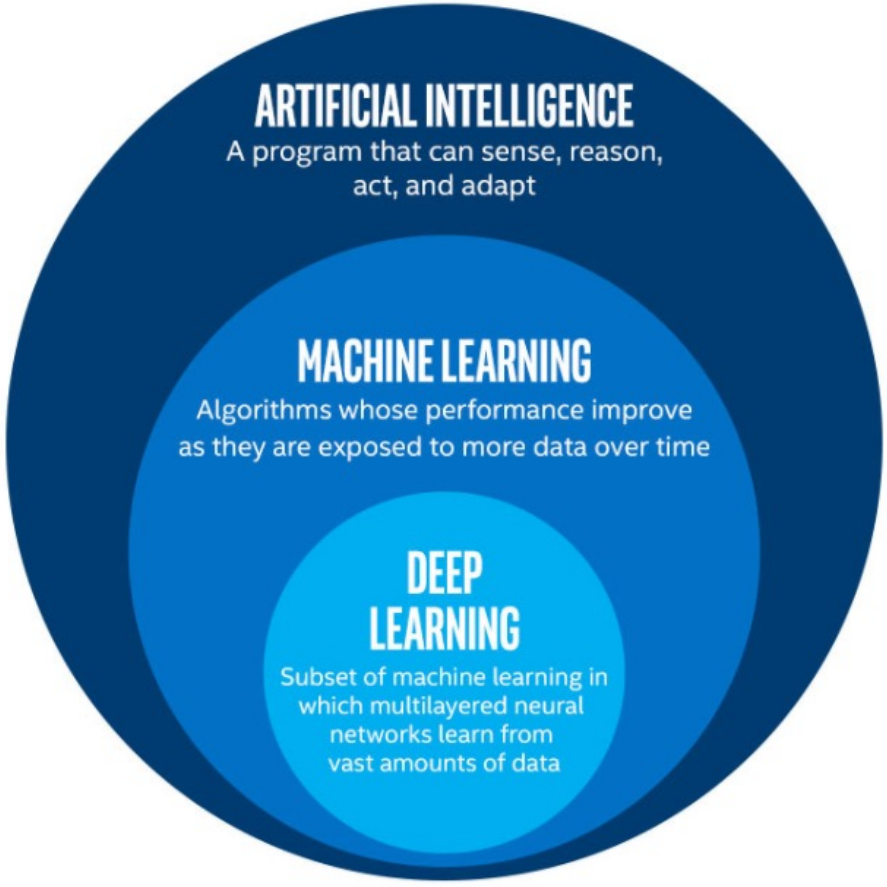
A gentle introduction to Deep Learning

Introduction



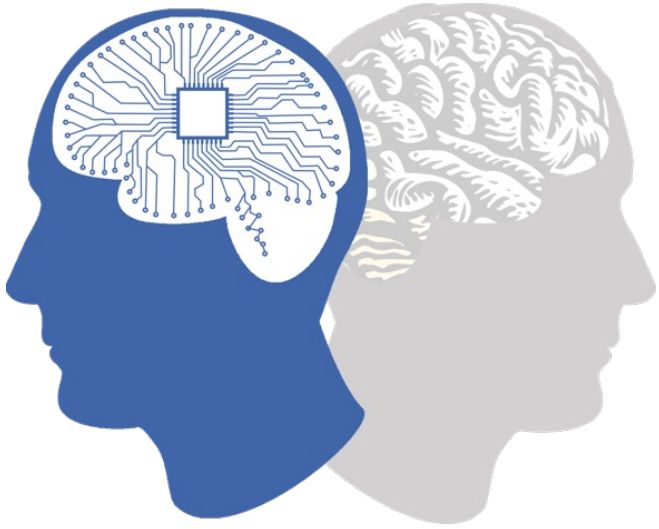
Introduction

Tabular data
(Traditional machine learning)

Photo, Video, Audio, Text data
(Deep learning)

AI applications

- Healthcare
- Automobile
- Banking, Finance
- Surveillance
- Social Media
- Entertainment



- Education
- Space Exploration
- Gaming
- Robotics
- Agriculture
- E-commerce

AI applications – Economics

GOOGL

Company	Symbol
Google	GOOGL
Apple	AAPL
Microsoft	MSFT
Amazon	AMZN
Tesla	TSLA

Beginning Stock Prediction ...

Loss after last Epoch (100) is: 0.0045591918751597404

Predicted Stock Price of GOOGL for date 16-02-2019 is: 1111.443$

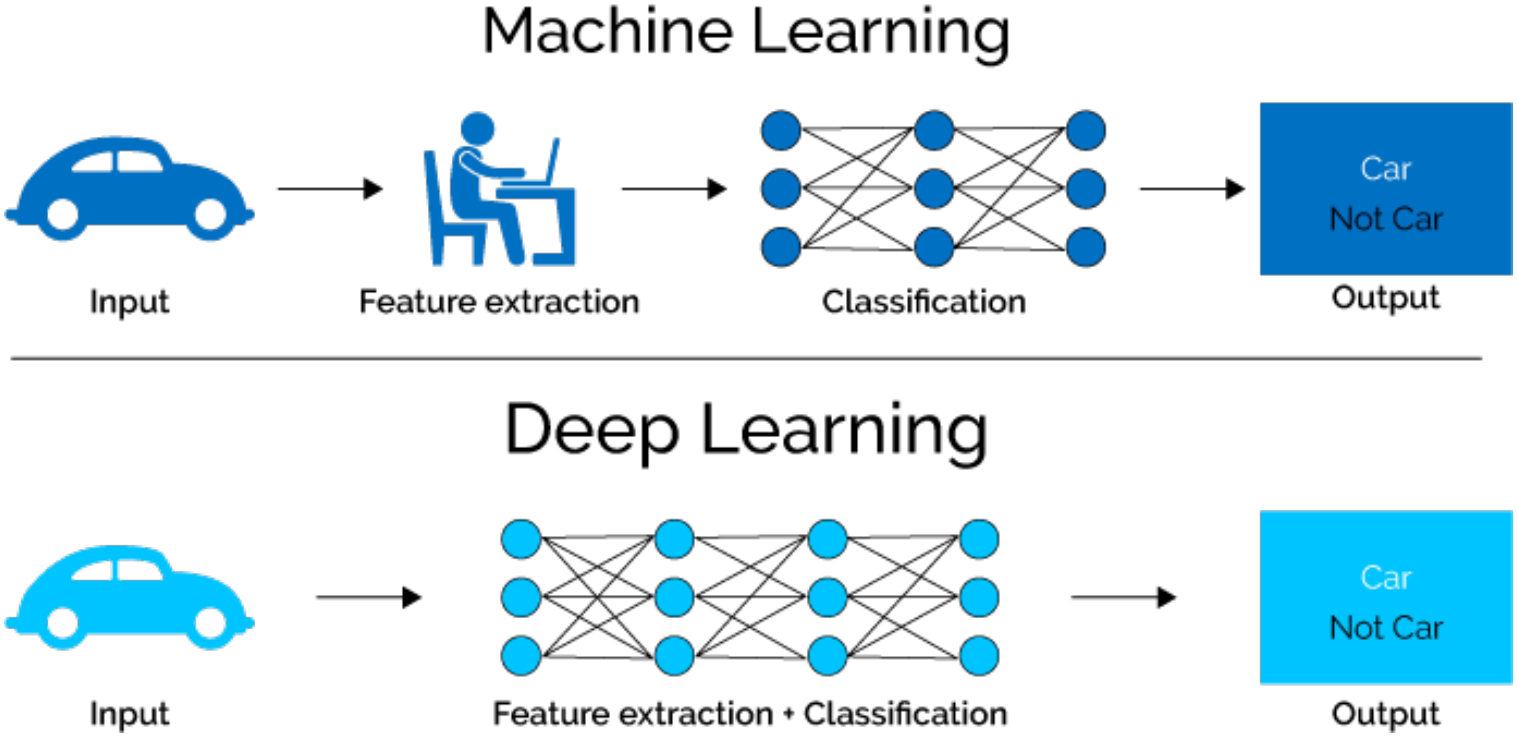
Stock / Cryptocurrency price prediction

What is Deep Learning (DL) ?

A machine learning subfield of learning **representations** of data. Exceptional effective at **learning patterns**.

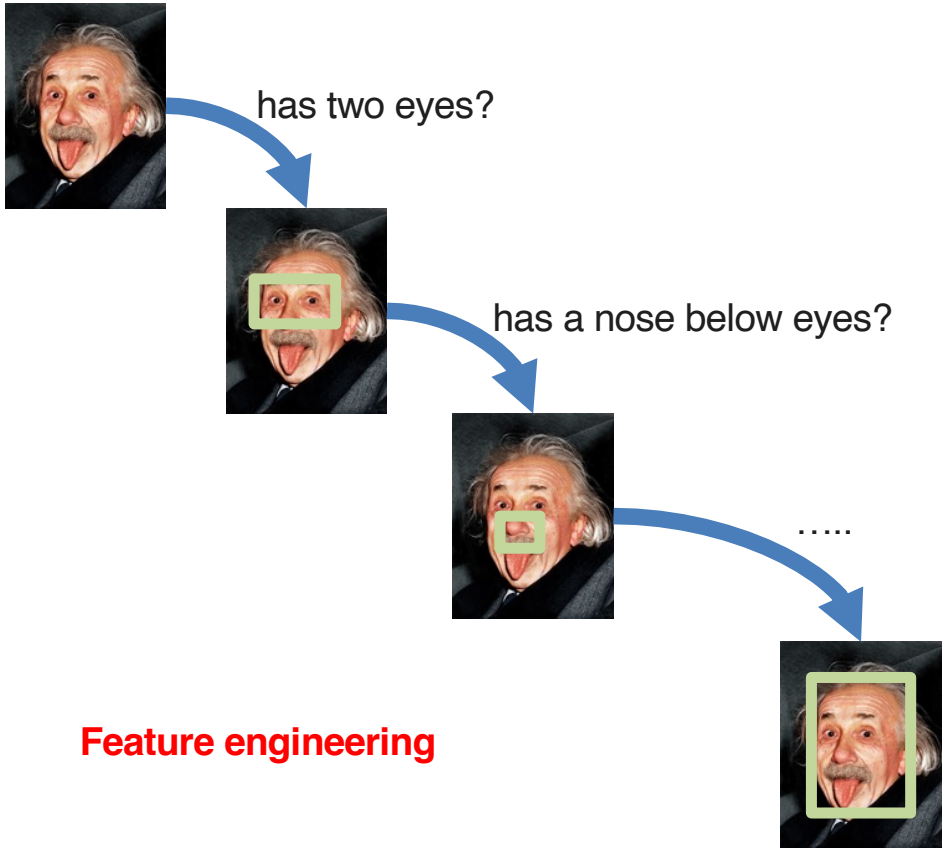
Deep learning algorithms attempt to learn (multiple levels of) representation by using a **hierarchy of multiple layers**

If you provide the system **tons of information**, it begins to understand it and respond in useful ways.



