deeplearning.ai

Case Studies

Why look at case studies?

Outline

Classic networks:

- LeNet-5 ←
- AlexNet ←
- VGG ←

ResNet (152)

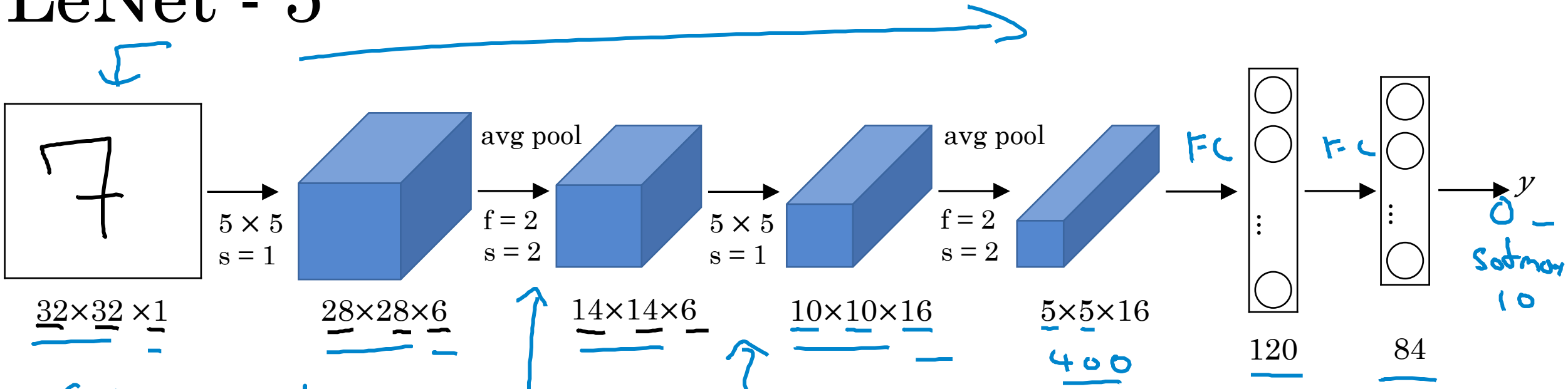
Inception

deeplearning.ai

Case Studies

Classic networks

LeNet - 5



60k parameters

$n_H, n_w \downarrow$ $n_c \uparrow$

non-linearity after pooling

$n_H \times n_w \times n_c$ $f \times f \times n_c$

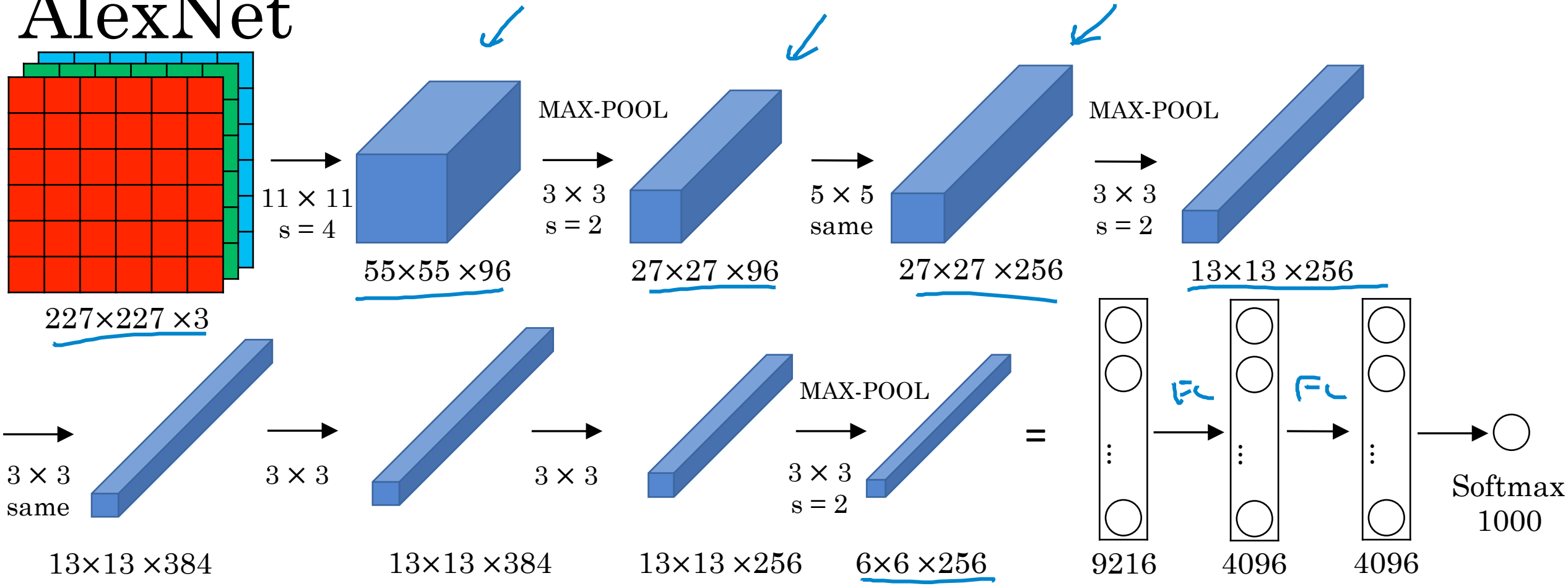
conv pool conv pool fc fc output

Activation: Sigmoid/tanh ReLU

II III

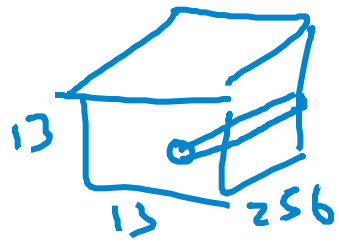
[LeCun et al., 1998. Gradient-based learning applied to document recognition]

AlexNet



- Similar to LeNet, but much bigger.
- ReLU
- Multiple GPUs.
