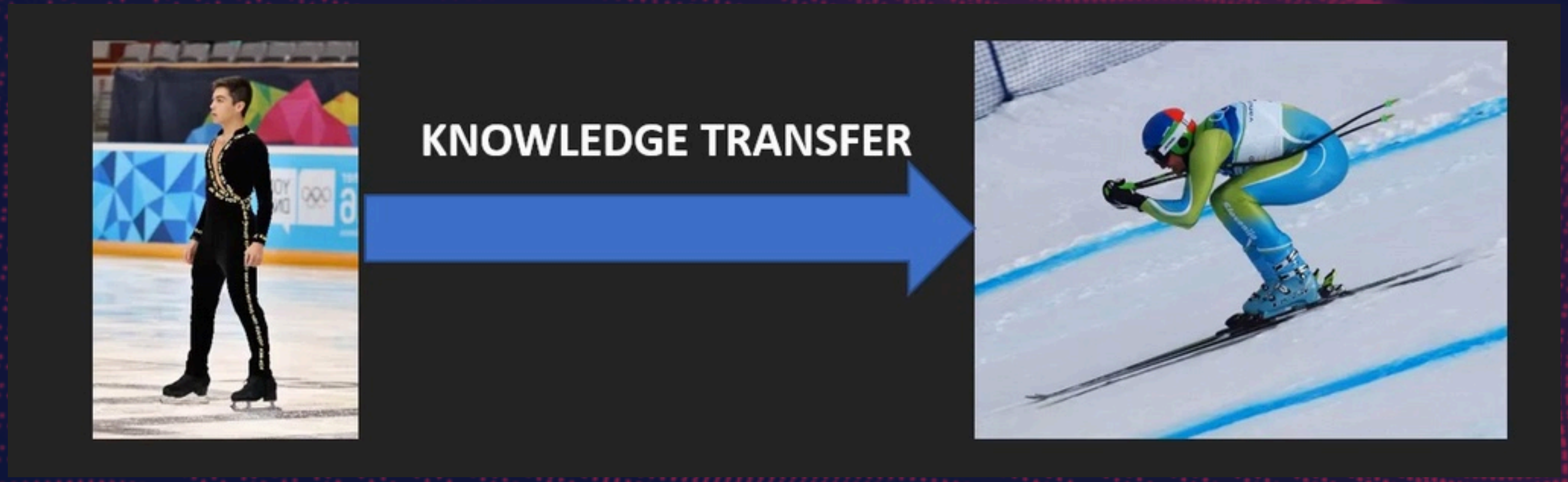
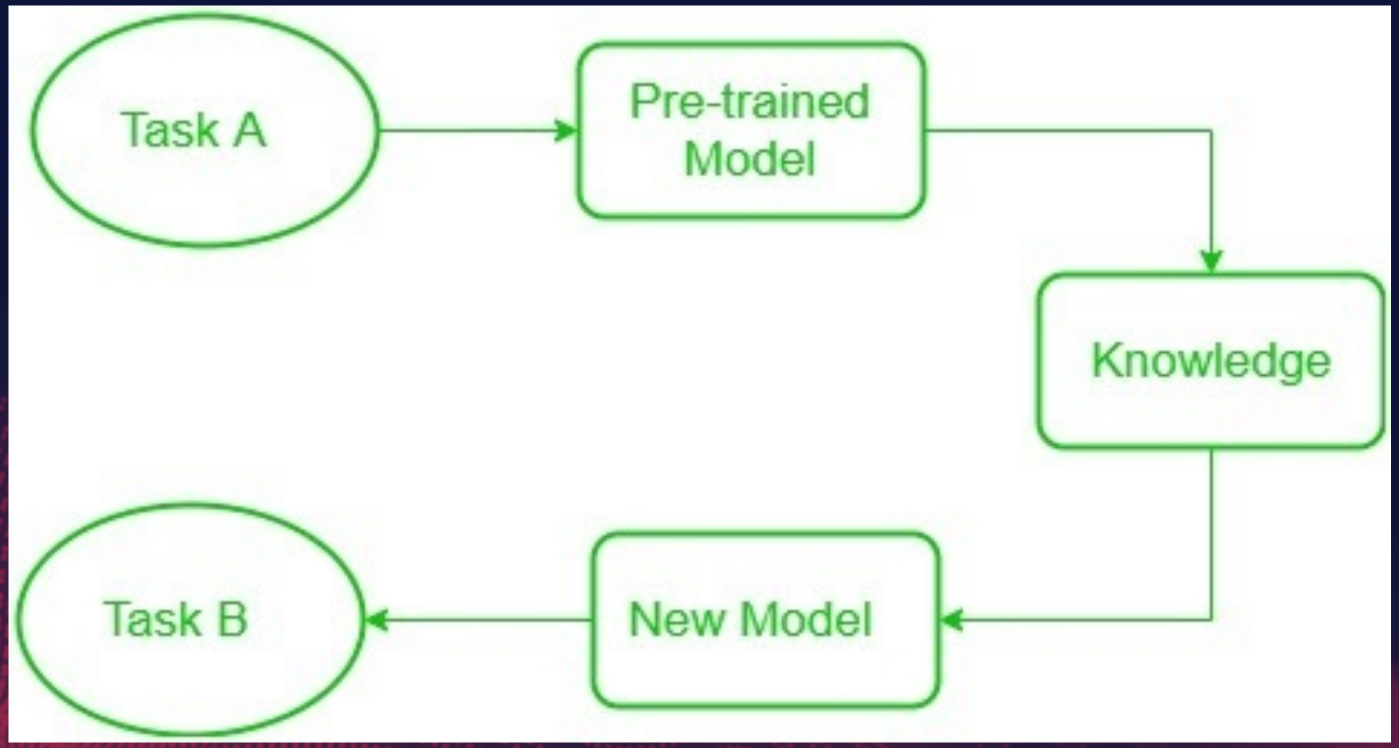
TRANSFER LEARNING
RESNET

