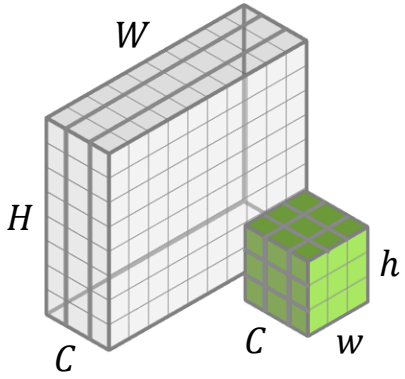
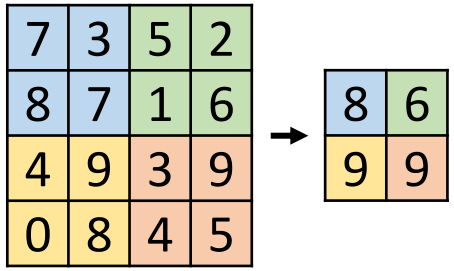
CNN Architectures

November 11th, 2021

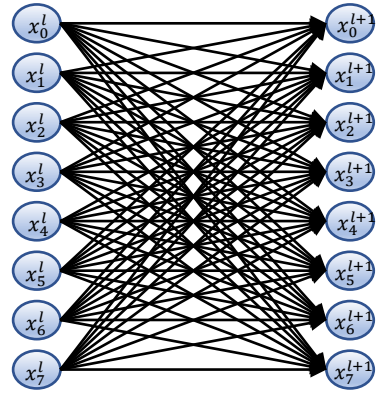
The ConvNet Building Blocks



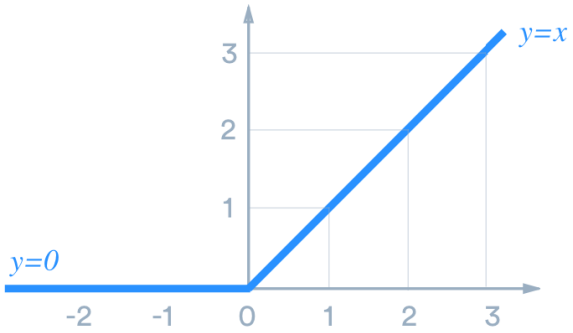
Conv Layer



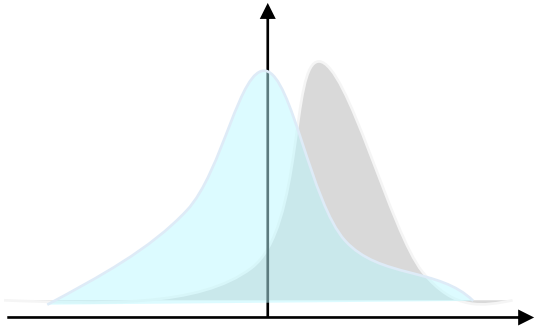
Max Pooling



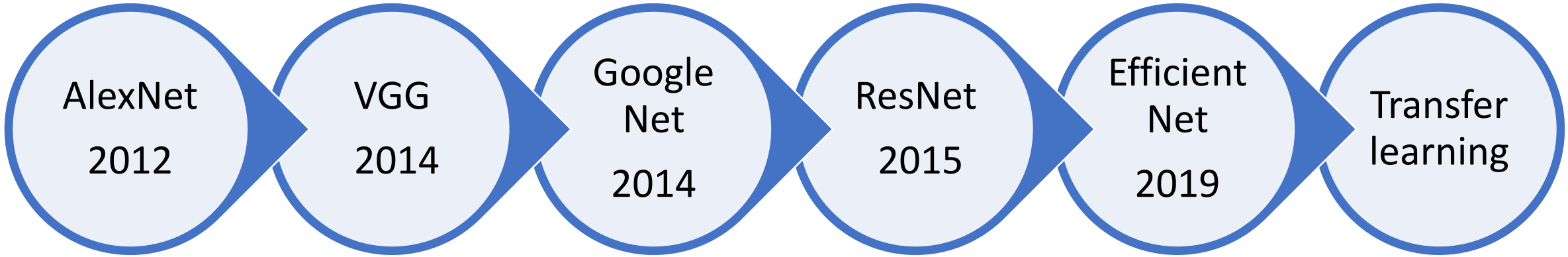
FC Layer



Activation Func.



Batch Norm


AlexNet
2012
VGG
2014
Google
Net
2014
ResNet
2015
Efficient
Net
2019
Transfer
learning

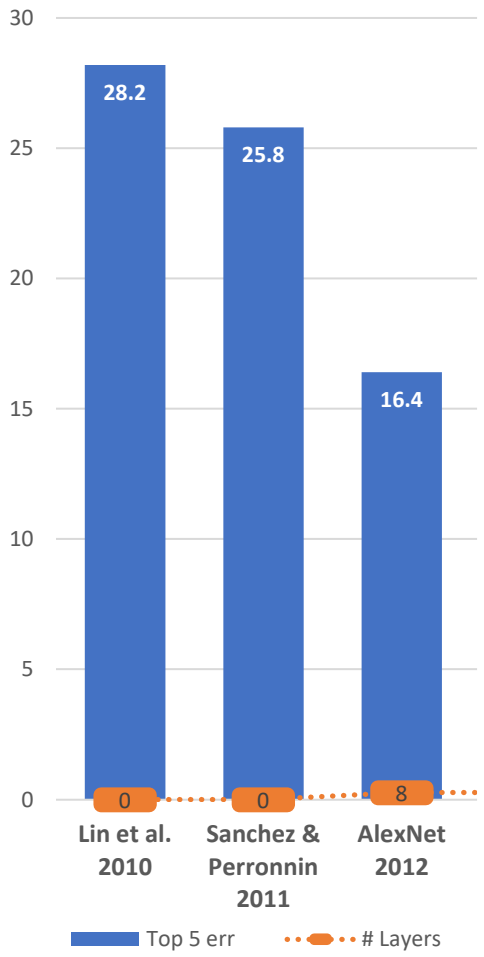
IMAGENET

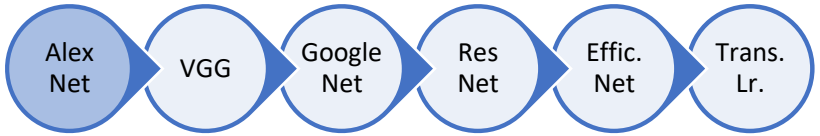
Visual Recognition Challenge (ILSVRC)

- 1.2M training images
- 100K testing images
- 1K categories

Olga Russakovsky et al. ImageNet Large Scale Visual Recognition Challenge. IJCV, 2015.

AlexNet

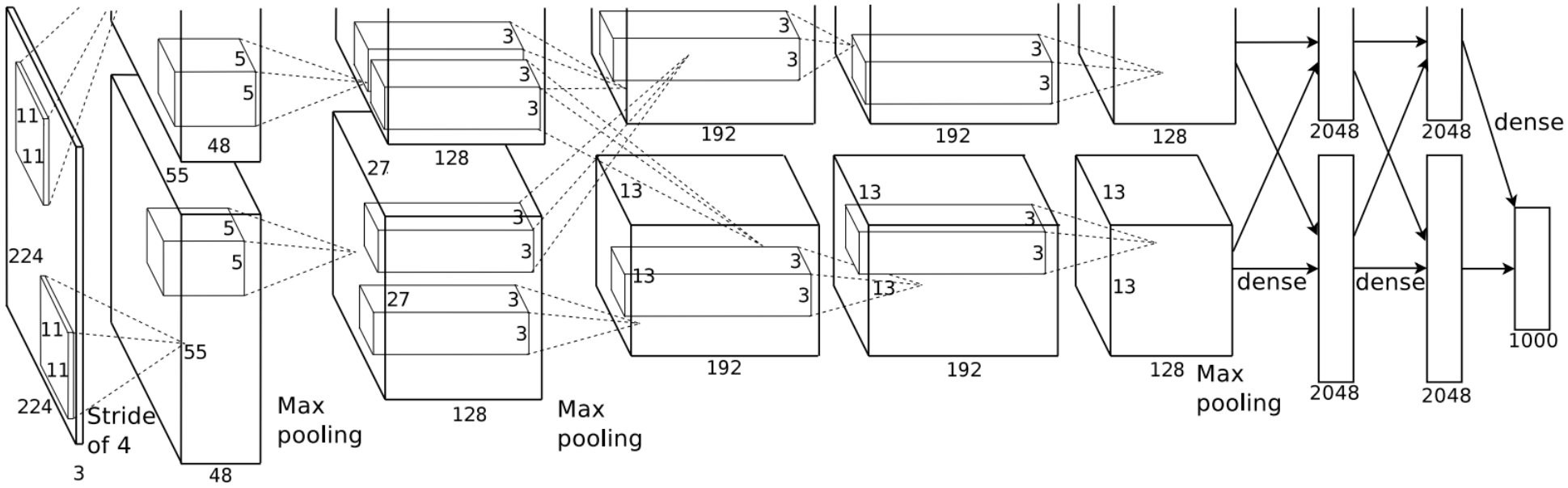




- Fukushima 1980
- LeCunn et al. 1989
- LeCunn et al. 1998

Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton. ImageNet classification with deep convolutional neural networks.NIPS, 2012

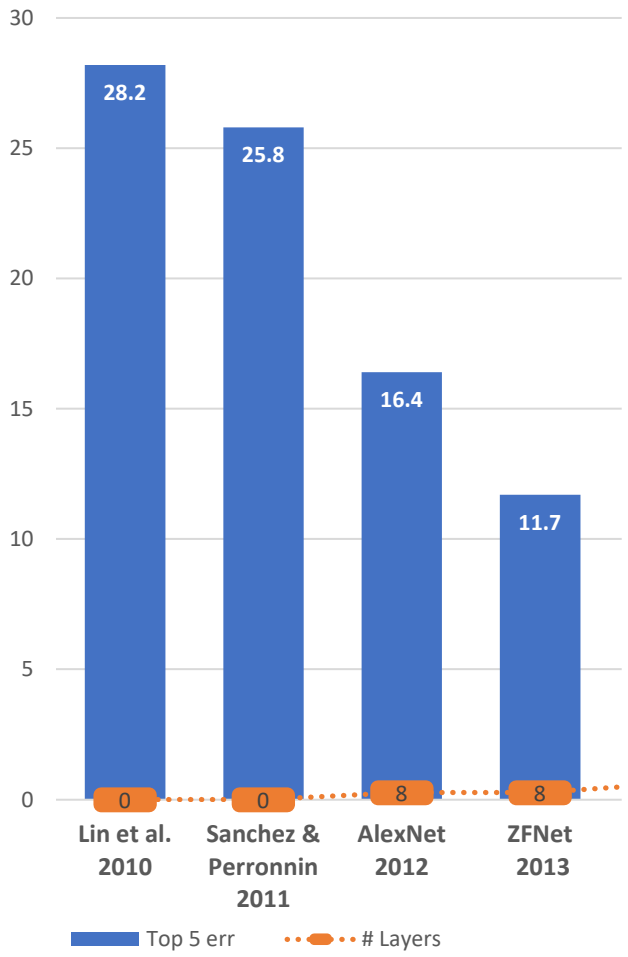
AlexNet

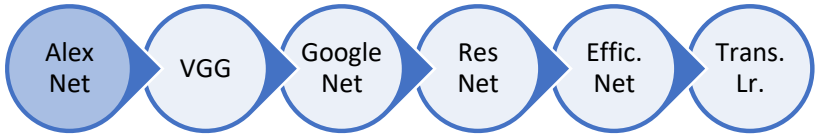


Details:

