CV / VLMs

Unit 5: State-of-the-Art Object Detection Techniques

5.1.1

Diving Deeper into Neural Networks

Residual connections and architectures

TIL-AI
TODAY I LEARNED AI

Residual connections and architectures

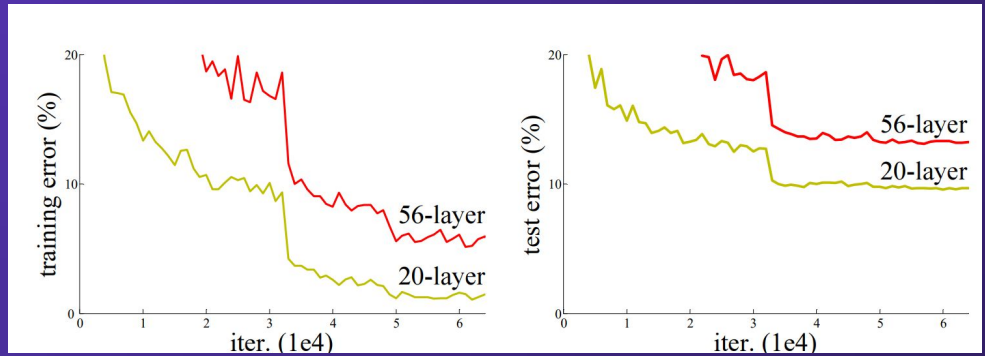
Why

As researchers train deeper and larger networks, they discovered that after a certain depth, the ‘plain’ (normal) CNN layers fail to learn additional patterns.

Hence, as a network grows, the training accuracy plateaus or even degrades.

Vanishing gradient problem: very deep neural networks tend to "forget" some features of their input dataset samples during training.

(top) 36 layer plain CNN layers (cropped), with just convolution and pooling filters and a fully connected layer at the end.



training error (left) and test error (right) on CIFAR-10 with 20-layer and 56-layer “plain” networks. The deeper network has higher training error, and thus test error.

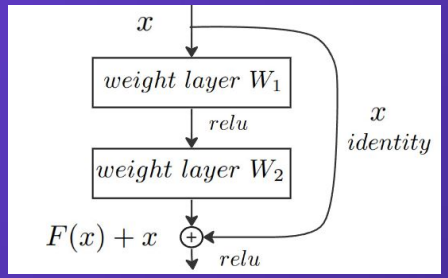
[Deep Residual Learning for Image Recognition]

Residual connections and architectures

How

- Residual connections are also known as skip connections. Skip connections in deep architectures, as the name suggests, skips some layers in the neural network and feeds the output of one layer as the input into the next layer.

- It circumvents the vanishing gradient problem by summing the input **x** to the result of a typical feed-forward computation in the following way:



- Mathematically,

$$F(x) + x = [W_2\sigma(W_1x)] + x$$

- This provides an alternative path for the gradient (with backpropagation).

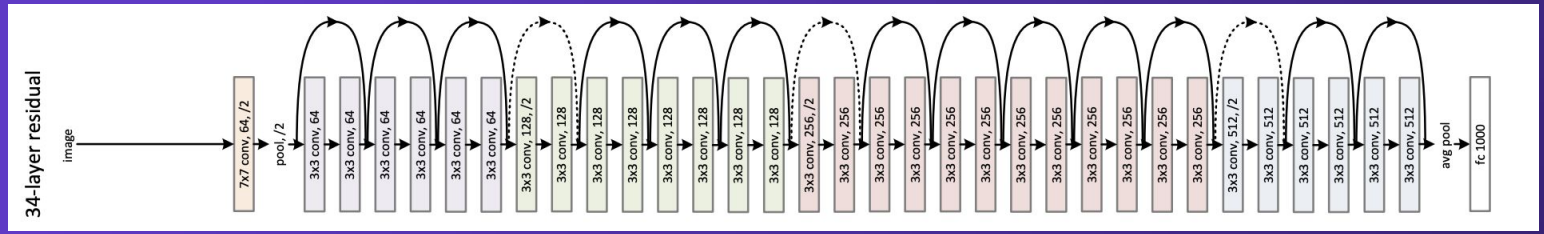
- It is experimentally validated that these additional paths are often beneficial for model convergence.

