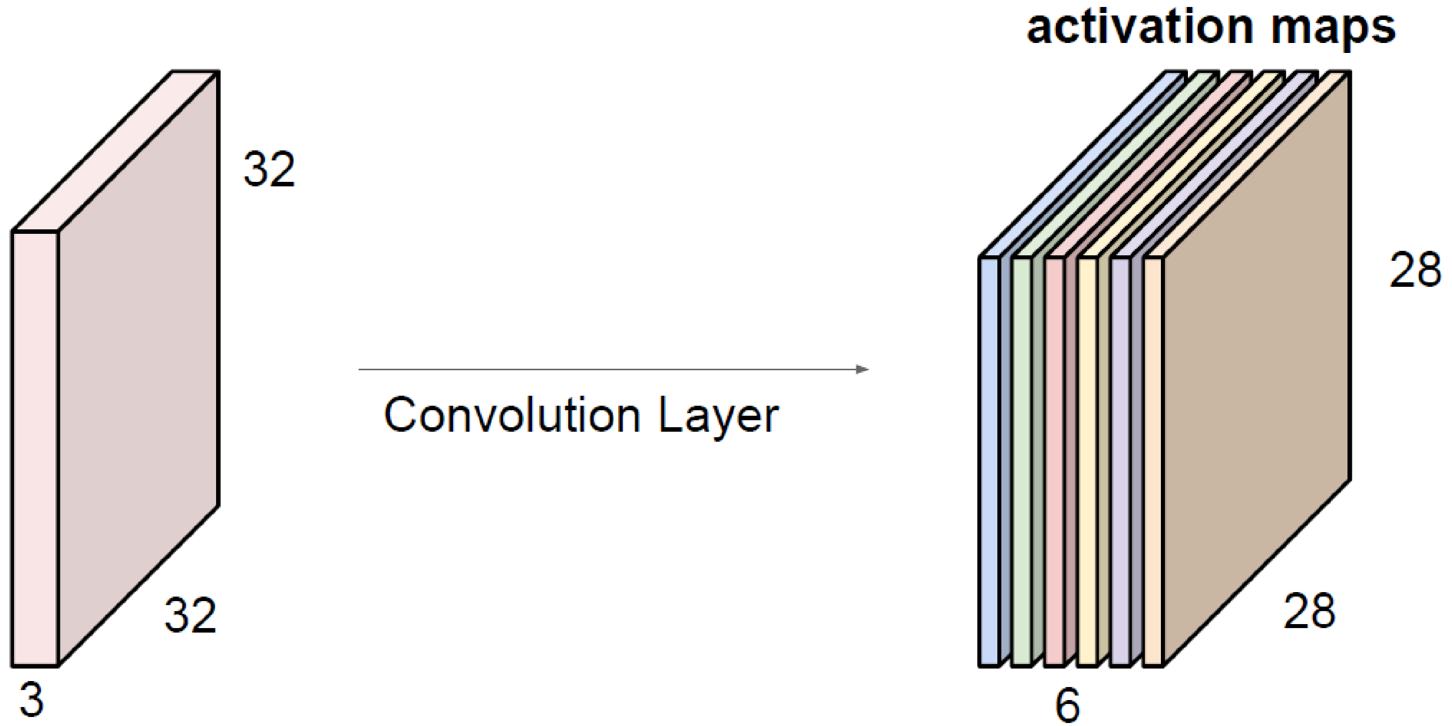
$$w^T x + b$$

Convolution Layer

consider a second, green filter

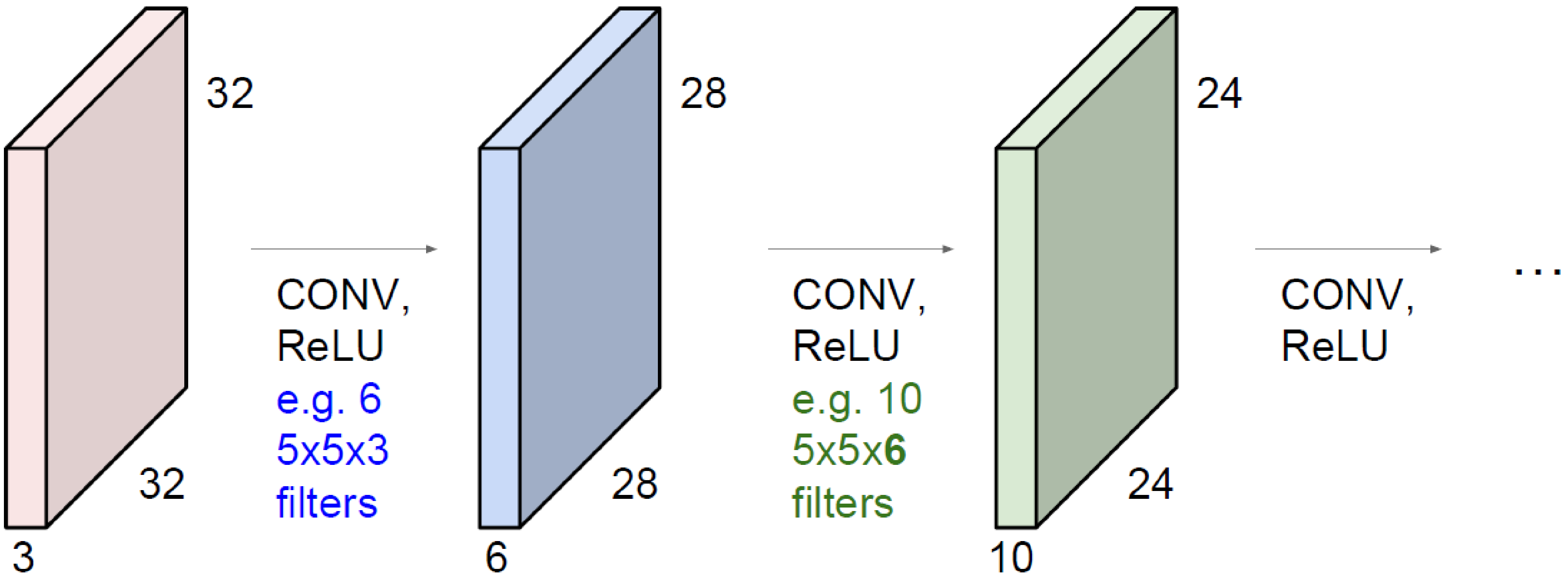


For example, if we had 6 5x5 filters, we'll get 6 separate activation maps:



We stack these up to get a "new image" of size 28x28x6!