TRANSFER LEARNING

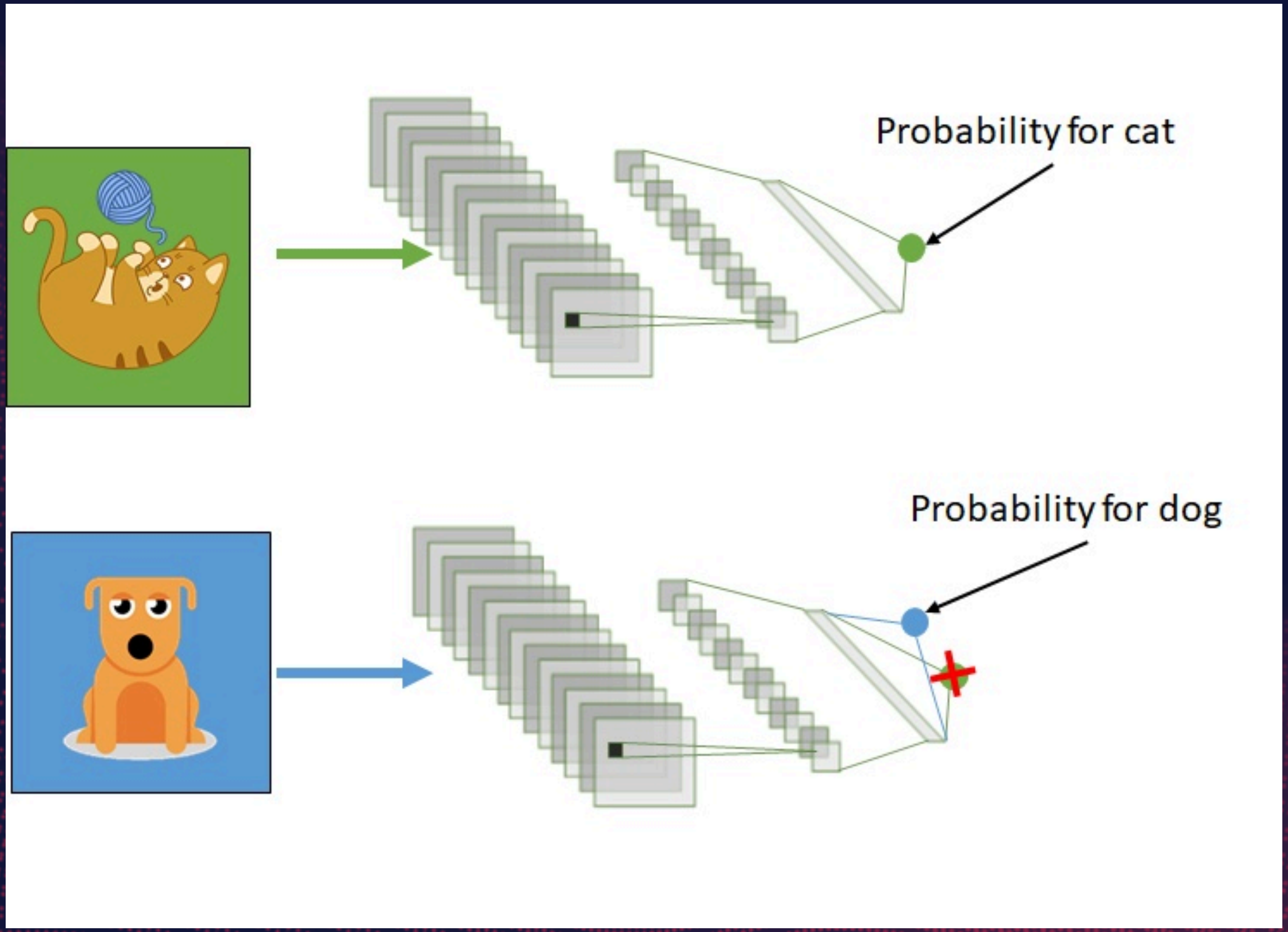
Transfer learning is a machine learning technique where a model developed for a particular task is reused as the starting point for a model on a different but related task.

By using the learned features from the first task as a starting point, the model can learn more quickly and effectively on the second task





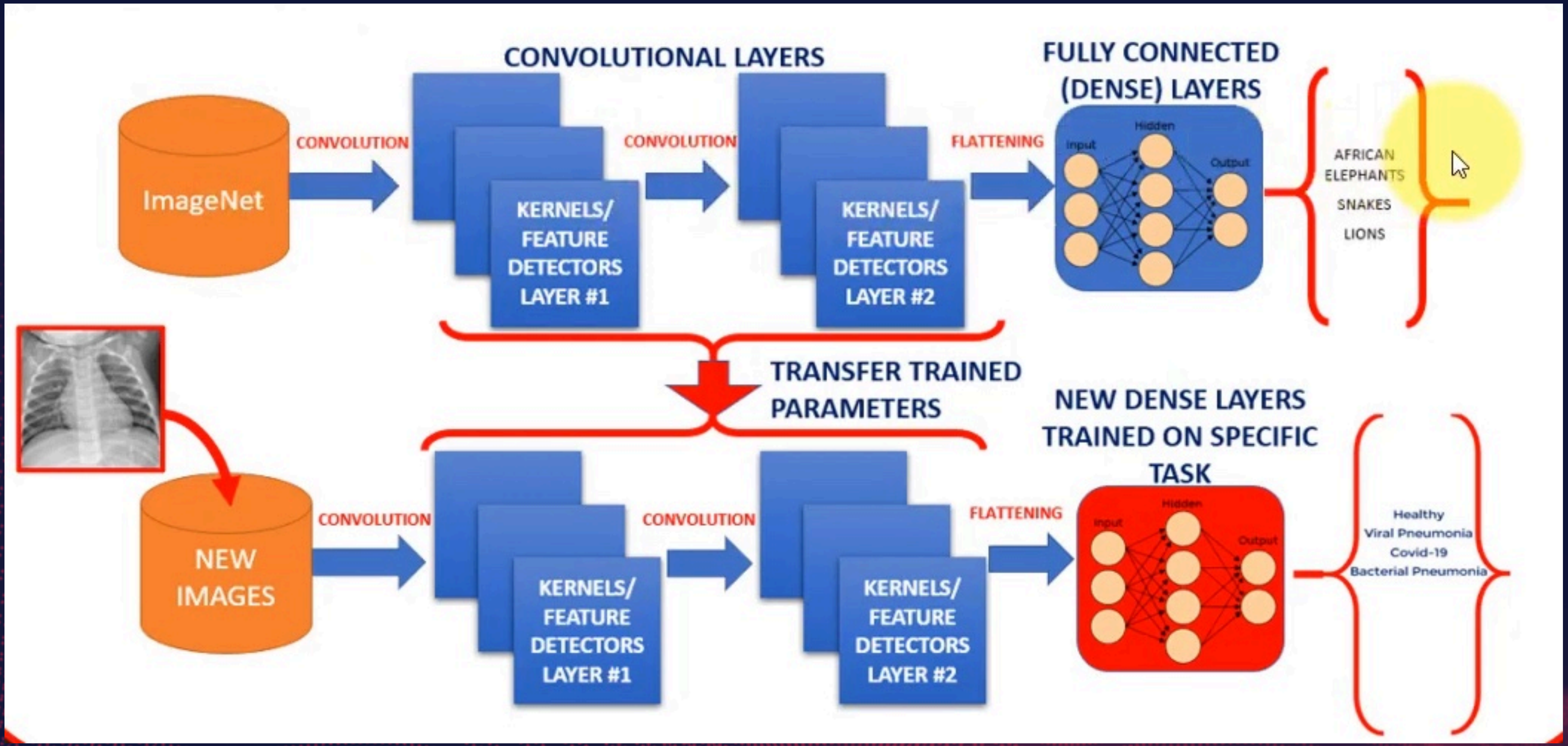
In the early layers of a CNN, the model learns low-level features such as edges, colors, and intensity variations. These features are universal across different datasets and tasks. Hence, the features learned for one task, can be effectively applied to another related task.