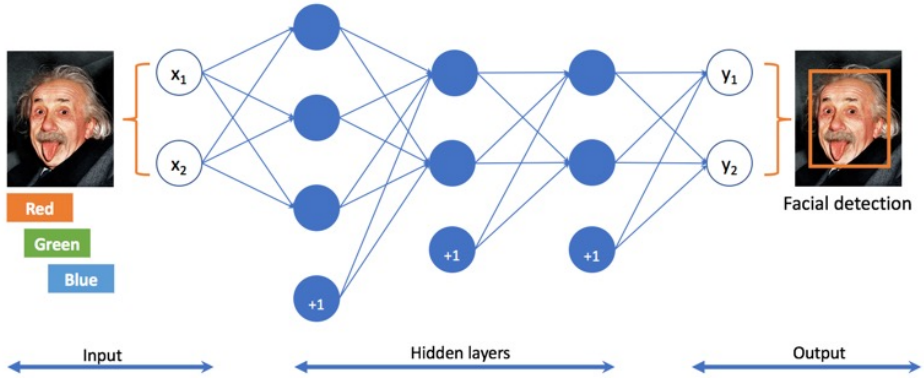
https://www.xenonstack.com/blog/static/public/uploads/media/machine-learning-vs-deep-learning.png

Traditional Machine Learning



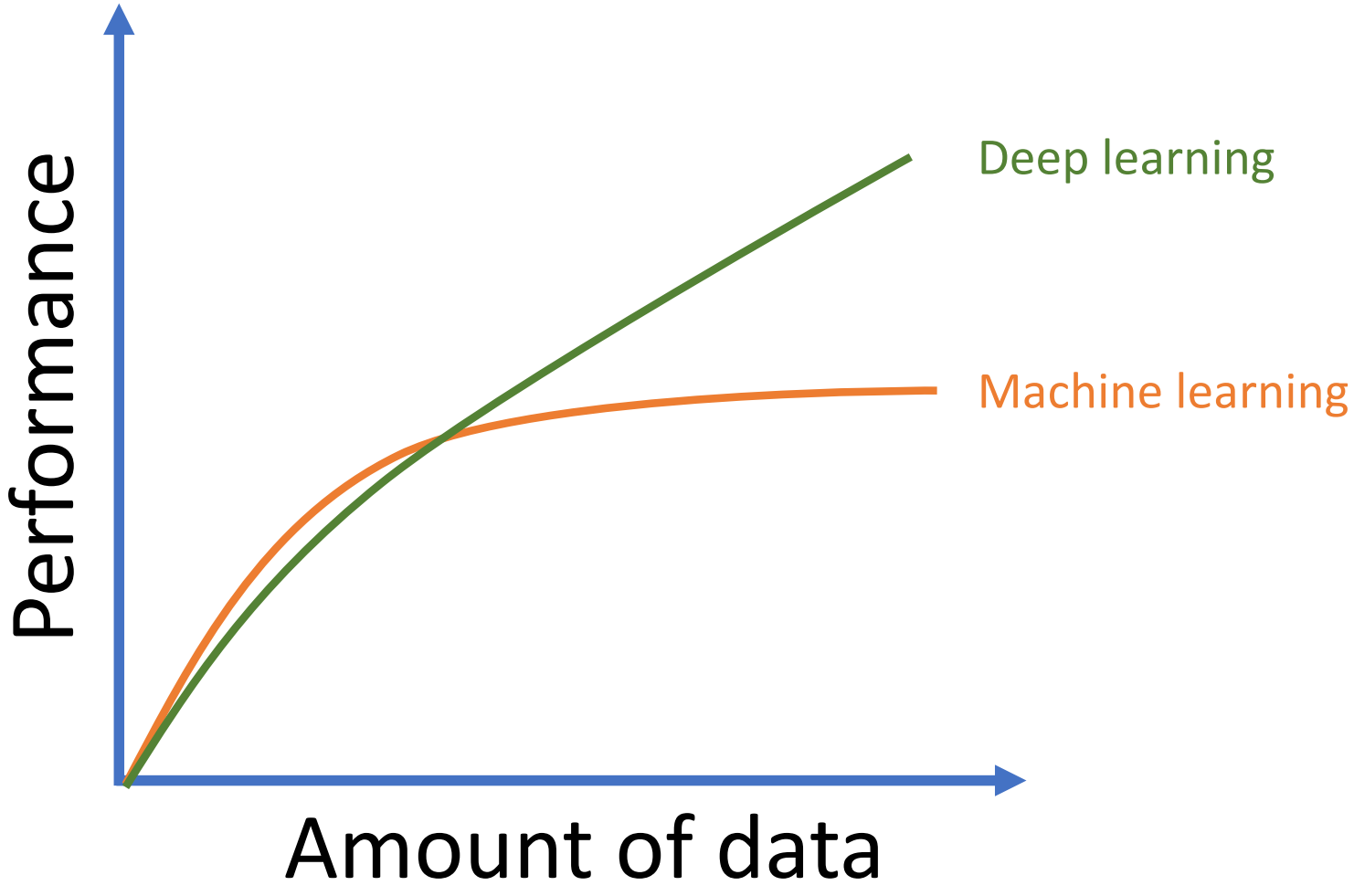
Feature engineering

Deep learning

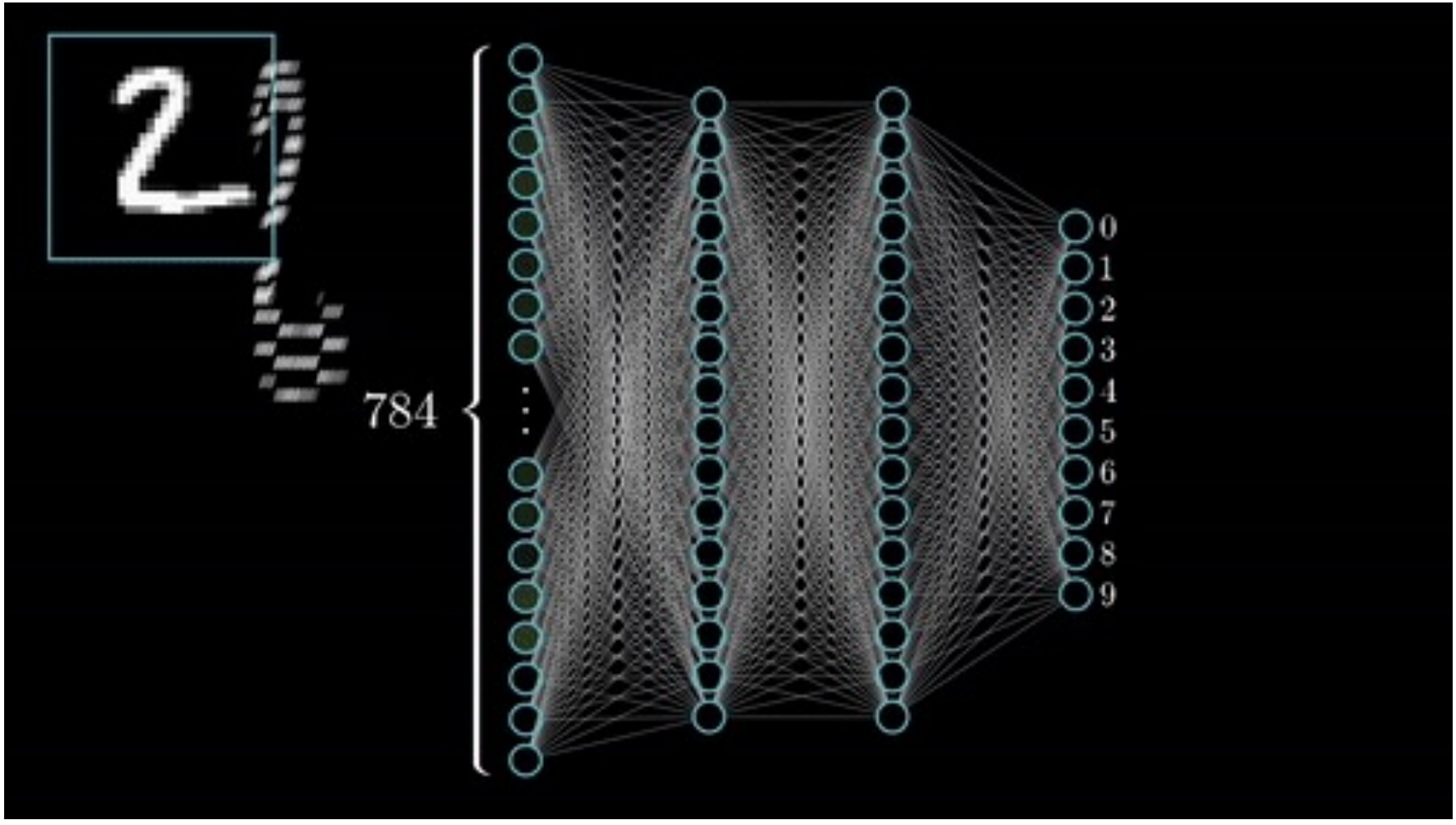


NO feature engineering

Why is DL useful?

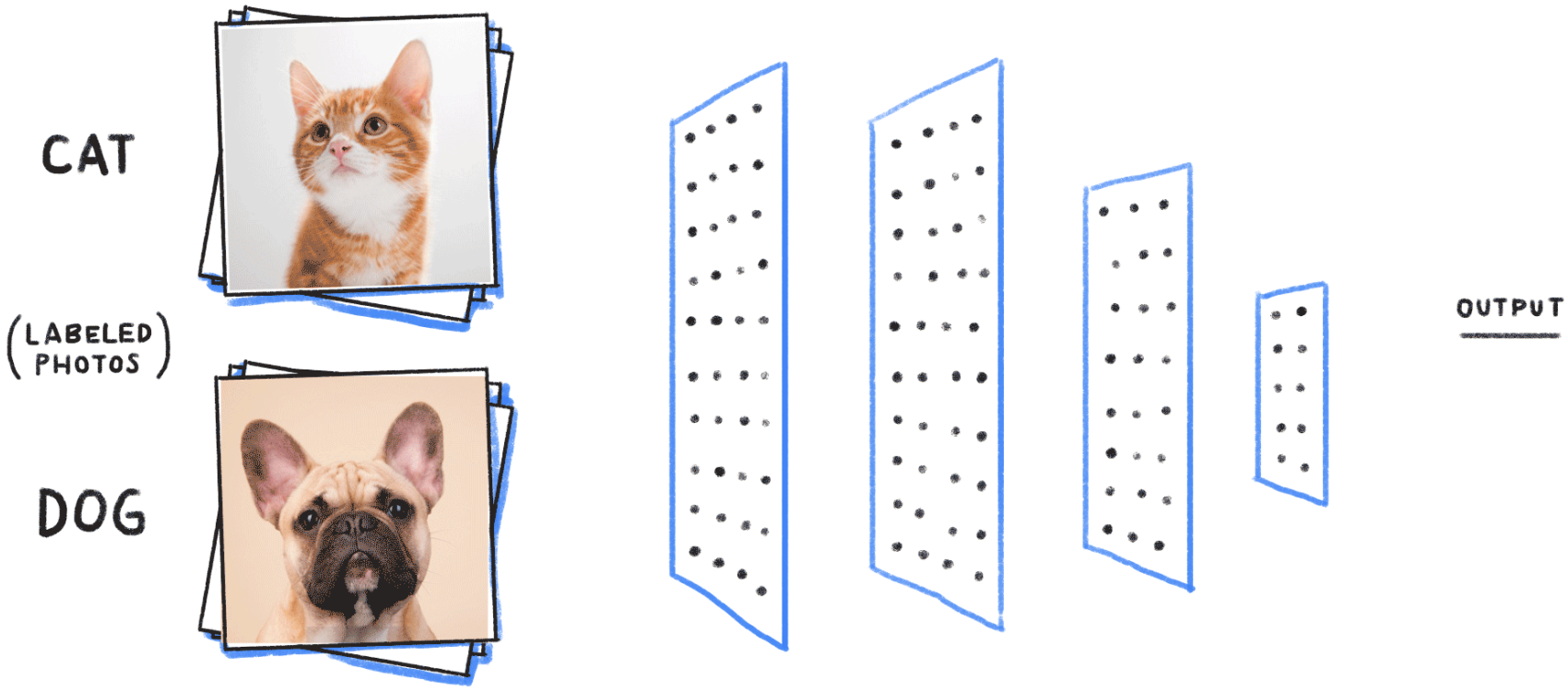


Deep Learning as a classifier



Neural Network is trying to predict the image (data sample) that given to it. it predicts that the number is 2 here.