Preview: ConvNet is a sequence of Convolutional Layers, interspersed with activation functions

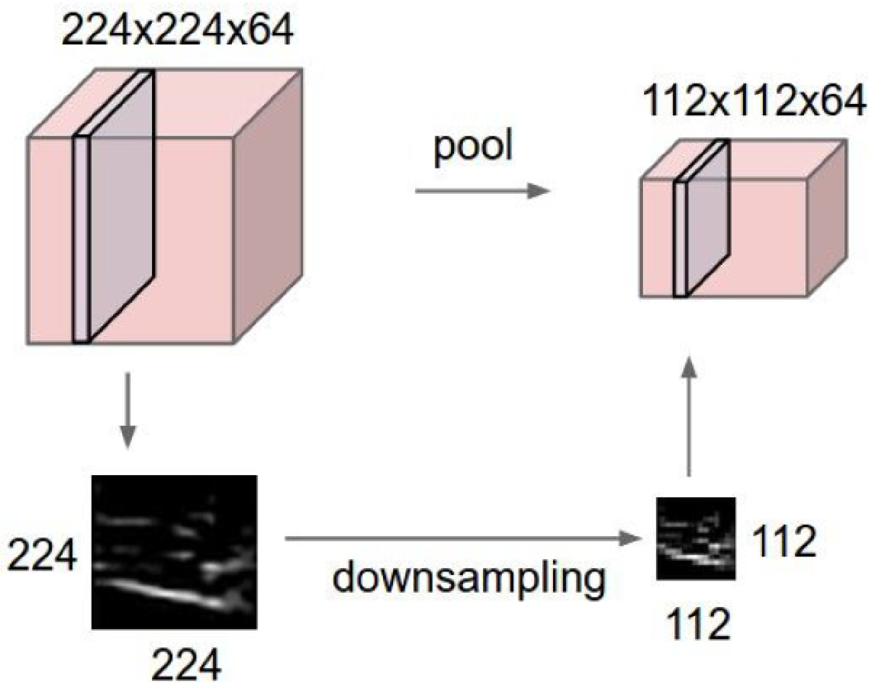


풀링 비디오

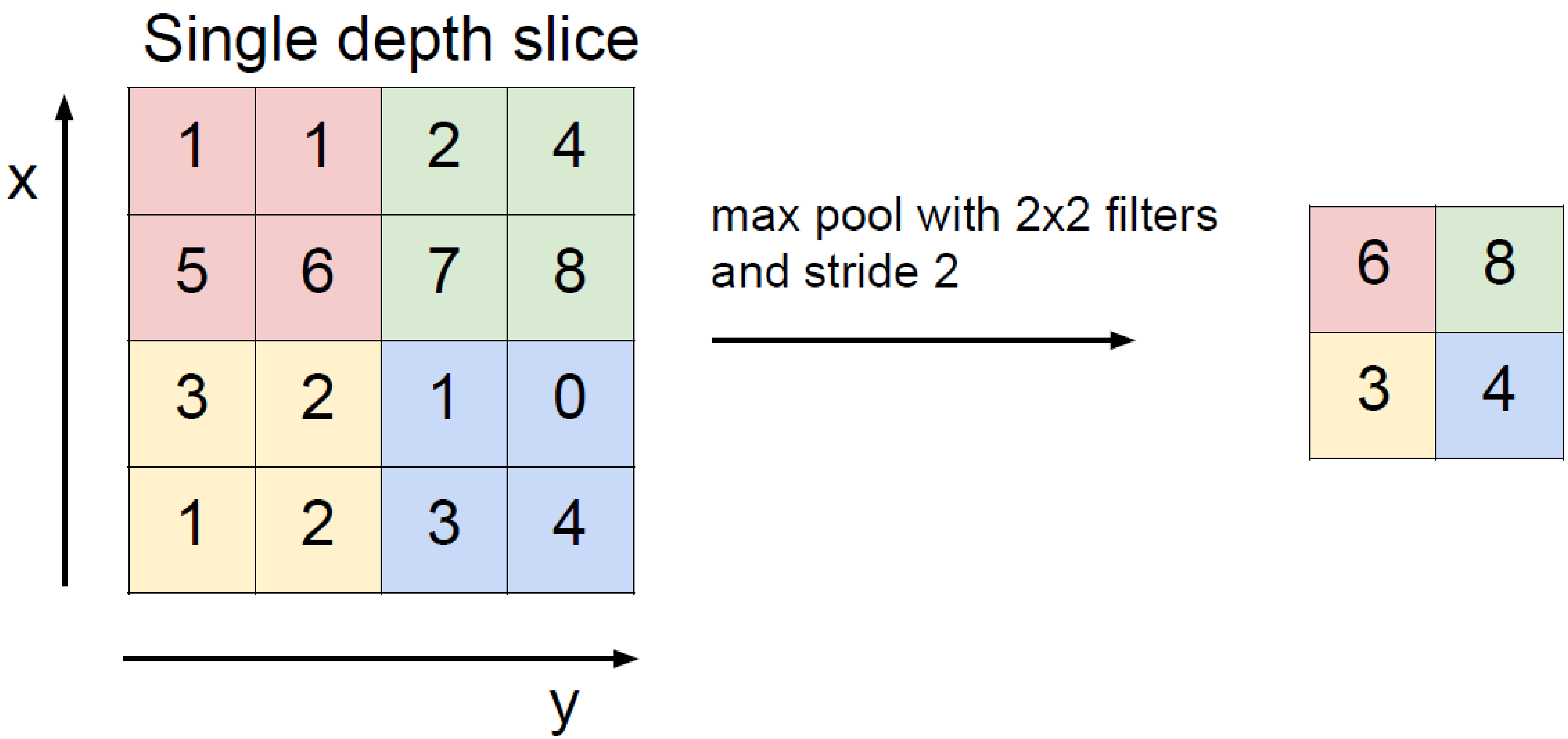
https://www.youtube.com/watch?v=mW3KyFZDNIQ