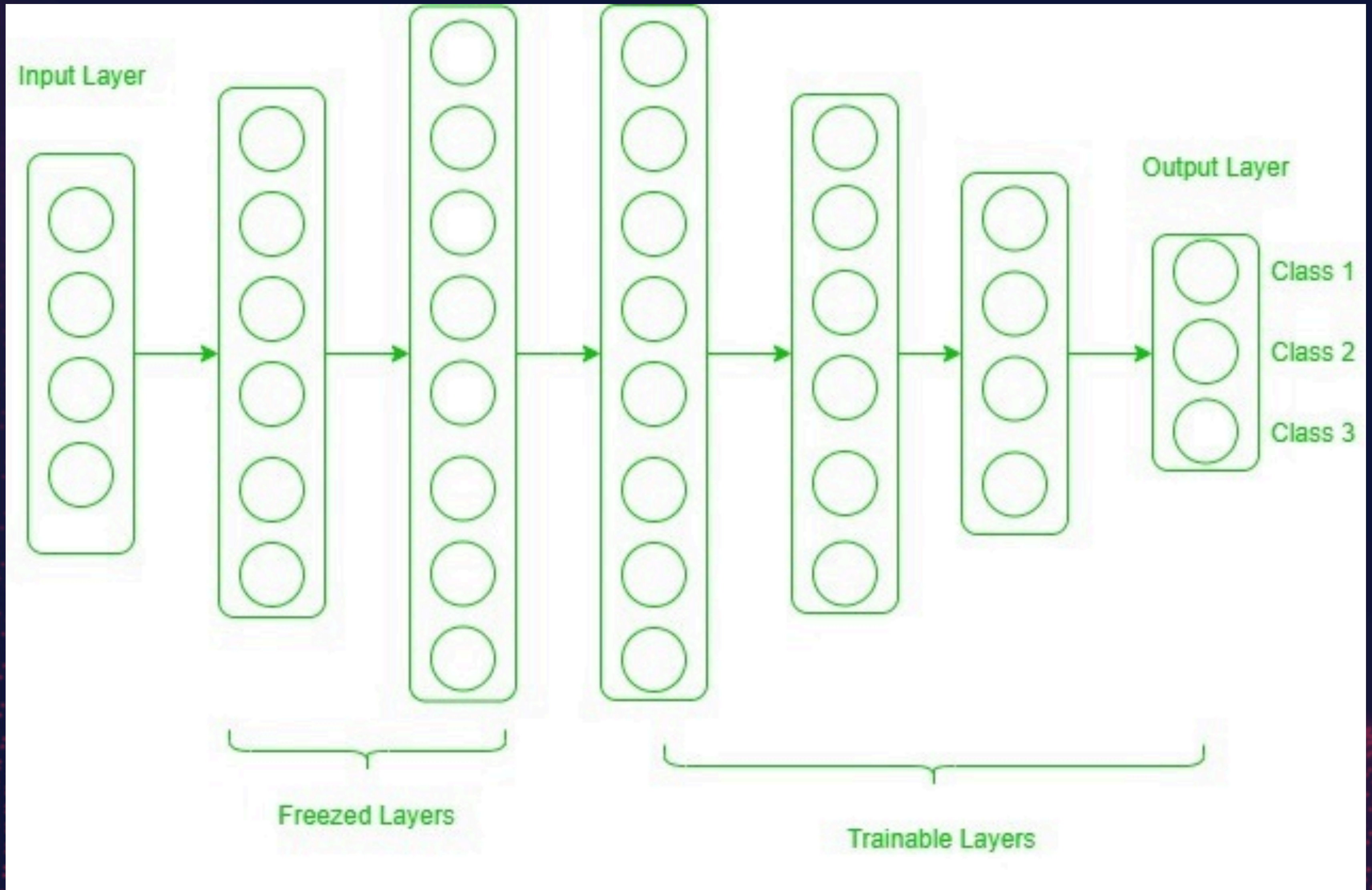
HOW DOES TRANSFER LEARNING WORK ?

- We start with a model that has previously been trained for a certain task using a large dataset. This pretrained model also called the base model has identified general features and patterns relevant to various different datasets.
- In the pre-trained model, find a set of layers that capture features relevant to the new task as well as the previous one. We transfer those layers directly to the new model and they are called freezing layers.
- Then we use the new dataset from the problem at hand to retrain the chosen layers. This procedure is called fine tuning. The idea is to preserve the knowledge from the pre-training while enabling the model to modify its parameters to better suit the demands of the task at hand.

An example of application of Transfer learning



FREEZING LAYERS



Freezing layers in transfer learning refers to fixing the weights of certain layers in a pre-trained neural network, so they do not get updated during the training process of a new problem.

How do we determine which layers we need to freeze, and which layers need to train ?

ADVANTAGES OF TRANSFER LEARNING

- It speeds up the training process and decreases the computational power required.
- Transfer learning can lead to better performance on the second task, as the model can leverage the knowledge it has gained from the first task.
- Transfer learning allows effective training even with smaller datasets.
- Transfer learning can be applied across various domains such as image classification, object detection, natural language processing, and medical imaging.

Is learning better networks as easy as stacking more layers?

