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Case Studies

Why look at
case studies?

Outline

Classic networks:

- LeNet-5 ←
- AlexNet ←
- VGG ←

ResNet (152)

Inception

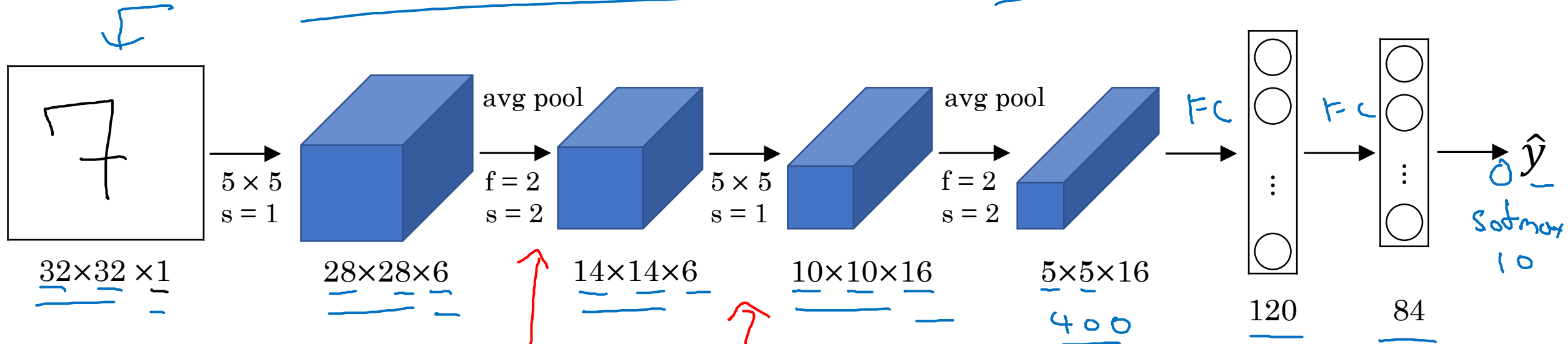


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Case Studies

Classic networks

LeNet - 5



60K parameters.

$n_H, n_W \downarrow$ $n_C \uparrow$

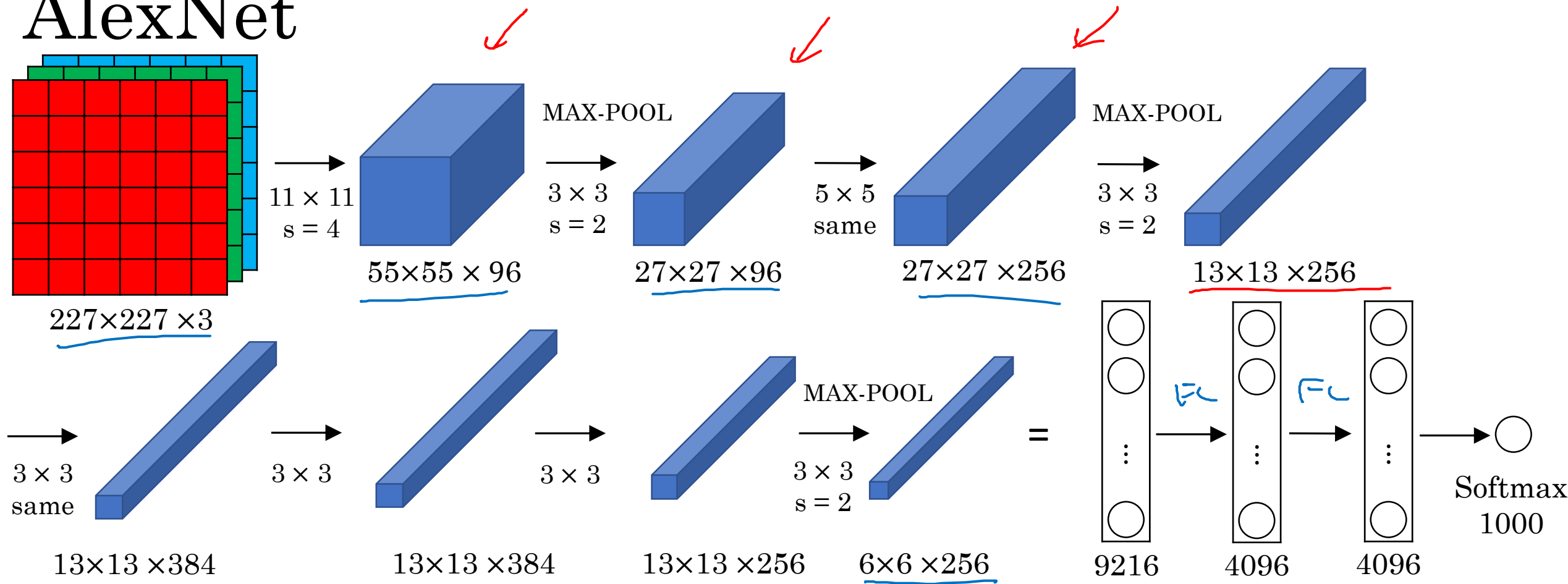
conv pool conv pool fc fc output

Advanced: sigmoid/tanh ReLU

II, III.

↓

AlexNet

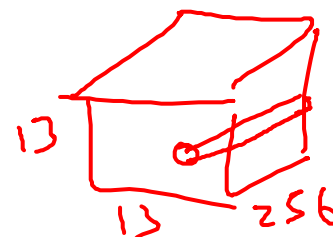


- Similar to LeNet, but much bigger.