ResNet 34 Classification Model: What is, How to Use (roboflow.com)
Deep Residual Learning for Image Recognition

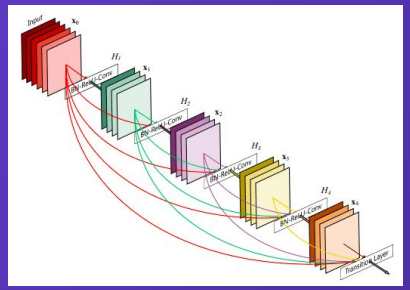
Residual connections and architectures

Example

- ResNet



- DenseNet

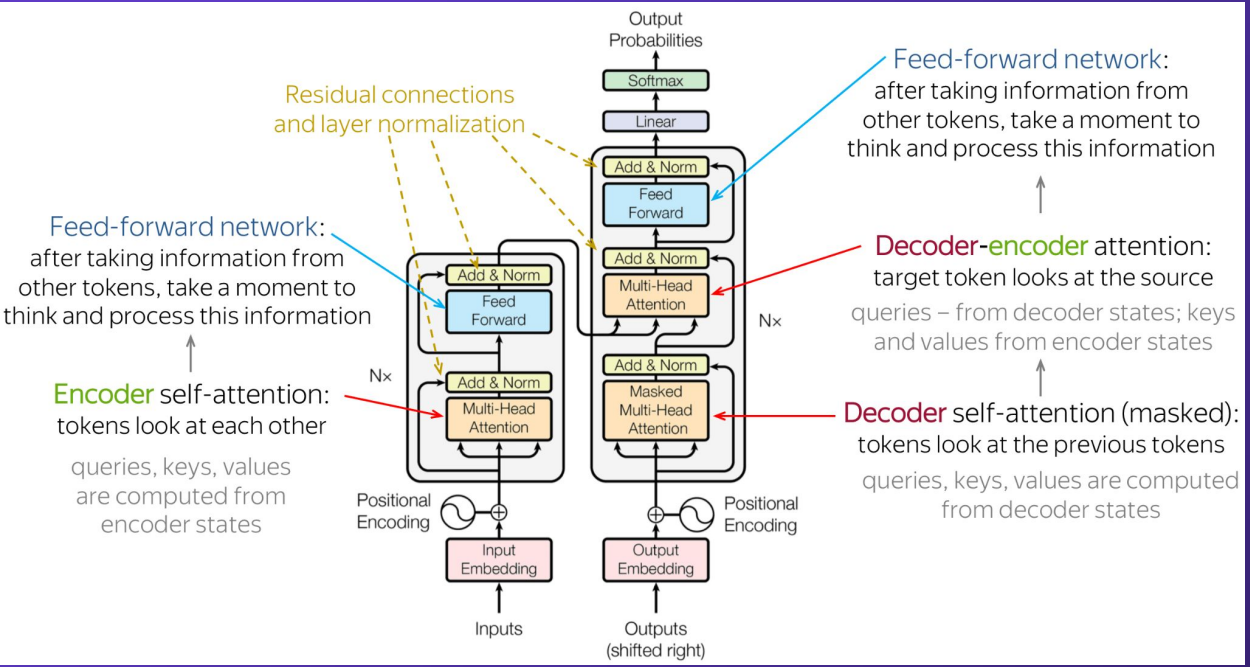


- Unet

[ResNet 34 Classification Model: What is, How to Use (roboflow.com)]
[Deep Residual Learning for Image Recognition]

Residual connections and architectures

Transformer architectures also utilize some residual networks to mitigate the vanishing gradient problem, as elaborated by the following picture:



- Deep Residual Learning for Image Recognition
- neural networks - Why are residual connections needed in transformer architectures? - Cross Validated (stackexchange.com)