- ReLU activation
- Max Pooling
- Dropout
- Batch
- SGD Momentum

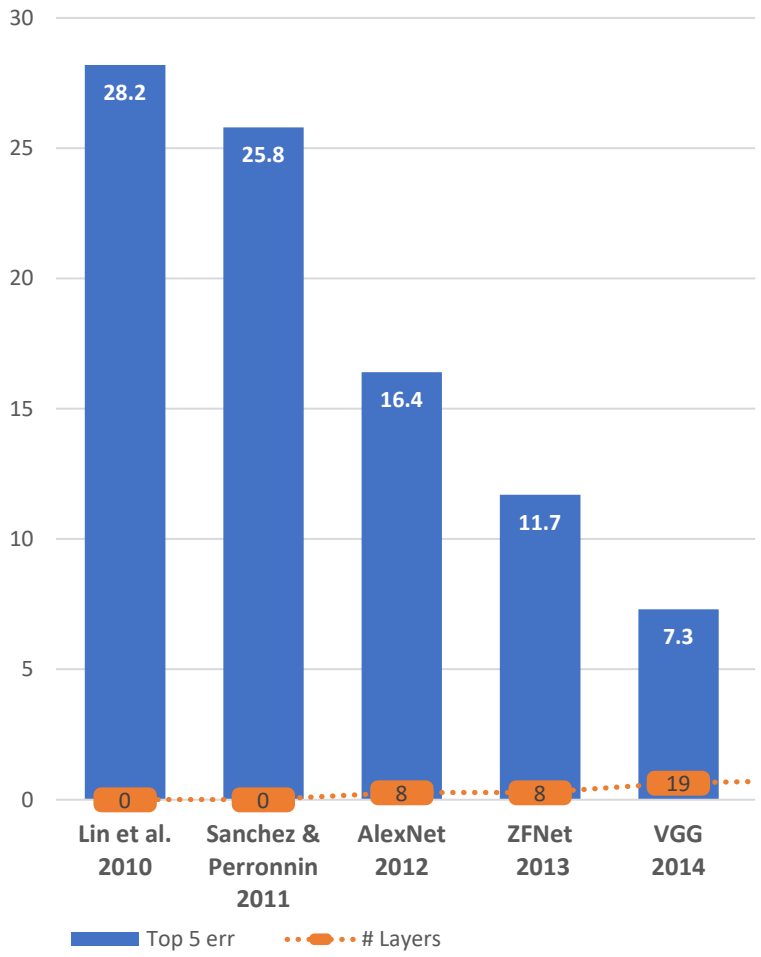
ZFNet

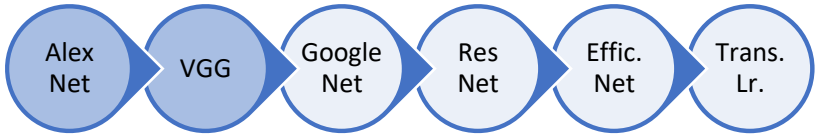


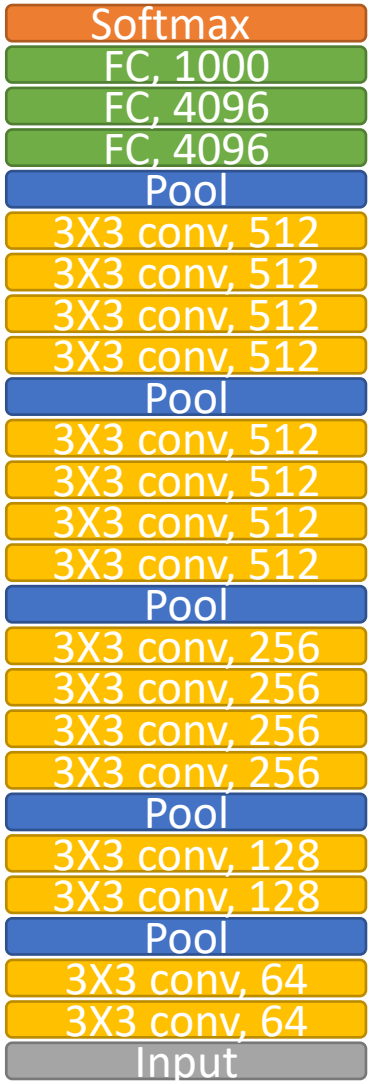


Matthew D Zeiler, Rob Fergus. Visualizing and Understanding Convolutional Networks. ECCV, 2014.

VGG

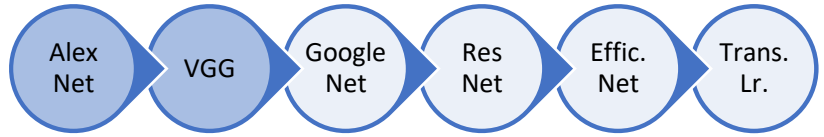




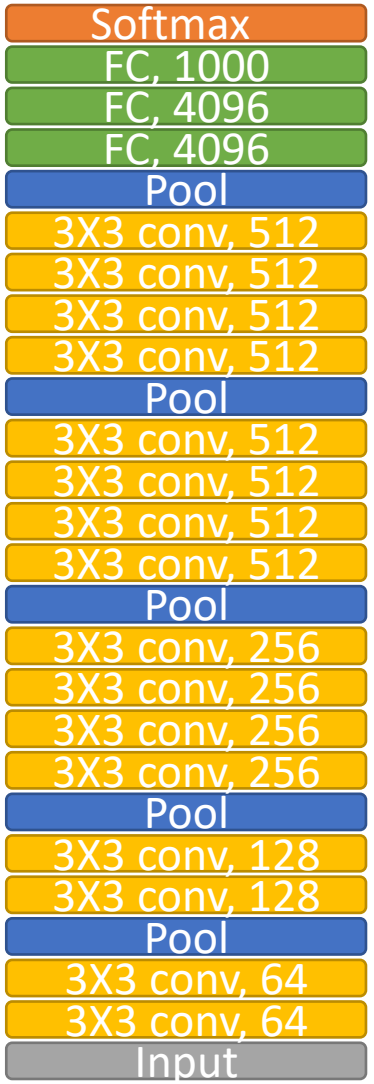


Karen Simonyan, Andrew Zisserman. Very Deep Convolutional Networks for Large-Scale Image Recognition. ICLR, 2015.

VGG



- All conv layers are 3x3, stride 1, pad 1
- All pooling layers are 2x2, stride 2
- After pooling, double the number of channels



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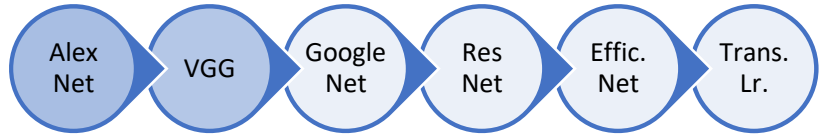
Why using 3x3 conv layers?

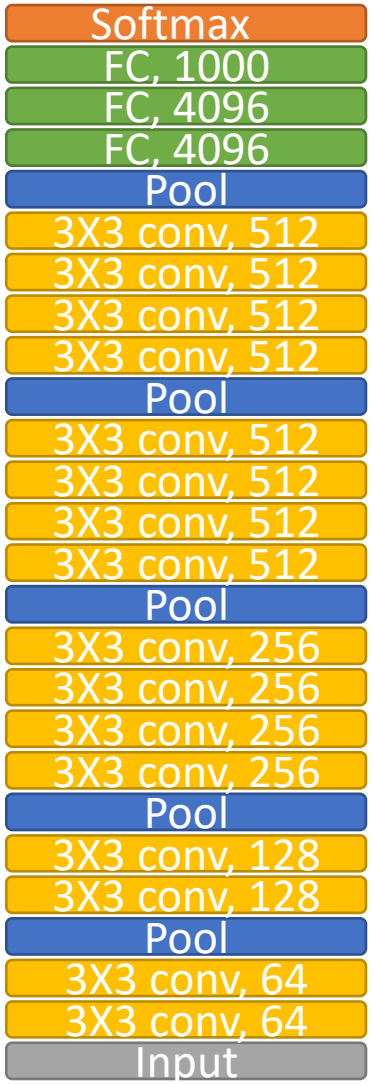


5X5 conv, C

3X3 conv, C

3X3 conv, C

Receptive Field



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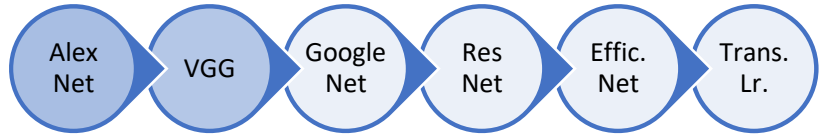
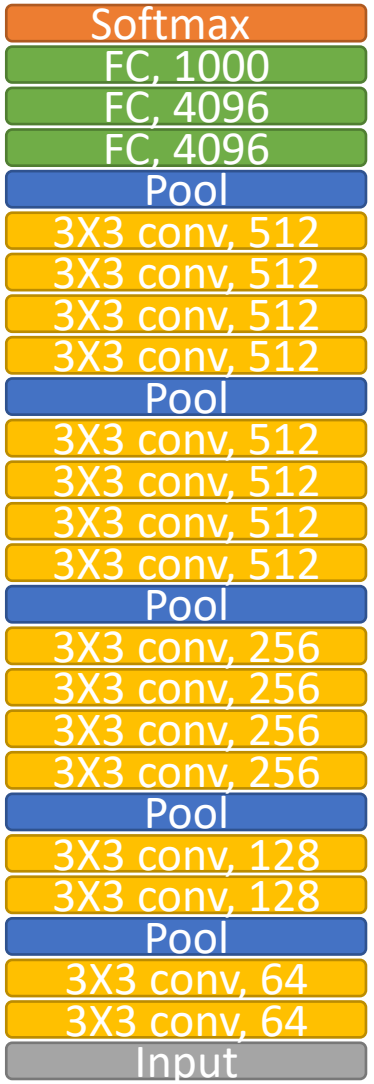


	5X5 conv, C	3X3 conv, C 3X3 conv, C
Receptive Field	5	5
# Parameters		



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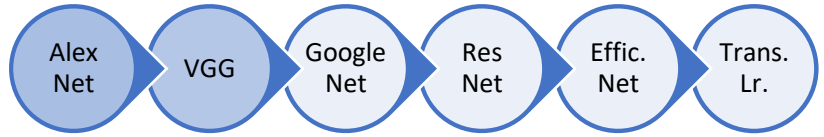
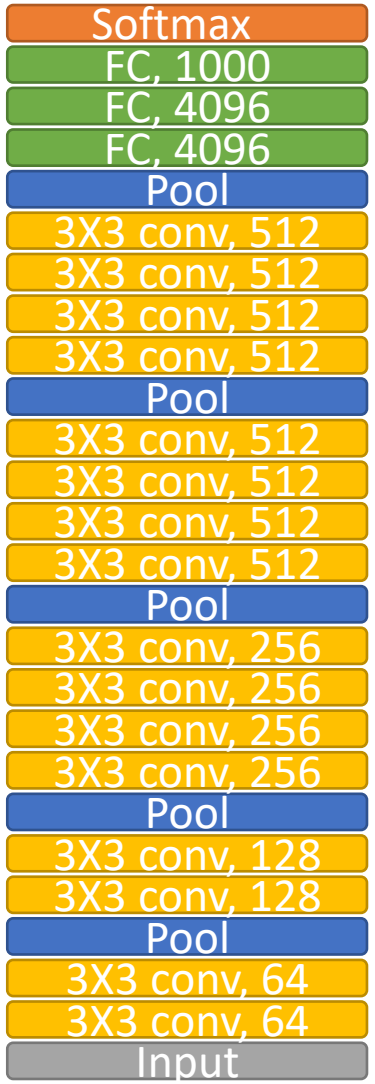


	5X5 conv, C	3X3 conv, C 3X3 conv, C
Receptive Field	5	5
# Parameters	$25C^2$	$9C^2+9C^2 = 18C^2$
# FLOPs		



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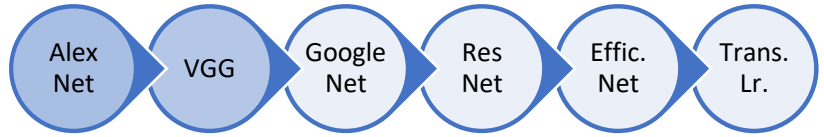
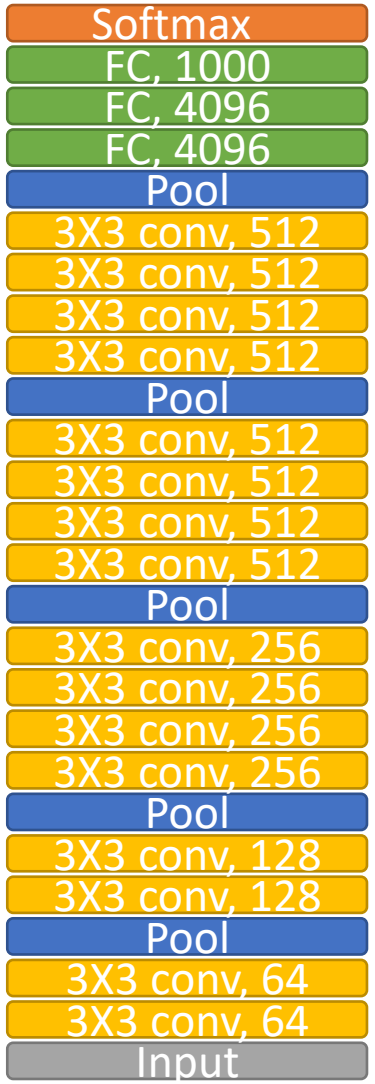


	5X5 conv, C	3X3 conv, C 3X3 conv, C
Receptive Field	5	5
# Parameters	$25C^2$	$9C^2+9C^2 = 18C^2$
# FLOPs	$25C^2HW$	$18C^2HW$