Deep Learning as a classifier



Neural network is predicting cat/dog image

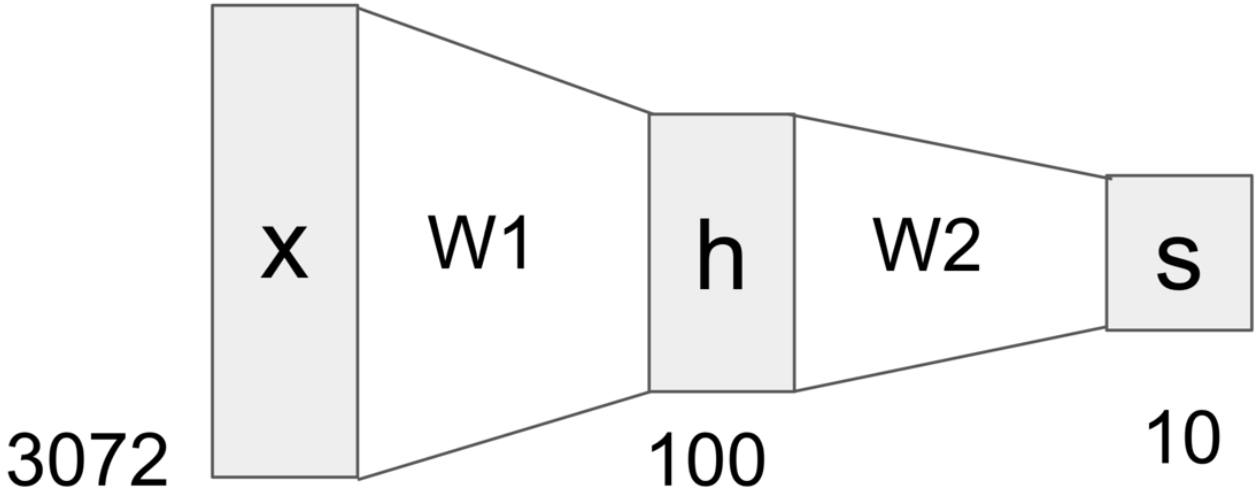
Neural Network

Linear score function:

$$f = Wx$$

2-layer Neural Network

$$f = W_2 \max(0, W_1 x)$$



Neural Network

Linear score function:

$$f = Wx$$

2-layer Neural Network

$$f = W_2 \max(0, W_1 x)$$

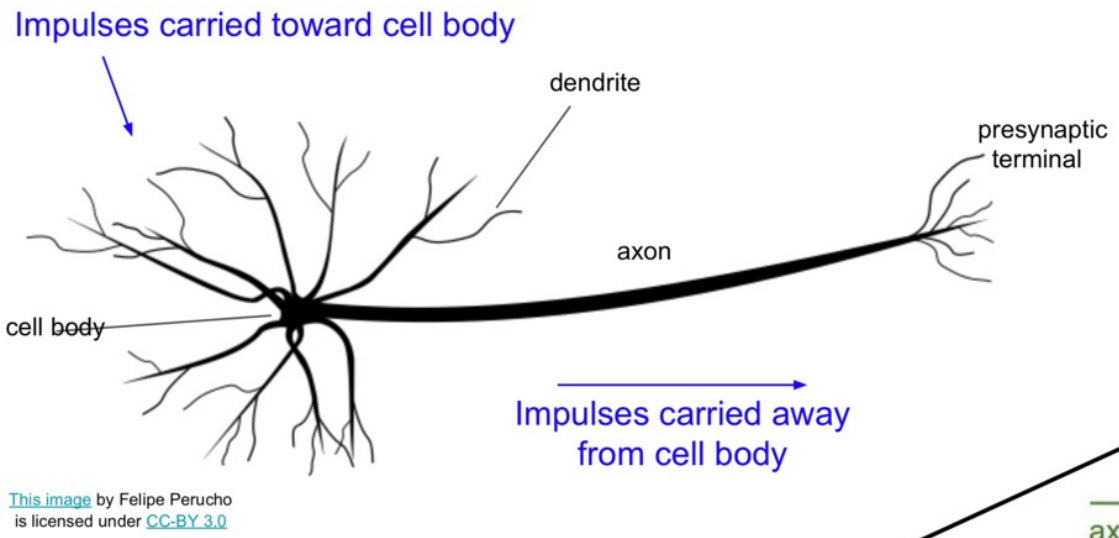
3-layer Neural Network

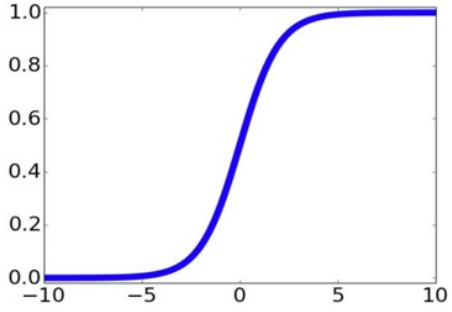
$$f = W_3 \max(0, W_2 \max(0, W_1 x))$$

... and so on.

Deep learning layers as Lego blocks

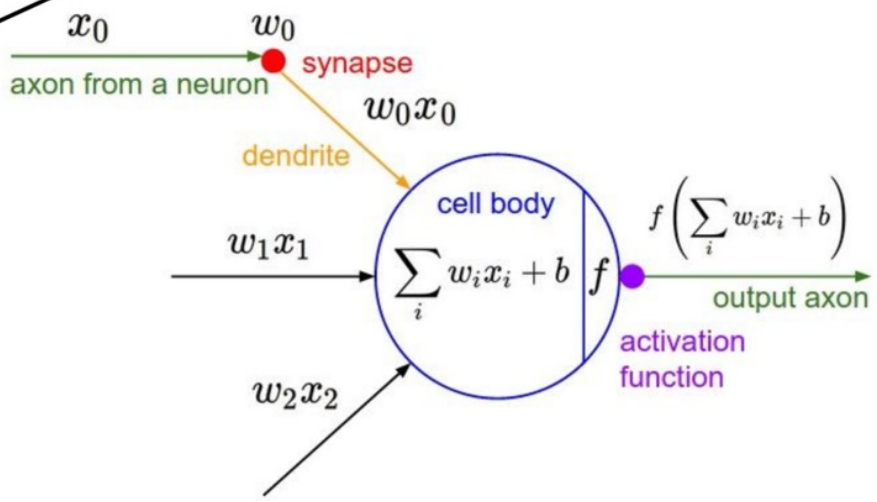
Neural Network





sigmoid activation function

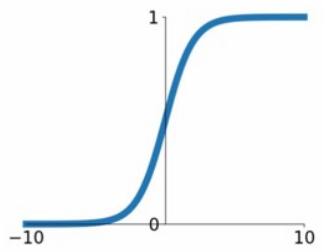
$$\frac{1}{1+e^{-x}}$$



Activation function

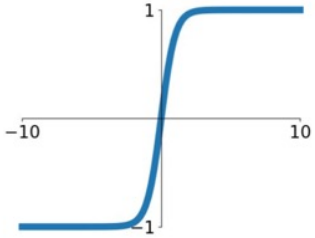
Sigmoid

$$\sigma(x) = \frac{1}{1+e^{-x}}$$



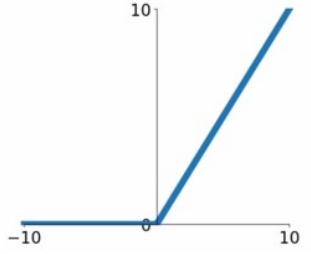
tanh

$$\tanh(x)$$



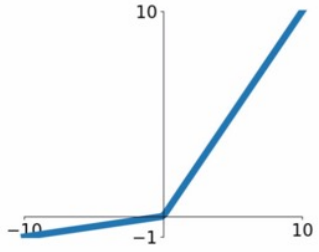
ReLU

$$\max(0, x)$$



Leaky ReLU

$$\max(0.1x, x)$$

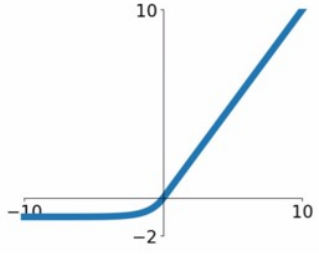


Maxout

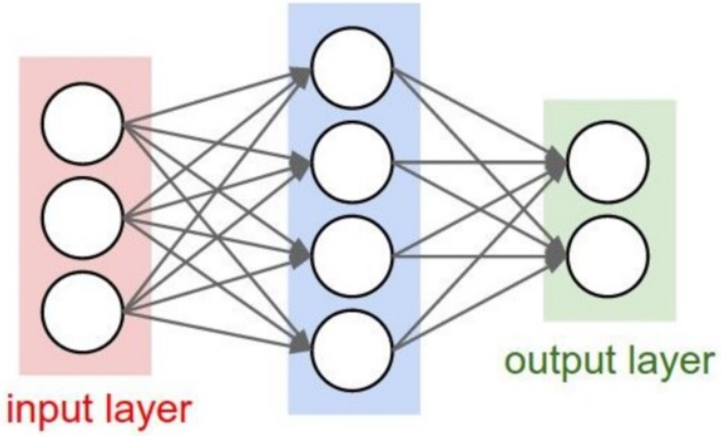
$$\max(w_1^T x + b_1, w_2^T x + b_2)$$

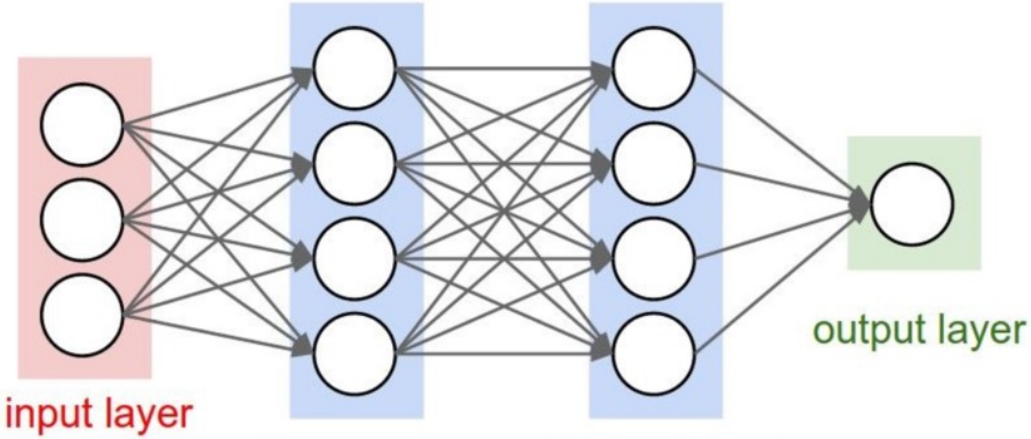
ELU

$$\begin{cases} x & x \geq 0 \\ \alpha(e^x - 1) & x < 0 \end{cases}$$



Neural Network Architectures



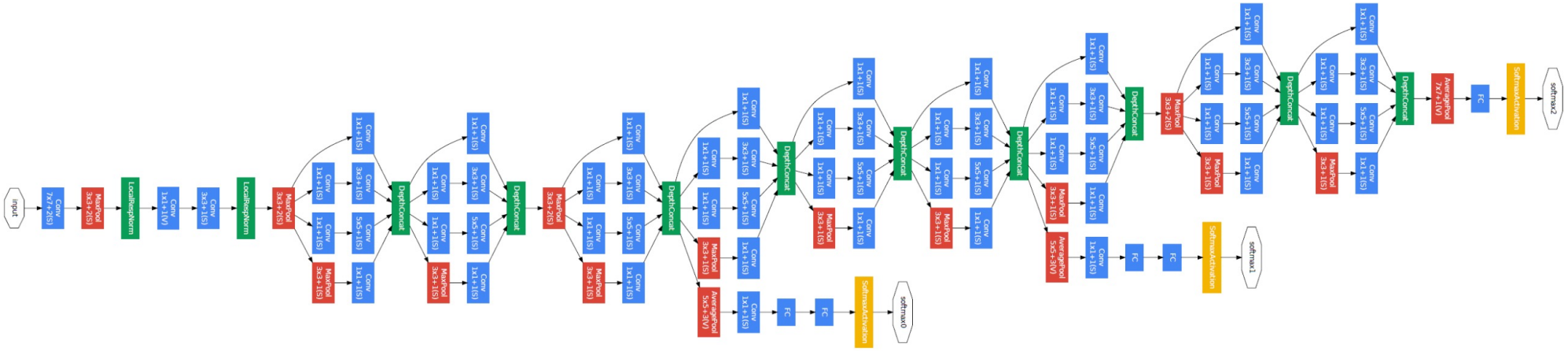


"2-layer Neural Net", or
"1-hidden-layer Neural Net"