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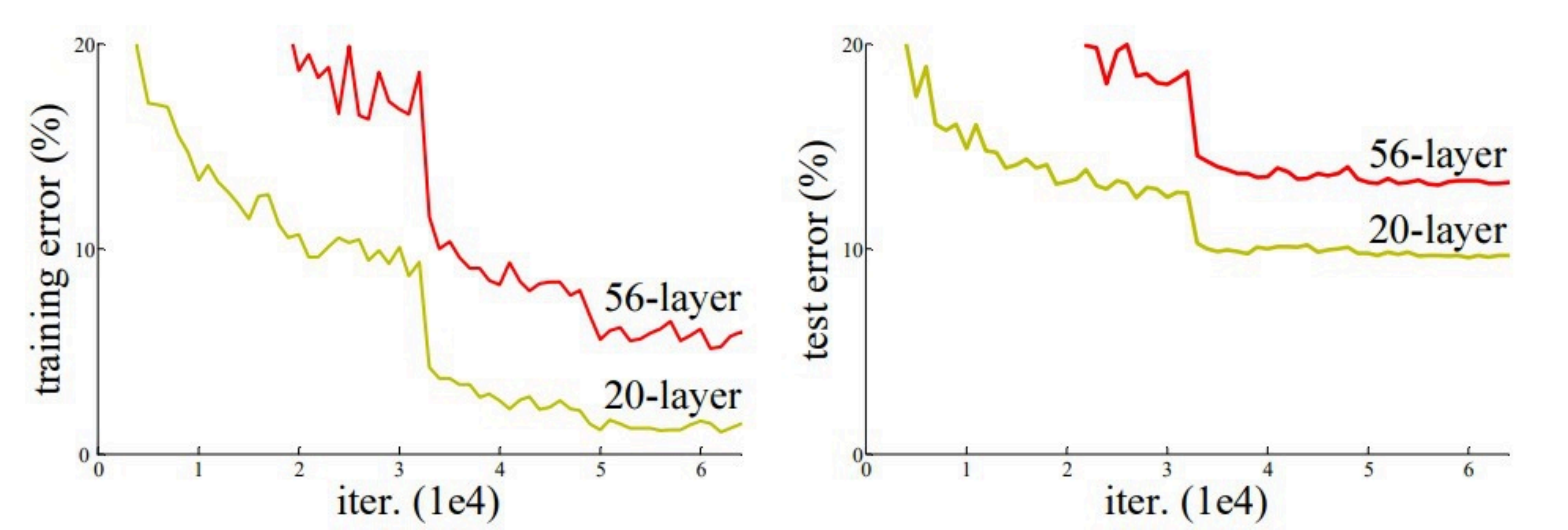
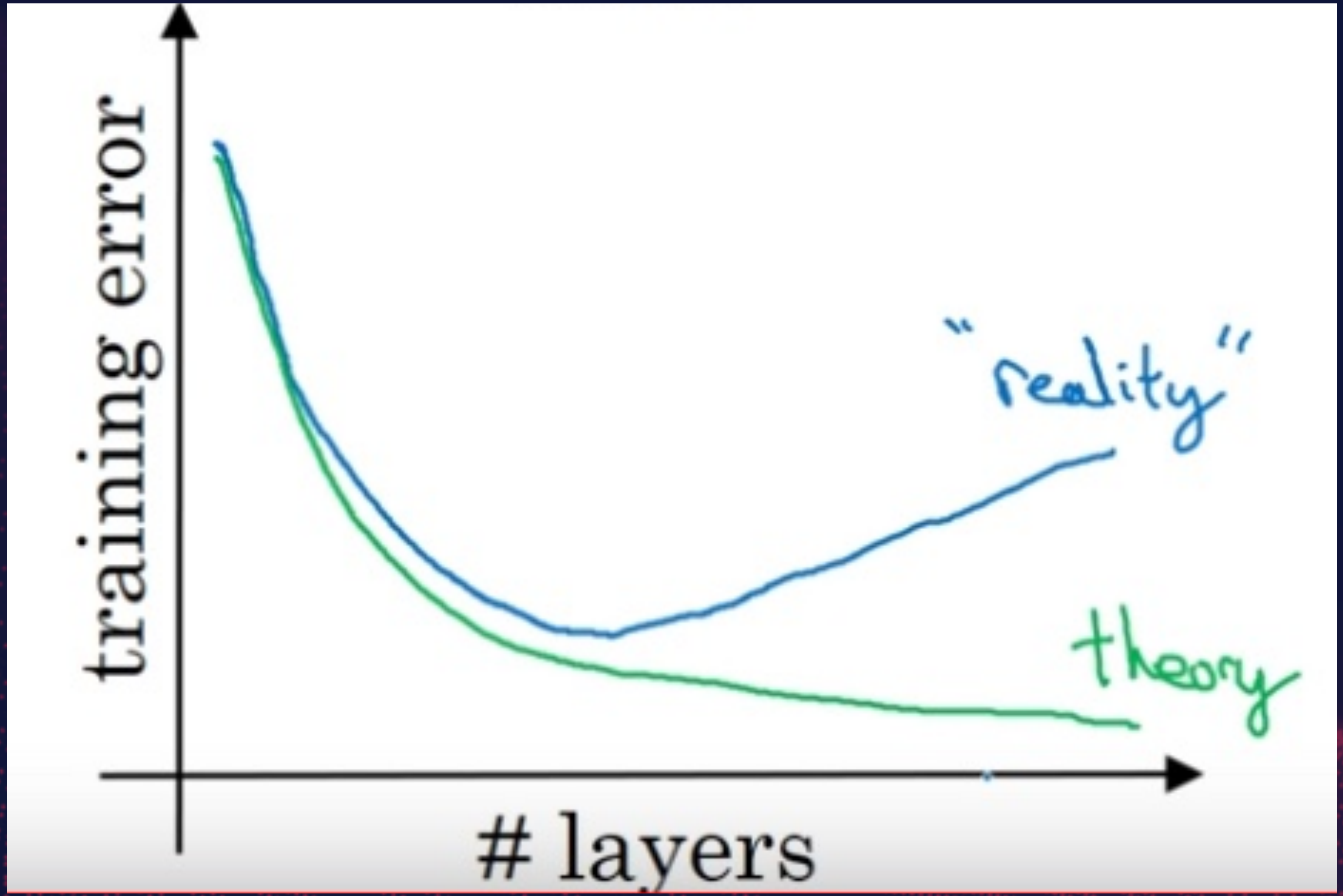
Graphs showing the testing and training error of a 20 layered and a 56 layered CNN model



Researchers had to tackle a new problem when they tried to come up with deeper models..