- Local Response Normalization (LRN)

9216



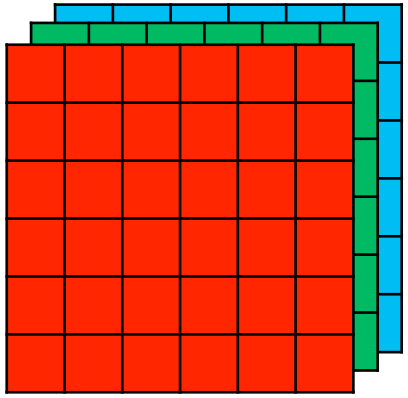
60M parameters

[Krizhevsky et al., 2012. ImageNet classification with deep convolutional neural networks]

VGG - 16

VGG-19

CONV = 3×3 filter, s = 1, same MAX-POOL = 2×2 , s = 2



224×224 ×3

→ [CONV 64] ×2 → 224×224×64 → POOL → 112×112 ×64 → [CONV 128] ×2 → 112×112 ×128 → POOL → 56×56 ×128

→ [CONV 256] ×3 → 56×56 ×256 → POOL → 28×28 ×256 → [CONV 512] ×3 → 28×28 ×512 → POOL → 14×14×512

→ [CONV 512] ×3 → 14×14 ×512 → POOL → 7×7×512 → FC 4096 → FC 4096 → Softmax 1000

$n_H, n_W \downarrow$ $n_c \uparrow$ ~138M

[Simonyan & Zisserman 2015. Very deep convolutional networks for large-scale image recognition]