"3-layer Neural Net", or
"2-hidden-layer Neural Net"

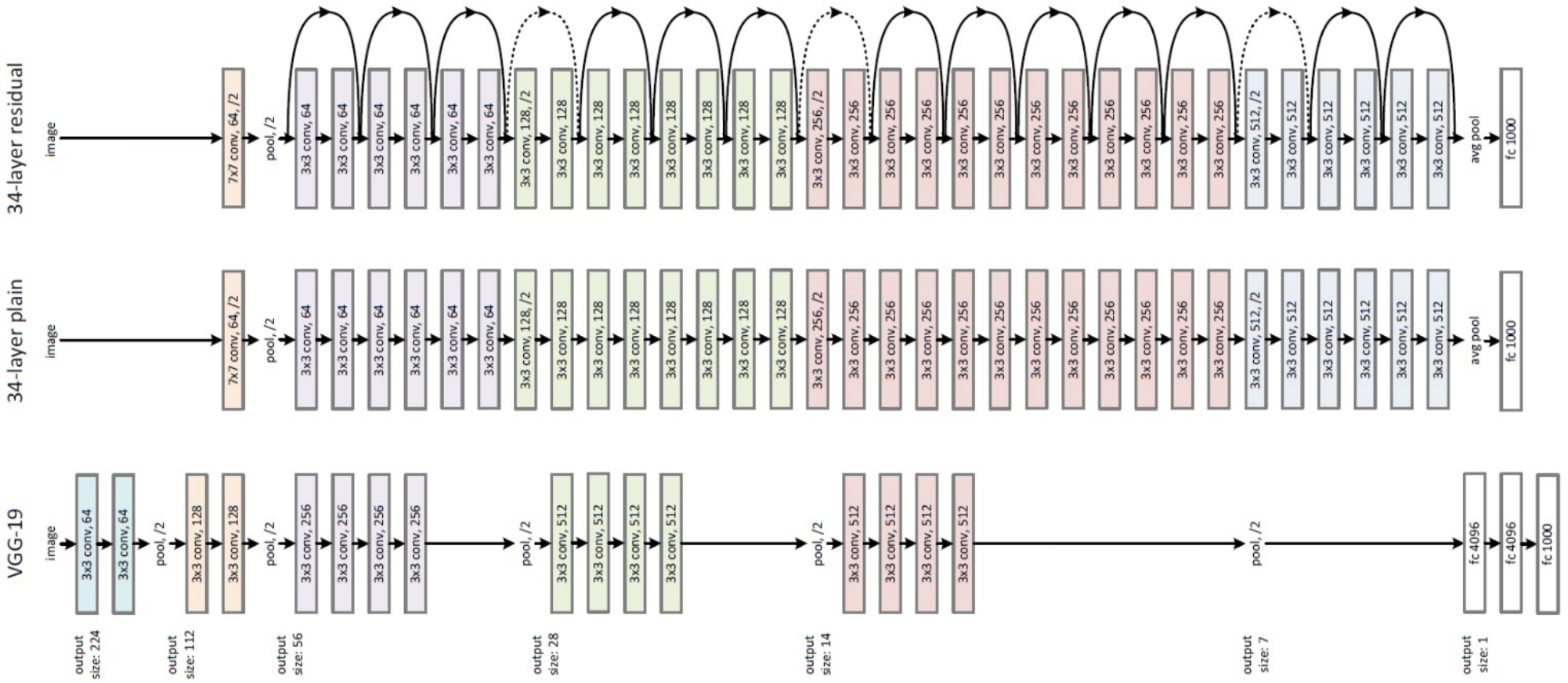
"Fully-connected" layers

Neural Network Architectures



GoogLe Net (Inception v1)

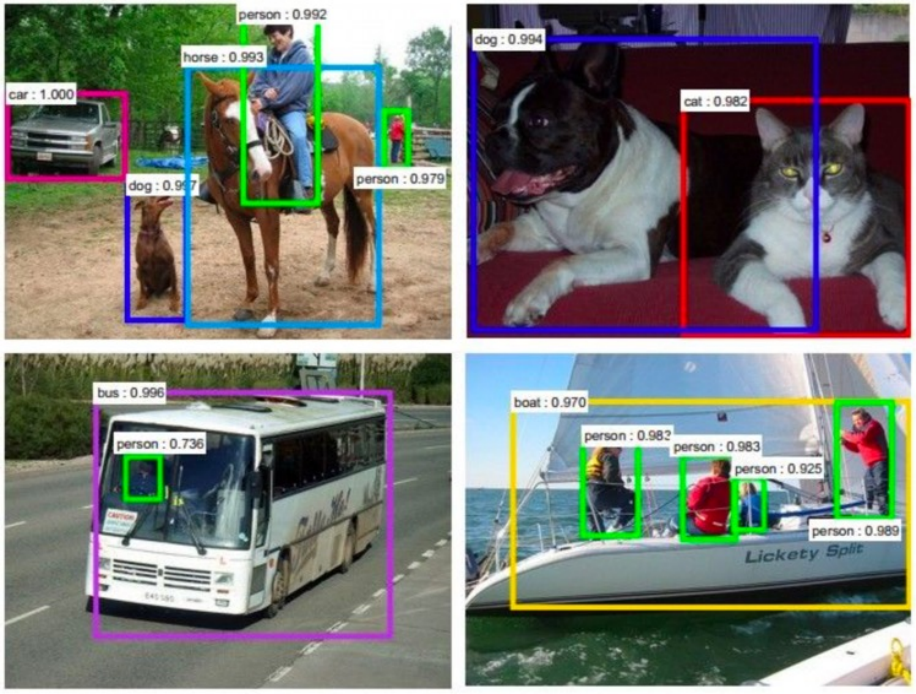
Neural Network Architectures



ResNet

Convolution Neural Network (ConvNet)

Detection



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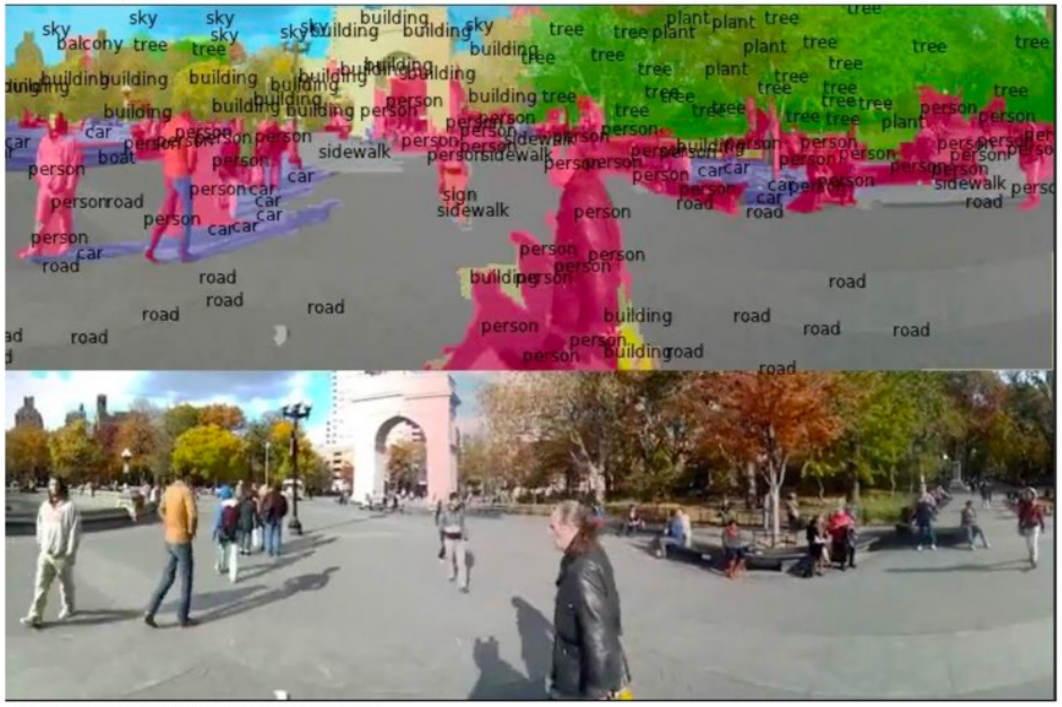
[Faster R-CNN: Ren, He, Girshick, Sun 2015]

Segmentation



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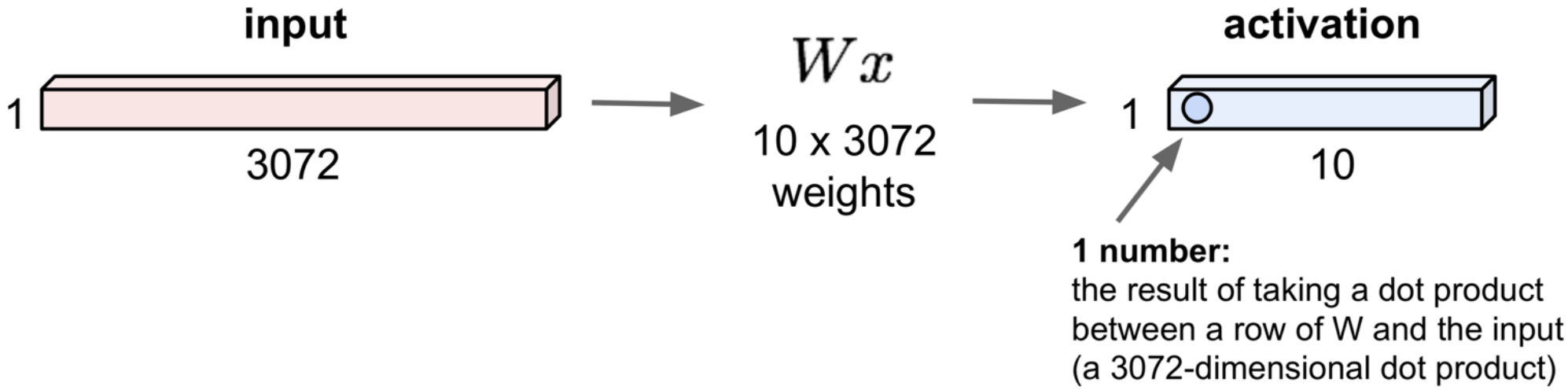
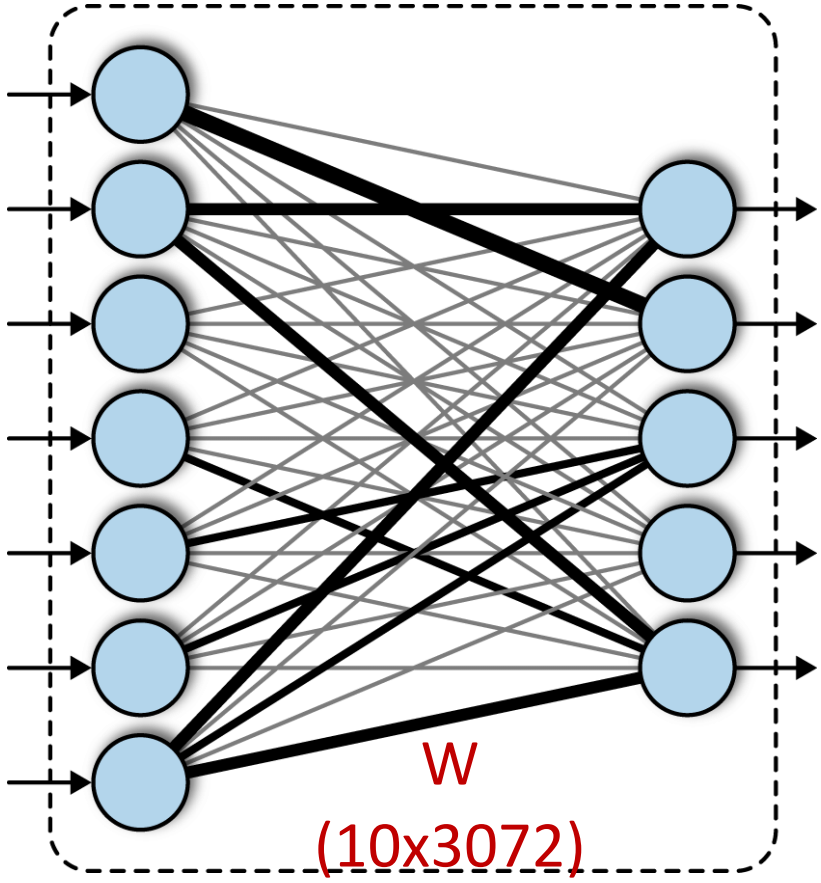
[Farabet et al., 2012]