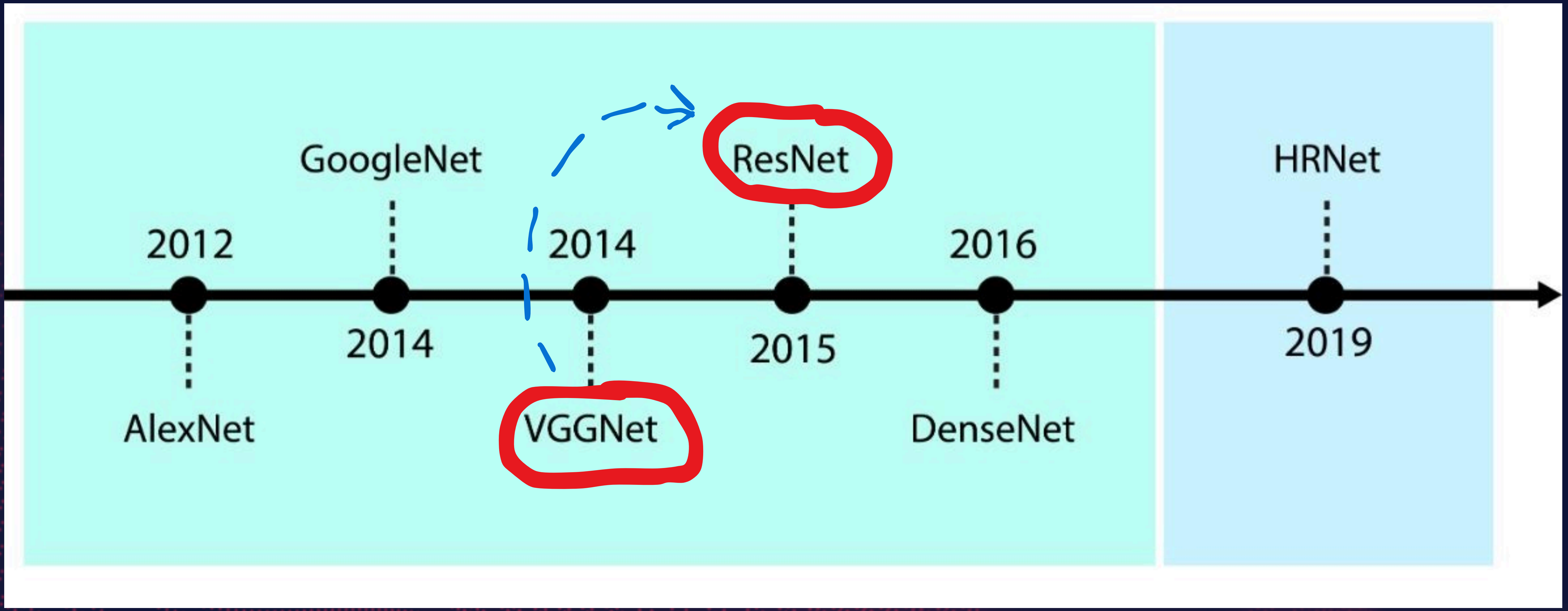


Vanishing Gradient Problem

When the network being trained is too deep, the gradients from where the cost function is calculated easily shrink to zero after several applications of the chain rule. Due to this the weights don't get updated and therefore, no learning taking place.

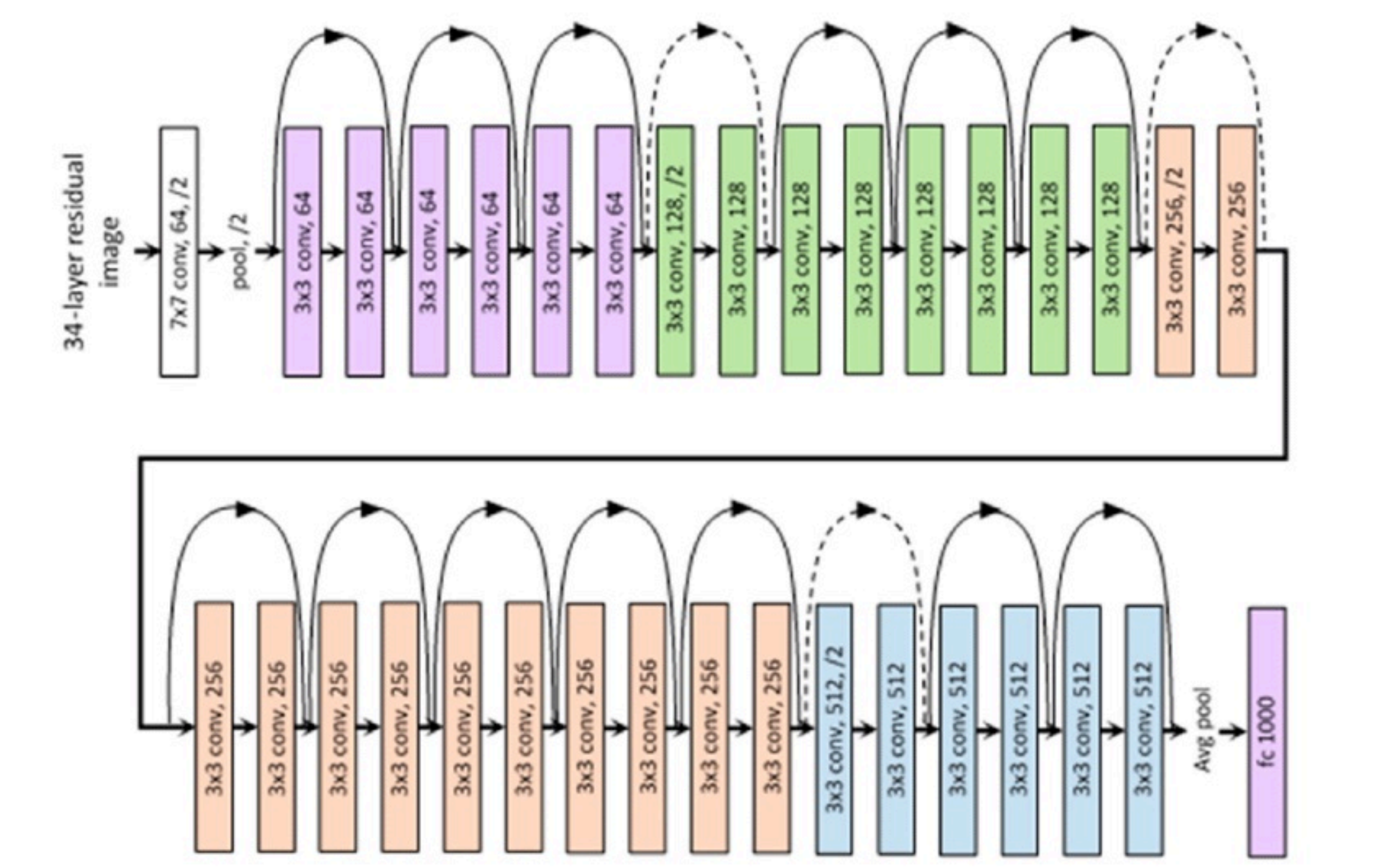
The large number of parameters in VGG networks increases the risk of overfitting, especially when training on smaller datasets.