Pooling layer

- makes the representations smaller and more manageable
- operates over each activation map independently:



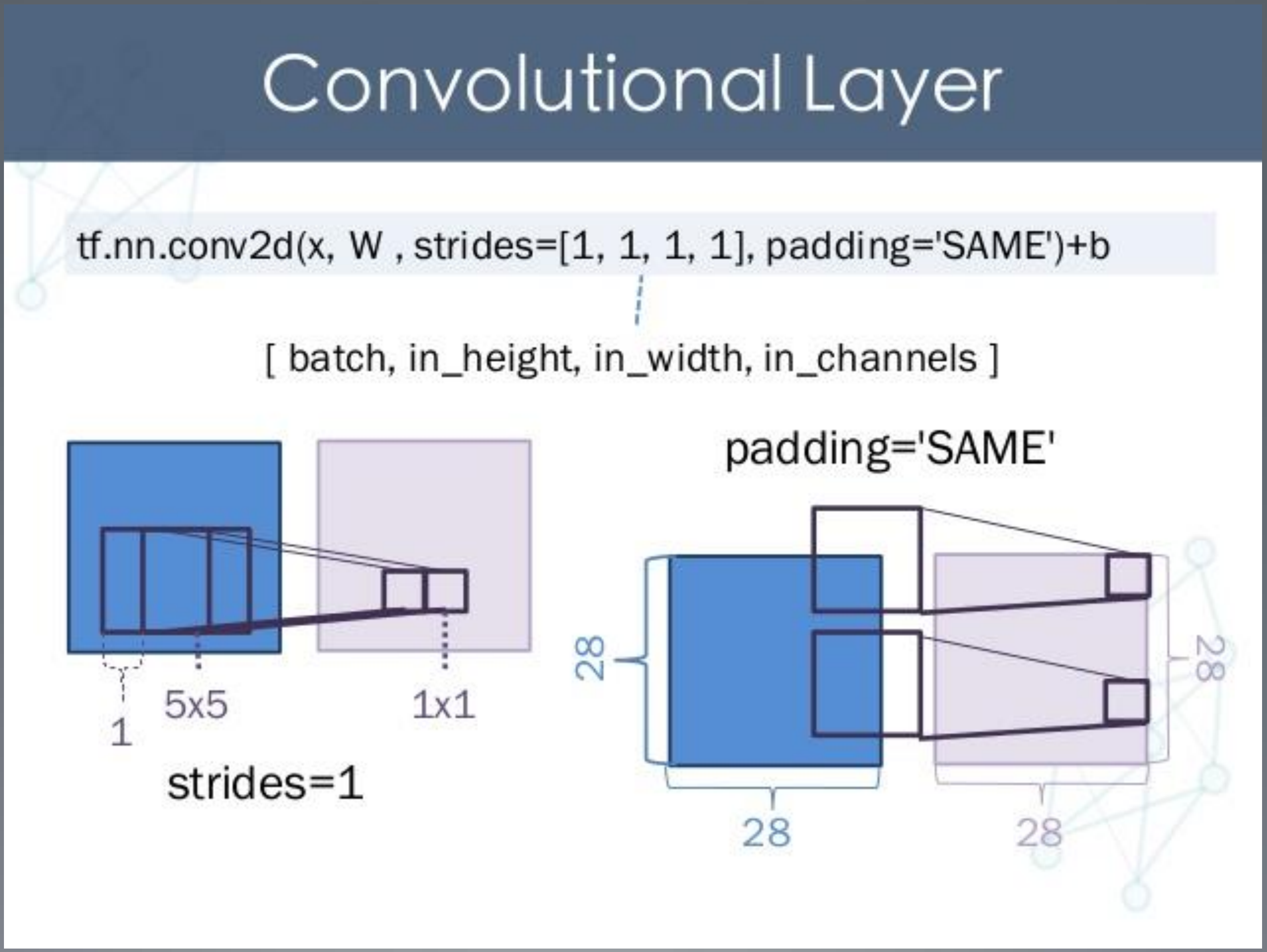
MAX POOLING



Single depth slice
x
y
1 1 2 4
5 6 7 8
3 2 1 0
1 2 3 4
max pool with 2x2 filters
and stride 2
6 8
3 4