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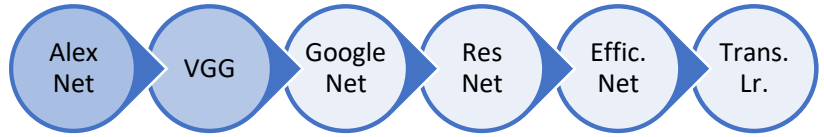
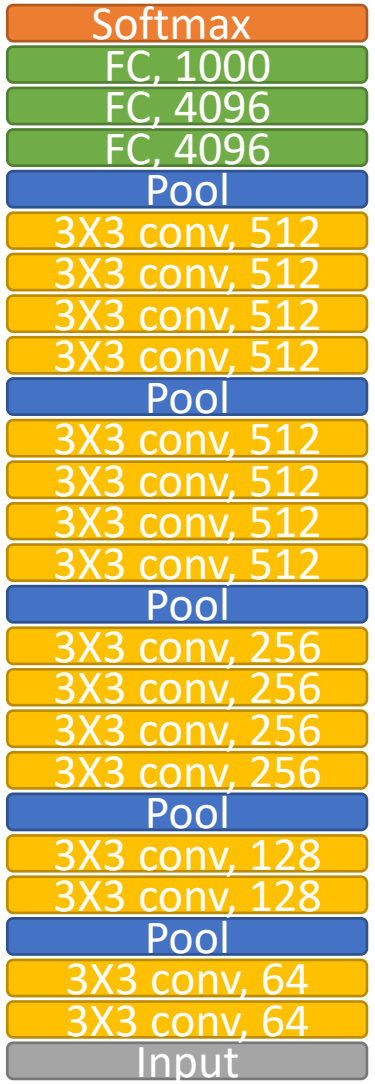


	5X5 conv, C	3X3 conv, C 3X3 conv, C
Receptive Field	5	5
# Parameters	$25C^2$	$9C^2+9C^2 = 18C^2$
# FLOPs	$25C^2HW$	$18C^2HW$
Memory Size (Output)		



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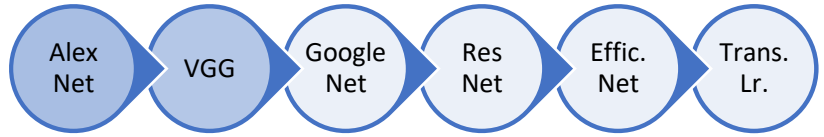
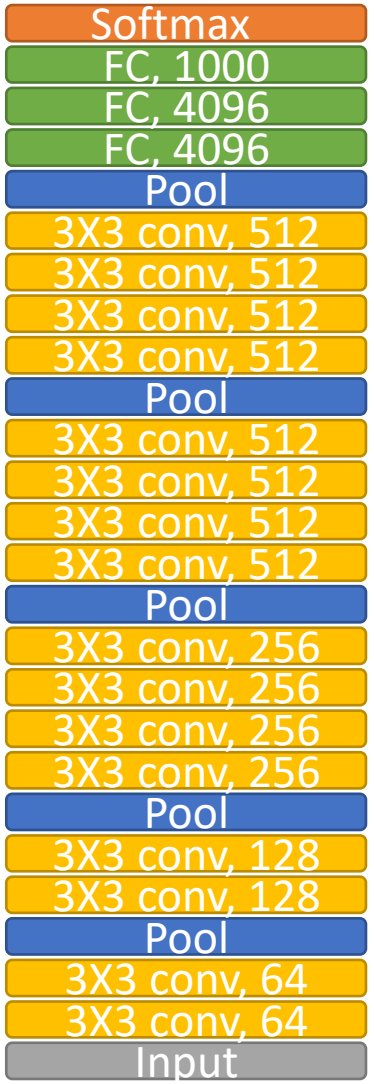


	5X5 conv, C	3X3 conv, C 3X3 conv, C
Receptive Field	5	5
# Parameters	$25C^2$	$9C^2+9C^2 = 18C^2$
# FLOPs	$25C^2HW$	$18C^2HW$
Memory Size (Output)	HWC	2HWC



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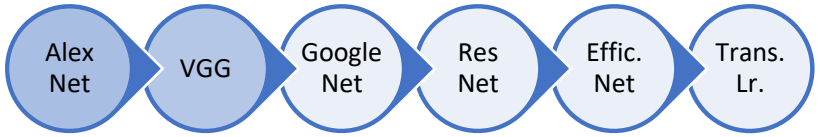
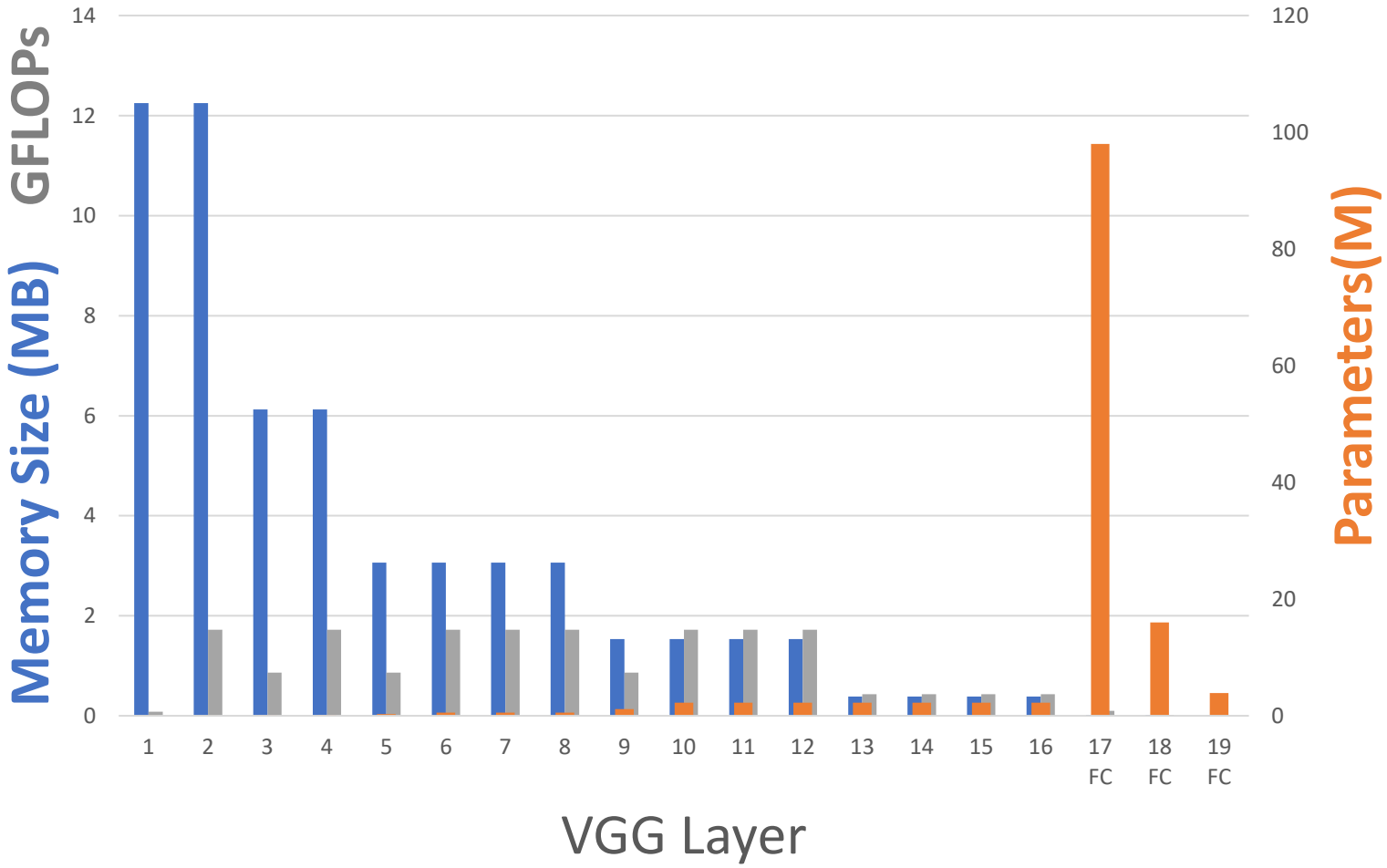
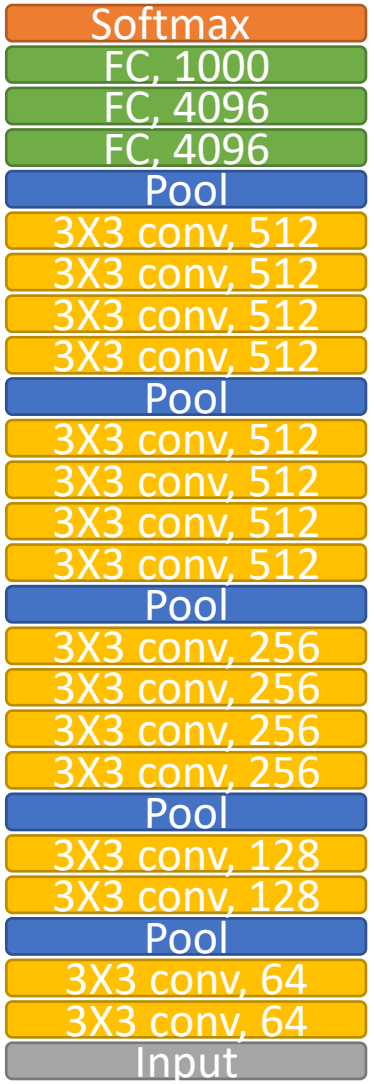
VGG resources







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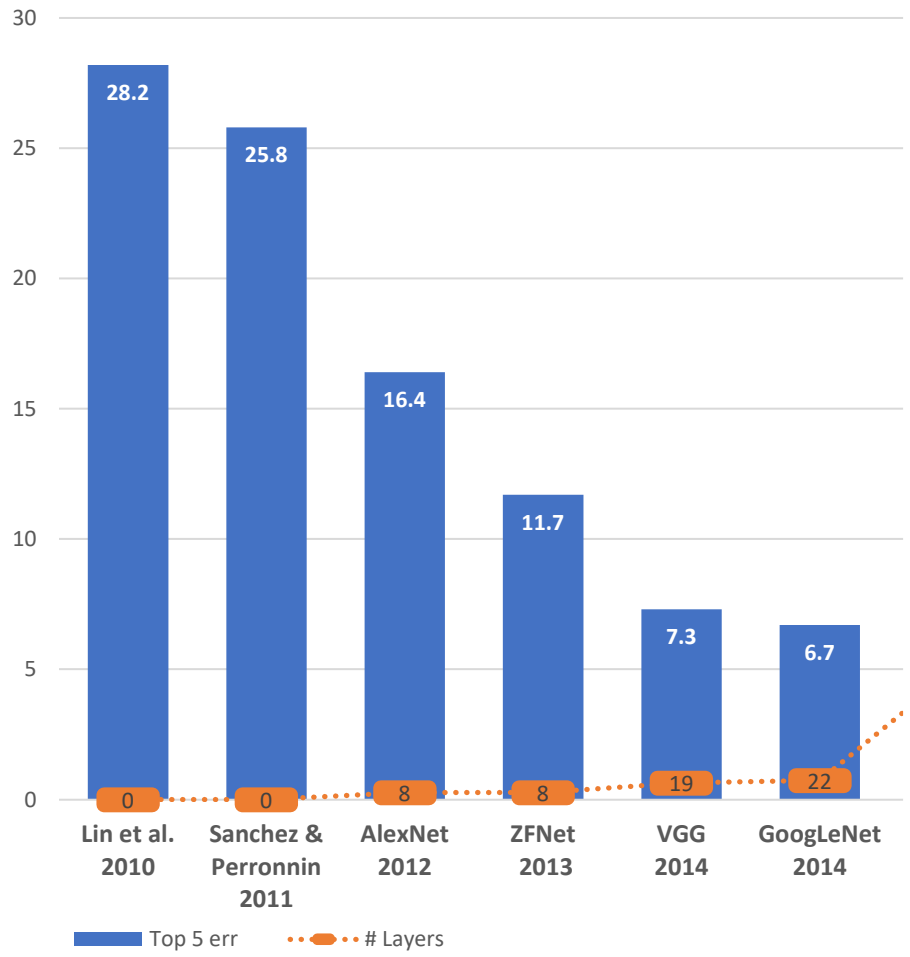
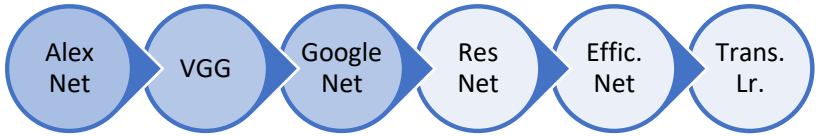
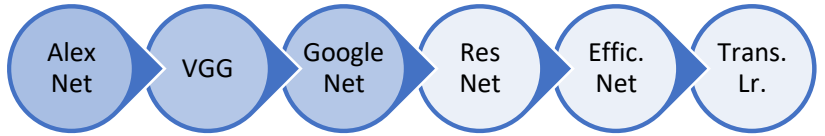
GoogLeNet

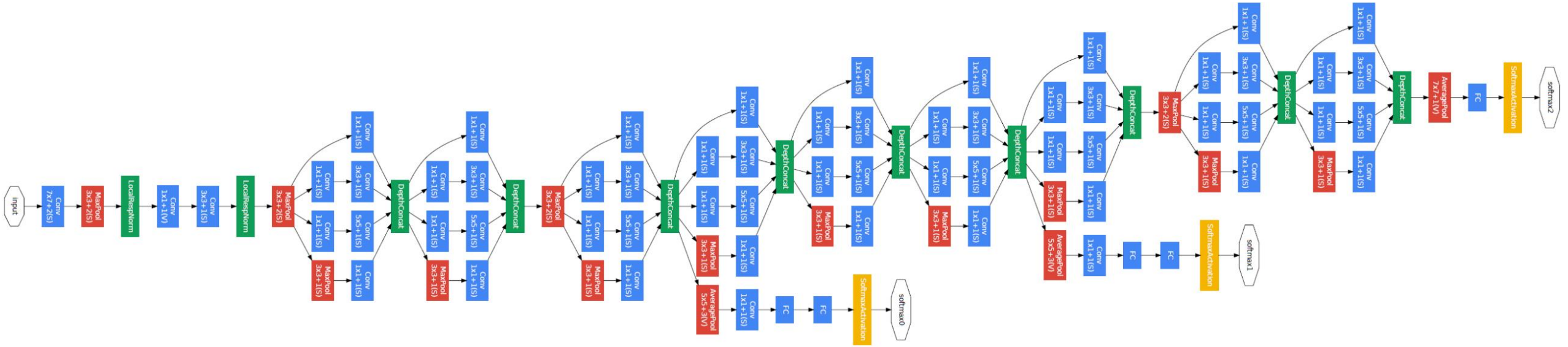




Christian Szegedy et al. Going deeper with convolutions. CVPR, 2015.