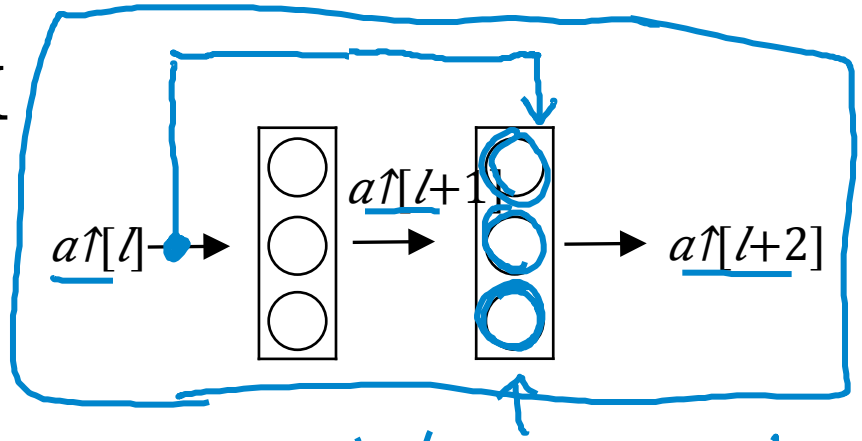
Andrew Ng

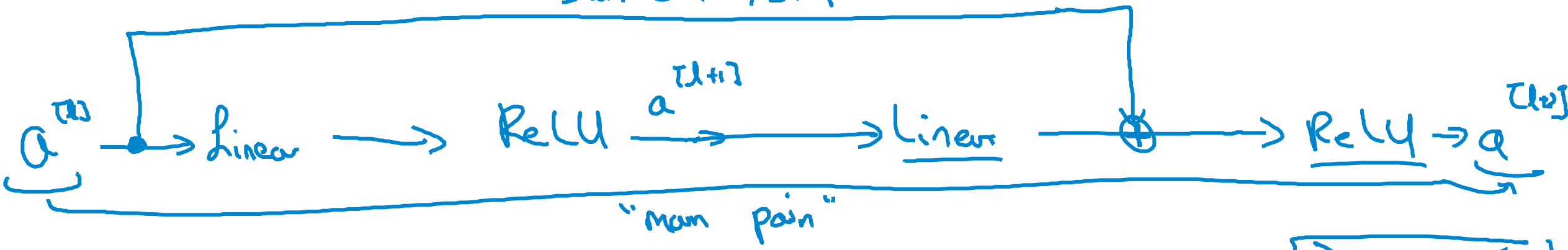
deeplearning.ai

Case Studies

Residual Networks (ResNets)

Residual block





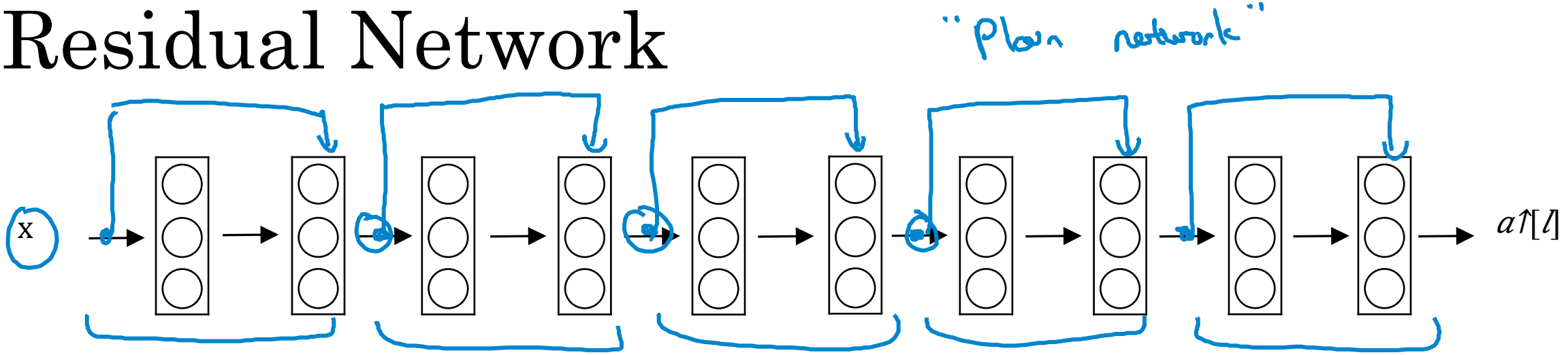
$$z^{[l+1]} = W^{[l+1]} a^{[l]} + b^{[l+1]} \quad a^{[l+1]} = g(z^{[l+1]})$$

