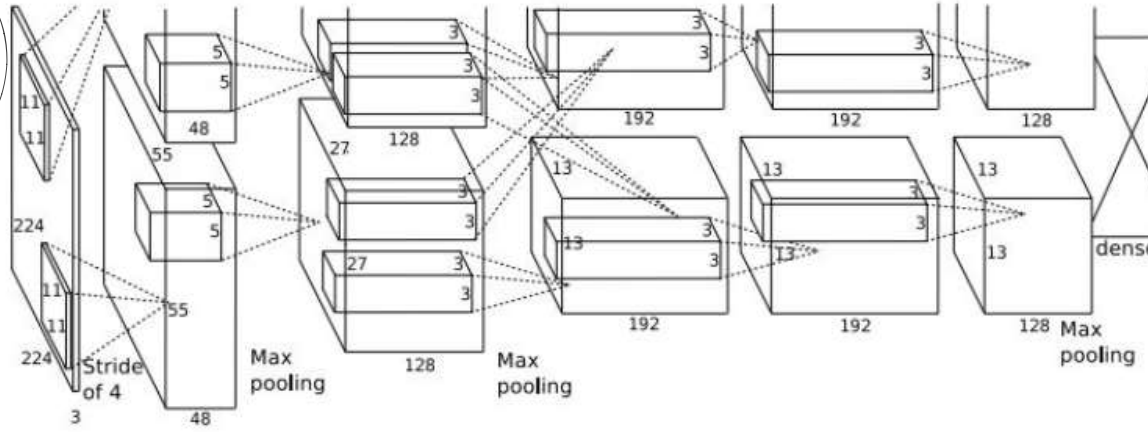
Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



Architecture:

CONV1

MAX POOL1

NORM1

CONV2

MAX POOL2

NORM2

CONV3

CONV4

CONV5

Max POOL3

FC6

FC7

FC8

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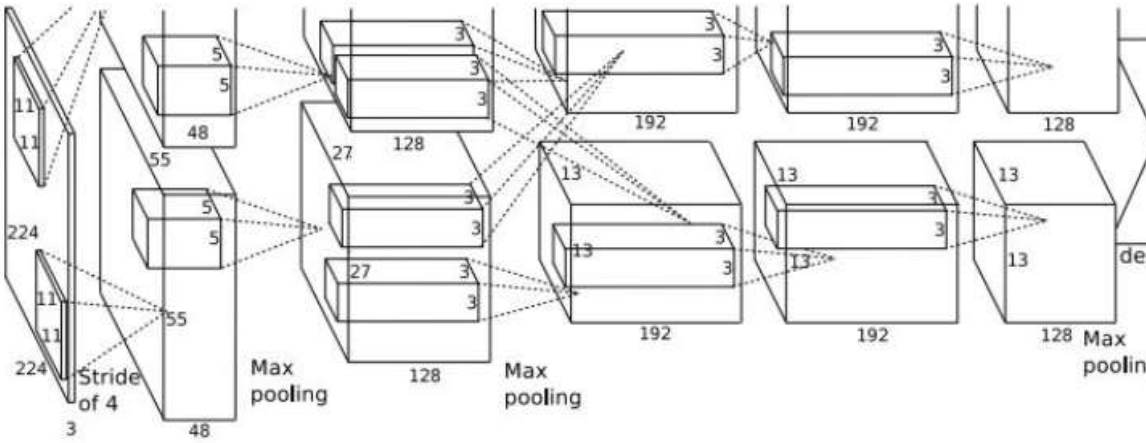
[Krizhevsky et al. 2012]



Input: 227x227x3 images

First layer (CONV1): 96 11x11 filters applied at stride 4

W' = (W - F + 2P)