텐서플로 실습

컨볼루션 in 텐서플로



Convolutional Layer
tf.nn.conv2d(x, W , strides=[1, 1, 1, 1], padding='SAME')+b
[batch, in_height, in_width, in_channels]
5x5
1x1
1
strides=1
padding='SAME'
28
28
28
28

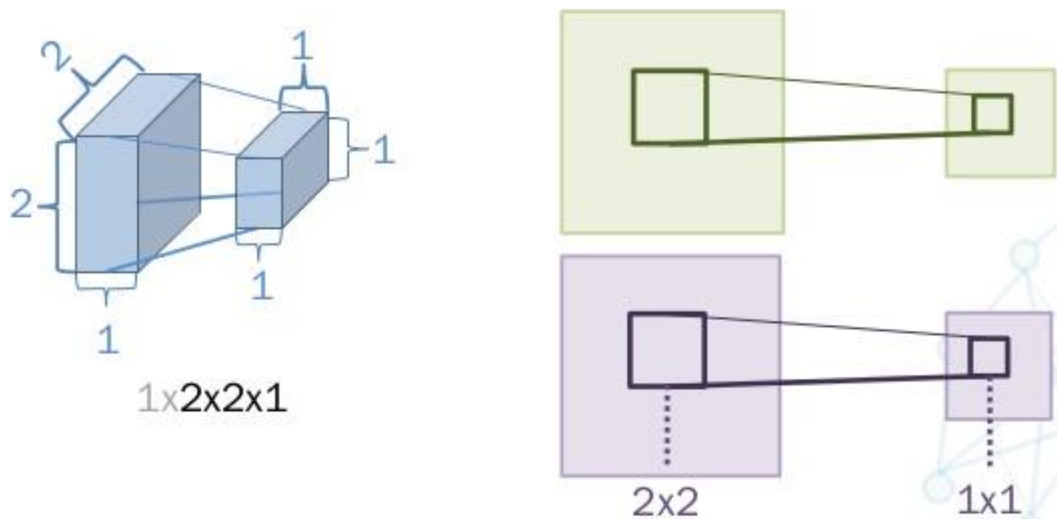
컨볼루션 in 텐서플로

```
def createNetwork():
    # network weights
    W_conv1 = weight_variable([3, 3, 4, 32])
    b_conv1 = bias_variable([32])

    W_conv2 = weight_variable([3, 3, 32, 64])
    b_conv2 = bias_variable([64])

    W_conv3 = weight_variable([3, 3, 64, 64])
    b_conv3 = bias_variable([64])


    W_fc1 = weight_variable([6400, 512])
    b_fc1 = bias_variable([512])

    W_fc2 = weight_variable([512, ACTIONS])
    b_fc2 = bias_variable([ACTIONS])

    # input layer
    s = tf.placeholder("float", [None, 80, 80, 4])

    # hidden layers
    h_conv1 = tf.nn.relu(conv2d(s, W_conv1, 1) + b_conv1)
    h_pool1 = max_pool_2x2(h_conv1)

    h_conv2 = tf.nn.relu(conv2d(h_pool1, W_conv2, 1) + b_conv2)
    h_pool2 = max_pool_2x2(h_conv2)

    h_conv3 = tf.nn.relu(conv2d(h_pool2, W_conv3, 1) + b_conv3)
    h_pool3 = max_pool_2x2(h_conv3)


    #h_pool3_flat = tf.reshape(h_pool3, [-1, 256])
    h_conv3_flat = tf.reshape(h_pool3, [-1, 6400])

    h_fc1 = tf.nn.relu(tf.matmul(h_conv3_flat, W_fc1) + b_fc1)
```

맥스풀링 in 텐서플로

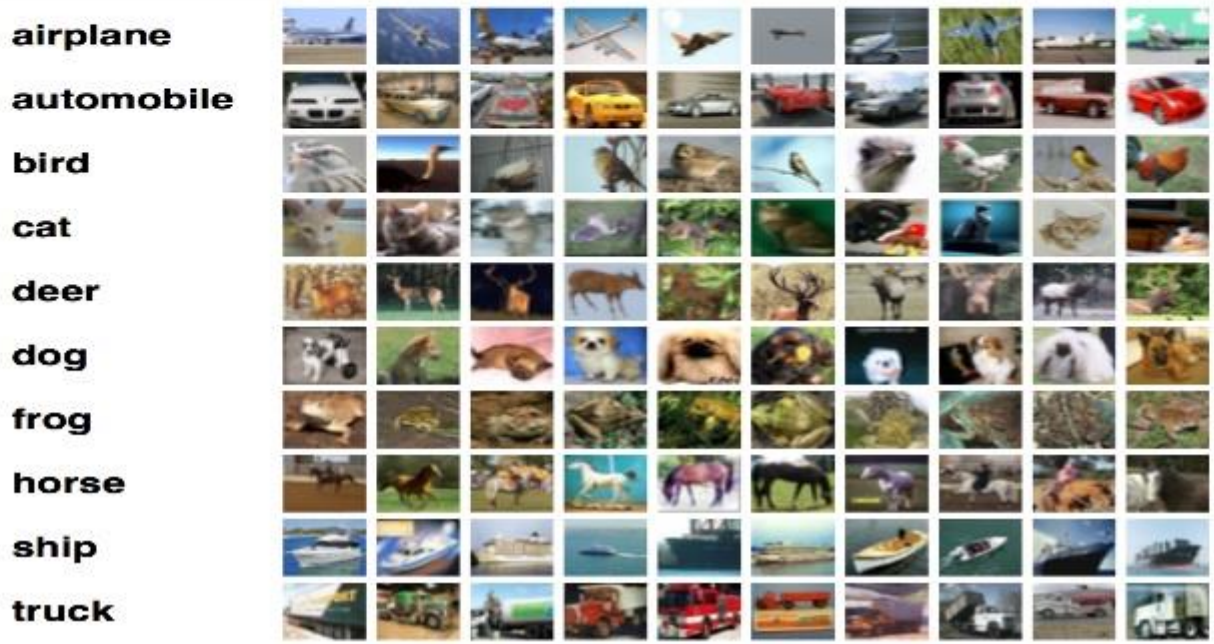
Pooling Layer

```
tf.nn.max_pool(x, ksize=[1, 2, 2, 1],
               strides=[1, 2, 2, 1], padding='SAME')
```