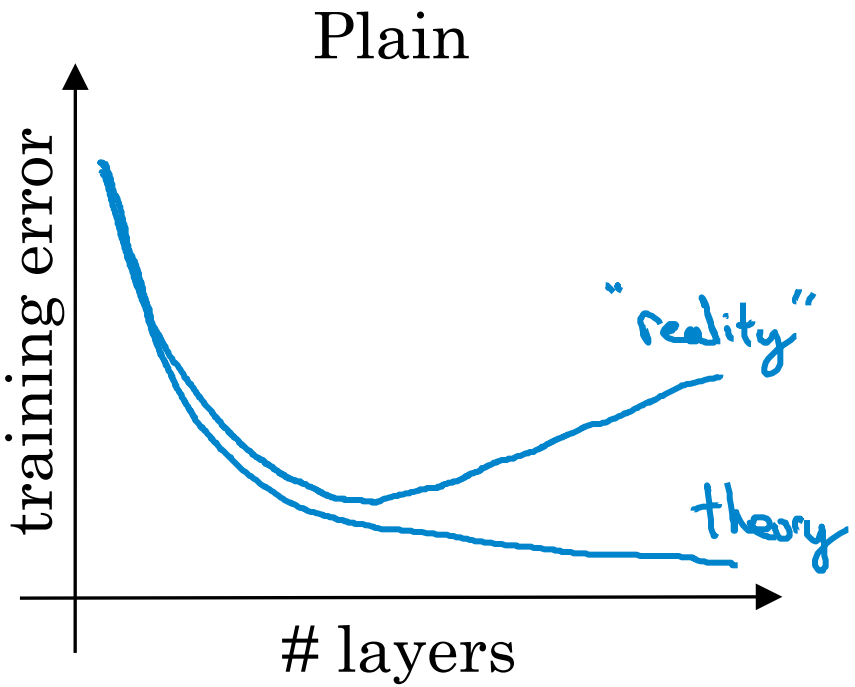
$$z^{[l+2]} = W^{[l+2]} a^{[l+1]} + b^{[l+2]} \quad a^{[l+2]} = g(z^{[l+2]})$$

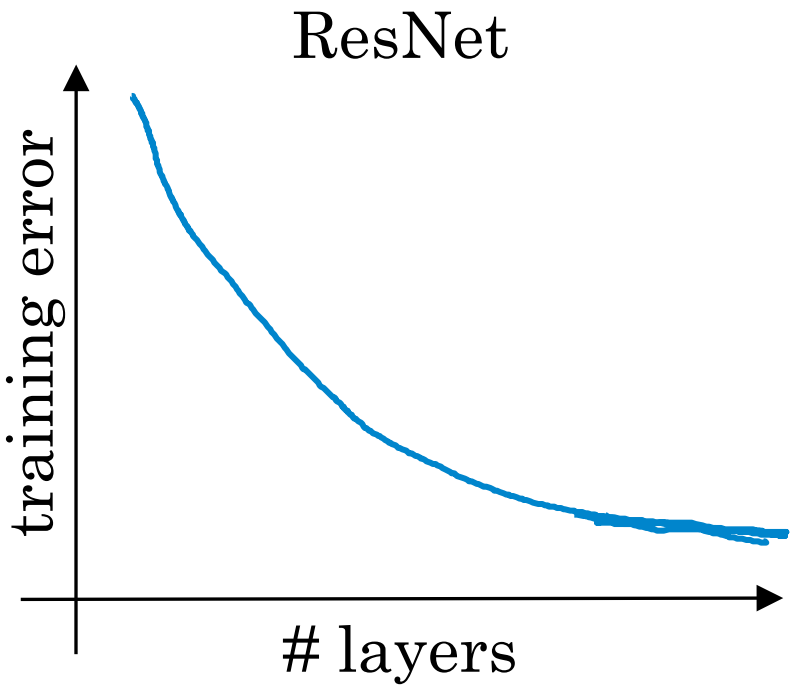
$$a^{[l+2]} = g(z^{[l+2]} + a^{[l]})$$

[He et al., 2015. Deep residual networks for image recognition]