- ReLU

- Multiple GPUs.

- Local Response Normalization (LRN)

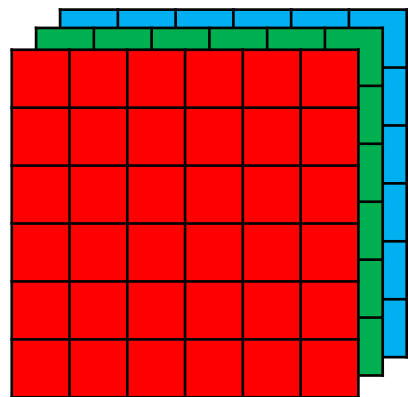


160M parameters

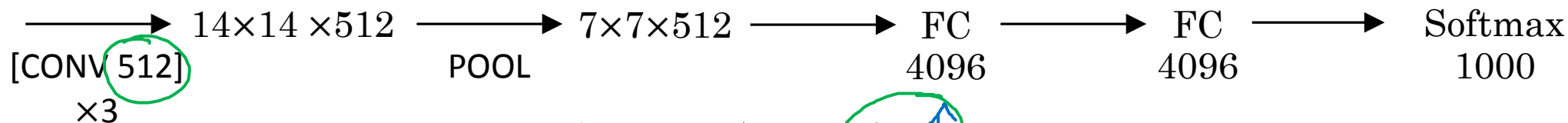
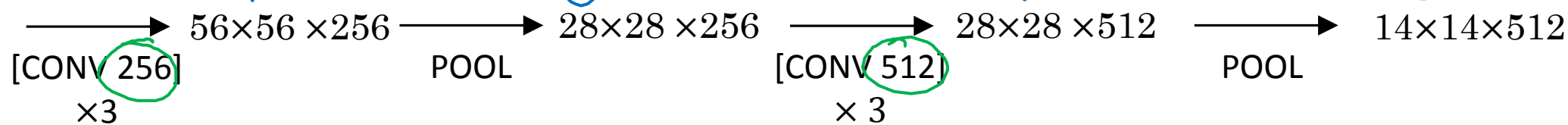
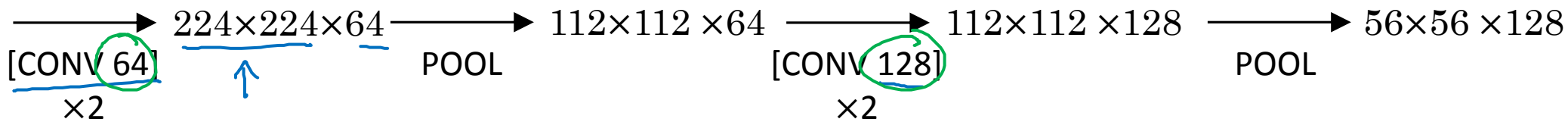
VGG - 16