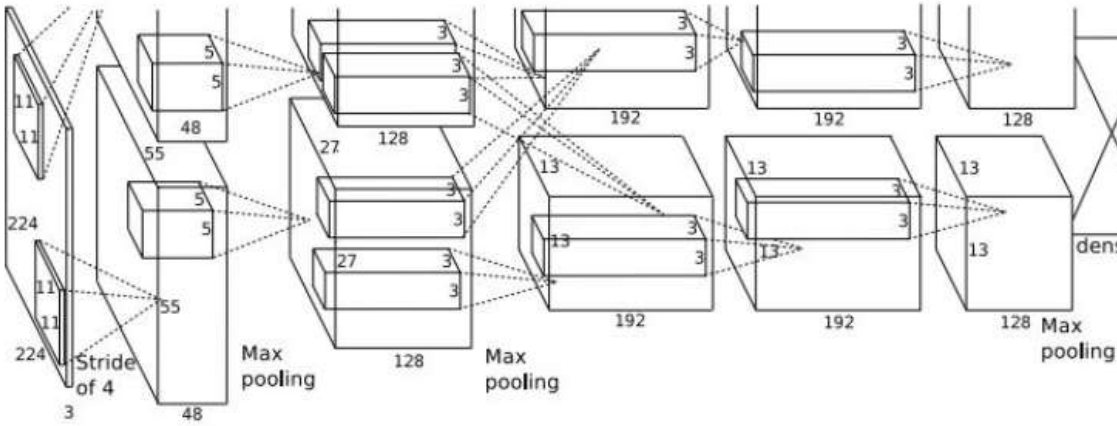
=>

Q: what is the output volume size? Hint: (227-11)/4+1 = 55

Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



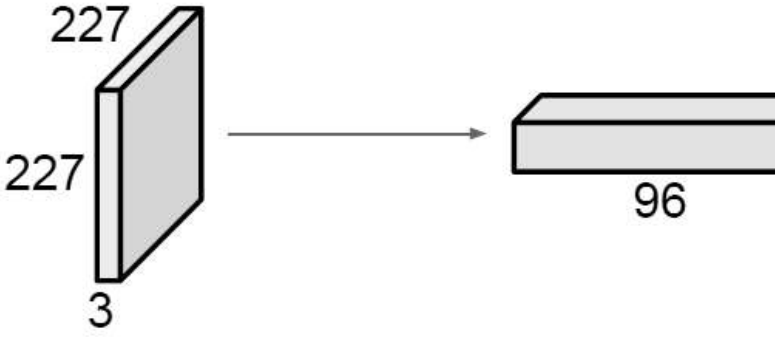
Input: 227x227x3 images

First layer (CONV1): 96 11x11 filters applied at stride 4

=>

Output volume **[55x55x96]**

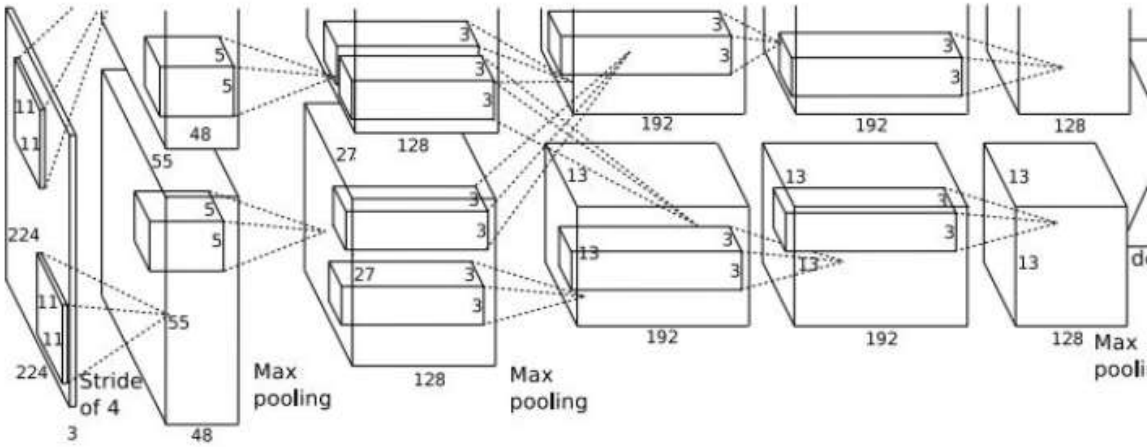
W' = (W - F + 2P)



Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



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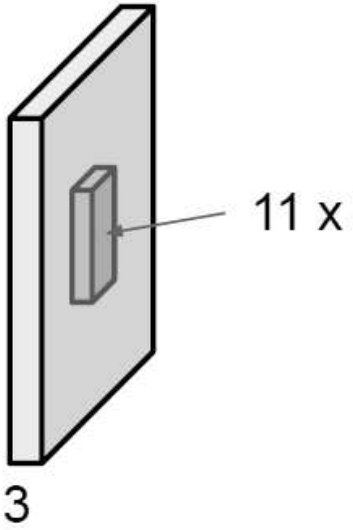
Output volume **[55x55x96]**



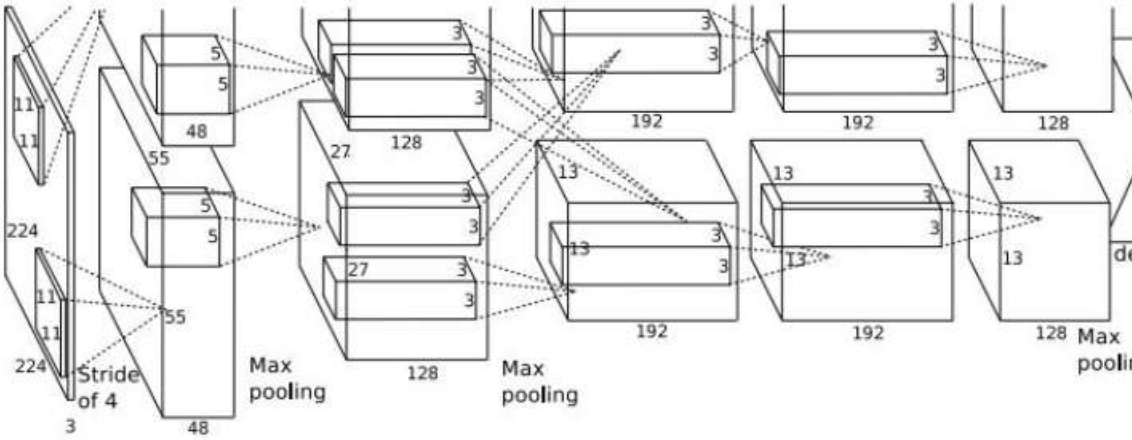
Q: What is the total number of parameters in this layer?