Residual Network







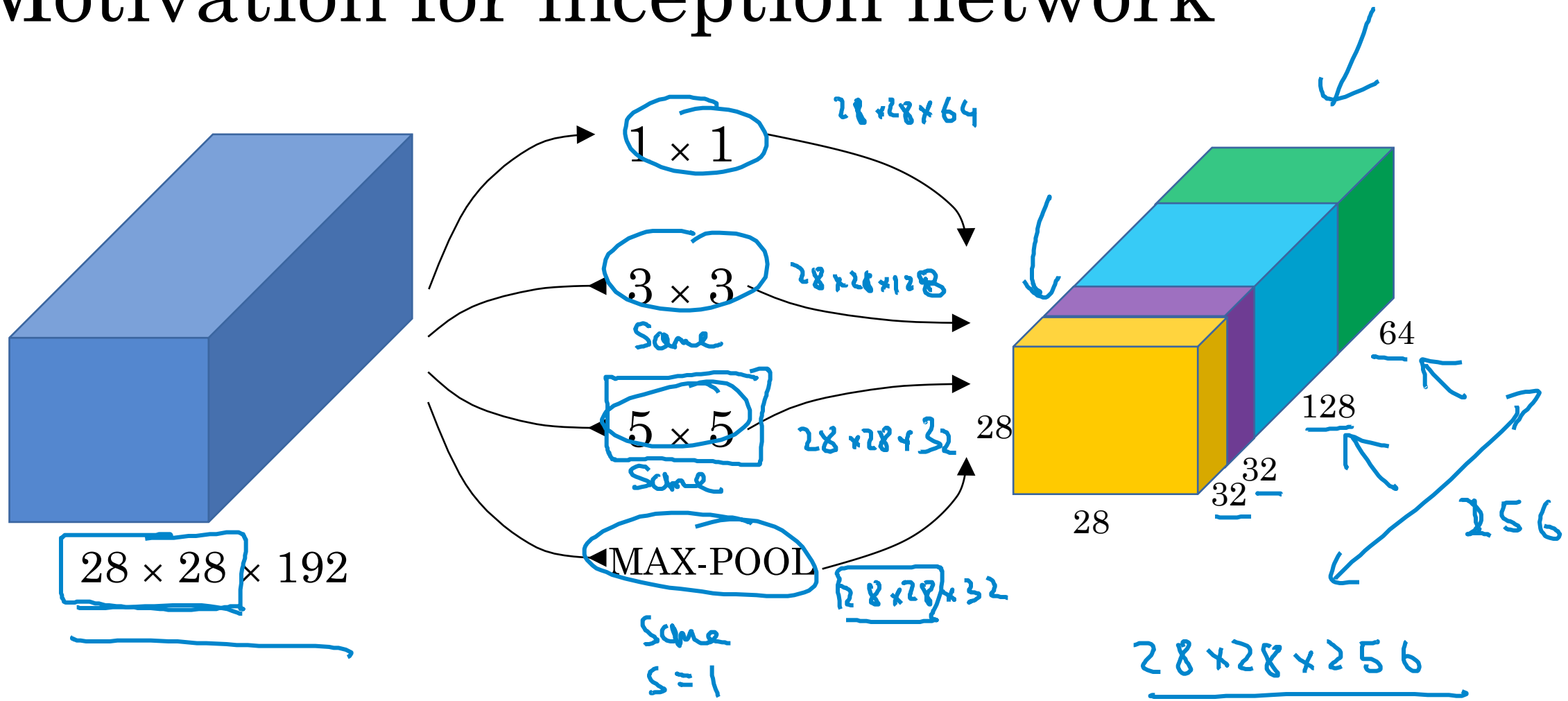
[He et al., 2015. Deep residual networks for image recognition]