TIMELINE OF COMPUTER VISION ARCHITECTURES



RESNET

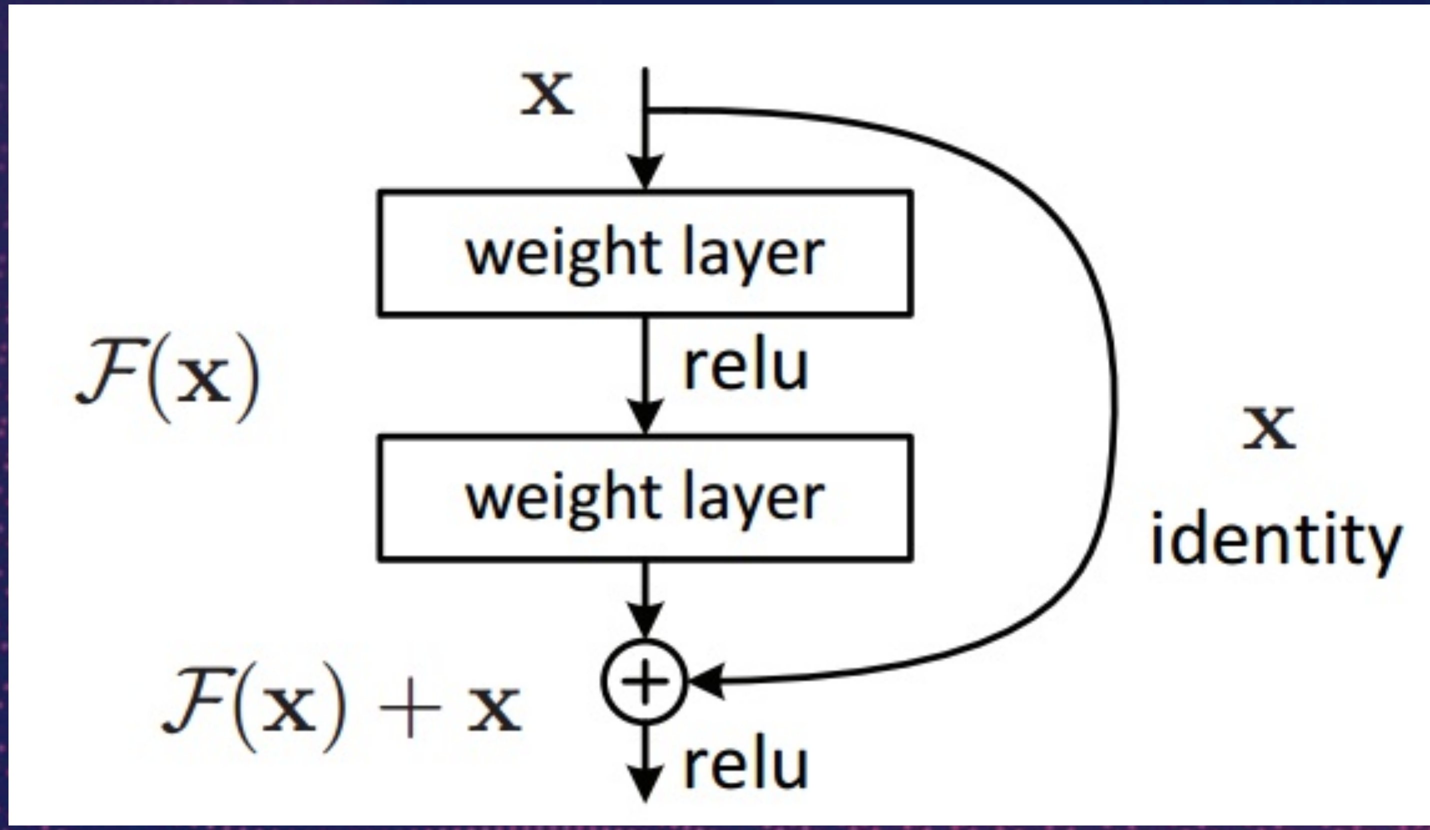
ResNet, short for Residual Networks,is deep learning architecture introduced by a group of Microsoft researchers in 2015. It addressed many of the limitations faced by previous deep architectures like VGG models.



What was so great about ResNet? How does it solve the problems faced by the VGG models ?