CIFAR-10

CIFAR-10 Model



Data Sets

data_sets.train	50000 images & labels
data_sets.validation	1000 images & labels
data_sets.test	10000 images & labels

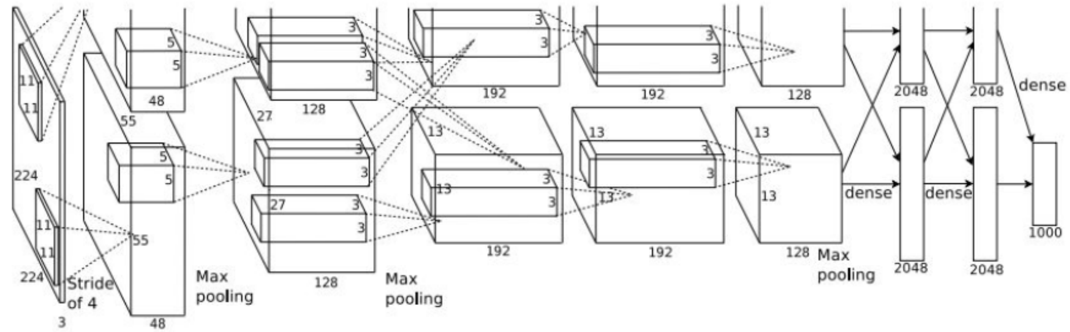
Source: http://www.cs.toronto.edu/~kriz/cifar.html

웹버전 실습

http://cs.stanford.edu/people/karpathy/convnetjs/demo/cifar10.html

Case Study: AlexNet

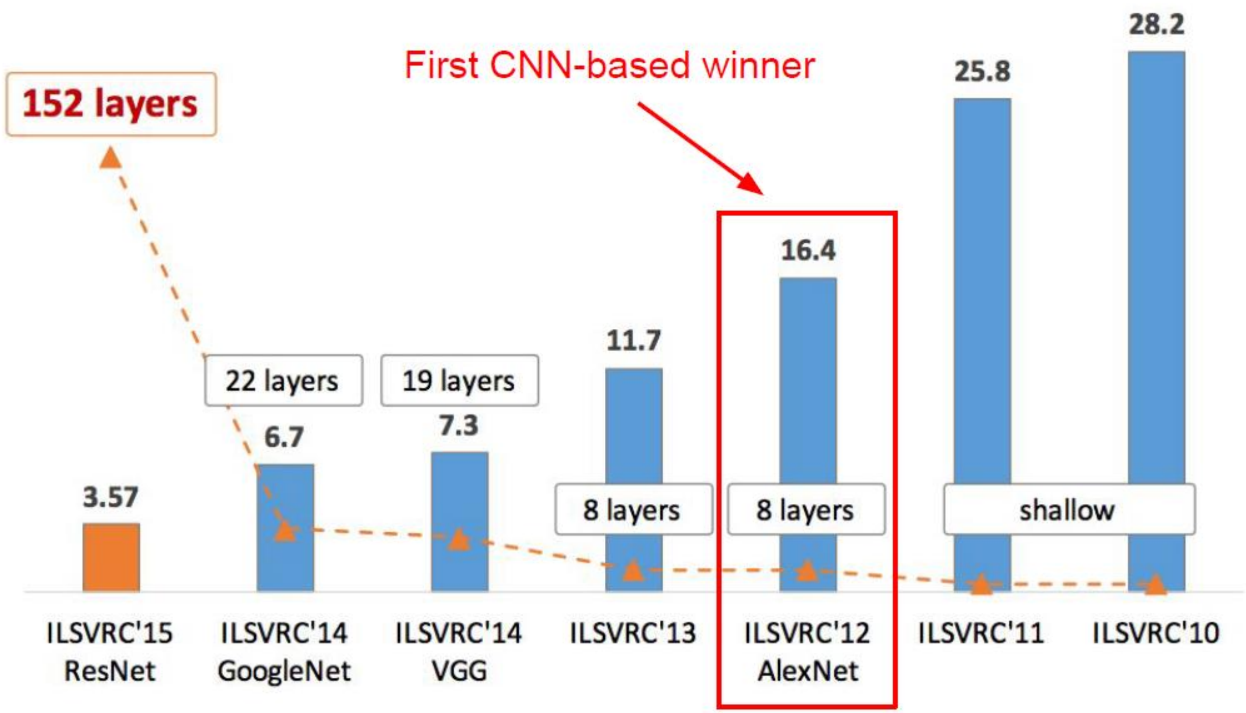
[Krizhevsky et al. 2012]