deeplearning.ai

Case Studies

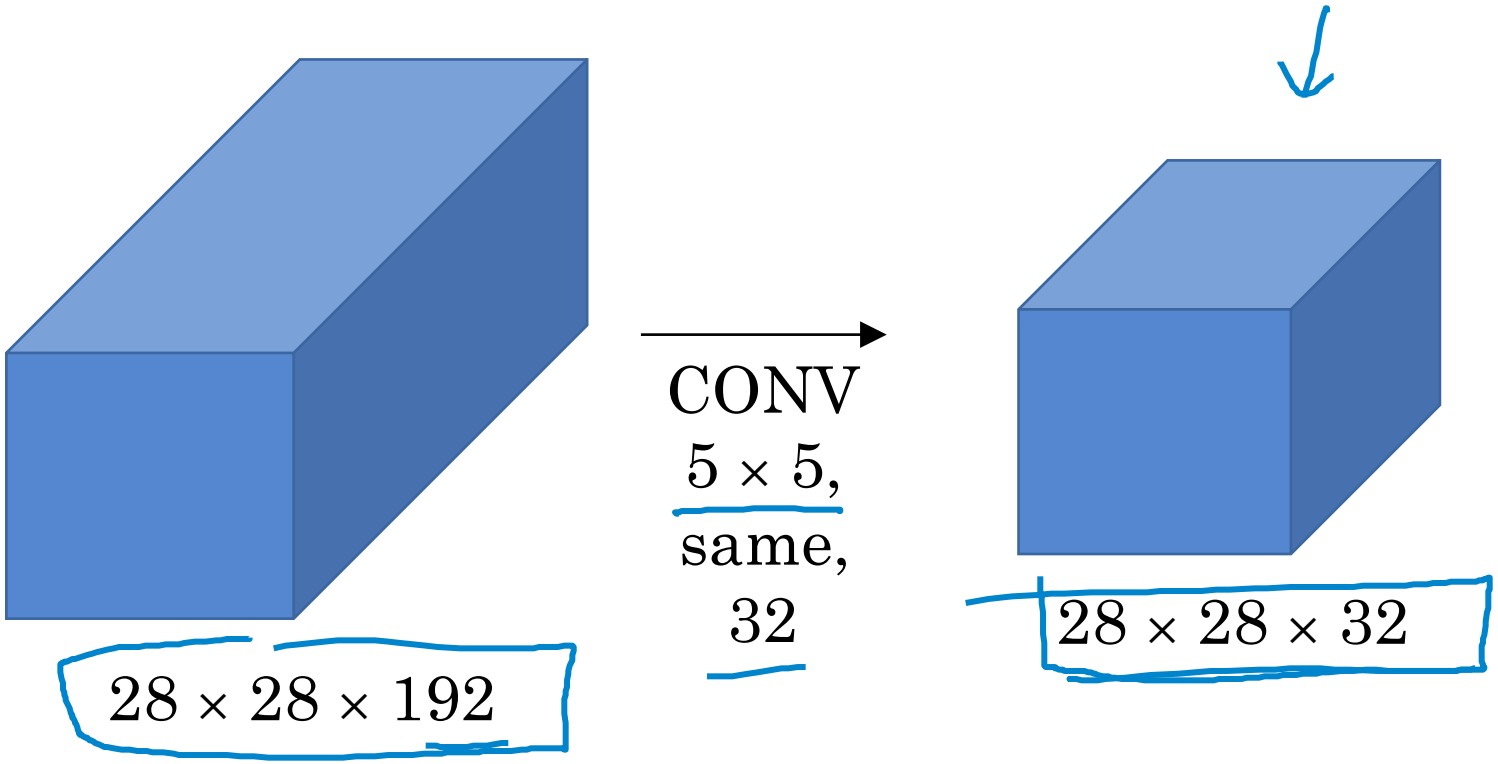
Inception network motivation

Motivation for inception network



[Szegedy et al. 2014. Going deeper with convolutions]

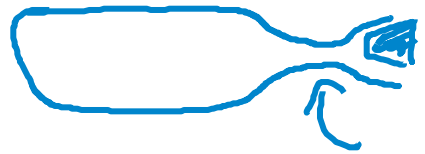
The problem of computational cost



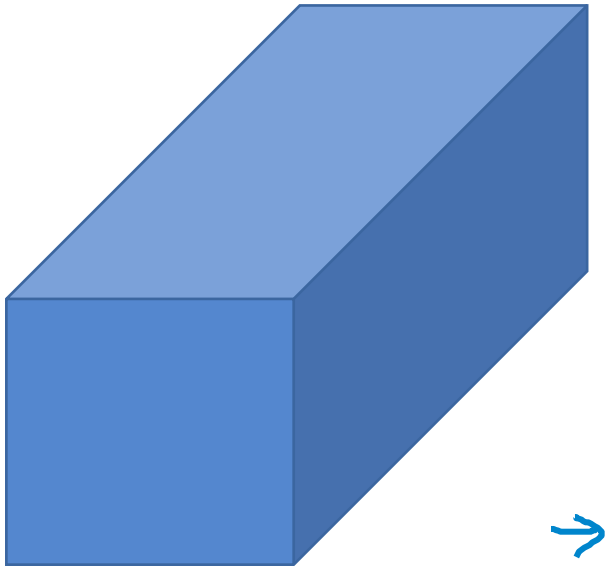
32 filters. filter one 5×5×192.

28×28×32 × 5×5×192 = 120M.

Using 1×1 convolution

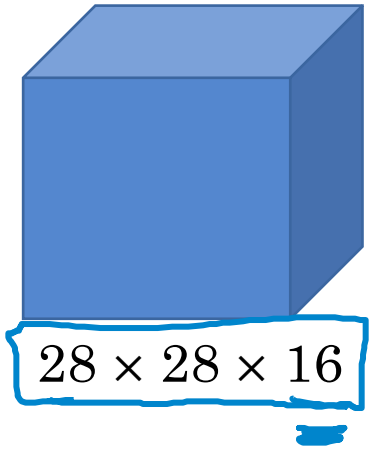


"bottleneck layer"