Fully Connected Layer

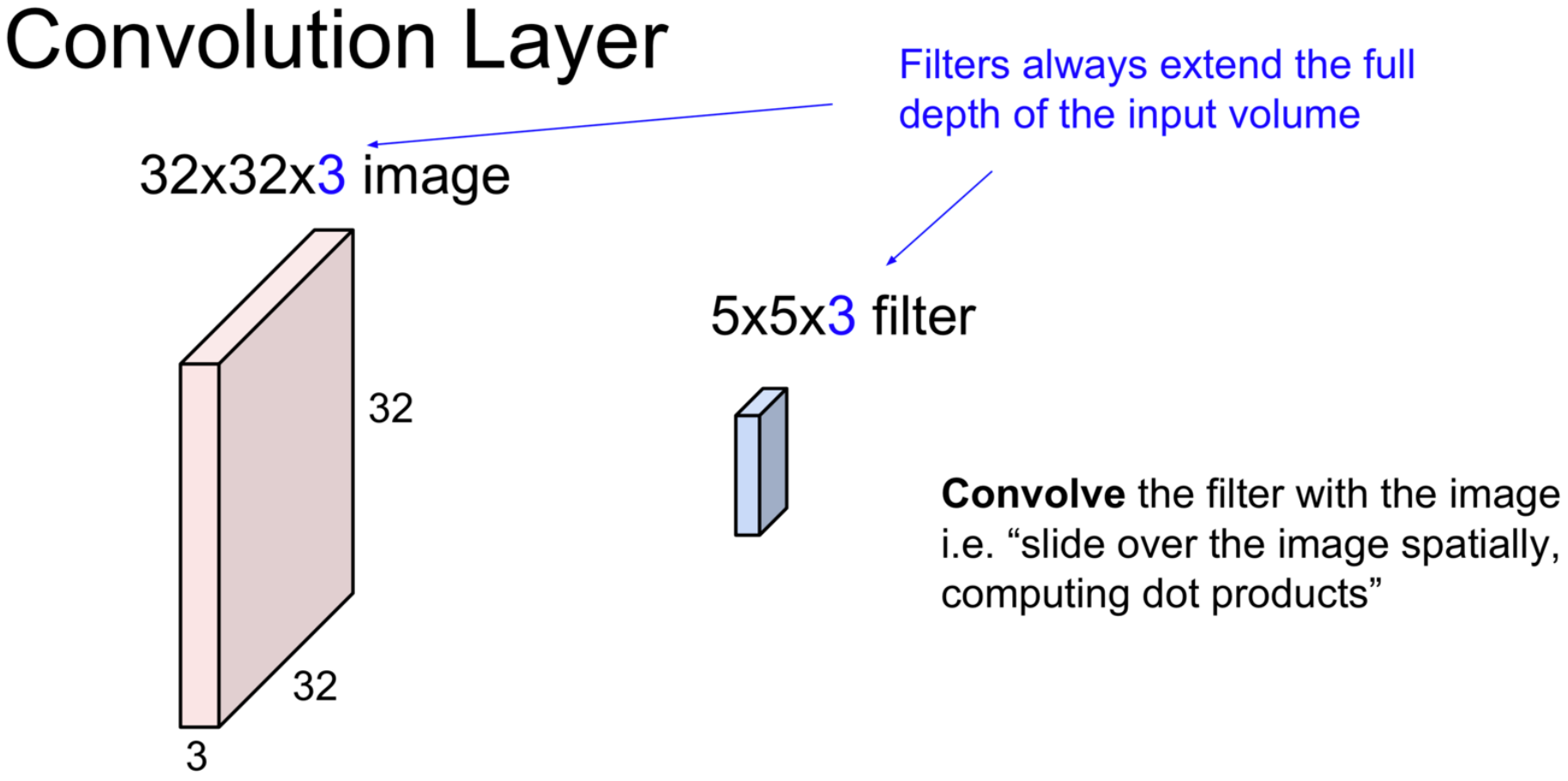
32x32x3 image -> stretch to 3072 x 1



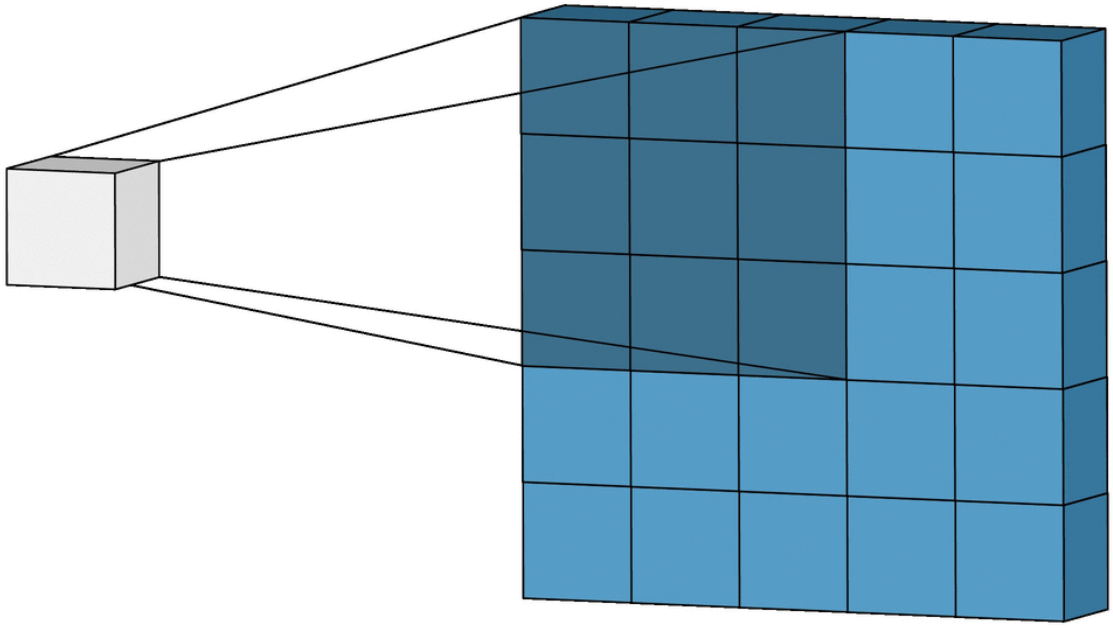
Fully Connected Layer



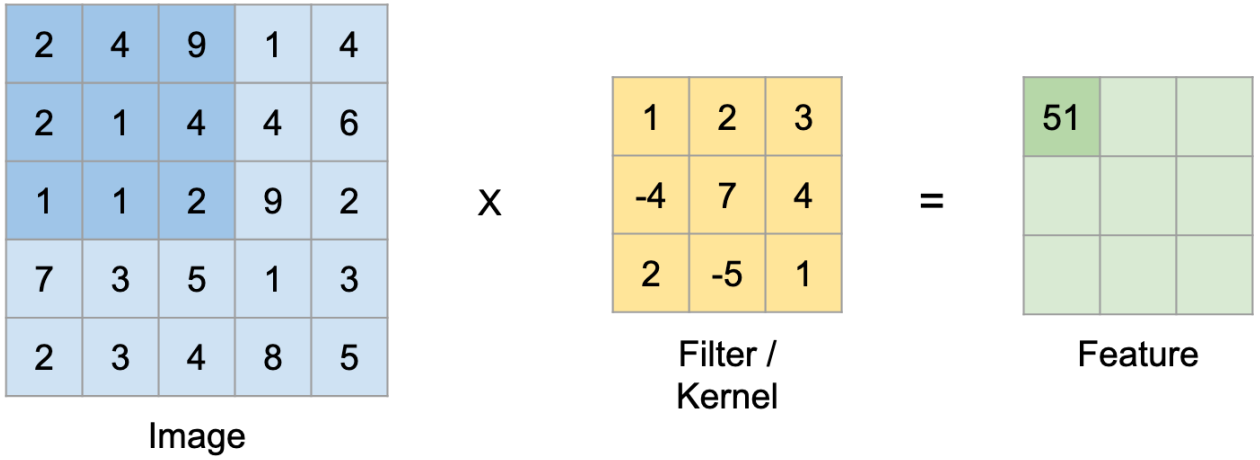
Convolutional layer

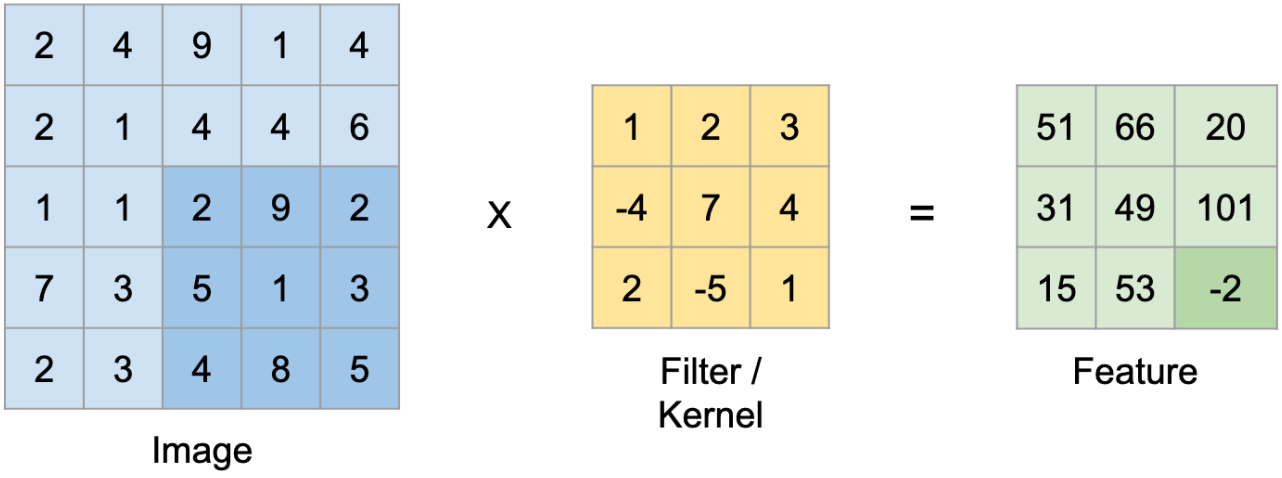


Convolutional layer

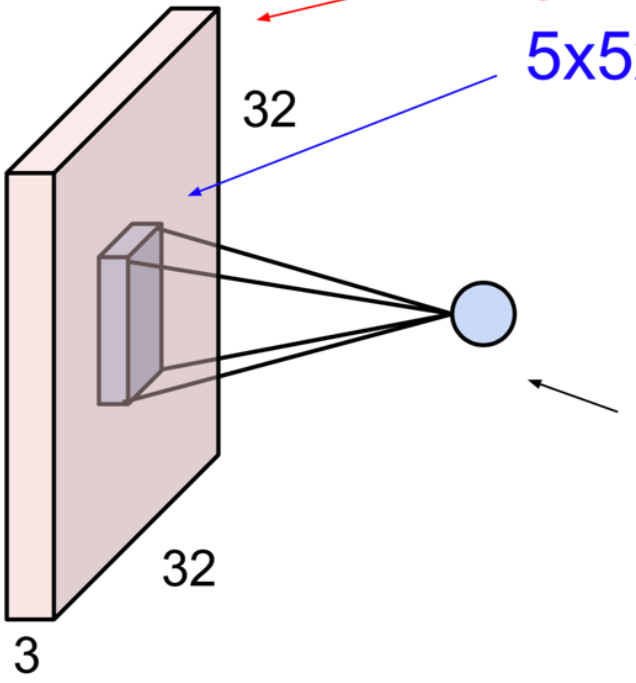


Convolutional layer





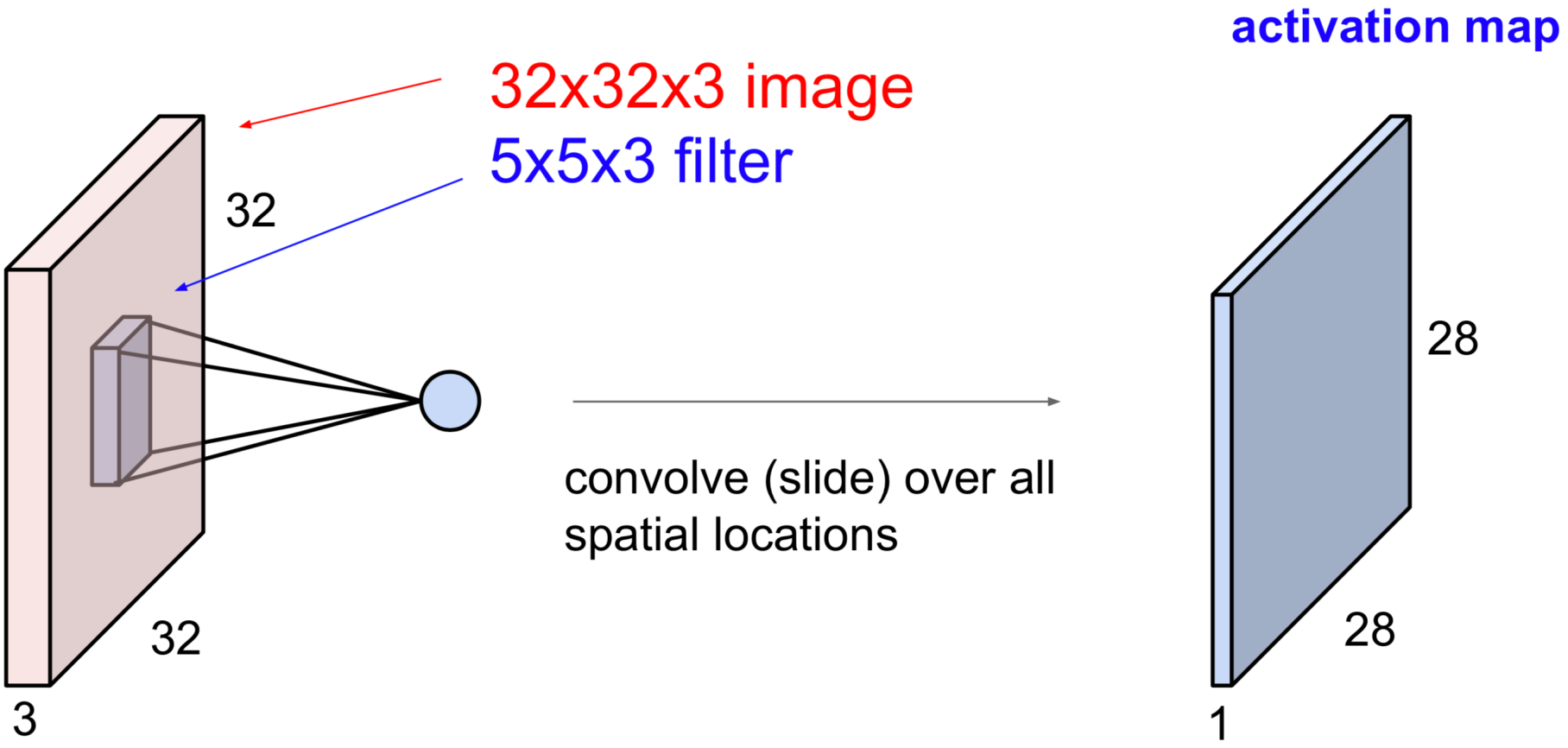
Convolutional layer



1 number:
the result of taking a dot product between the filter and a small 5x5x3 chunk of the image
(i.e. 5*5*3 = 75-dimensional dot product + bias)