GoogLeNet





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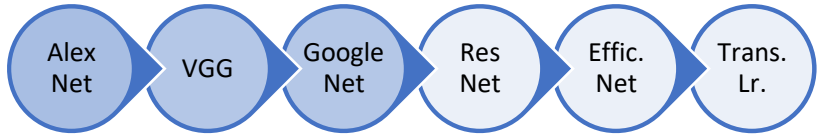
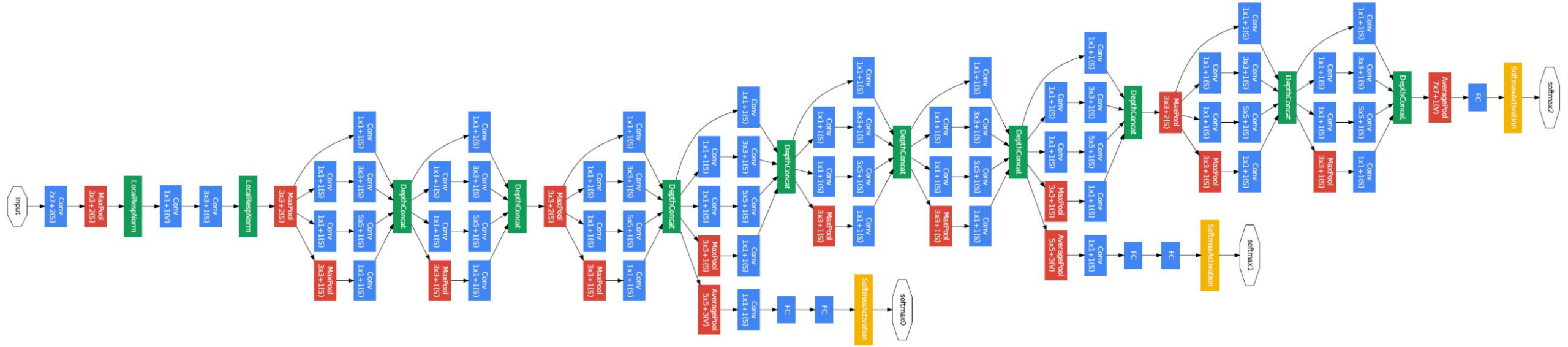

Alex Net
VGG
Google Net
Res Net
Effic. Net
Trans. Lr.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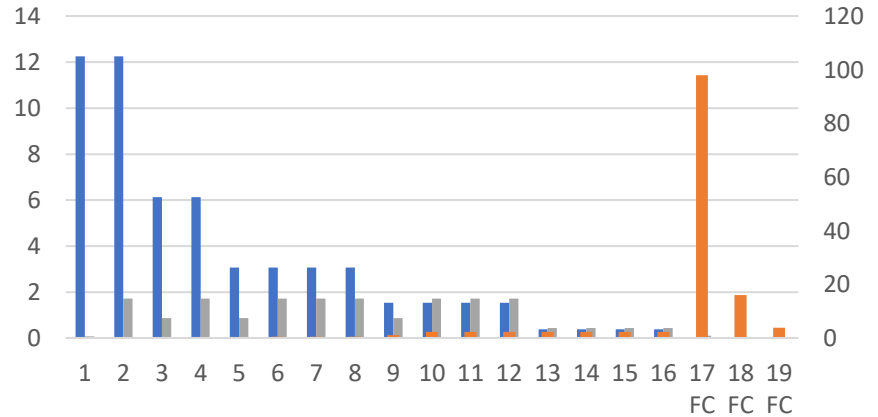
softmax2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10
8
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120
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80
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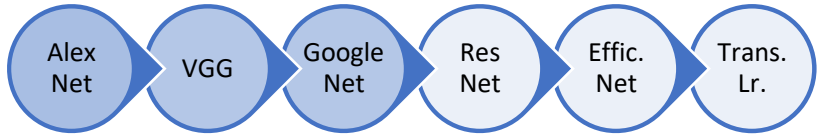
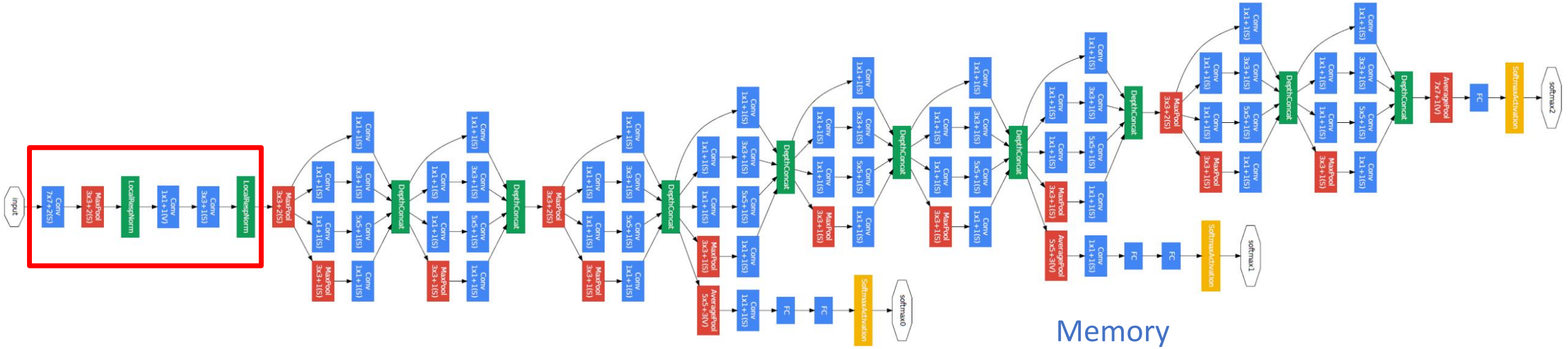
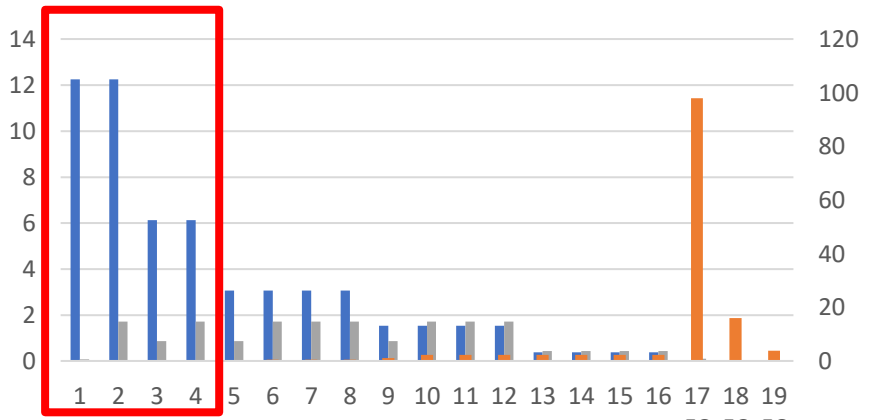
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
FC FC FC