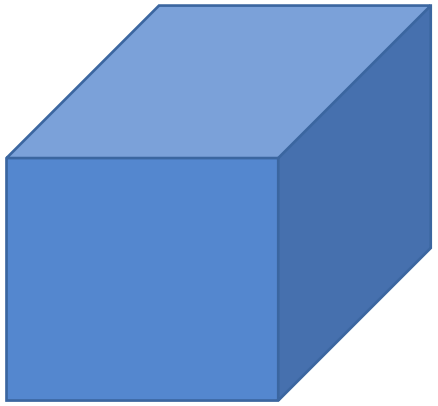
28 × 28 × 192

CONV
1 × 1,
16,
1 × 1 × 192



28 × 28 × 16

CONV
5 × 5,
32,
5 × 5 × 16



28 × 28 × 32

28×28×16 × 192 = 2.4M

28×28×32 × 5×5×16 = 10.0M

12.4M

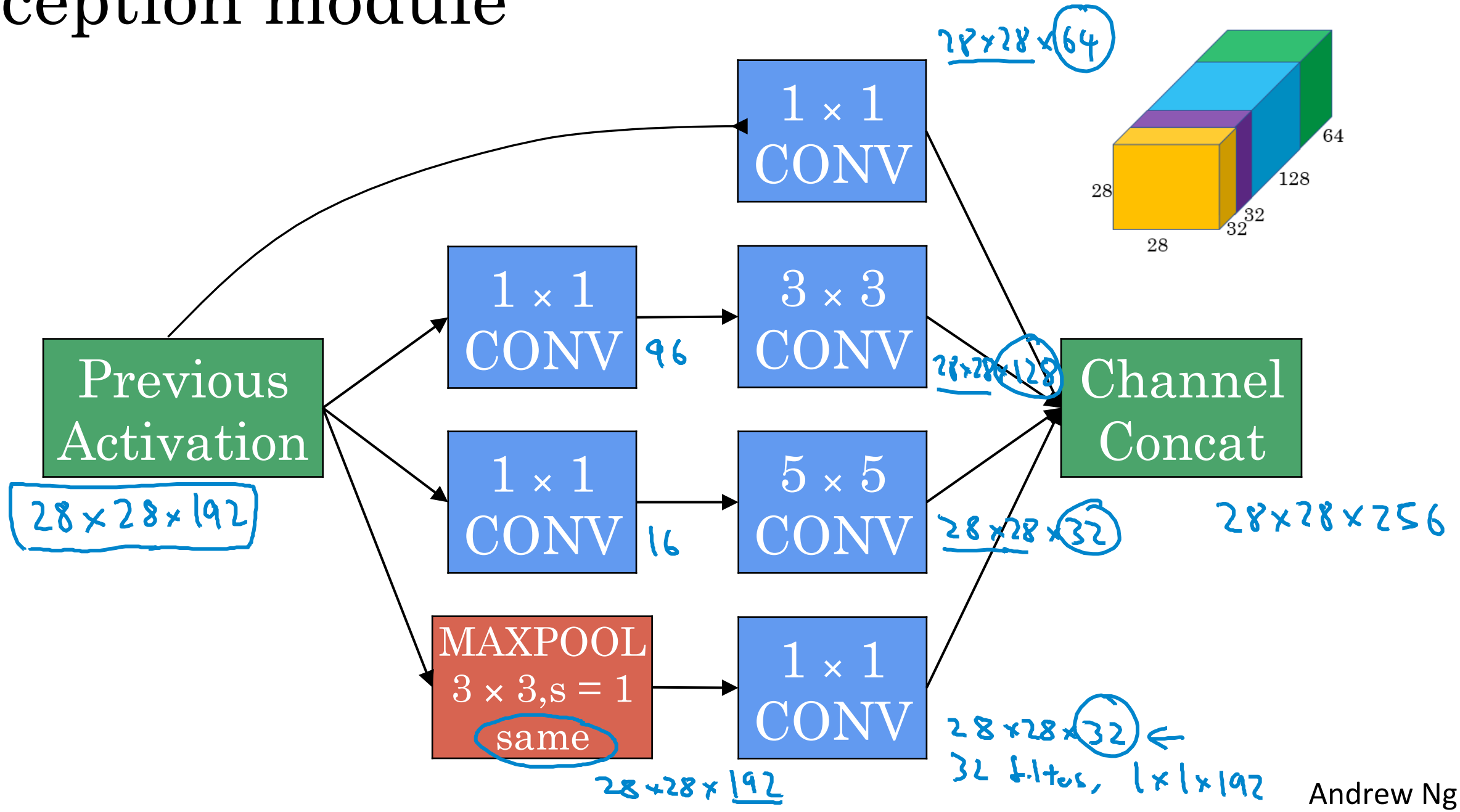