$$w^T x + b$$

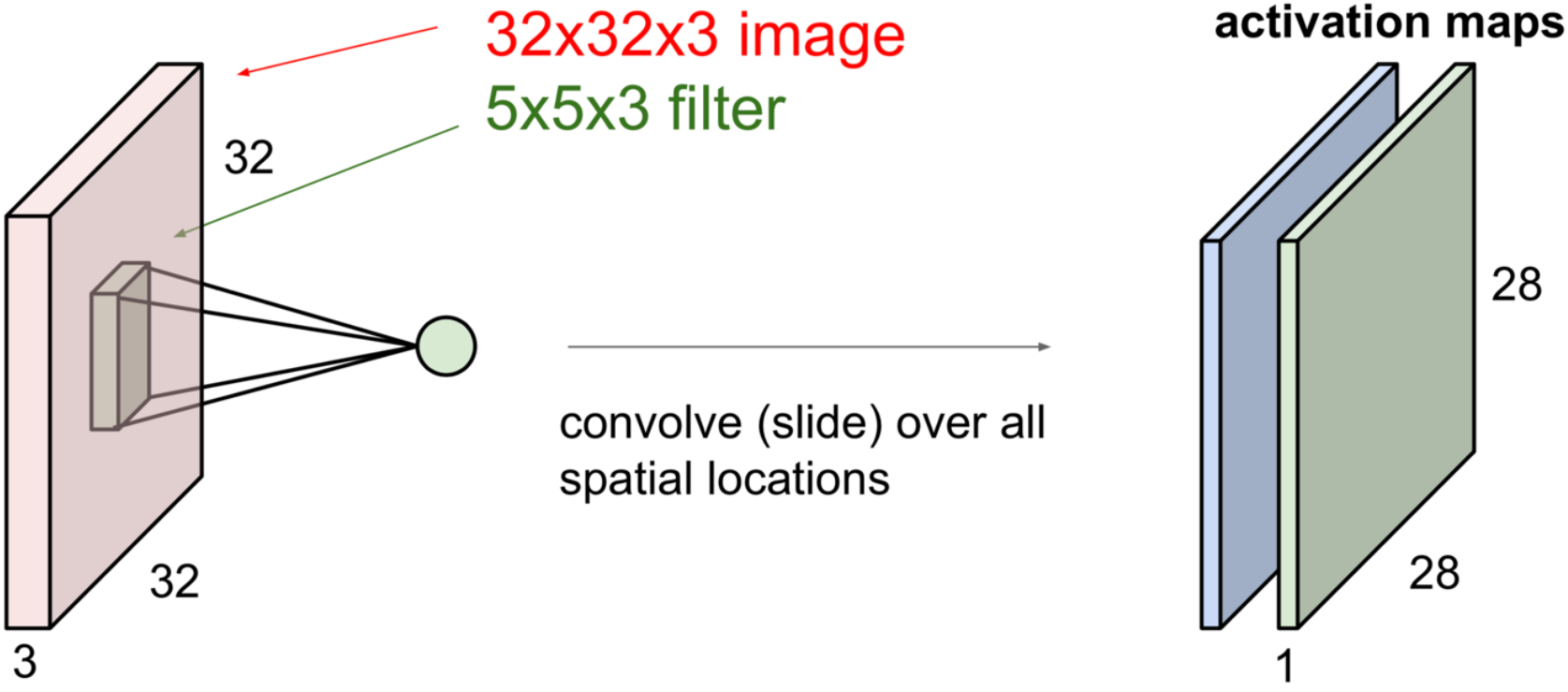
Convolutional layer



Convolutional layer

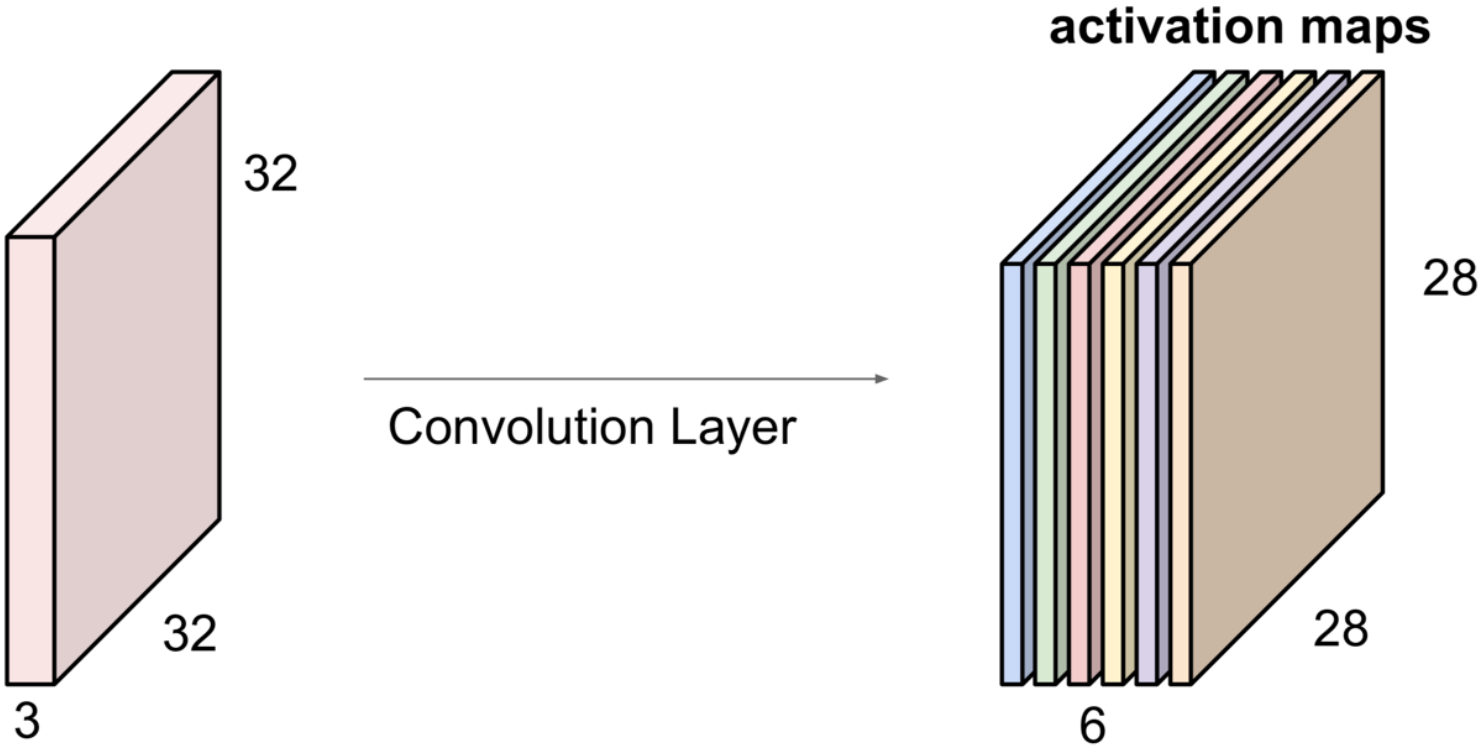
Convolution Layer

consider a second, green filter



Convolutional layer

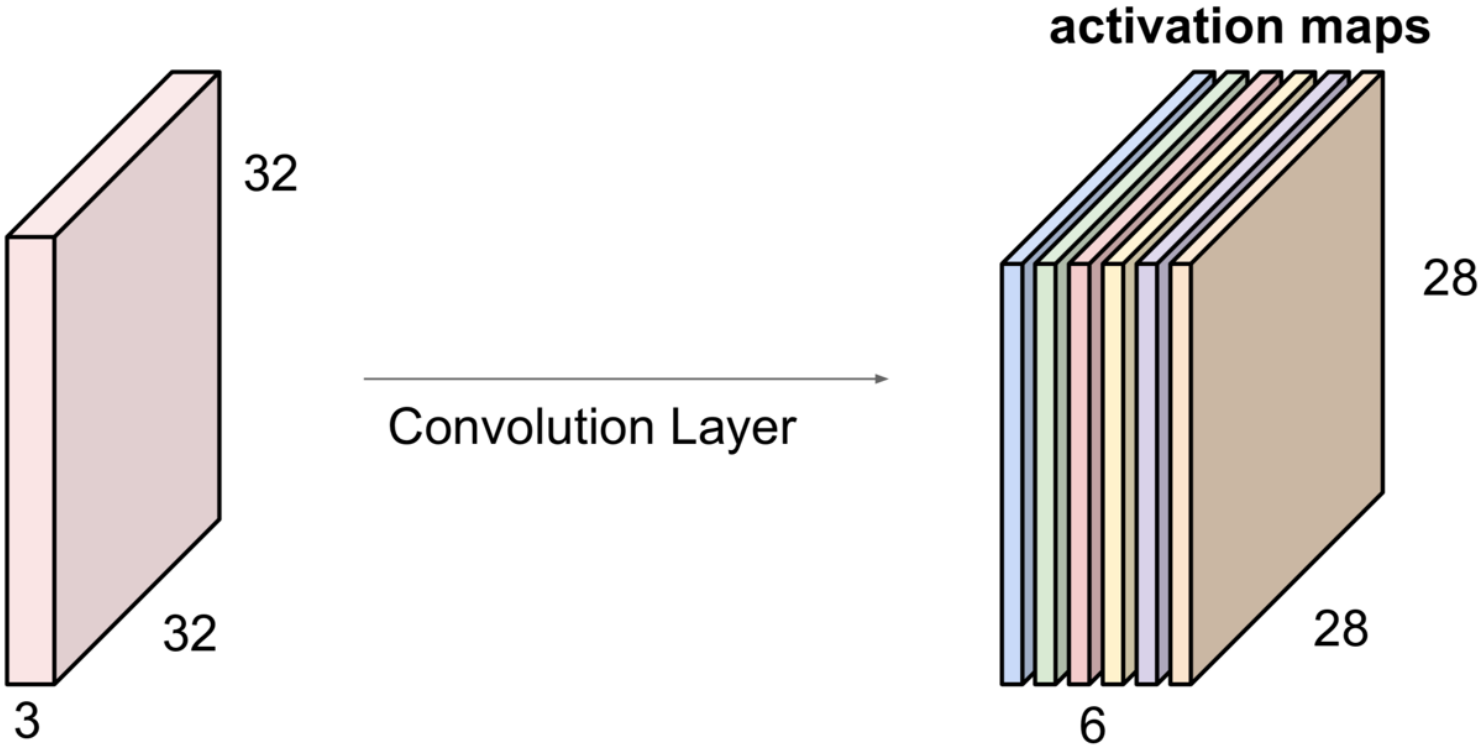
For example, if we had 6 5x5 filters, we'll get 6 separate activation maps:



We stack these up to get a "new image" of size 28x28x6!

Convolutional layer

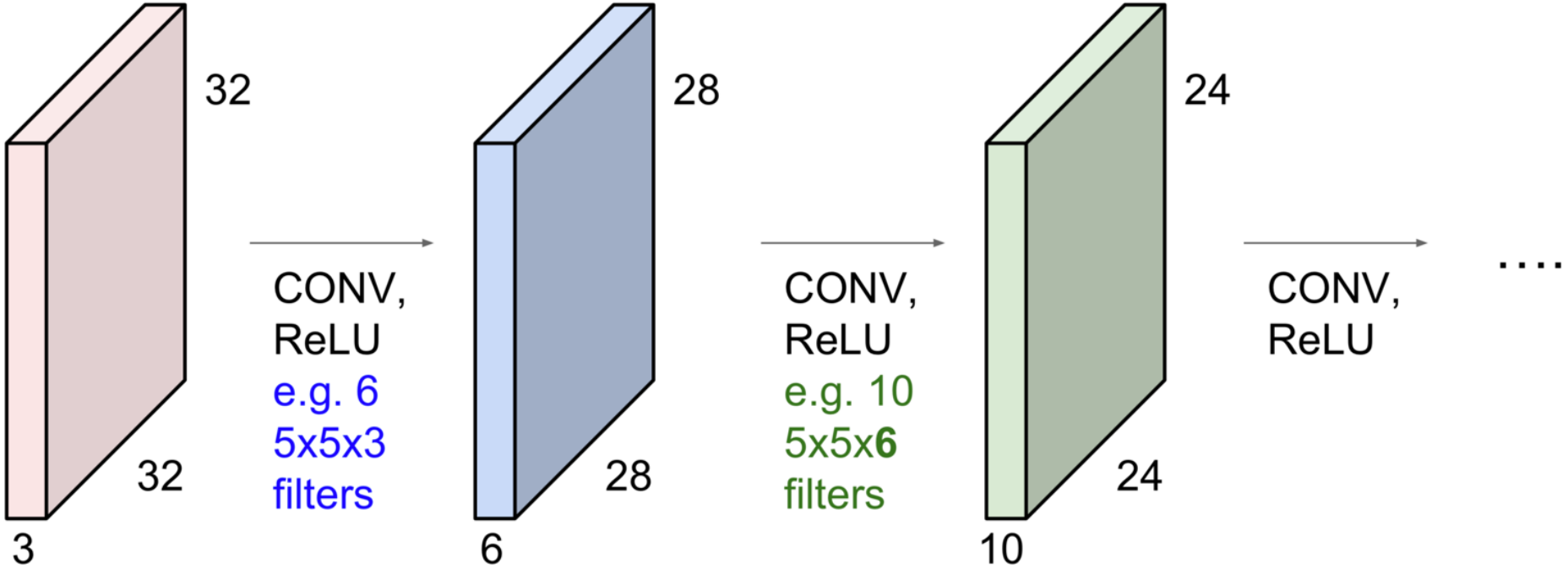
For example, if we had 6 5x5 filters, we'll get 6 separate activation maps:



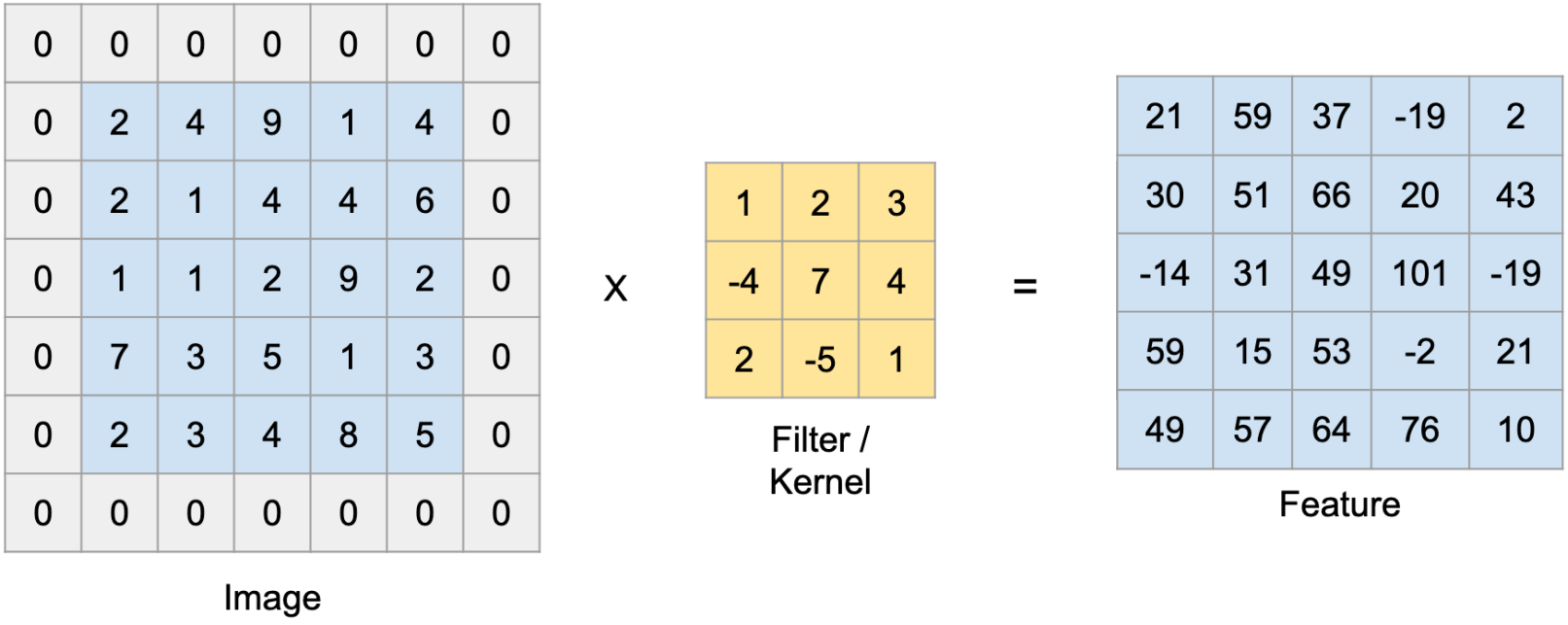
We stack these up to get a "new image" of size 28x28x6!

Convolutional layer

Preview: ConvNet is a sequence of Convolutional Layers, interspersed with activation functions



Convolutional layer



- Input 5x5 with padding 1.
- Filter with kernel size 3x3 and stride 1.

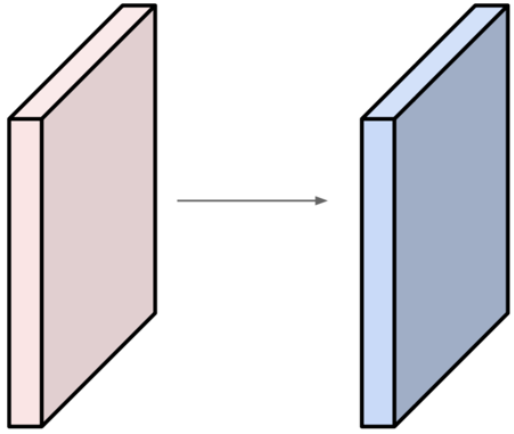
→ Output is 5x5.

Convolutional layer

Examples time:

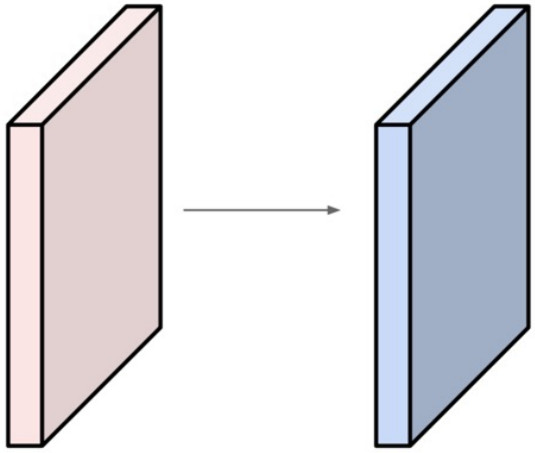
Input volume: **32x32x3**
10 5x5 filters with stride 1, pad 2

Output volume size: ?