11 x 11 x 3 x 96

Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



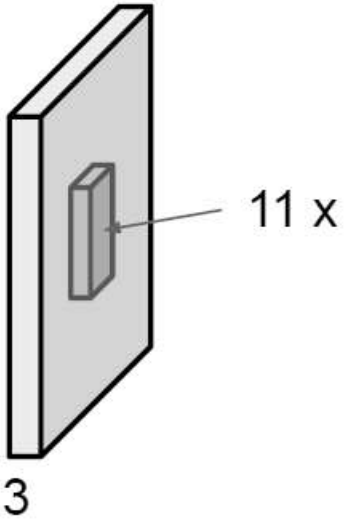
Input: 227x227x3 images

First layer (CONV1): 96 11x11 filters applied at stride 4

=>

Output volume **[55x55x96]**

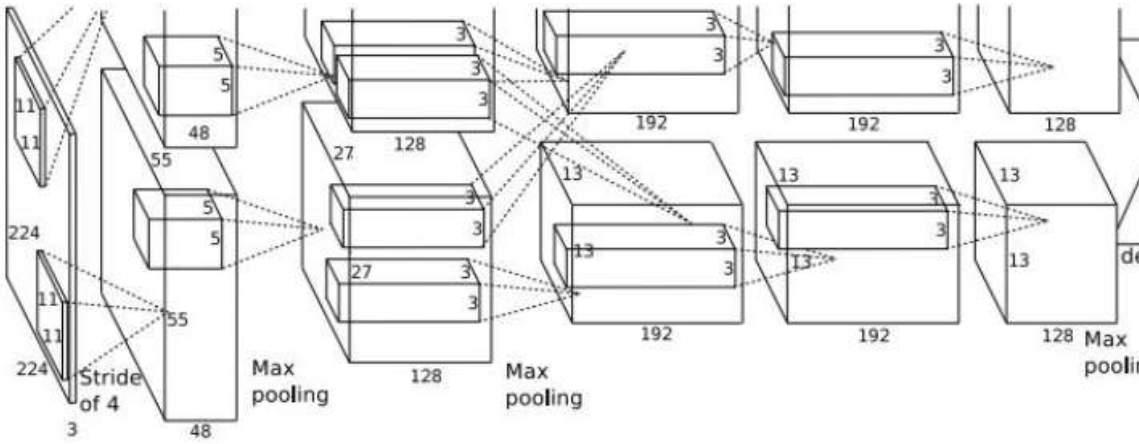
Parameters: (11*11*3 + 1)*96 **= 35K**



Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



Input: 227x227x3 images
After CONV1: 55x55x96

$W' = (W - F + 2P$

Second layer (POOL1): 3x3 filters applied at stride 2

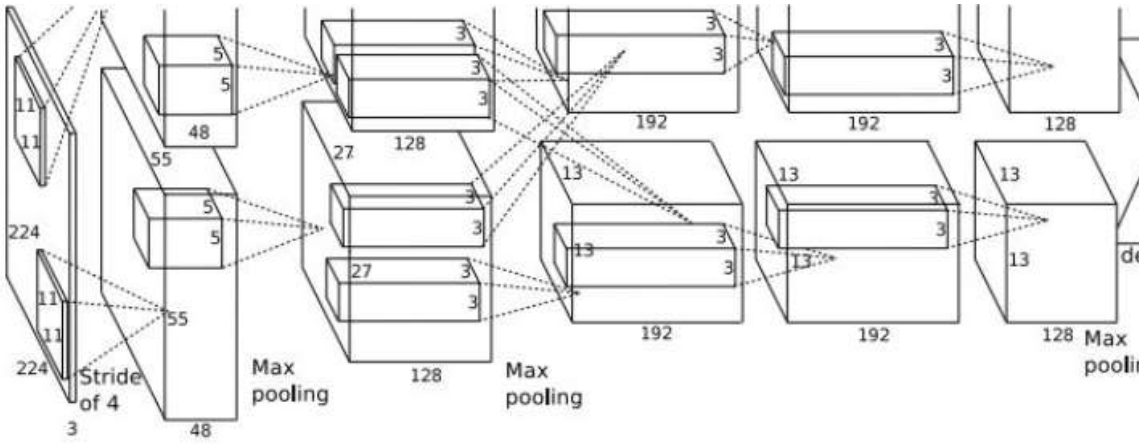
Q: what is the output volume size? Hint: (55-3)/2+1 = 27

27x27

Architectures

Case Study: AlexNet

[Krizhevsky et al. 2012]