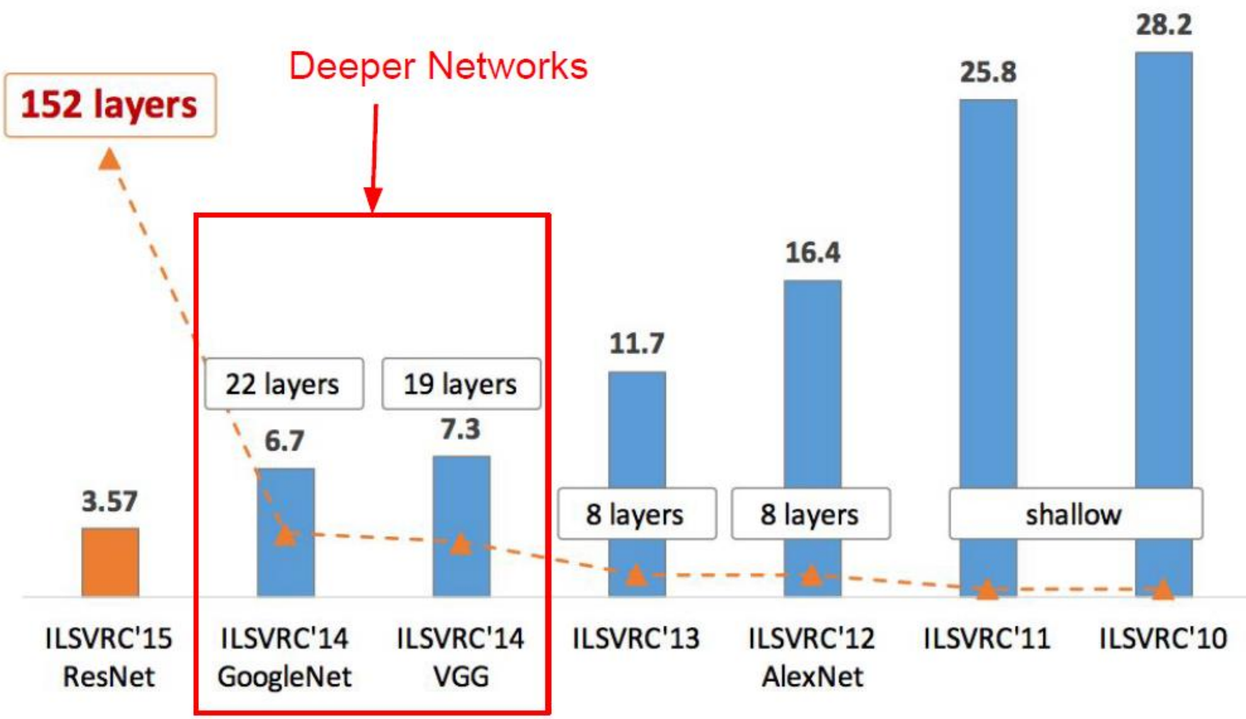
Full (simplified) AlexNet architecture:
[227x227x3] INPUT
[55x55x96] CONV1: 96 11x11 filters at stride 4, pad 0
[27x27x96] MAX POOL1: 3x3 filters at stride 2
[27x27x96] NORM1: Normalization layer
[27x27x256] CONV2: 256 5x5 filters at stride 1, pad 2
[13x13x256] MAX POOL2: 3x3 filters at stride 2
[13x13x256] NORM2: Normalization layer
[13x13x384] CONV3: 384 3x3 filters at stride 1, pad 1
[13x13x384] CONV4: 384 3x3 filters at stride 1, pad 1
[13x13x256] CONV5: 256 3x3 filters at stride 1, pad 1
[6x6x256] MAX POOL3: 3x3 filters at stride 2
[4096] FC6: 4096 neurons
[4096] FC7: 4096 neurons
[1000] FC8: 1000 neurons (class scores)

Details/Retrospectives:
- first use of ReLU
- used Norm layers (not common anymore)
- heavy data augmentation
- dropout 0.5
- batch size 128
- SGD Momentum 0.9
- Learning rate 1e-2, reduced by 10 manually when val accuracy plateaus
- L2 weight decay 5e-4
- 7 CNN ensemble: 18.2% -> 15.4%