CONV = 3x3 filter, s = 1, same

MAX-POOL = 2x2, s = 2



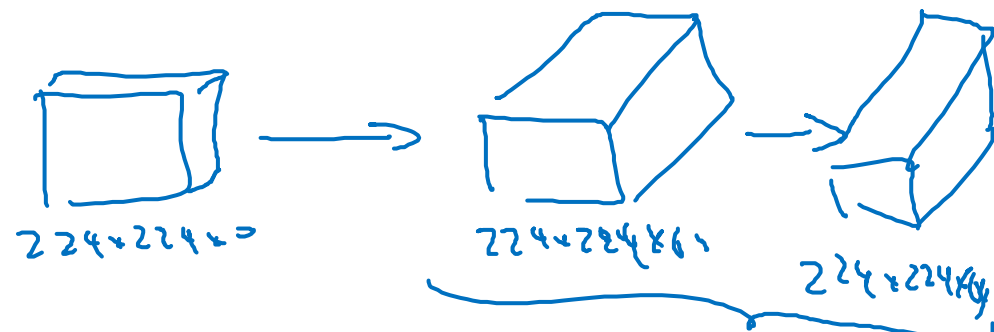
224x224 x 3



$n_h, n_w \downarrow$

$n_c \uparrow$

$\sim 138M$



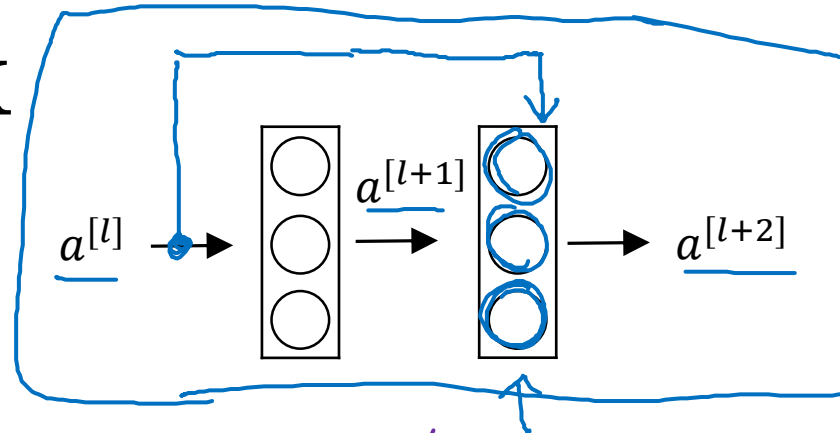


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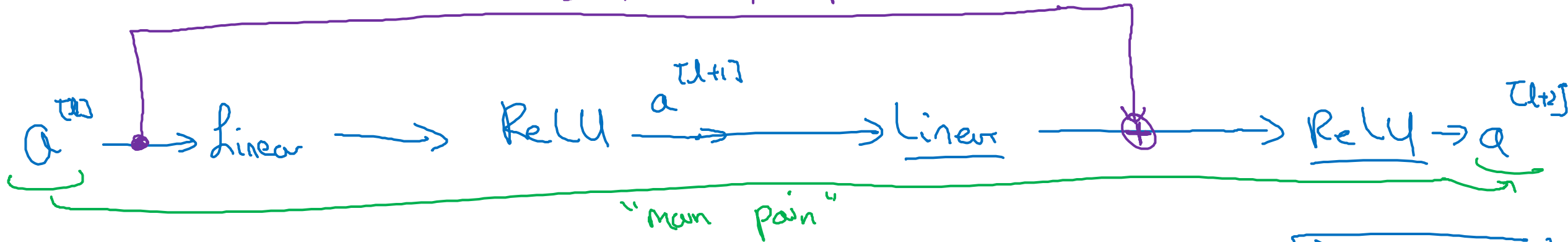
Case Studies

Residual Networks (ResNets)

Residual block



"short cut" / skip connection



$$\underline{z^{[l+1]}} = W^{[l+1]} \underline{a^{[l]}} + b^{[l+1]}$$

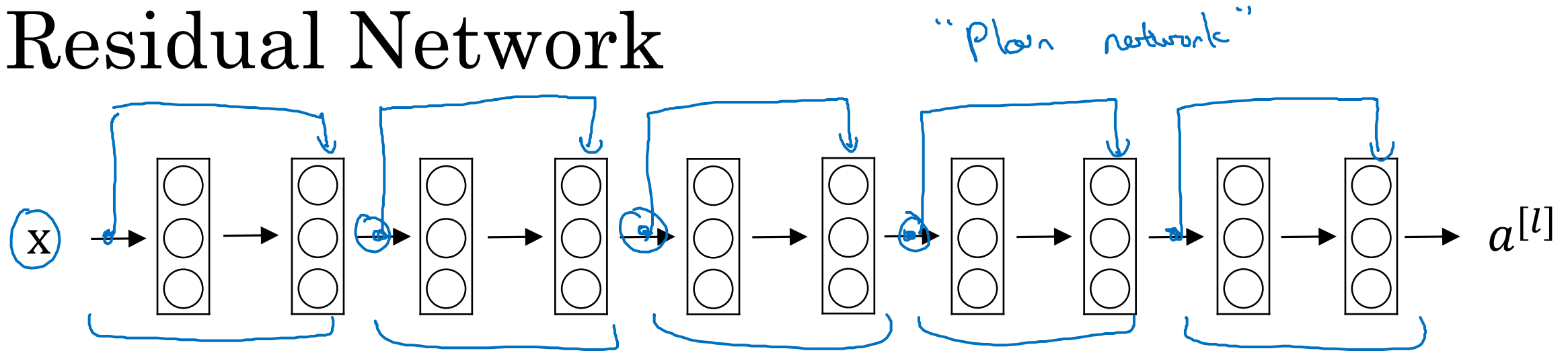
$$\underline{a^{[l+1]}} = g(\underline{z^{[l+1]}})$$

$$\underline{z^{[l+2]}} = W^{[l+2]} \underline{a^{[l+1]}} + b^{[l+2]}$$

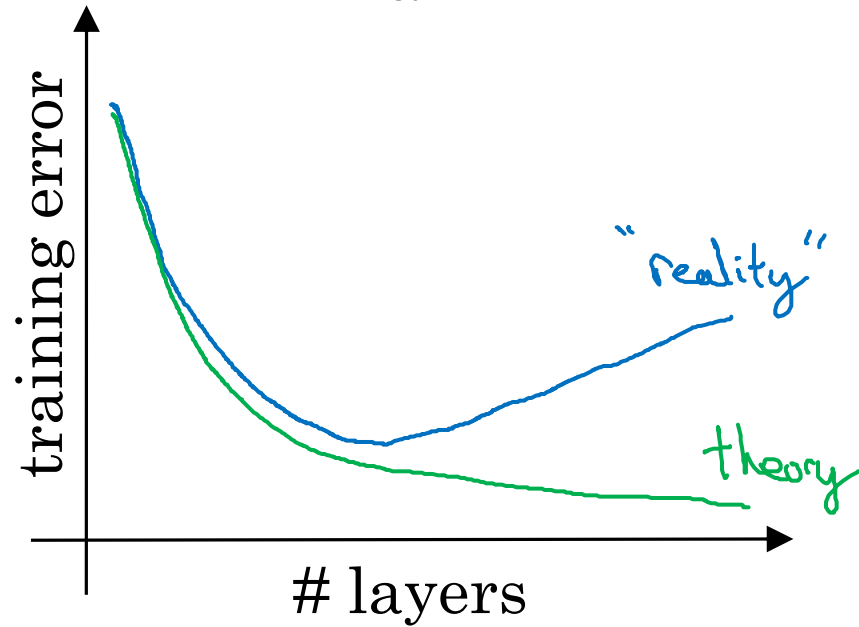
~~$$\underline{a^{[l+2]}} = g(\underline{z^{[l+2]}})$$~~

