Convolutional neural network architectures for image classification and detection

Mohammad G. Syed[1,2], Stephen McKenna[2], Mohan V. [3],Emanuele Trucco[2]

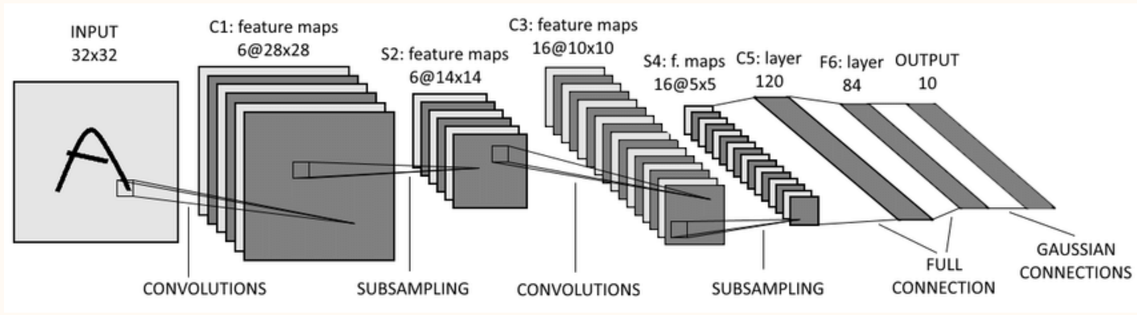
[1]School of Medicine, University of Dundee, UK; [2]School of Computing, University of Dundee, UK; [3]Madras Diabetes Research Foundation, Chennai, India.

1. Abstract

- CNNs are very well suited for image classification and detection.
- As an initial exercise for my PhD on deep-learning discovery of features in retinal images specifically associating to clinical outcomes, some notable CNN architectures are studied.
- ImageNet Large Scale Visual Recognition Challenge (ILSVRC) is an annual competition since 2010 for visual recognition task . It provided around 1.2M/50K/100K images as training/validation/testing data respectively spread across 1000 distinct image categories for competitions.
- Different CNN architectures participated in ILSVRC competition are discussed.

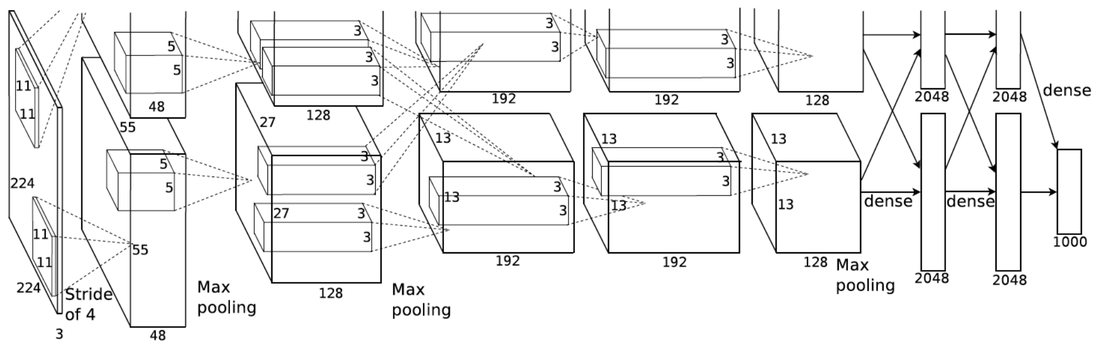
2. LeNet-5

- LeNet-5 is a CNN developed by LeCun et al. in 1998. It became standard structure of CNN.
- It is a 7-layered architecture with 60K trainable parameters.



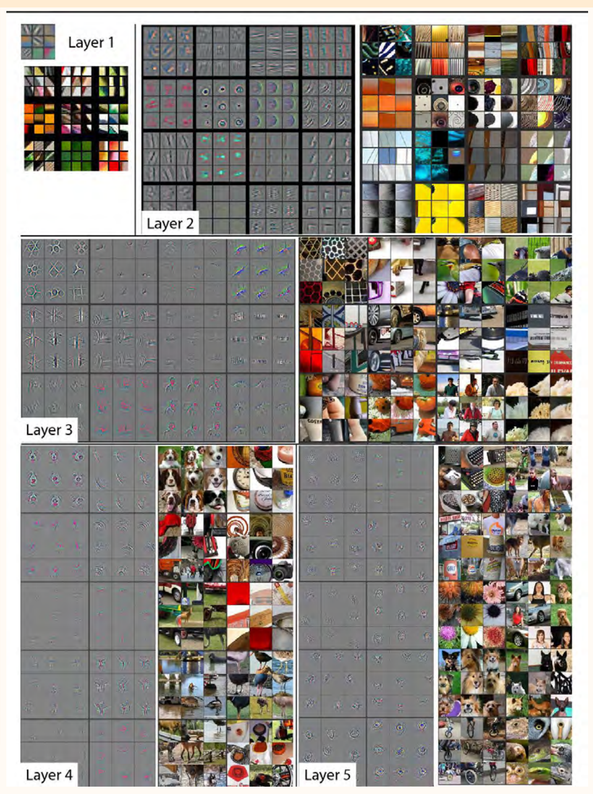
3. AlexNet

- By Krizhevsky et al. & ILSVRC 12 winner.
- Used 2 NVIDIA GPUs.
- 8-layered architecture with 60M parameters.
- Achieved top-5 error rate of 16.4% on test.