Input: 227x227x3 images
After CONV1: 55x55x96

W' = (W - F + 2P

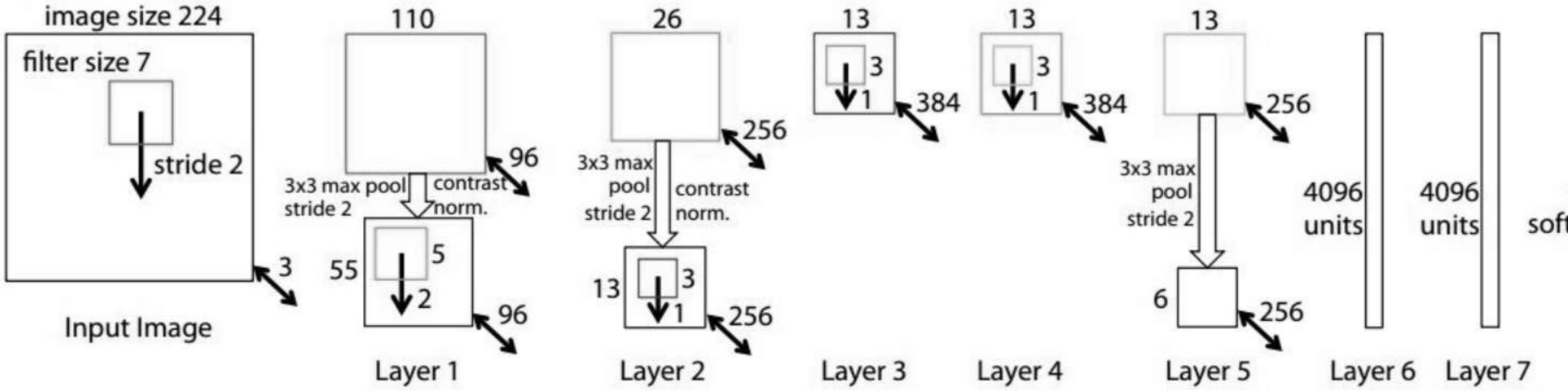
Second layer (POOL1): 3x3 filters applied at stride 2
Output volume: 27x27x96

Q: what is the number of parameters in this layer?

Architectures

ZFNet

[Zeiler and Fergus, 2013]



AlexNet but:
CONV1: change from (11x11 stride 4) to (7x7 stride 2)
CONV3,4,5: instead of 384, 384, 256 filters use 512, 1024, 512

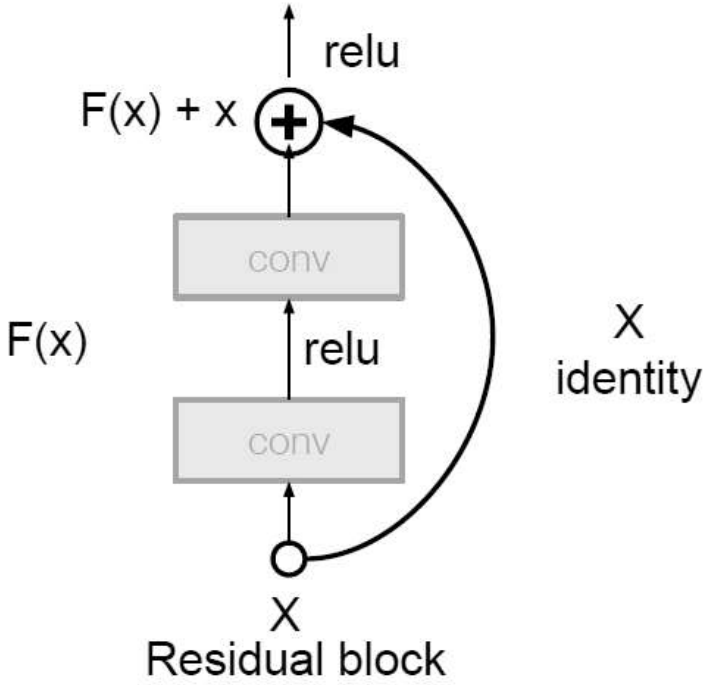
ImageNet top 5 error: 16.4% ->

Case Study: ResNet

[He et al., 2015]