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

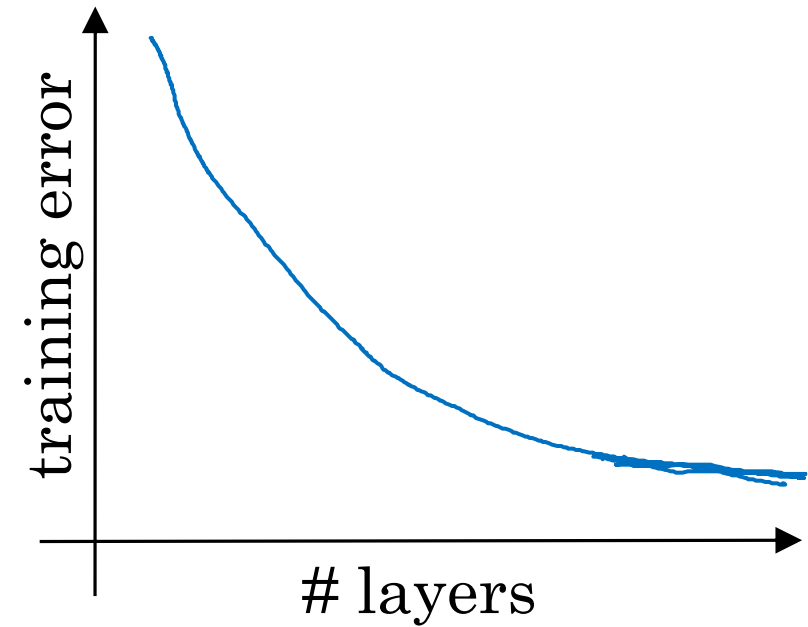
Residual Network



Plain



ResNet





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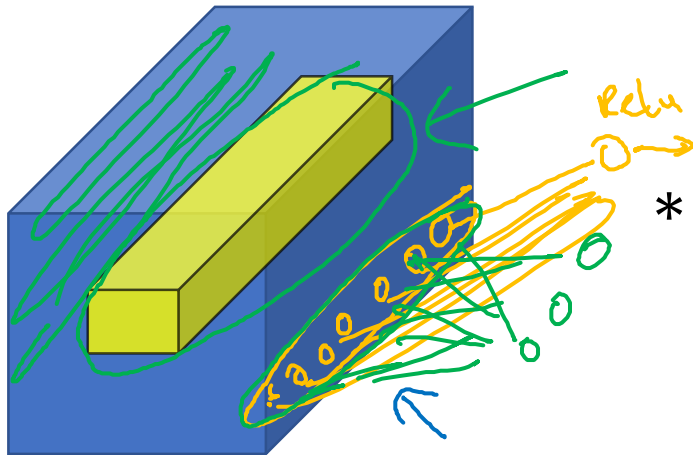
Case Studies

Network in Network
and 1×1 convolutions

Why does a 1×1 convolution do?

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

$6 \times 6 \times 1$



$6 \times 6 \times 32$

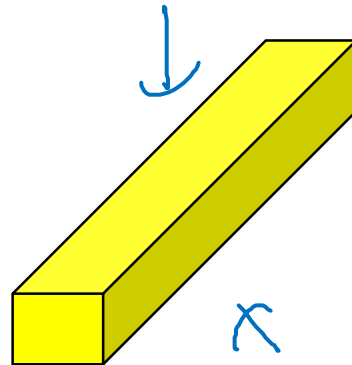
*

2

=

2	4	6	...		