CHARECTERISTICS OF RESNET

RESIDUAL BLOCKS



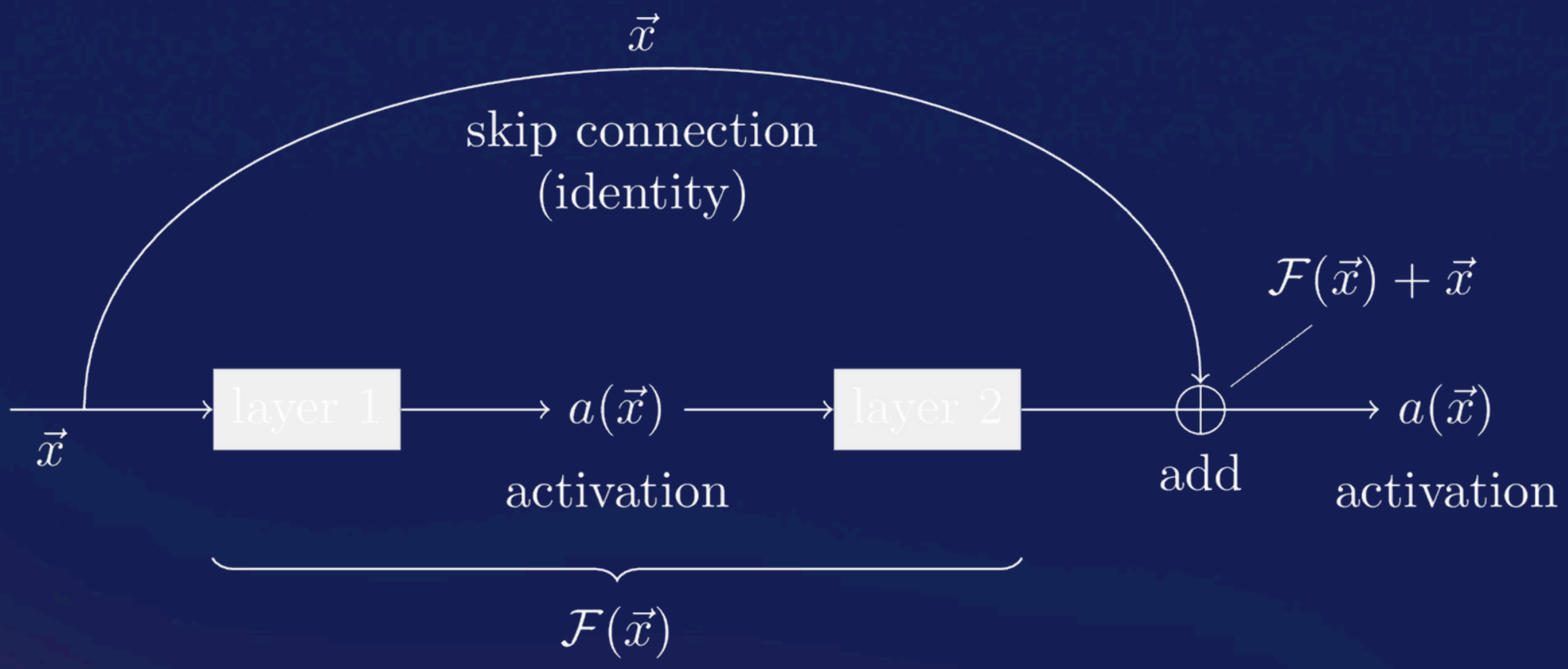
A residual block in ResNet consists of of two or more convolutional layers and an activation function like ReLU and most importantly connections called ***Skip connections*** which is the key feature of the ResNet architecture.

A residual block is the building block of the ResNet architecture

So what are skip connections ?
what’s their role in the architecture?

SKIP CONNECTIONS

Skip connections in ResNet bypass the convolutional layers in the residual block and connect the the input directly to the output of the residual block. This helps in solving the vanishing gradient problem and also ensures that the higher layer will perform at least as good as the input layer and not worse as in the case of deep convolutional neural networks.



MOTIVATION BEHIND SKIP CONNECTIONS

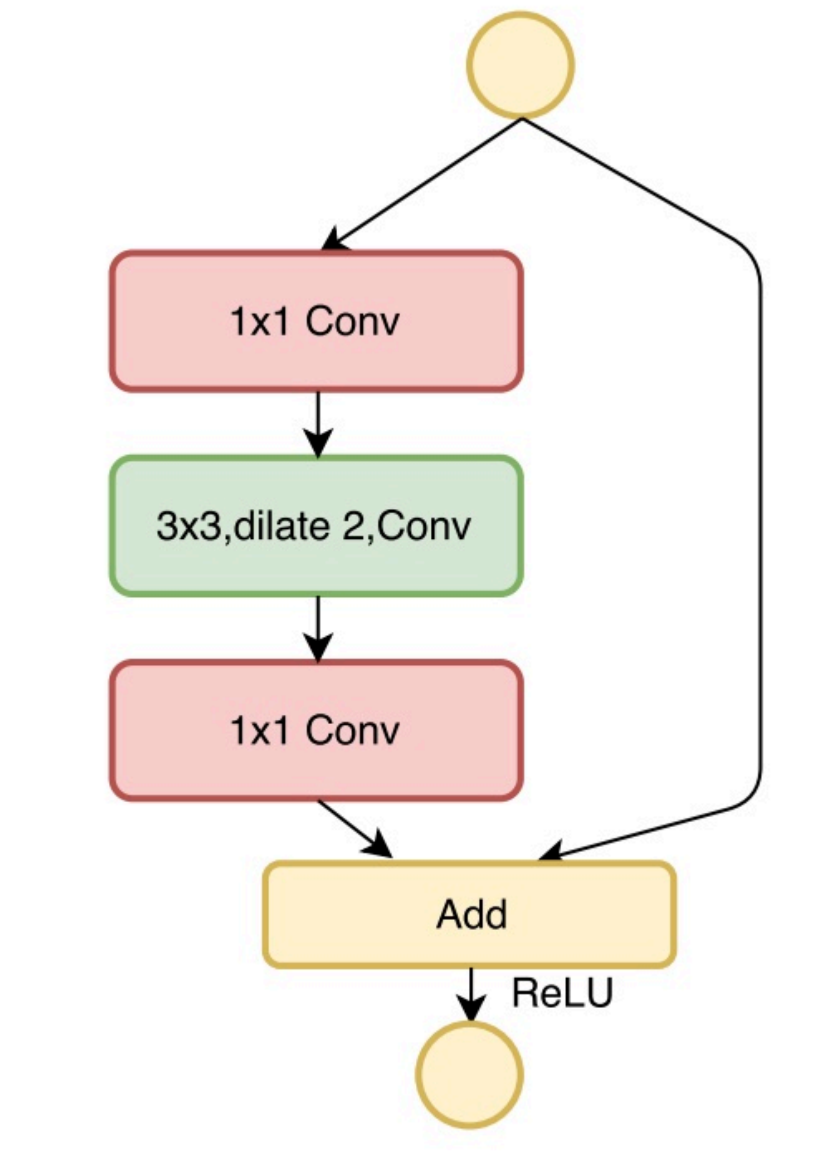
Neural networks are good function approximators ie. they should be able to easily learn the identify function, where the output of a function becomes the input itself.

$$f(x) = x \qquad\qquad h(x) = f(x) + x$$

The idea is the network should be atleast able to predict whatever function it was learning before with the input added to it.