ImageNet Large Scale Visual Recognition Challenge (ILSVRC) winners



ImageNet Large Scale Visual Recognition Challenge (ILSVRC) winners



Case Study: VGGNet

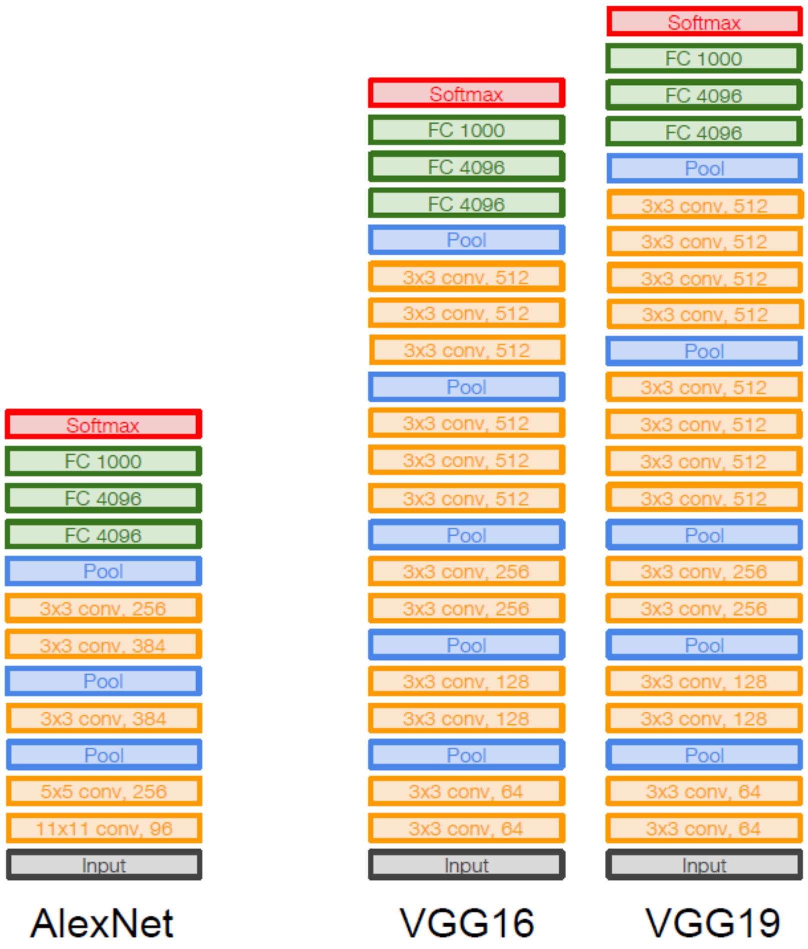
[Simonyan and Zisserman, 2014]

Small filters, Deeper networks

8 layers (AlexNet)
-> 16 - 19 layers (VGG16Net)

Only 3x3 CONV stride 1, pad 1
and 2x2 MAX POOL stride 2

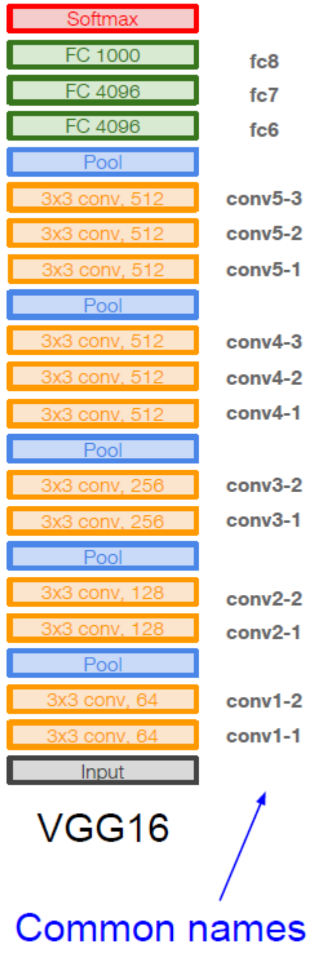
11.7% top 5 error in ILSVRC'13
(ZFNet)
-> 7.3% top 5 error in ILSVRC'14



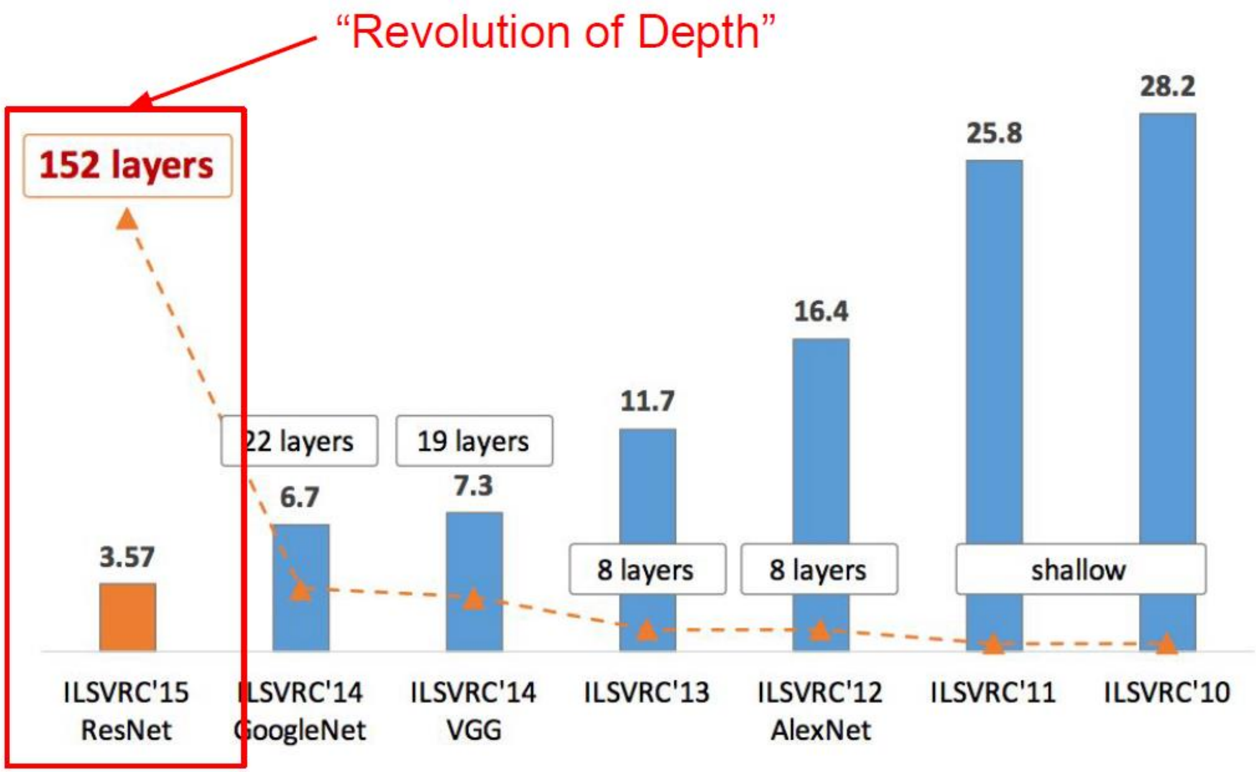
(not counting biases)