32 \rightarrow # filters.
 $n_c^{[l+1]}$

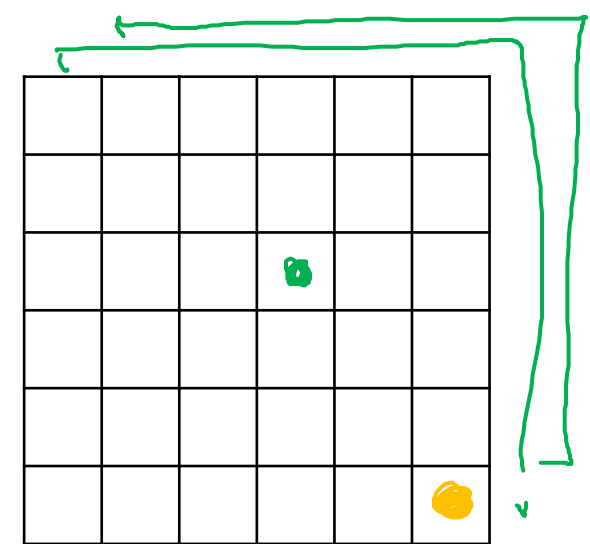


$1 \times 1 \times 32$

=

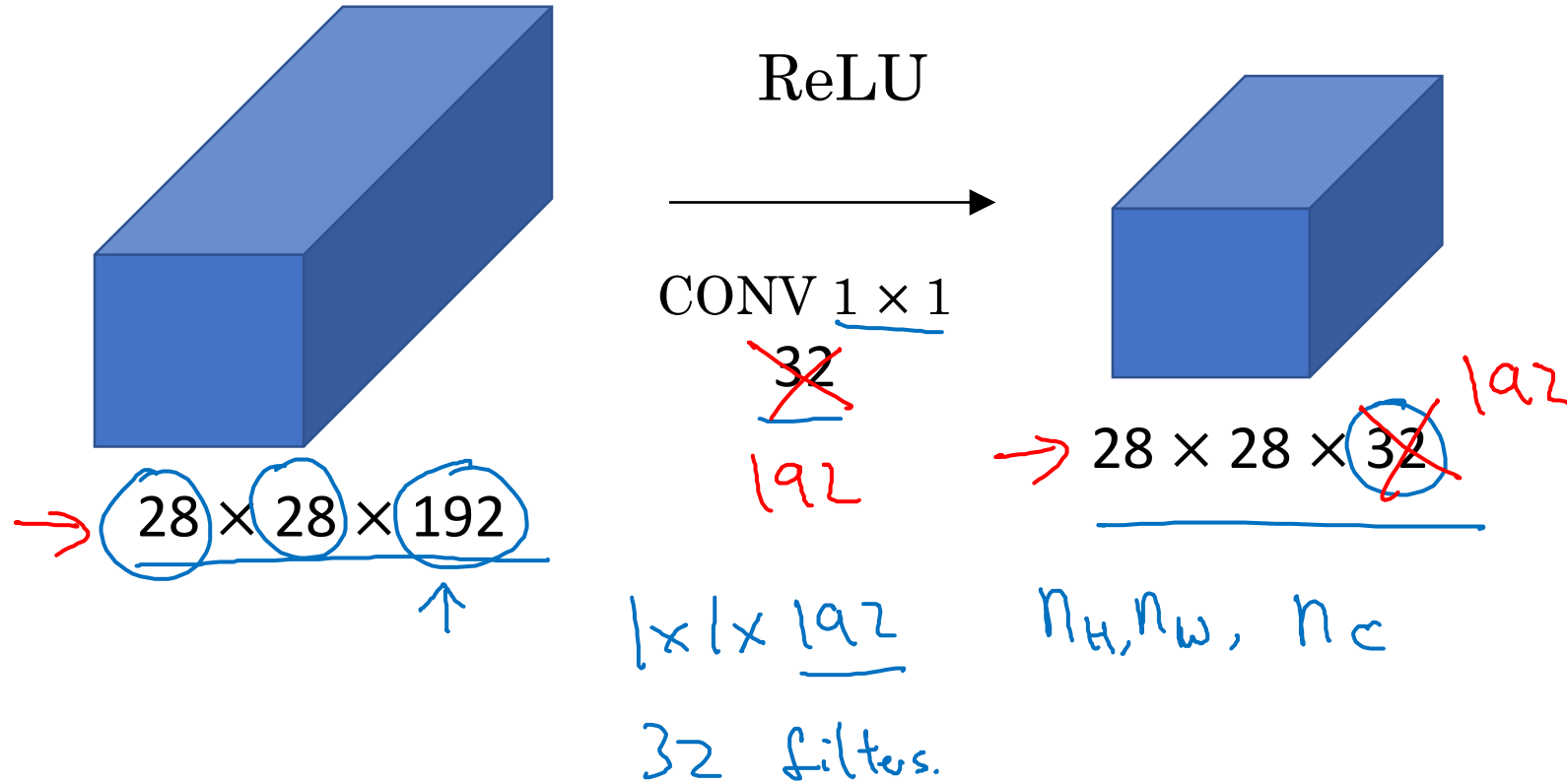
ReLU

Network in
Network