120M

deeplearning.ai

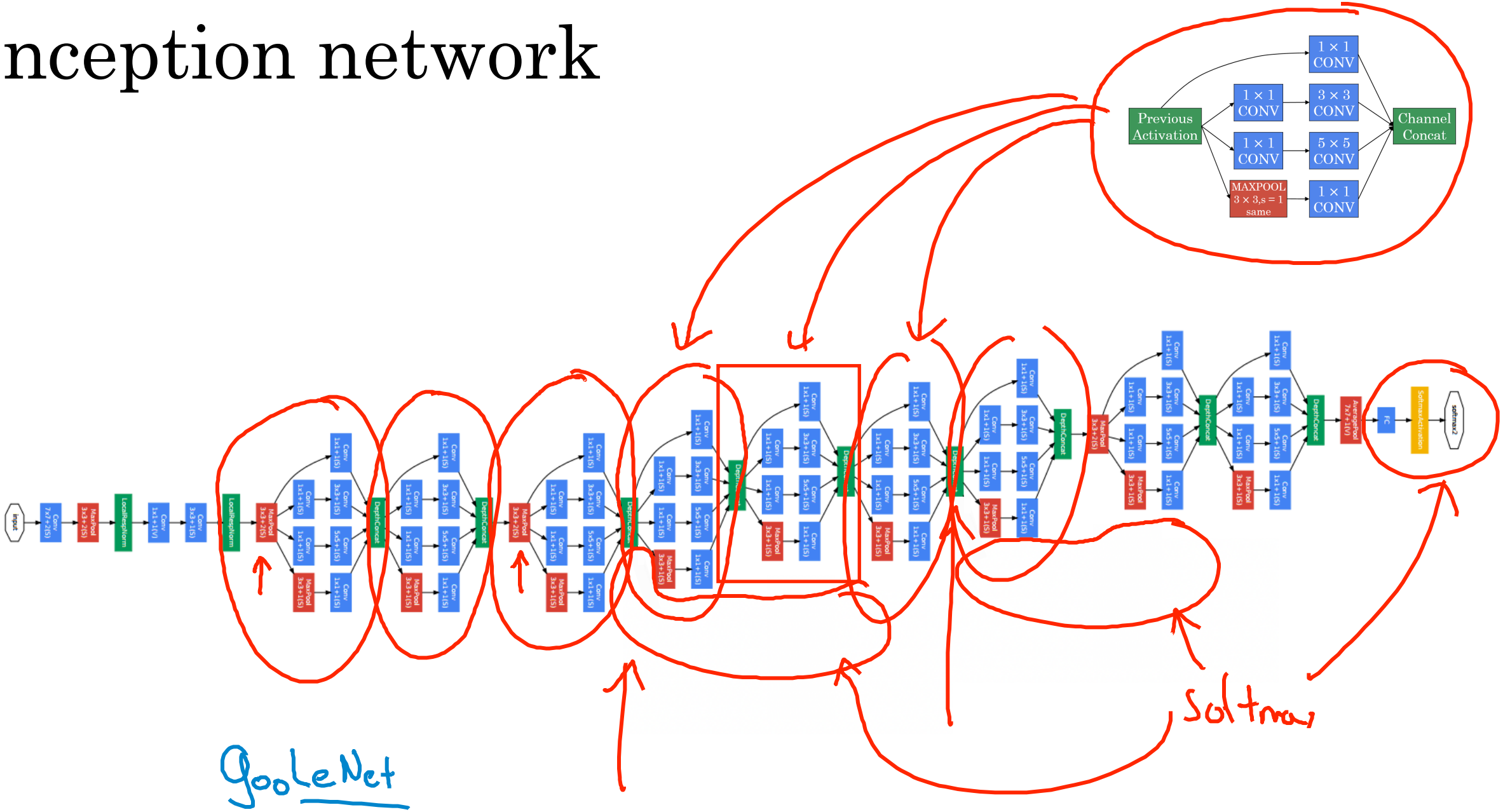
Case Studies

Inception network

Inception module



Inception network



[Szegedy et al., 2014, Going Deeper with Convolutions]

http://knowyourmeme.com/memes/we-need-to-go-deeper