Very deep networks using residual connections

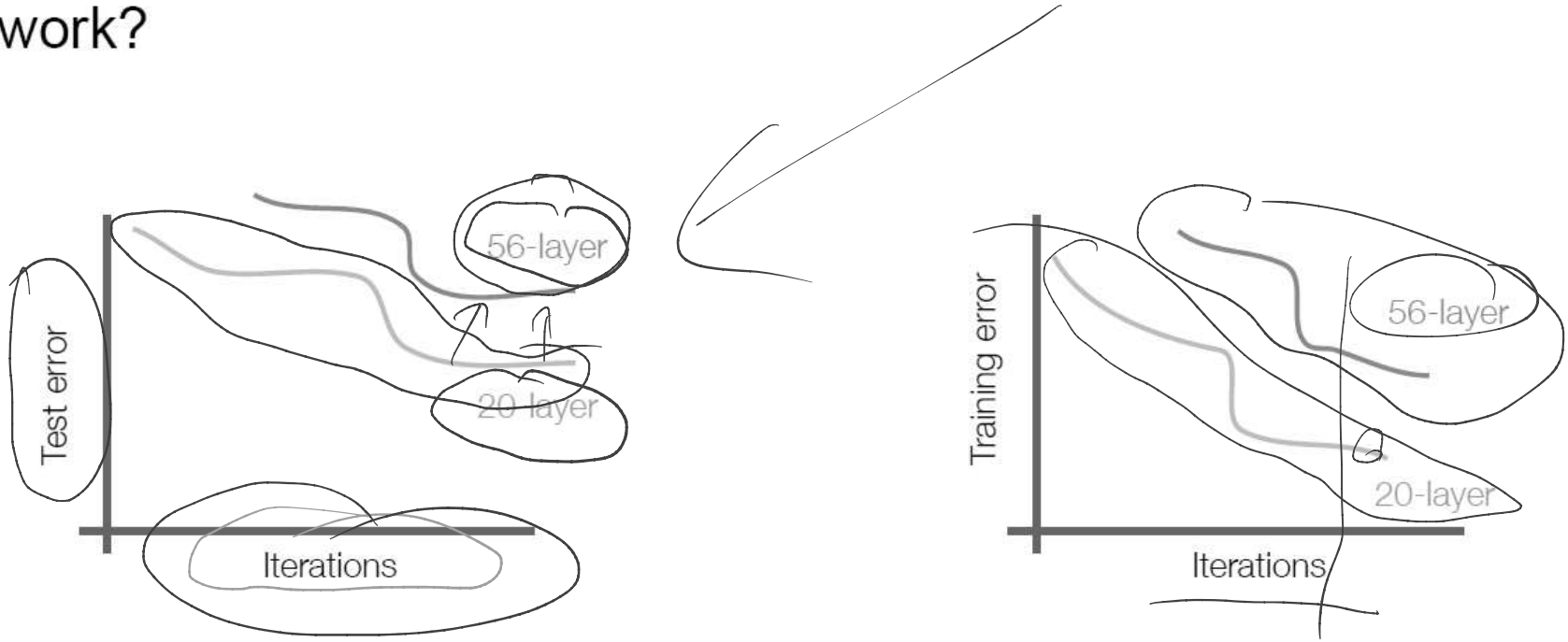
- 152-layer model for ImageNet
- ILSVRC'15 classification winner (3.57% top 5 error)
- Swept all classification and detection competitions in ILSVRC'15 and COCO'15!



Case Study: ResNet

[He et al., 2015]

What happens when we continue stacking deeper layers on a “plain” convoluti
neural network?



56-layer model performs worse on both test and training error
-> The deeper model performs worse, but it’s not caused by overfitting!

Case Study: ResNet

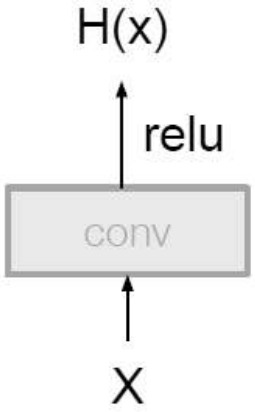
[He et al., 2015]

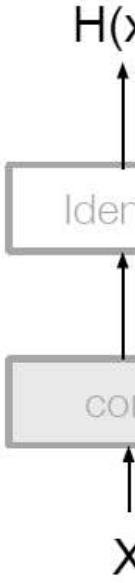
Fact: Deep models have more representation power (more parameters) than shallower models.

Hypothesis: the problem is an *optimization* problem, deeper models are harder to optimize

What should the deeper model learn to be at least as good as the shallower model?

A solution by construction is copying the learned layers from the shallower model and setting additional layers to identity mapping.