Aggressive downsampling

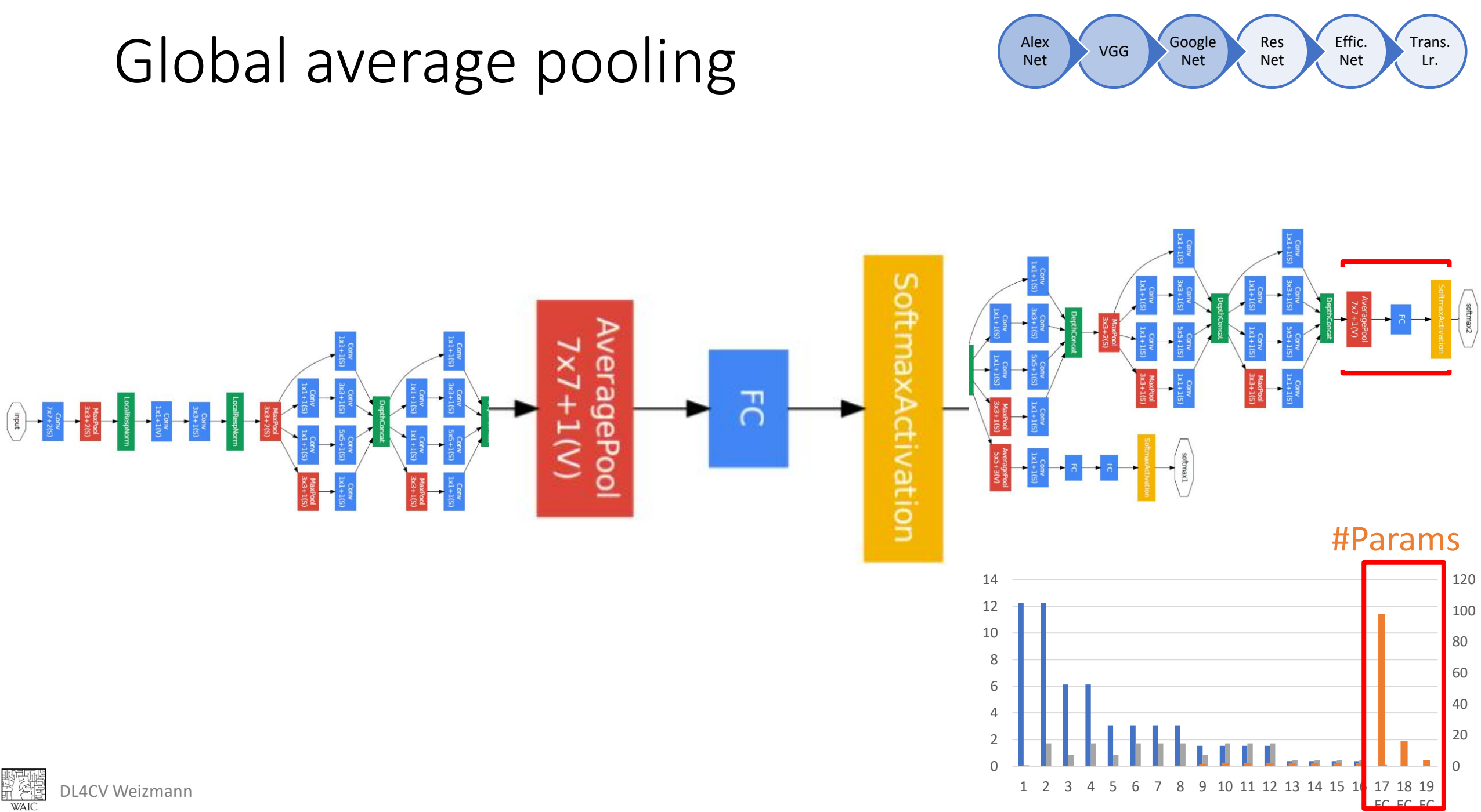




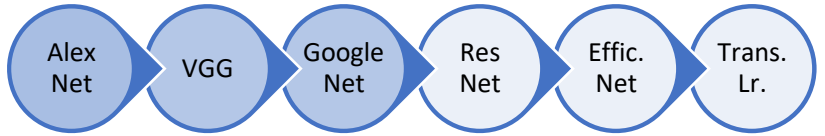
Memory

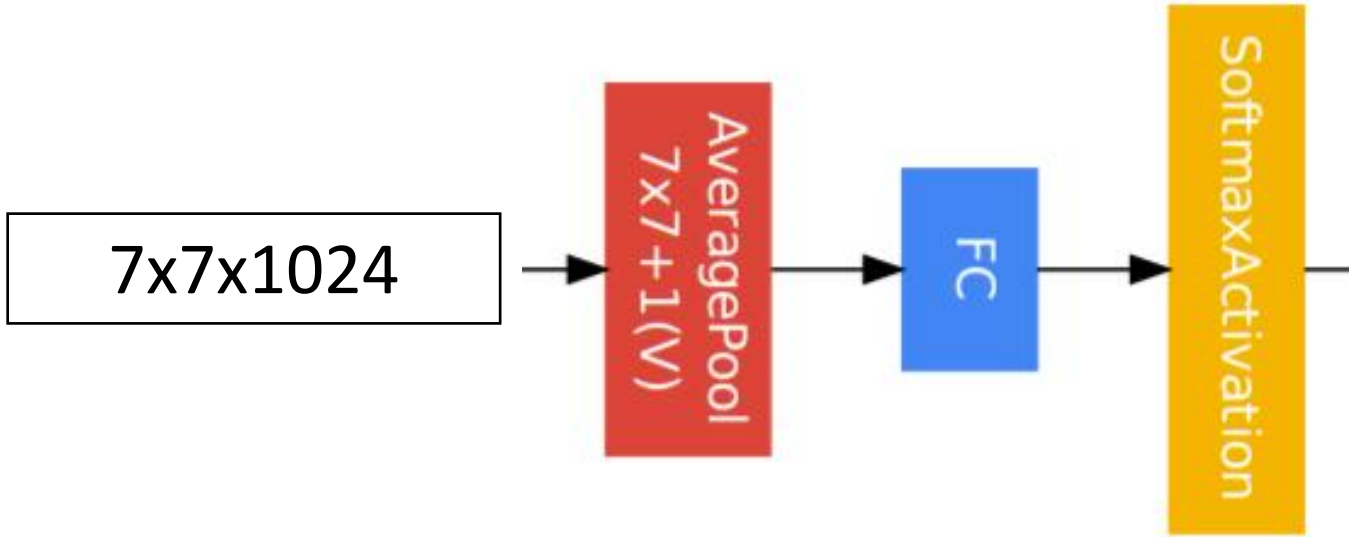


Global average pooling

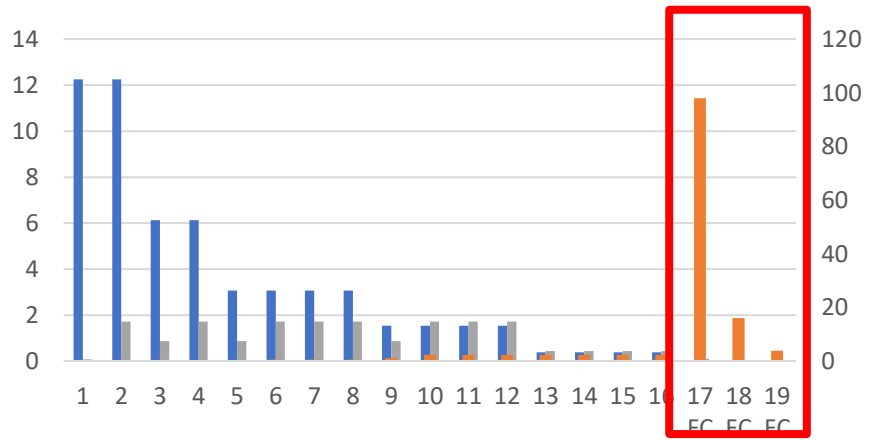


Global average pooling

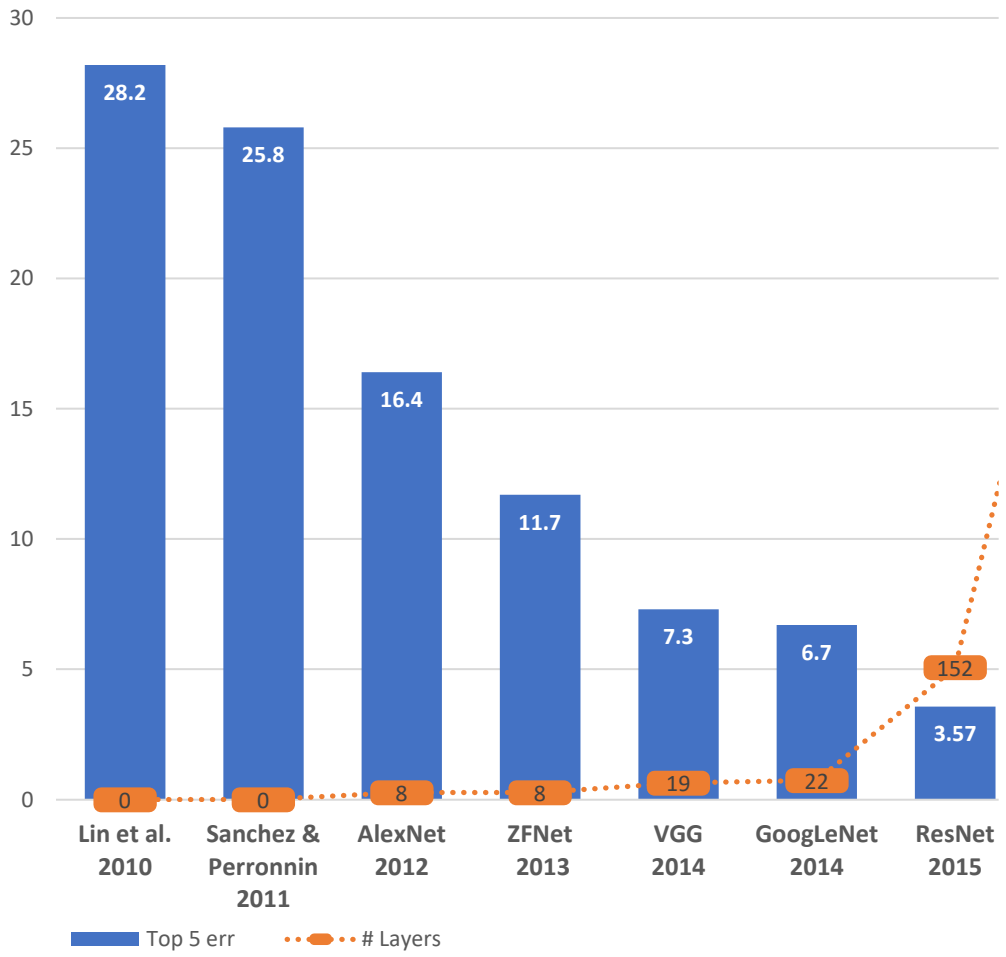


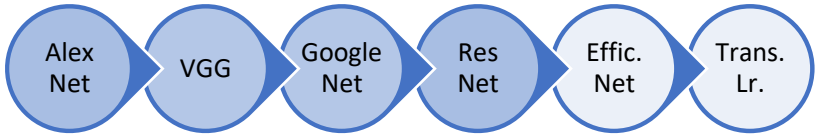


#Params



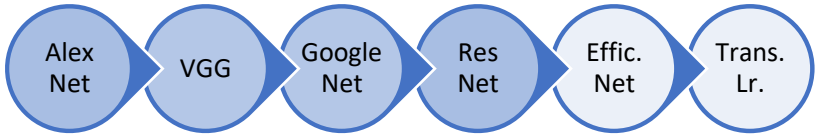
ResNet

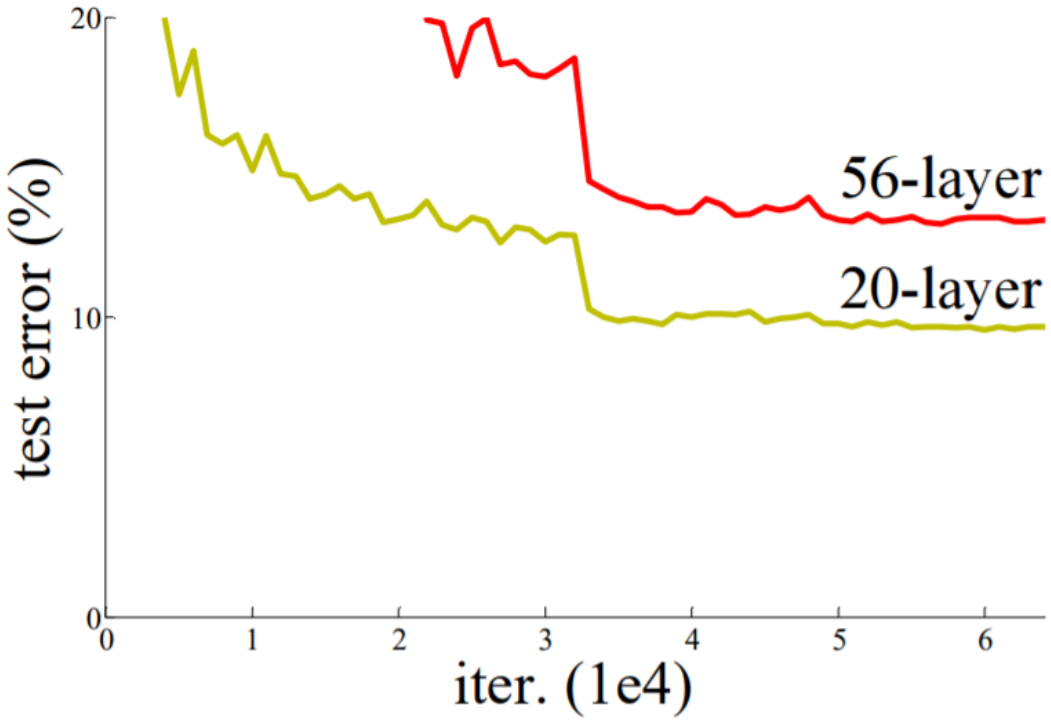




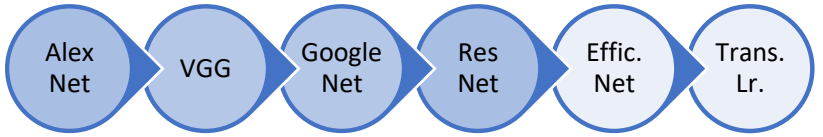
Kaiming He et al. Deep Residual Learning for Image Recognition. CVPR, 2016.

ResNet


Alex Net
VGG
Google Net
Res Net
Effic. Net
Trans. Lr.