Convolutional layer

Examples time:

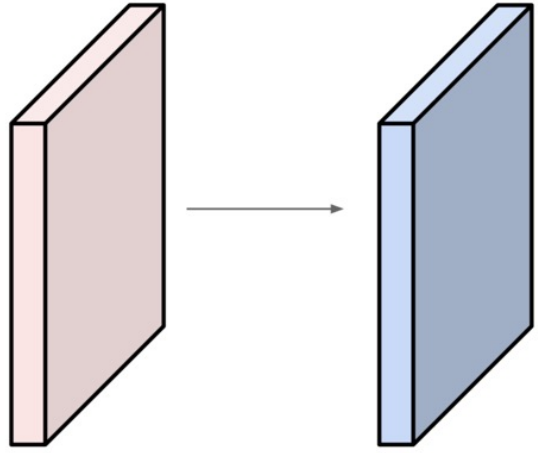


Input volume: **32x32x3**
10 5x5 filters with stride 1, pad 2

Output volume size:
(32+2*2-5)/1+1 = 32 spatially, so
32x32x10

Convolutional layer

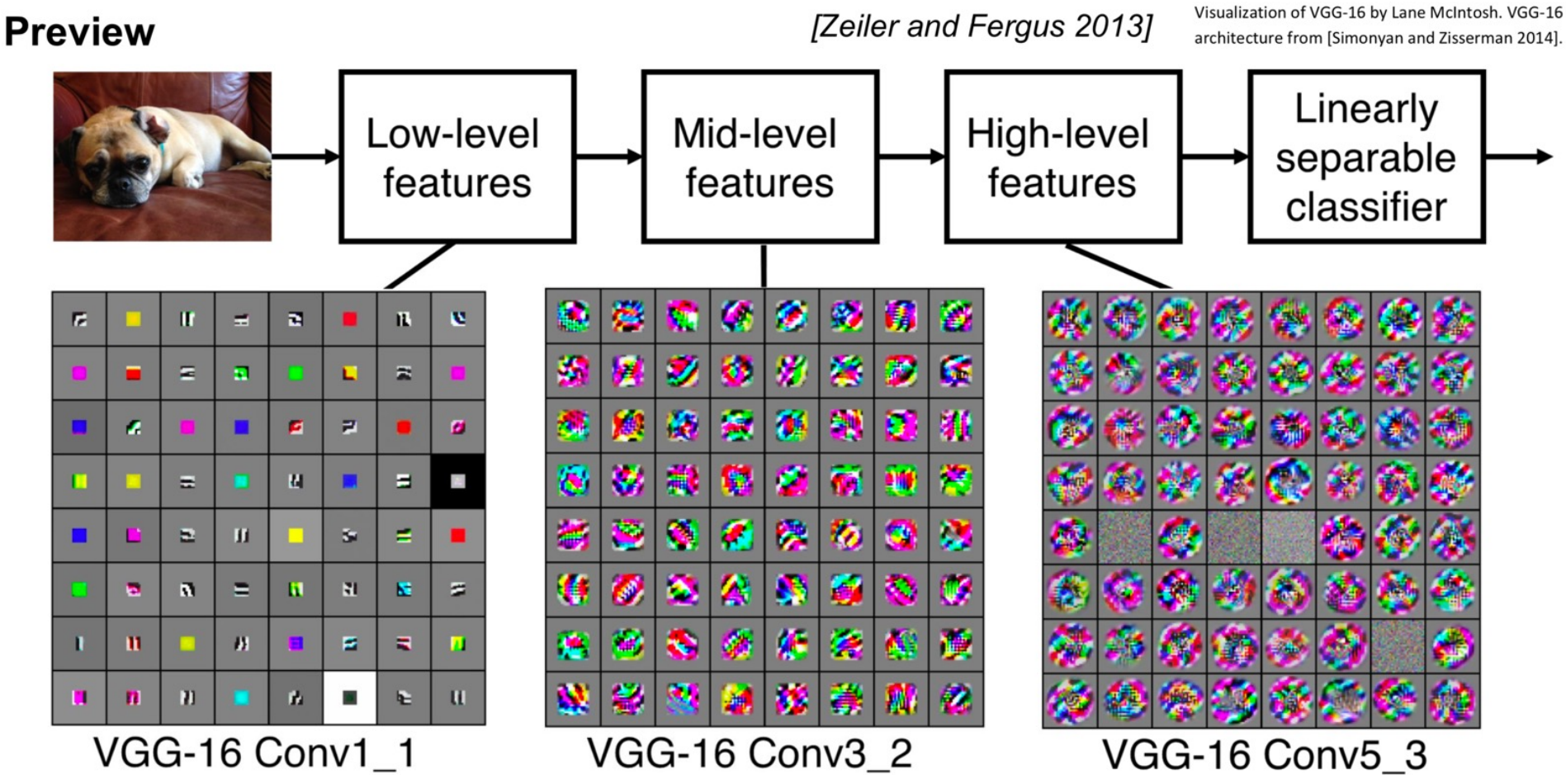
Examples time:



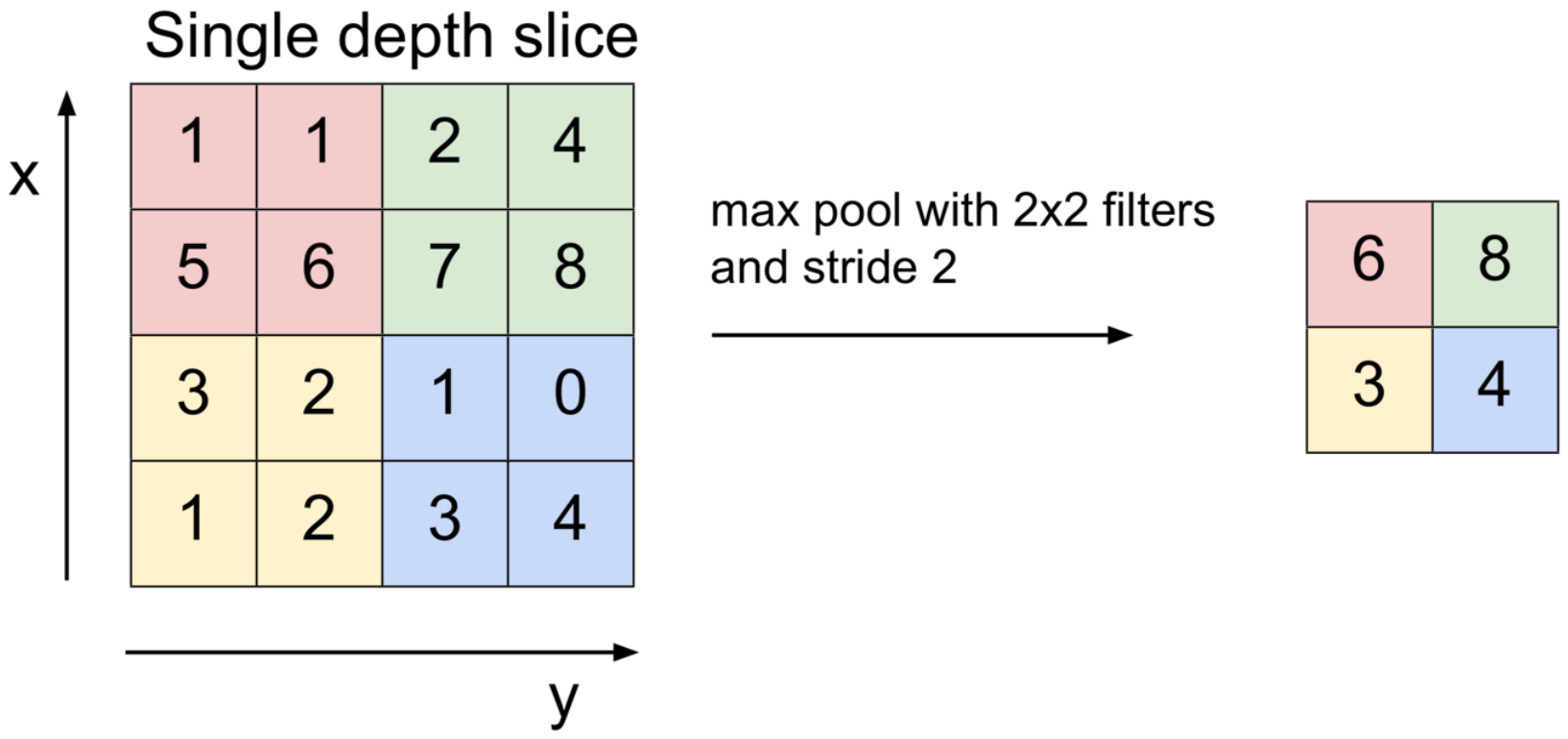
Input volume: **32x32x3**
10 5x5 filters with stride 1, pad 2

Number of parameters in this layer?
each filter has 5*5*3 + 1 = 76 params (+1 for bias)
=> 76*10 = **760**

Convolutional layer

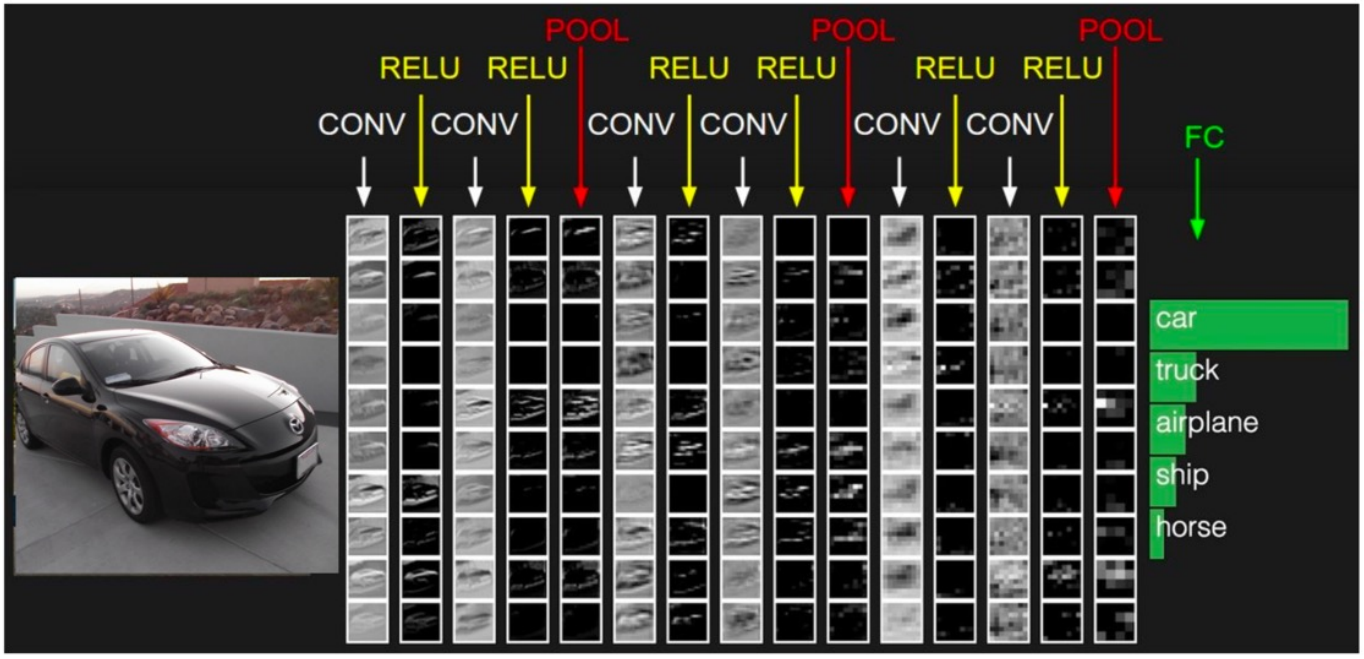


Pooling layer



Deep Neural network - An example structure

- Contains neurons that connect to the entire input volume, as in ordinary Neural Networks



Summary

- Introduction to deep learning and neural networks.
- Feature engineering in machine learning and deep learning.
- Fully connected layer.
- Convolutional layer.
- Activation function.
- Pooling layer.

Q&A

Thank you