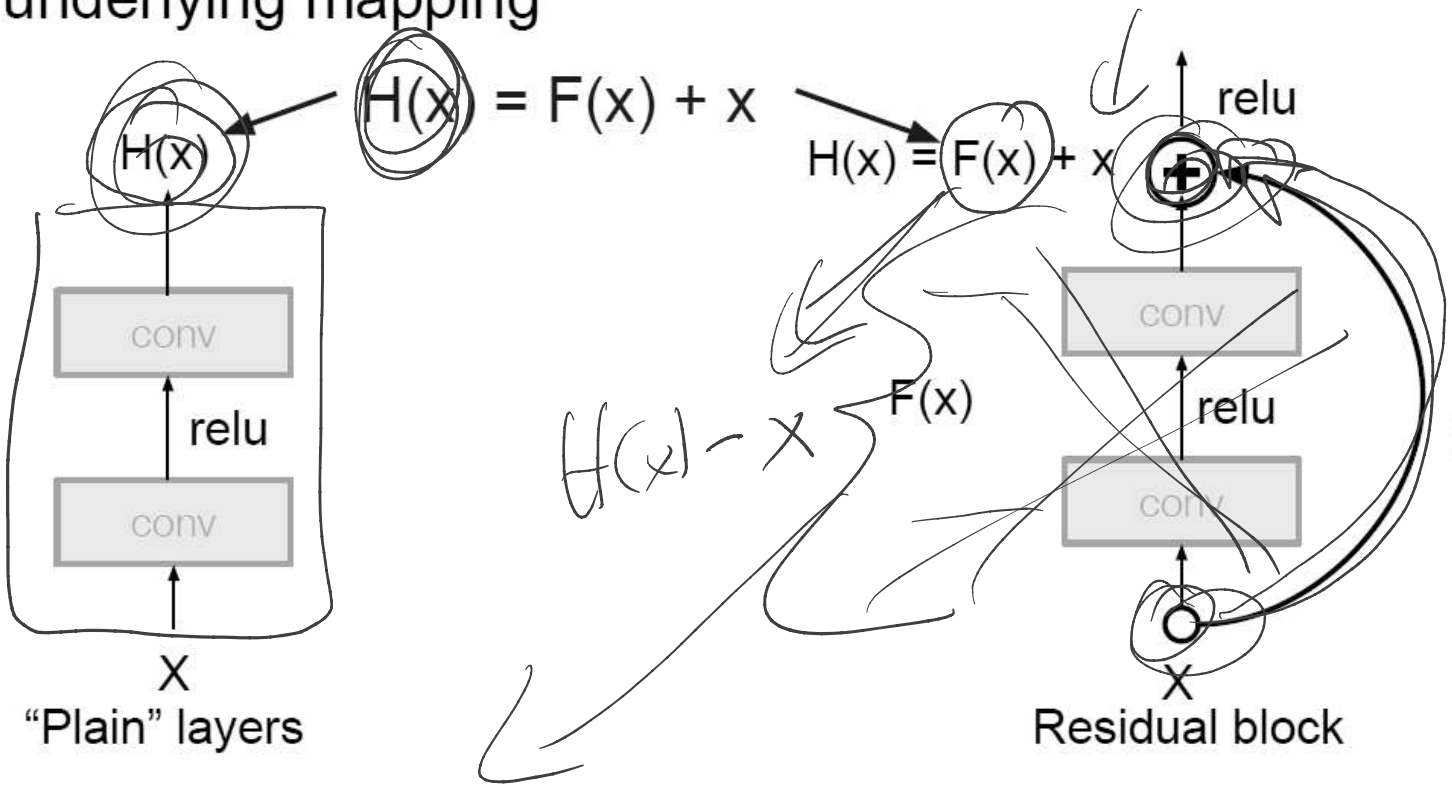


Architectures

Case Study: ResNet

[He et al., 2015]

Solution: Use network layers to fit a residual mapping instead of directly trying t
desired underlying mapping



Identity mappi
H(x) = x if F(x)

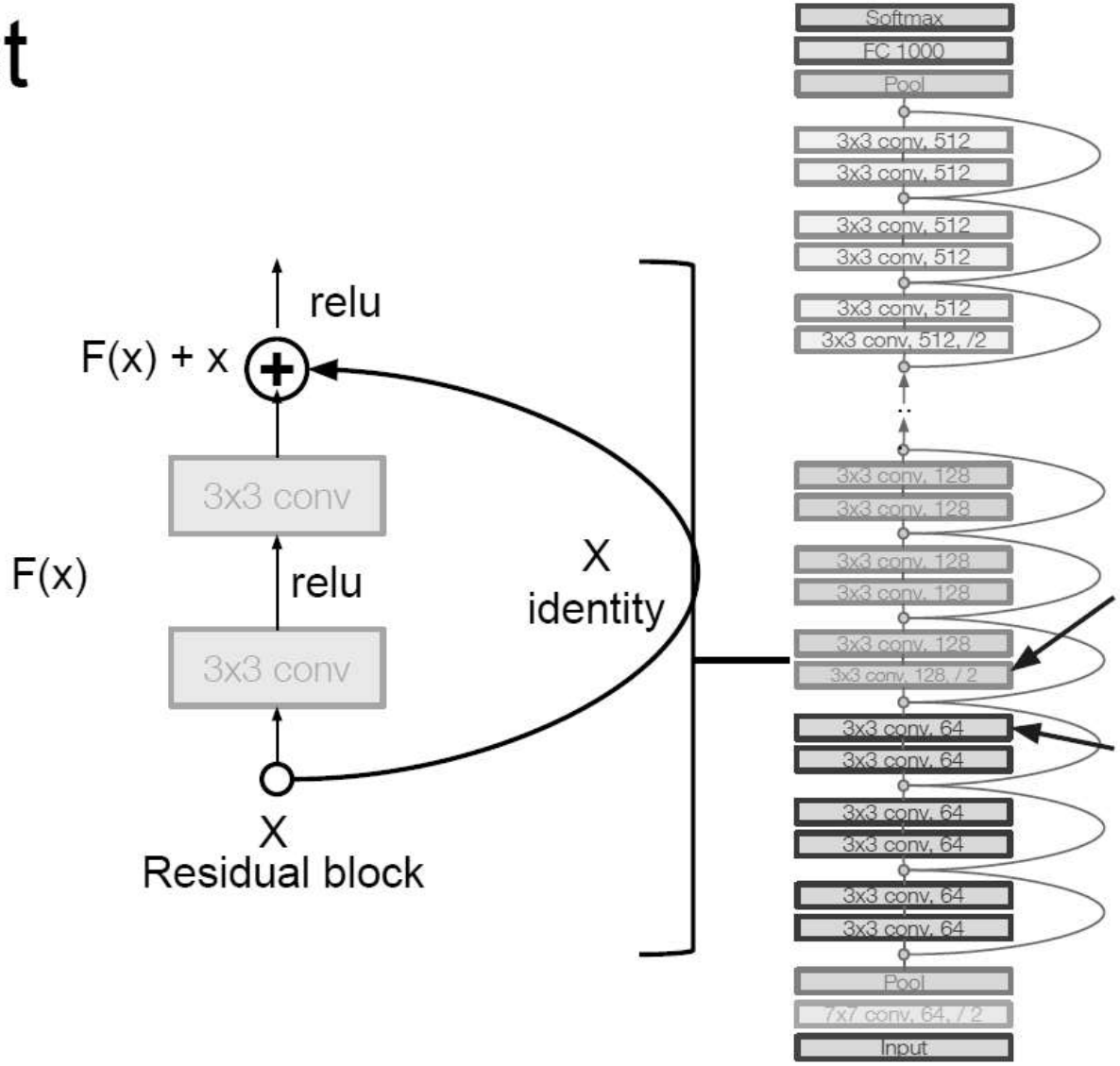
Use layer
fit **residu**
F(x) = H(
instead o
H(x) direc