20
10
0
test error (%)
0
1
2
3
4
5
6
iter. (1e4)
56-layer
20-layer

ResNet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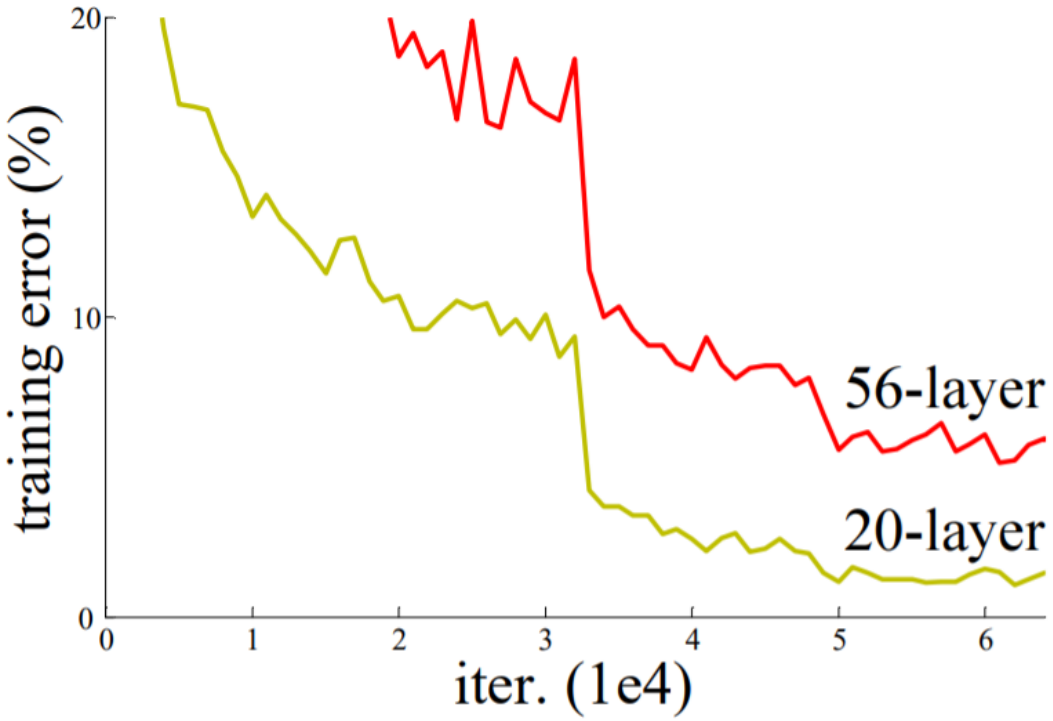
training error (%)
iter. (1e4)
56-layer
20-layer
0
10
20
0
1
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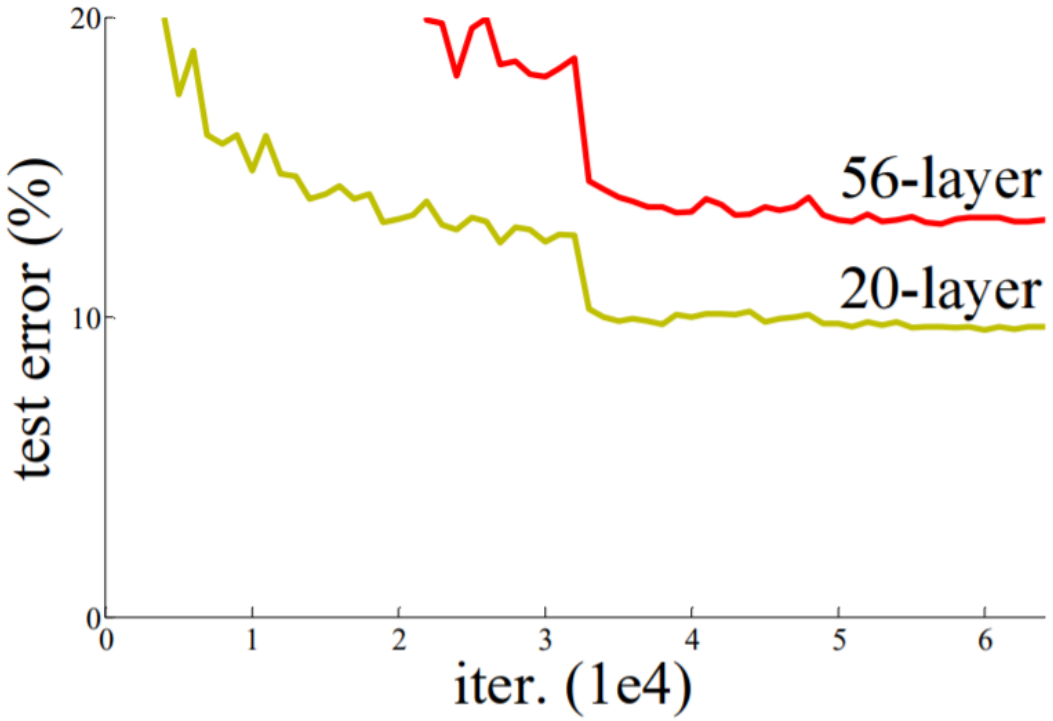
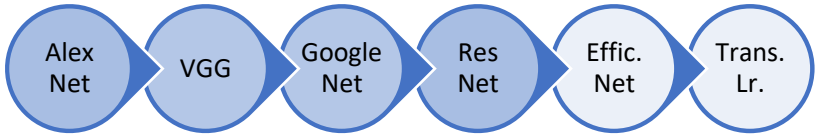
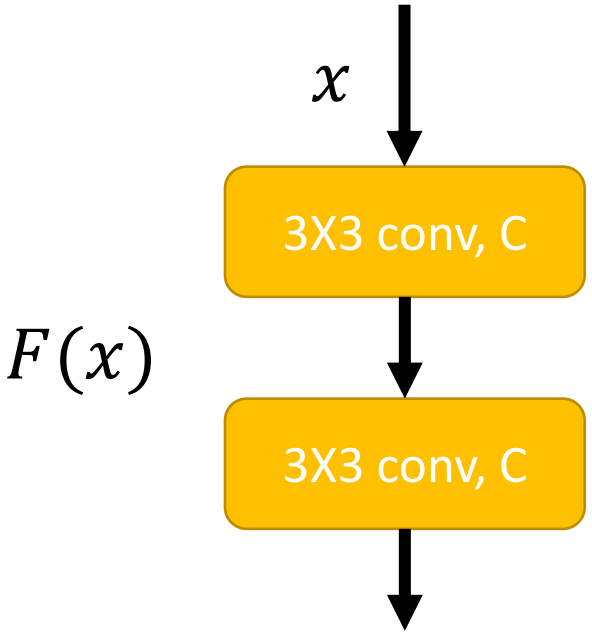
3
4
5
6