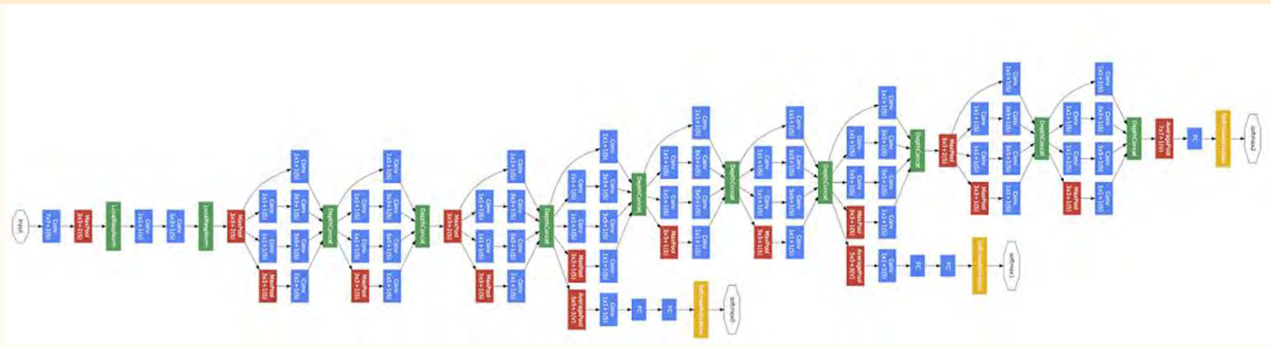
4. ZFNet

- Developed by Zeiler and Fergus in 2013.
- ZFNet architecture is similar to AlexNet, with a few modifications (in kernel size, stride and feature maps).
- Used deconvolution for visualizing and understanding Convolutional Networks.
- Winner of ILSVRC 13 with improved hyper-parameters.
- Achieved top-5 error rate of 11.7% on test data.



5. GoogLeNet

- Developed by Szegedy et al. in 2014 and is the winner of ILSVRC 14.
- Introduced Inception modules with dimensionality reduction using 1x1 convolutions.
- Used only 3 small kernels of size 1x1, 3x3 and 5x5 through out the networks.
- It is 22-layered deep architecture with 4M parameters.
- Achieved top-5 error rate of 6.67% on test data.



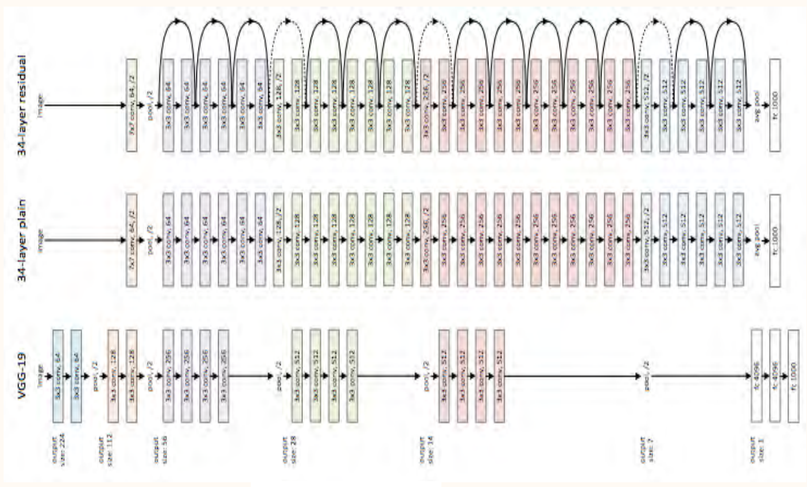
6. VGGNet

- Developed by Simonyan and Zisserman; runners in ILSVRC 14.
- 11 to 19 layered architecture.
- Top-5 error rate of 7.3% on test data.

ConvNet Configuration					
A	A-LRN	B	C	D	E
11 weight layers	11 weight layers	13 weight layers	16 weight layers	16 weight layers	19 weight layers
input (224 × 224 RGB image)					
conv3-64	conv3-64 **LRN**	conv3-64 **conv3-64**	conv3-64 conv3-64	conv3-64 conv3-64	conv3-64 conv3-64
maxpool					
conv3-128	conv3-128	conv3-128 **conv3-128**	conv3-128 conv3-128	conv3-128 conv3-128	conv3-128 conv3-128
maxpool					
conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256	conv3-256 conv3-256 **conv1-256**	conv3-256 conv3-256 **conv3-256**	conv3-256 conv3-256 conv3-256 **conv3-256**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512	conv3-512 conv3-512 **conv1-512**	conv3-512 conv3-512 **conv3-512**	conv3-512 conv3-512 conv3-512 **conv3-512**
maxpool					
FC-4096					
FC-4096					
FC-1000					
soft-max					

7. ResNet

- Developed by He K. et al in 2015; winner in ILSVRC 15.
- Introduced a residual learning framework by shortcuts.
- Trained very deep architecture up to 152 layered.
- Achieved top-5 error rate of 3.37% on test data.



8. Summary

- With the increase in computational power and large training data, CNN are growing deeper & achieving greater accuracy in vision tasks.
- We plan to use deep learning to identify retinal feature associated with diabetic phenotype and genotype, leveraging the GoDARTS bioresource.
- We also plan to use the deconvolution technique of ZFNet authors in visualizing the discovered retinal features.

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