Case Study: ResNet

[He et al., 2015]

Full ResNet architecture:

- Stack residual blocks
- Every residual block has two 3x3 conv layers
- Periodically, double # of filters and downsample spatially using stride 2 (/2 in each dimension) Reduce the activation volume by half.



Case Study: ResNet

[He et al., 2015]

Full ResNet architecture:

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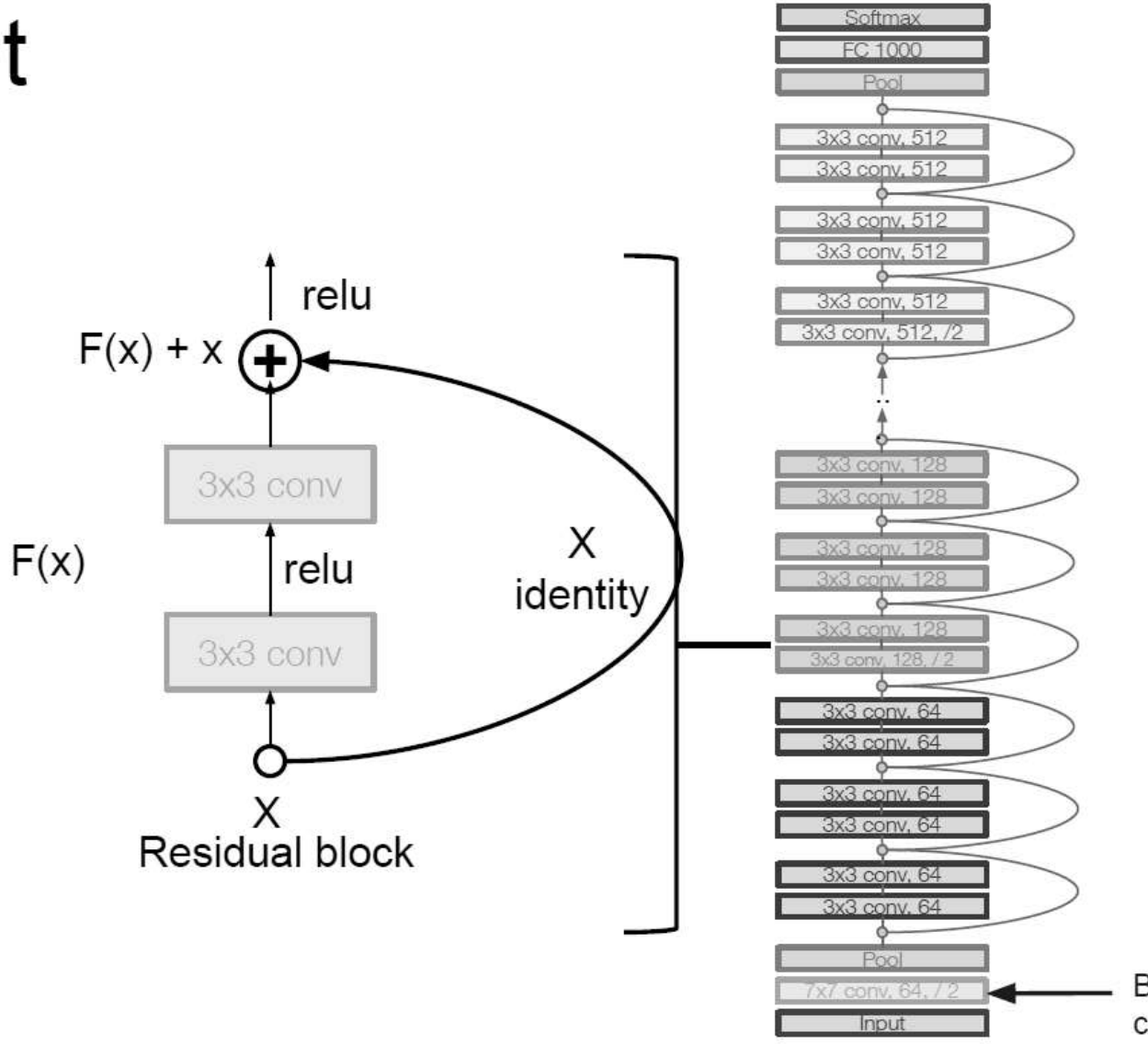
- Every residual block has two 3x3 conv layers
- Periodically, double # of filters and downsample spatially using stride 2 (/2 in each dimension)
- Additional conv layer at the beginning (stem)