$6 \times 6 \times \# \text{ filters}$

Using 1×1 convolutions



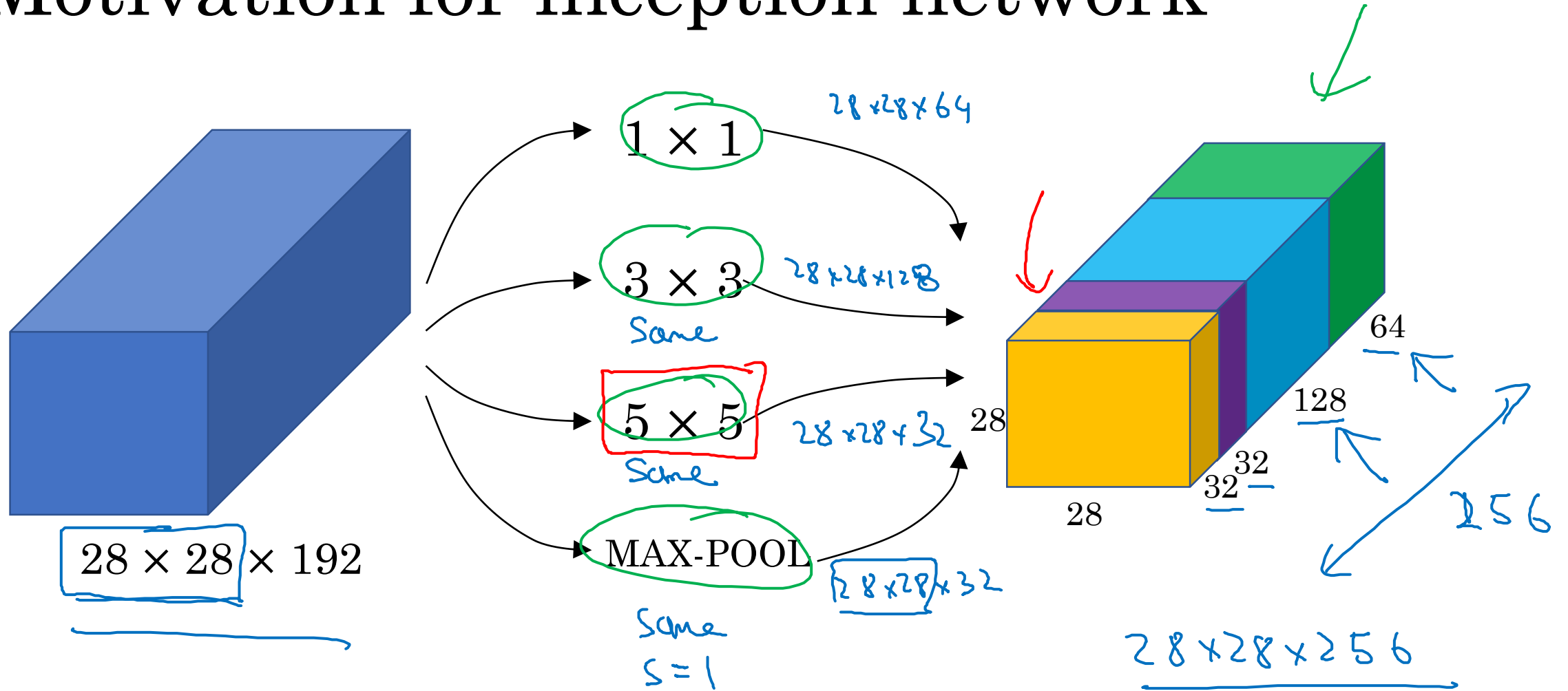


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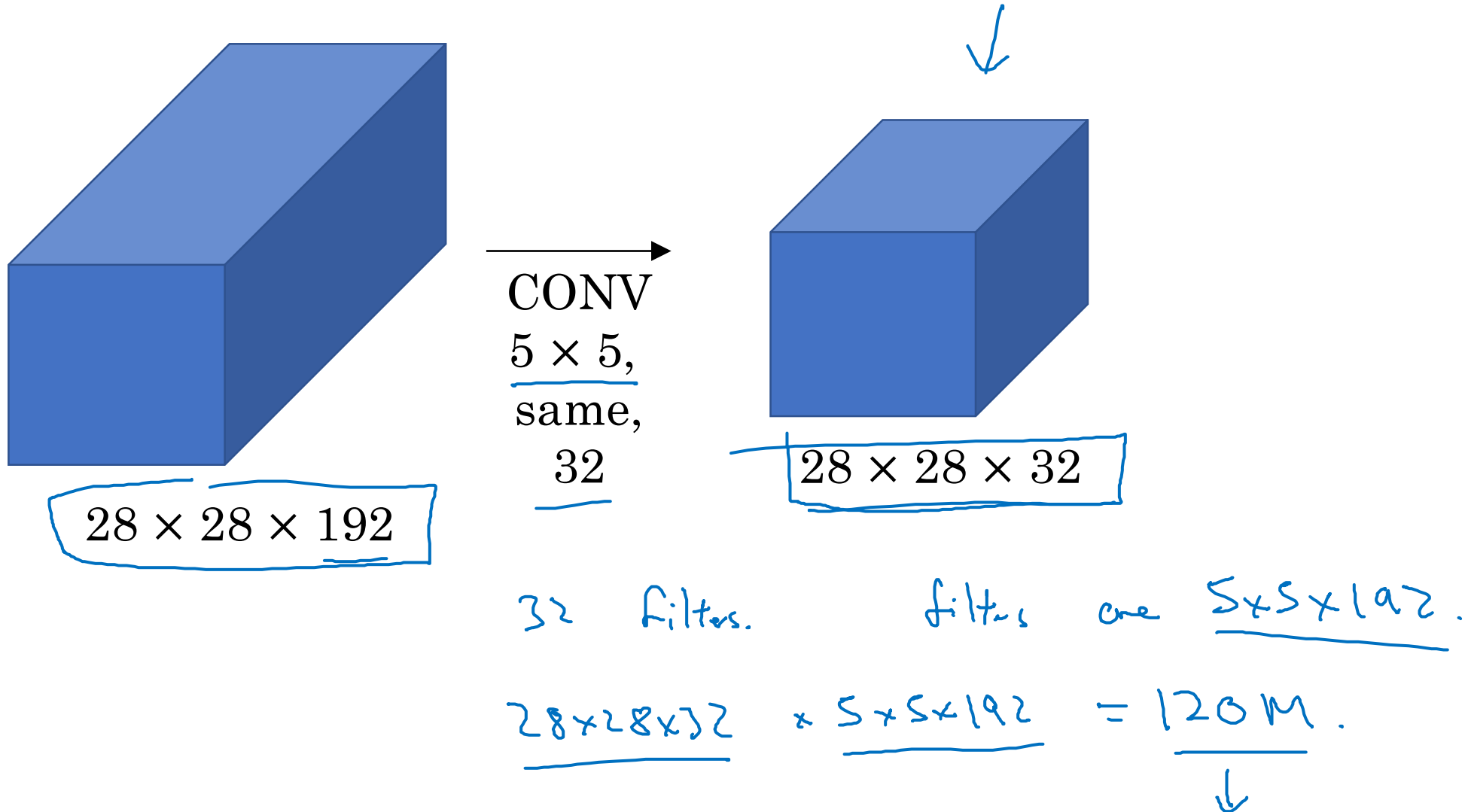
Case Studies