BOTTLE NECK RESIDUAL BLOCK

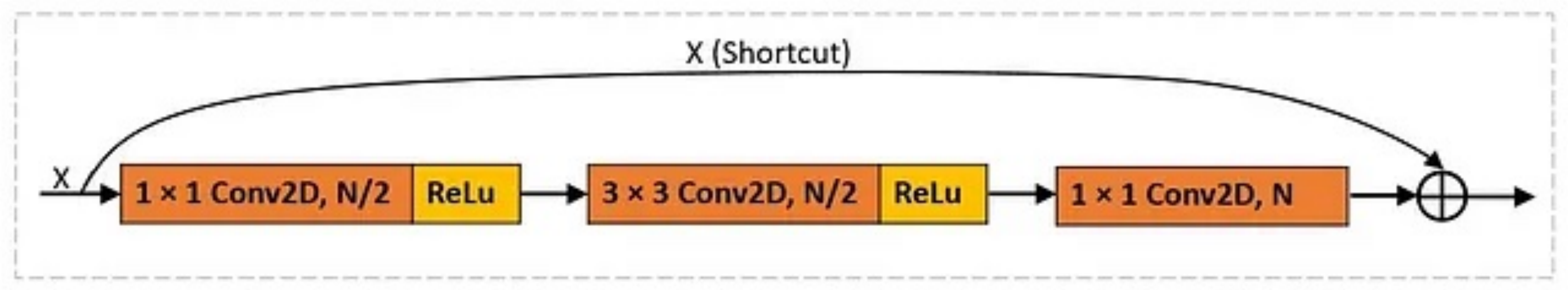
A bottleneck residual block is a particular type of residual block used in deep convolutional neural networks to improve efficiency and reduce computational complexity.



This is achieved by using a three-layer architecture instead of the traditional two-layer one found in standard residual blocks.

- The first 1x1 convolutional layer also called the **reduction layer** reduces the number of channels in the input tensor by a factor, usually a half. This reduction lowers the computational power and the number of parameters for the subsequent 3x3 convolution.

- The 3x3 convolutional layer also known as the **processing layer** performs the convolution operation on the reduced number of channels. This layer is responsible for learning spatial features.



- The second 1x1 Convolution layer called the **expansion layer** , expands the reduced feature map back to the original number of channels and then is added to the input recieved through the **skip connections**

QUIZ TIME

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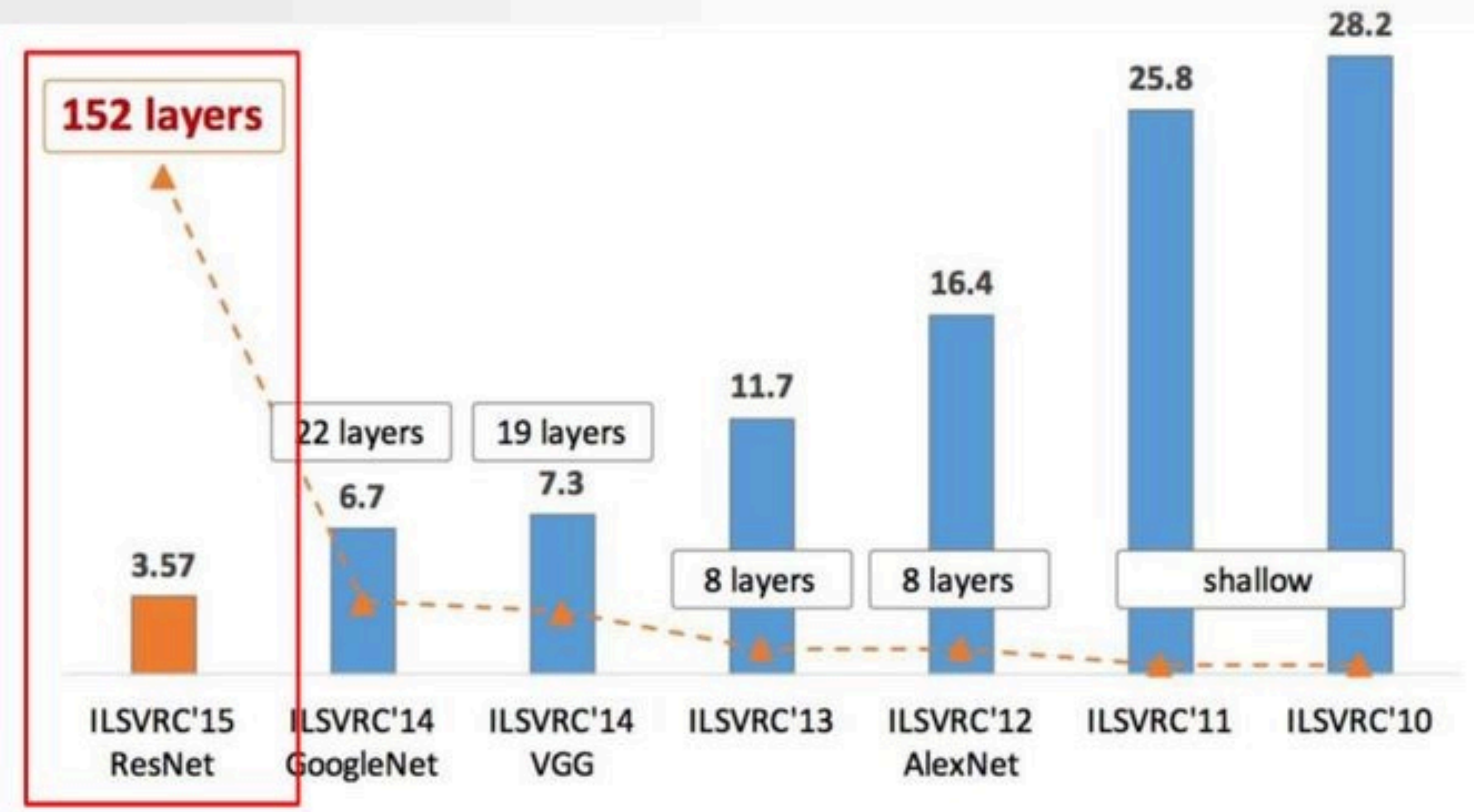
ACHIEVEMENTS OF RESNET

- ResNet - 152 was the top performer in the ImageNet Large Scale Visual Recognition Challenge (ILSVRC) 2015 with an error of 3.57%.
- ResNet demonstrated that it is possible to train very deep networks (with over 100 layers) effectively since the skip connections in the architecture solved the vanishing gradient problem.
- ResNet's pretrained models on large datasets like ImageNet are widely used for transfer learning.
- The idea of bottleneck residual blocks in deeper versions (e.g., ResNet-50, ResNet-101, ResNet-152) optimizes computational efficiency and reduces the number of parameters while maintaining performance.

ImageNet Large Scale Visual Recognition Challenge (ILSVRC) winners



CODE IMPLEMENTATION

Attendance QR

THANK YOU