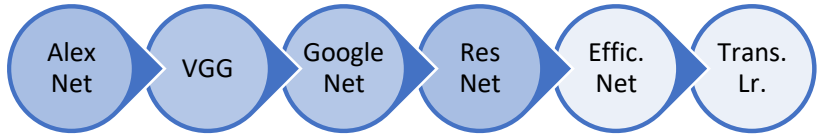

test error (%)
iter. (1e4)
56-layer
20-layer
0
10
20
0
1
2
3
4
5
6

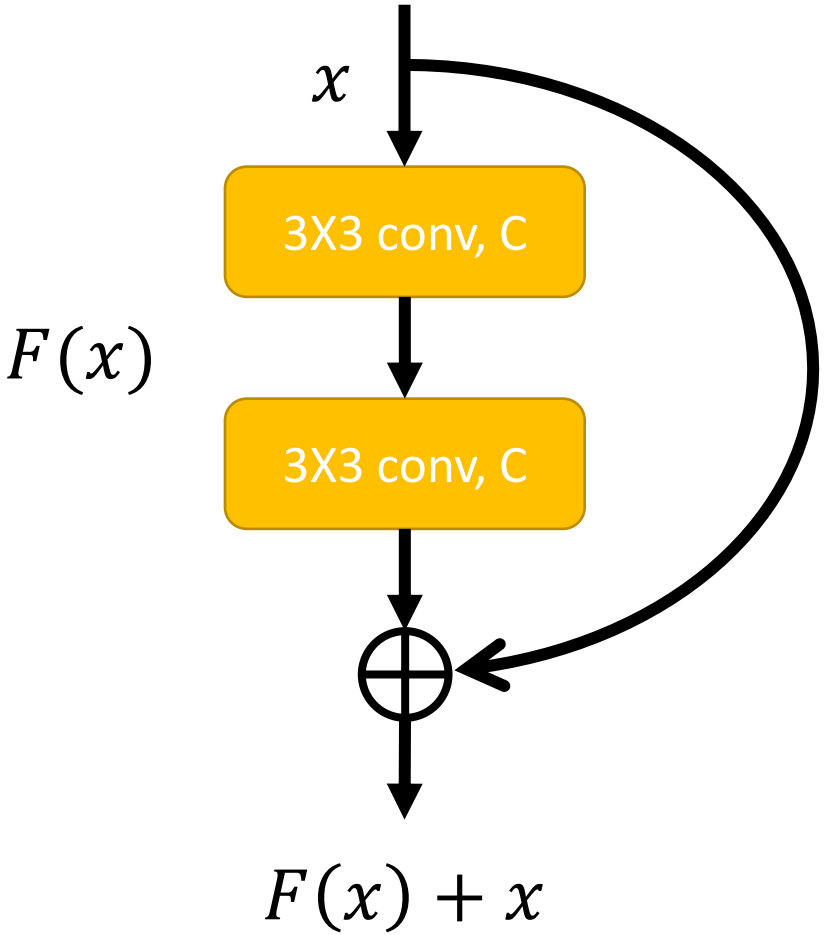
Residual Building Block



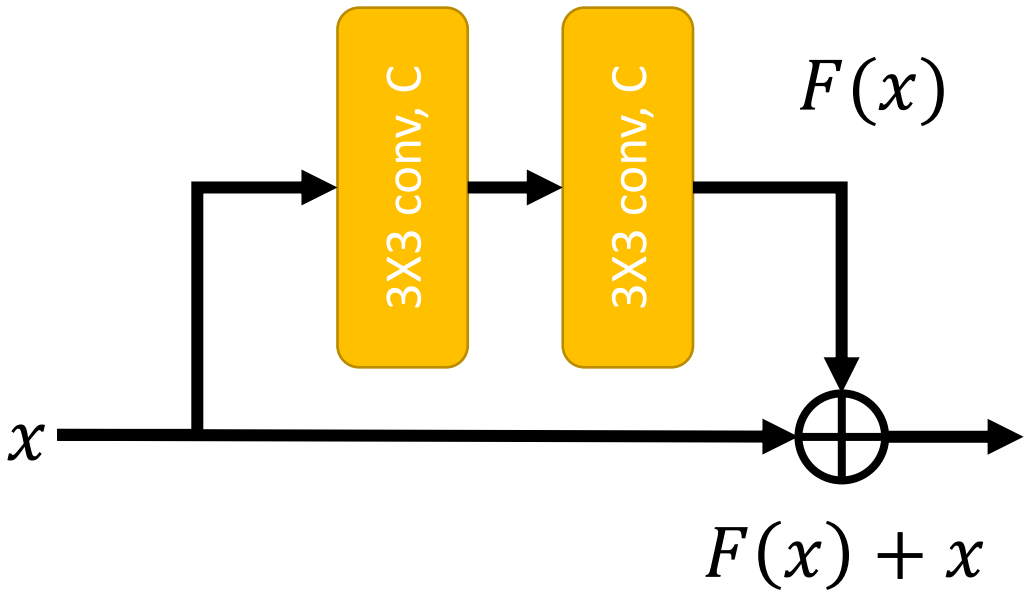


Residual Building Block





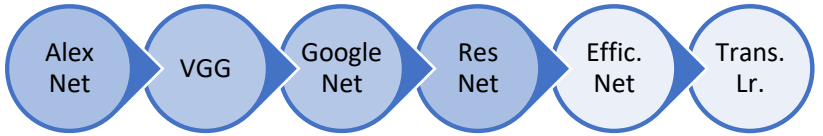
Same blocks

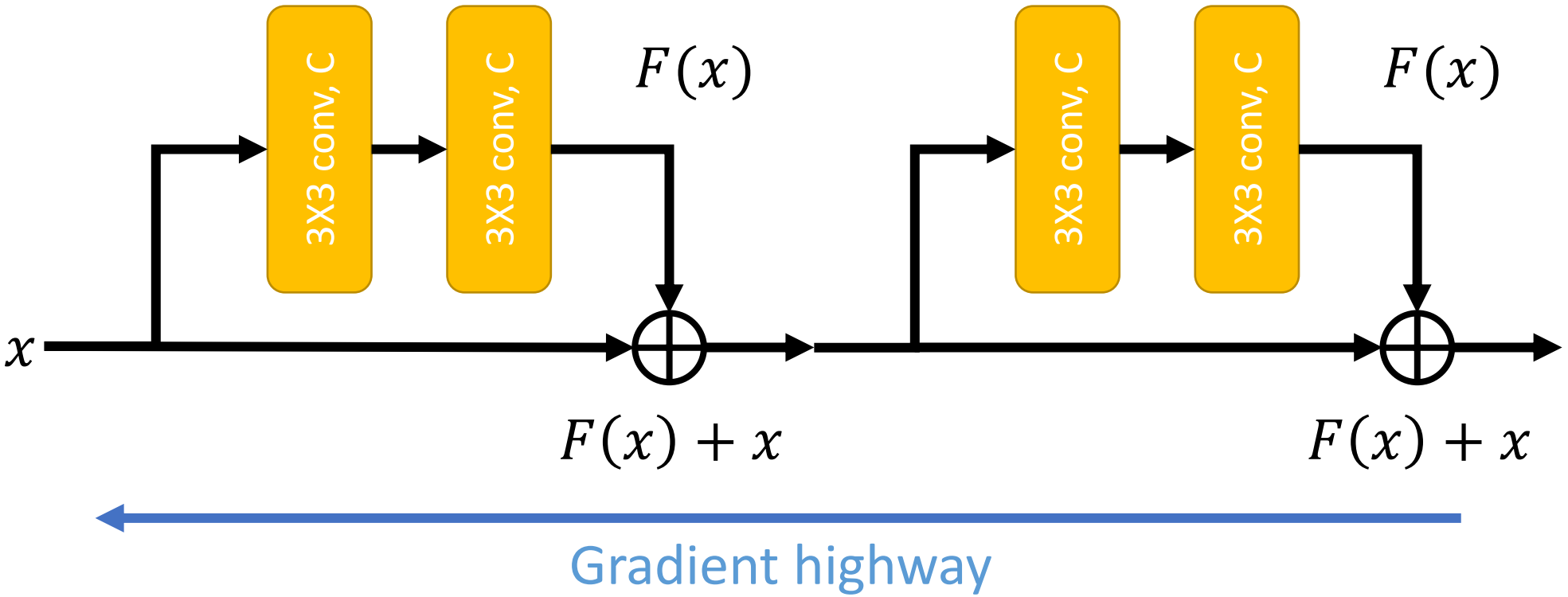


Encourage identity mapping

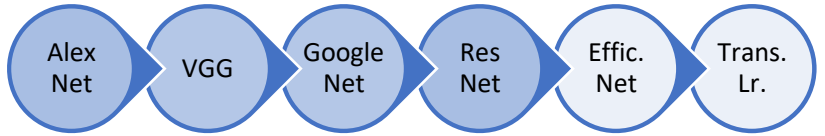
Predict small residual

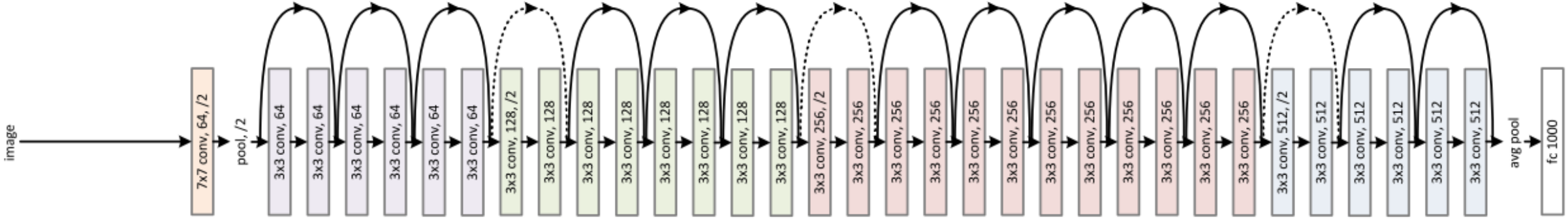
ResNet Gradient propagation



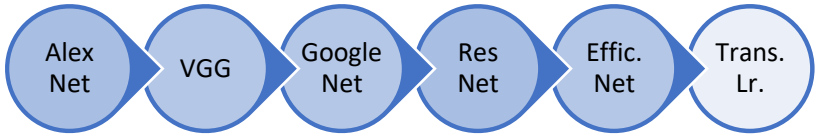


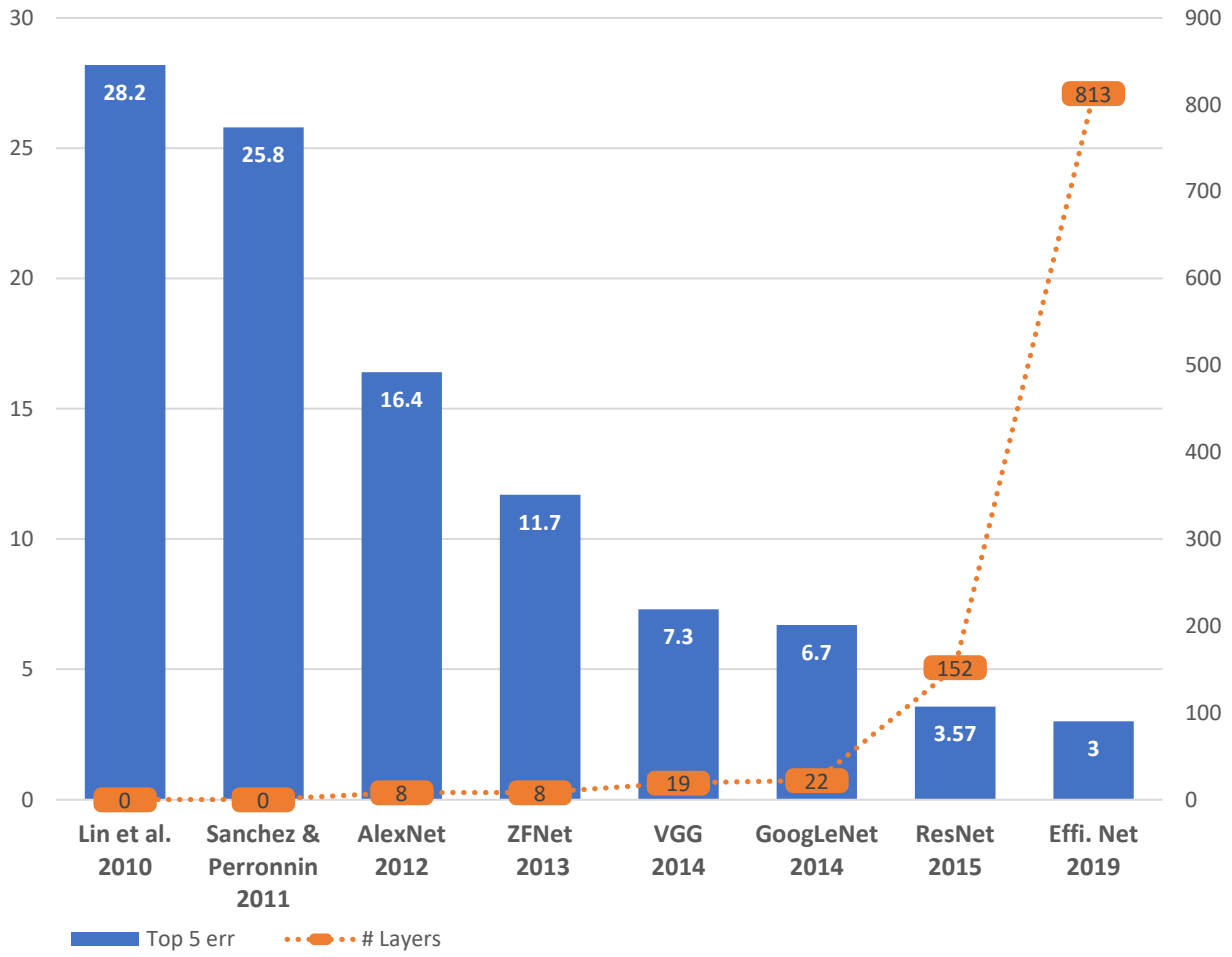
ResNet Architecture





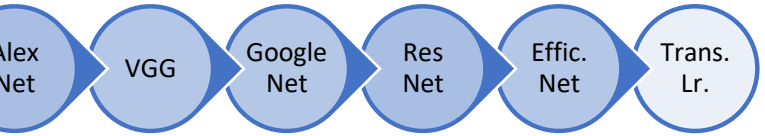
EfficientNet

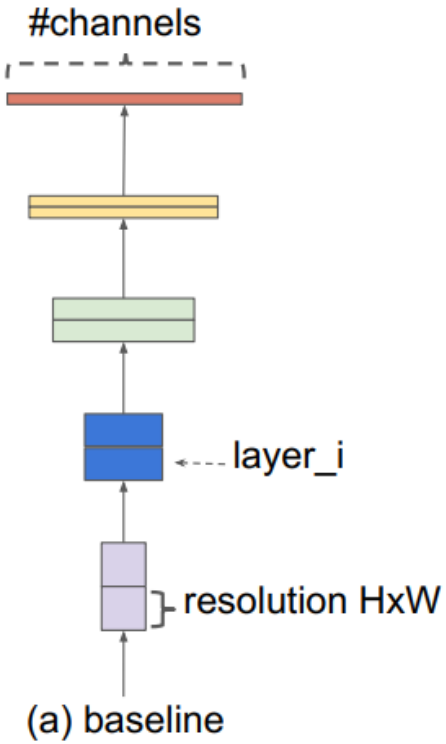




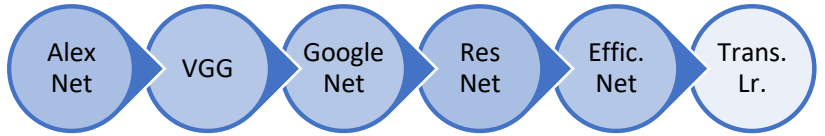
Mingxing Tan and Quoc V. Le. EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks. ICML, 2019.

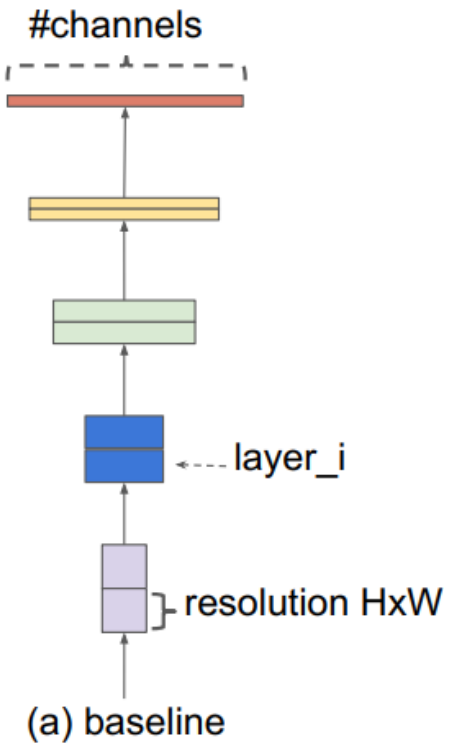
EfficientNet

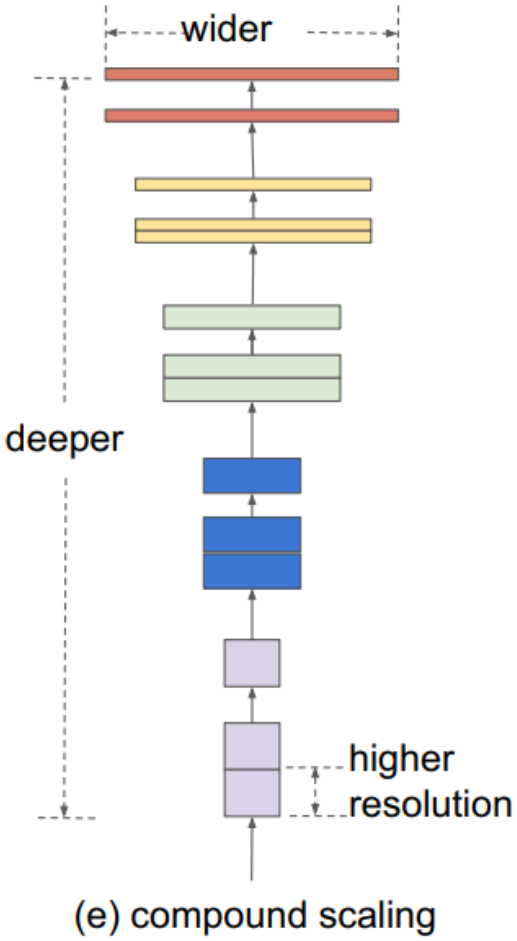




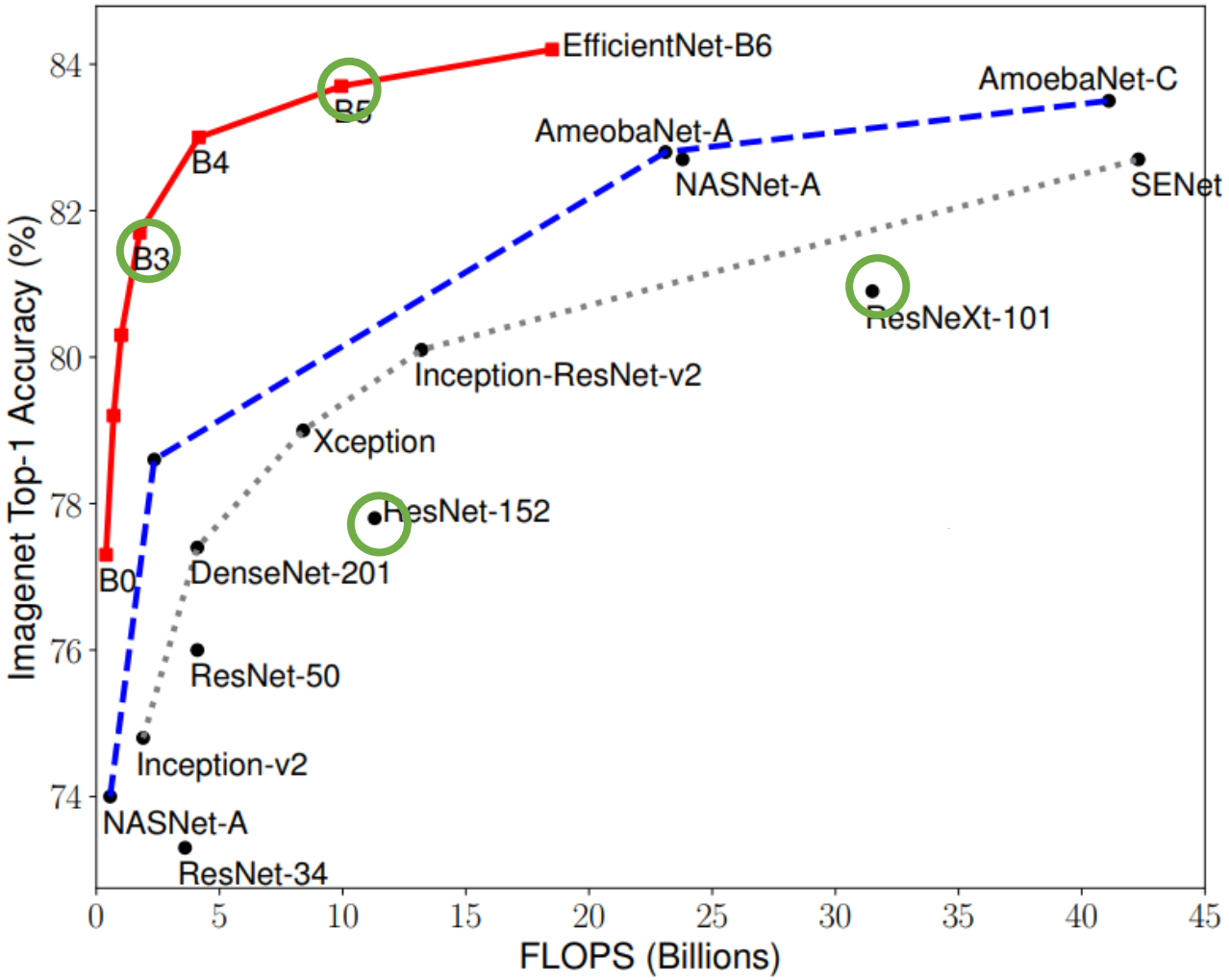
EfficientNet



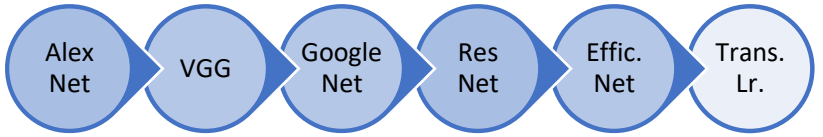




Results

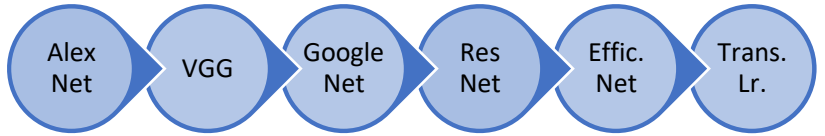

EfficientNet-B6
AmoebaNet-C
AmeobaNet-A
B4
NASNet-A
SENet
B3
ResNeXt-101
Inception-ResNet-v2
Xception
ResNet-152
B0
DenseNet-201
ResNet-50
Inception-v2
NASNet-A
ResNet-34
Imagenet Top-1 Accuracy (%)
FLOPS (Billions)
84
82
80
78
76
74
0
5
10
15
20
25
30
35
40
45