Inception network motivation

Motivation for inception network

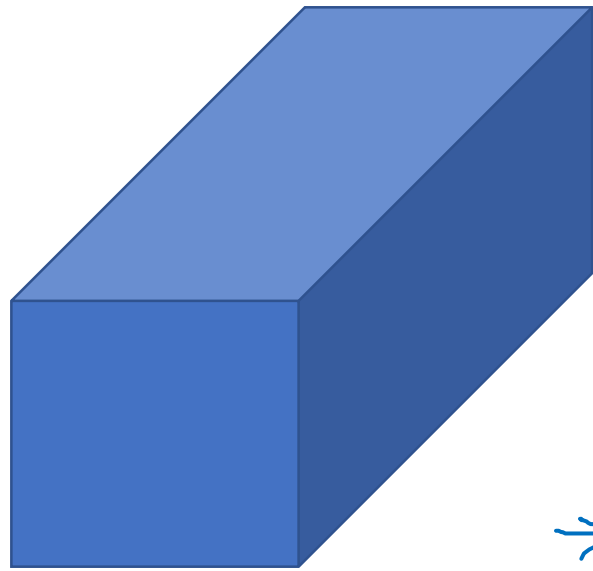
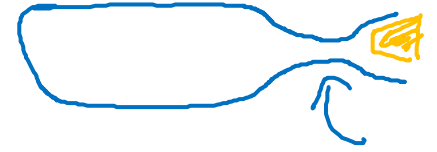


The problem of computational cost



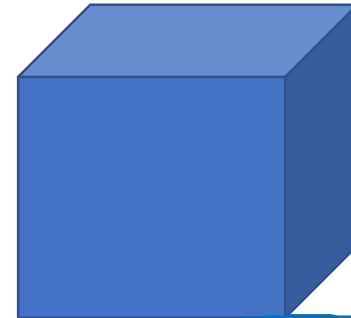
Using 1×1 convolution

"bottleneck layer"