Architectures

Case Study: ResNet

[He et al., 2015]

Full ResNet architecture:

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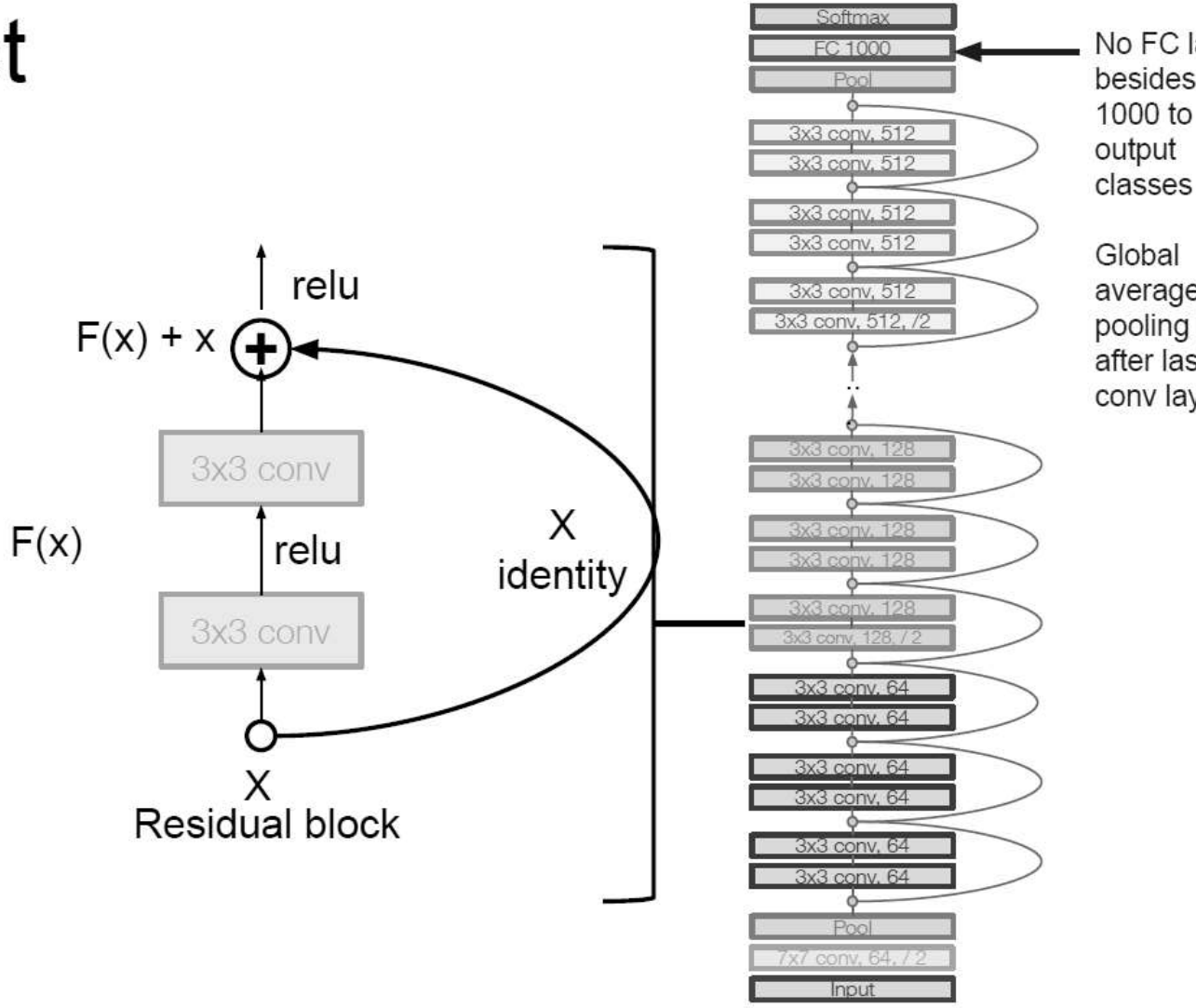
- Additional conv layer at the beginning (stem)
- No FC layers at the end (only FC 1000 to output classes)
- (In theory, you can train a ResNet with input image of variable sizes)



Architectures

Case Study: ResNet

[He et al., 2015]

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