CNN architecture

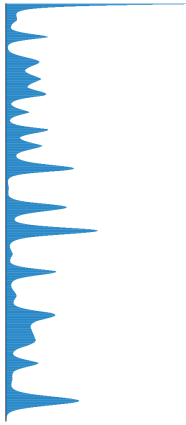


- Design your network according to your task and resources
- Take into consideration
  - # Parameters
  - # FLOPs
  - Memory Size
- Use identity mapping (Skip connections)
- Use **existing architecture**
- Use a **pre-trained model**

Transfer Learning

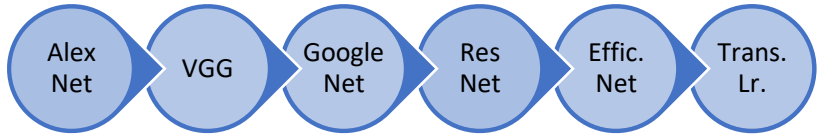


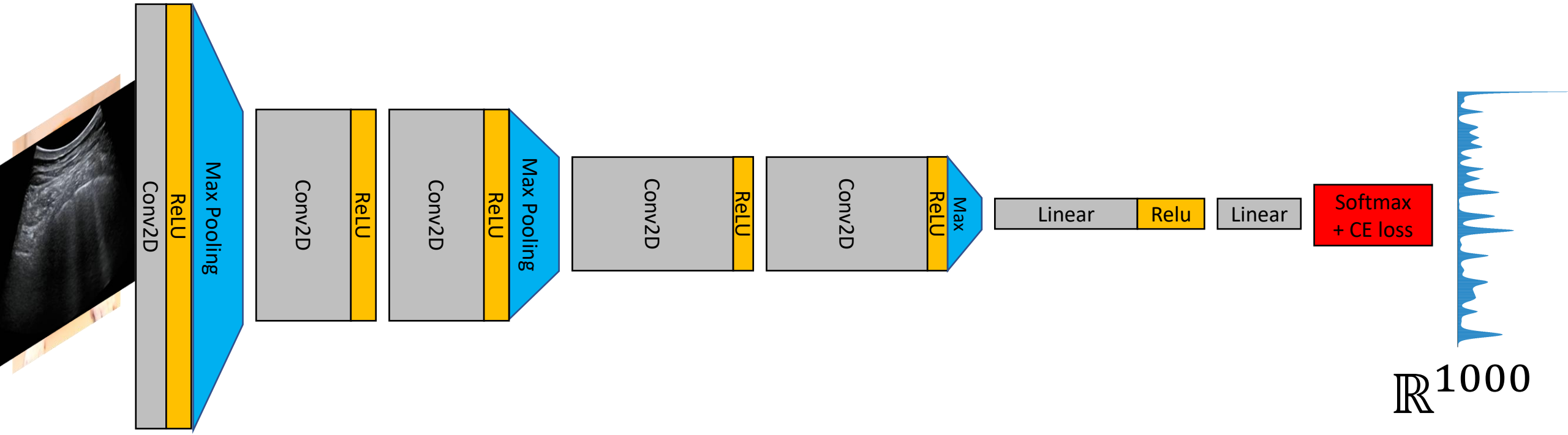
Conv2D
ReLU
Max Pooling
Conv2D
ReLU
Conv2D
ReLU
Max Pooling
Conv2D
ReLU
Conv2D
ReLU
Max
Linear
Relu
Linear
Softmax + CE loss



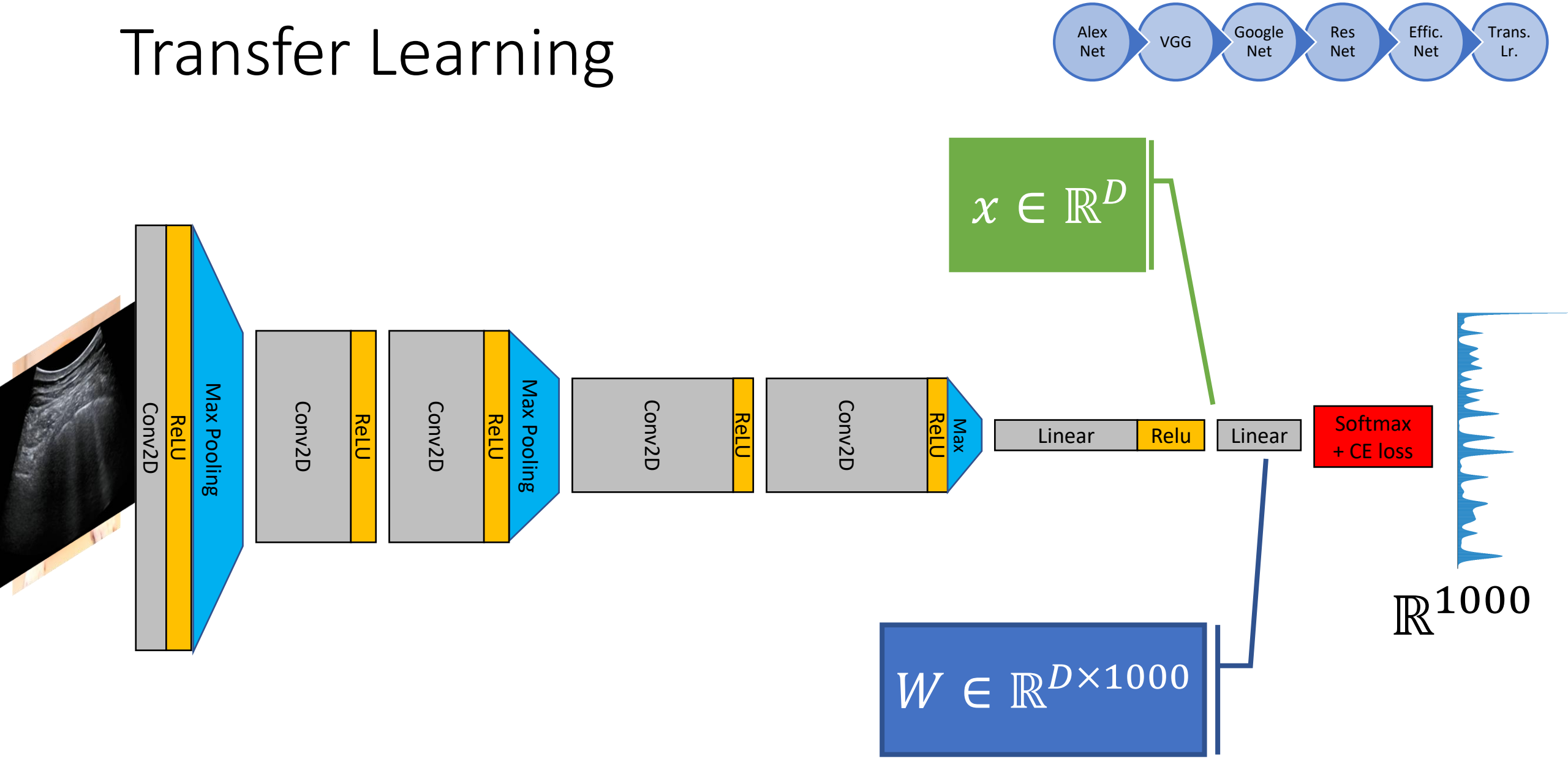
$\mathbb{R}^{1000}$

Transfer Learning

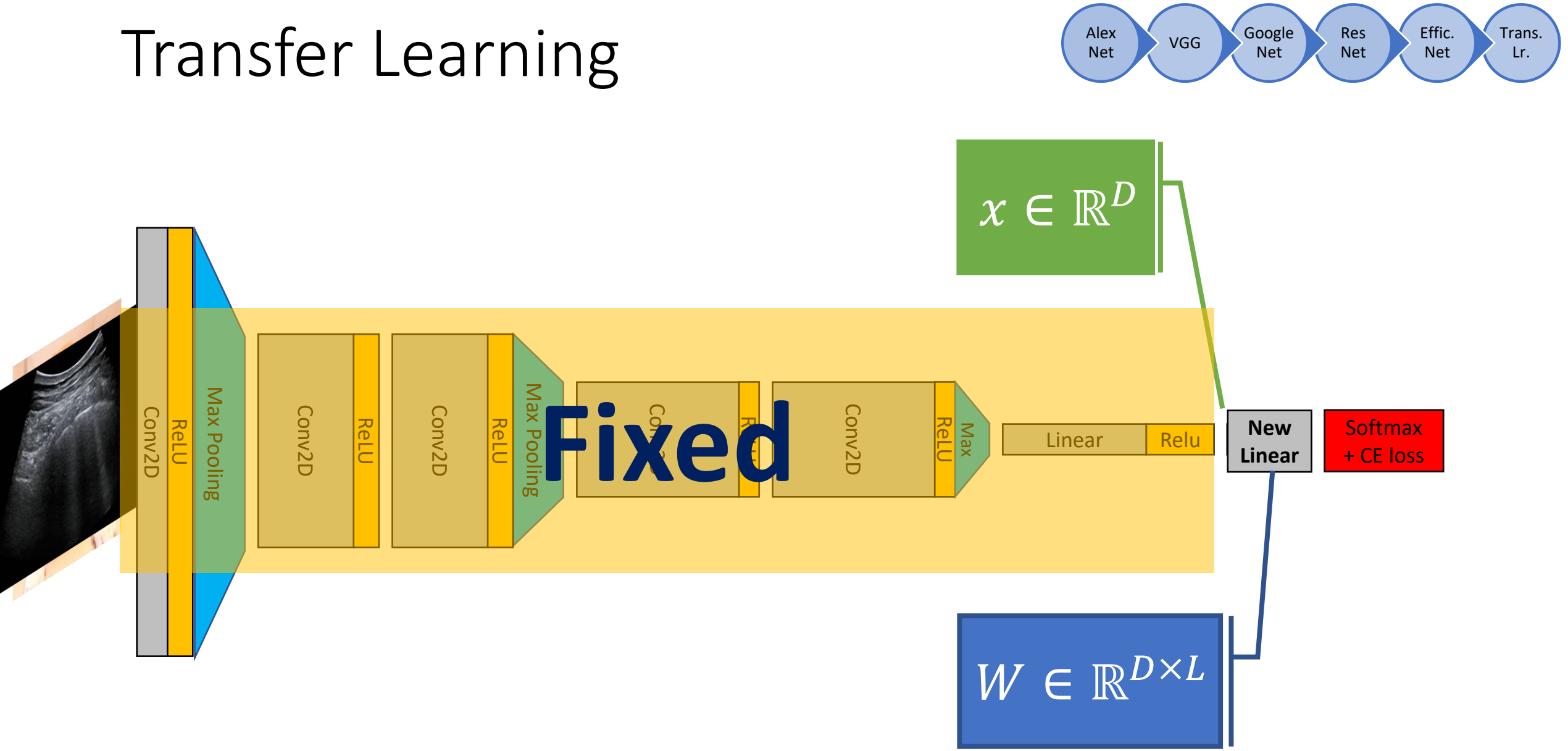




Transfer Learning



Transfer Learning



Questions?