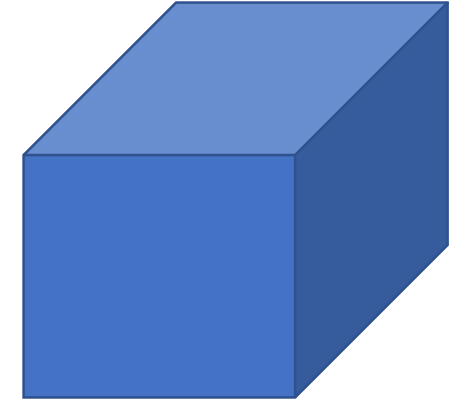
$28 \times 28 \times 192$

CONV
 1×1 ,
 $\rightarrow 16$,
 $\rightarrow 1 \times 1 \times 192$



$28 \times 28 \times 16$

CONV
 5×5 ,
32,
 $5 \times 5 \times 16$



$28 \times 28 \times 32$

$$28 \times 28 \times 16 \times 192 = 2.4M$$

$$28 \times 28 \times 32 \times 5 \times 5 \times 16 = 10.0M$$

12.4M

120M

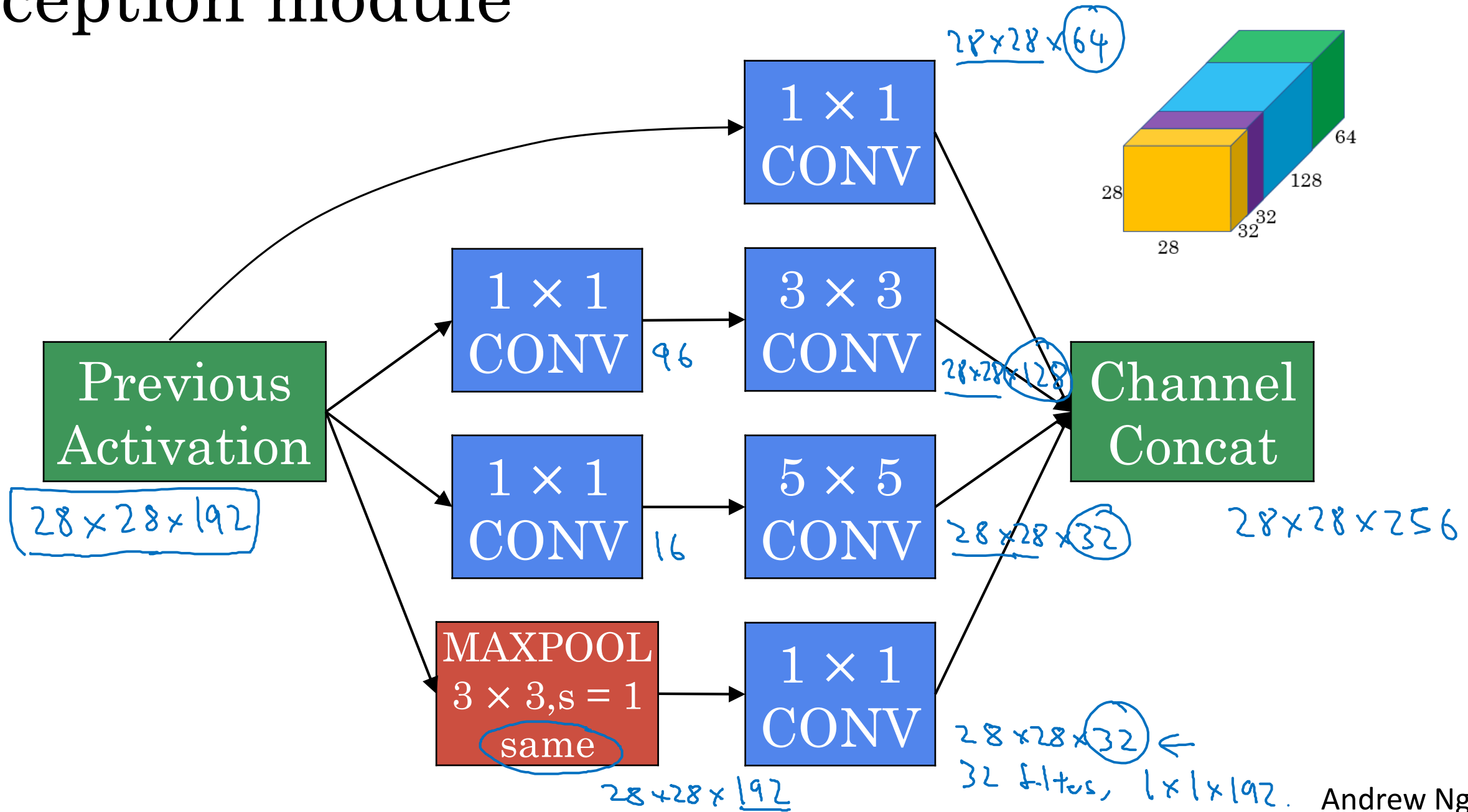


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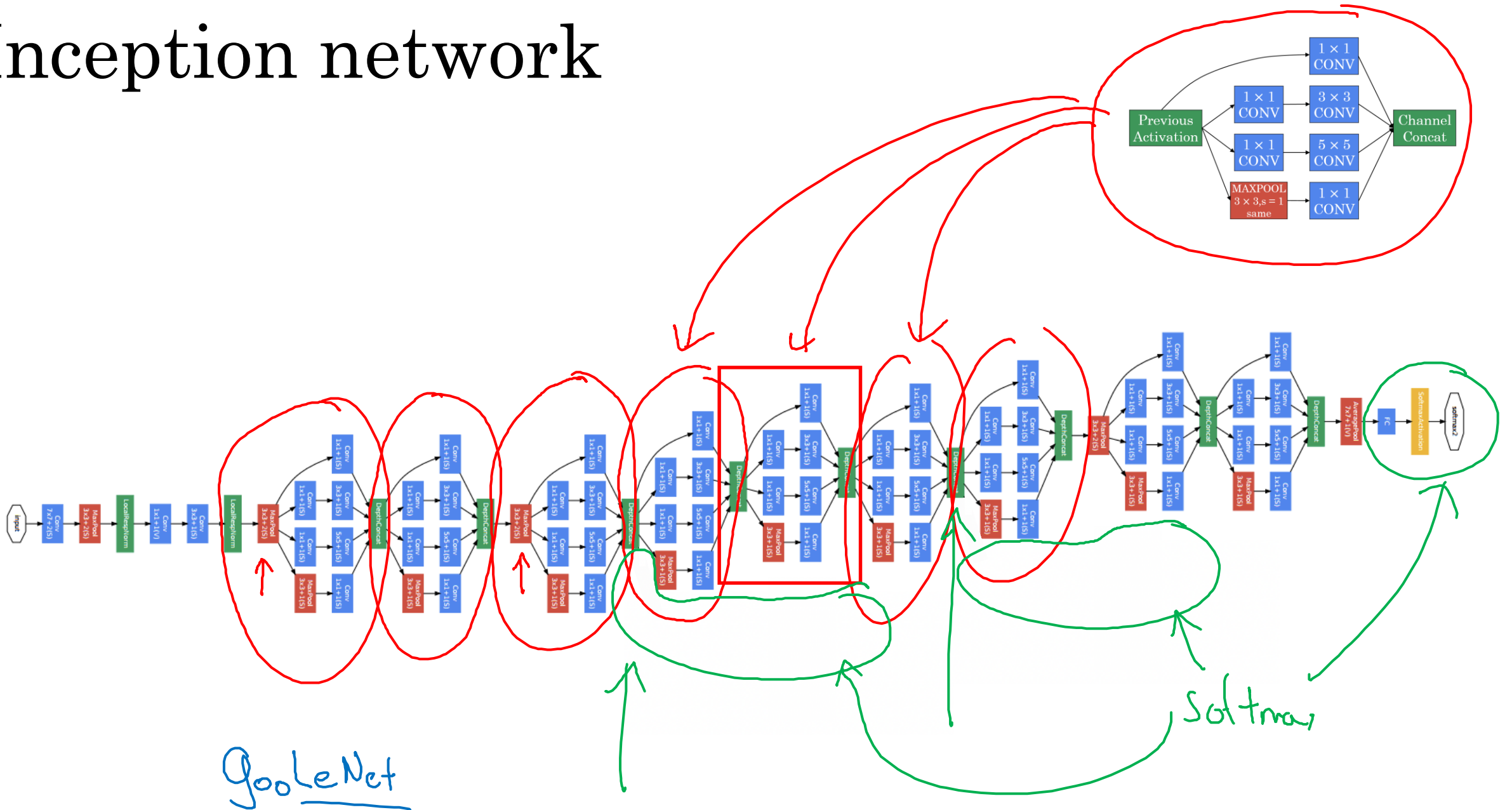
Case Studies

Inception network

Inception module



Inception network



GooleNet

Softmax