INPUT: [224x224x3] memory: 224*224*3=150K params: 0
CONV3-64: [224x224x64] memory: 224*224*64=3.2M params: (3*3*3)*64 = 1,728
CONV3-64: [224x224x64] memory: 224*224*64=3.2M params: (3*3*64)*64 = 36,864
POOL2: [112x112x64] memory: 112*112*64=800K params: 0
CONV3-128: [112x112x128] memory: 112*112*128=1.6M params: (3*3*64)*128 = 73,728
CONV3-128: [112x112x128] memory: 112*112*128=1.6M params: (3*3*128)*128 = 147,456
POOL2: [56x56x128] memory: 56*56*128=400K params: 0
CONV3-256: [56x56x256] memory: 56*56*256=800K params: (3*3*128)*256 = 294,912
CONV3-256: [56x56x256] memory: 56*56*256=800K params: (3*3*256)*256 = 589,824
CONV3-256: [56x56x256] memory: 56*56*256=800K params: (3*3*256)*256 = 589,824
POOL2: [28x28x256] memory: 28*28*256=200K params: 0
CONV3-512: [28x28x512] memory: 28*28*512=400K params: (3*3*256)*512 = 1,179,648
CONV3-512: [28x28x512] memory: 28*28*512=400K params: (3*3*512)*512 = 2,359,296
CONV3-512: [28x28x512] memory: 28*28*512=400K params: (3*3*512)*512 = 2,359,296
POOL2: [14x14x512] memory: 14*14*512=100K params: 0
CONV3-512: [14x14x512] memory: 14*14*512=100K params: (3*3*512)*512 = 2,359,296
CONV3-512: [14x14x512] memory: 14*14*512=100K params: (3*3*512)*512 = 2,359,296
CONV3-512: [14x14x512] memory: 14*14*512=100K params: (3*3*512)*512 = 2,359,296
POOL2: [7x7x512] memory: 7*7*512=25K params: 0
FC: [1x1x4096] memory: 4096 params: 7*7*512*4096 = 102,760,448
FC: [1x1x4096] memory: 4096 params: 4096*4096 = 16,777,216
FC: [1x1x1000] memory: 1000 params: 4096*1000 = 4,096,000

TOTAL memory: 24M * 4 bytes ~= 96MB / image (only forward! ~*2 for bwd)
TOTAL params: 138M parameters



ImageNet Large Scale Visual Recognition Challenge (ILSVRC) winners

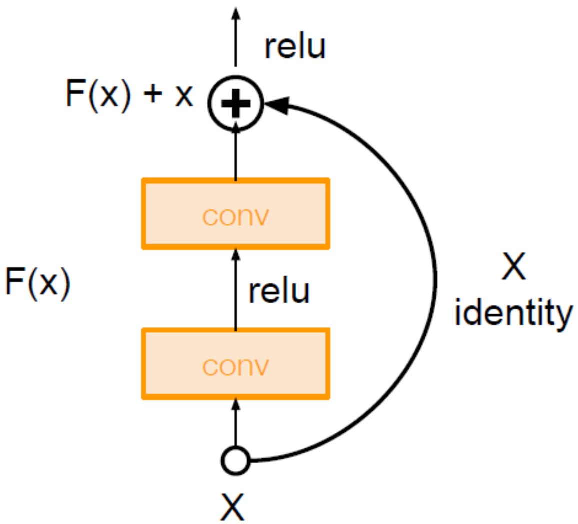


Case Study: ResNet

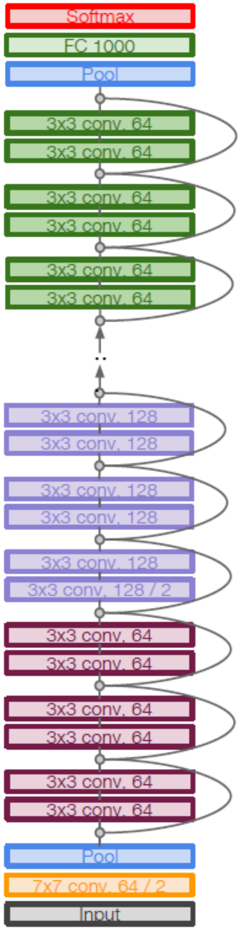
[He et al., 2015]

Very deep networks using residual connections

- 152-layer model for ImageNet
- ILSVRC'15 classification winner (3.57% top 5 error)
- Swept all classification and detection competitions in ILSVRC'15 and COCO'15!



Residual block



감사합니다