

# Introduction to Deep Learning

# About me

Intelligent Systems  
*2008 - 2014*

Universität Bielefeld

Research Engineer  
*2014 - 2018*



Data Scientist  
*since 2018*



M.Sc. Denis Stalz-John

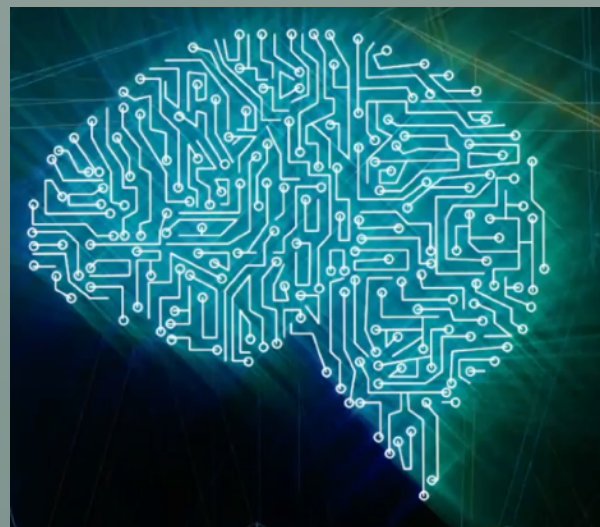
# Contents

- What is Deep Learning?
- Deep Learning Achievements
- History
- Fundamentals
- Practical Deep Learning
- Coding Example
- Outro

# What is Deep Learning?

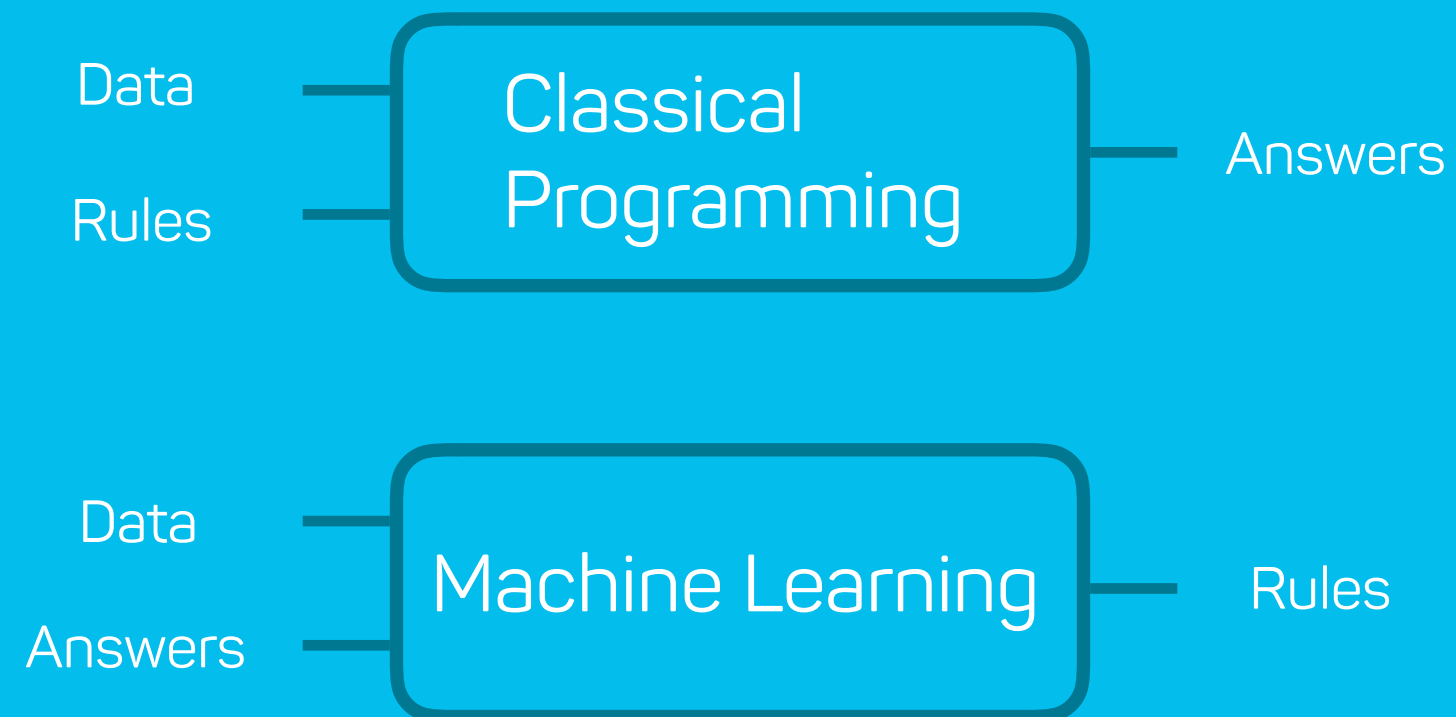
## Artificial Intelligence

Any technique that enables computers to mimic human behavior



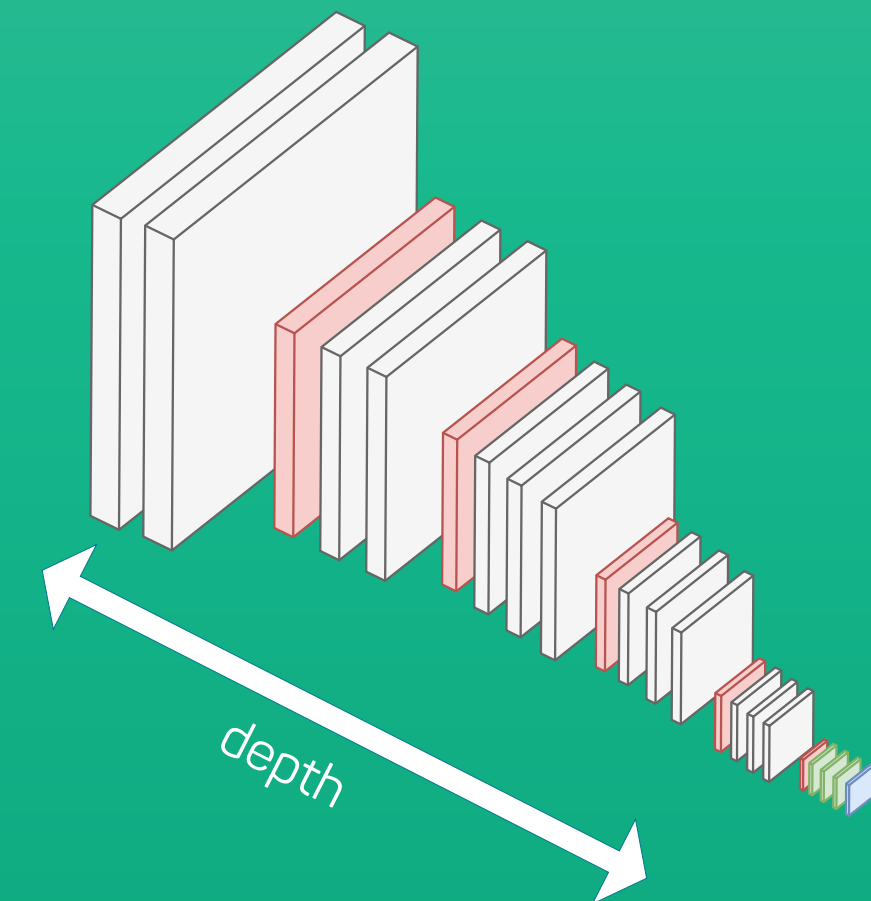
## Machine Learning

Ability to learn rules from data



## Deep Learning

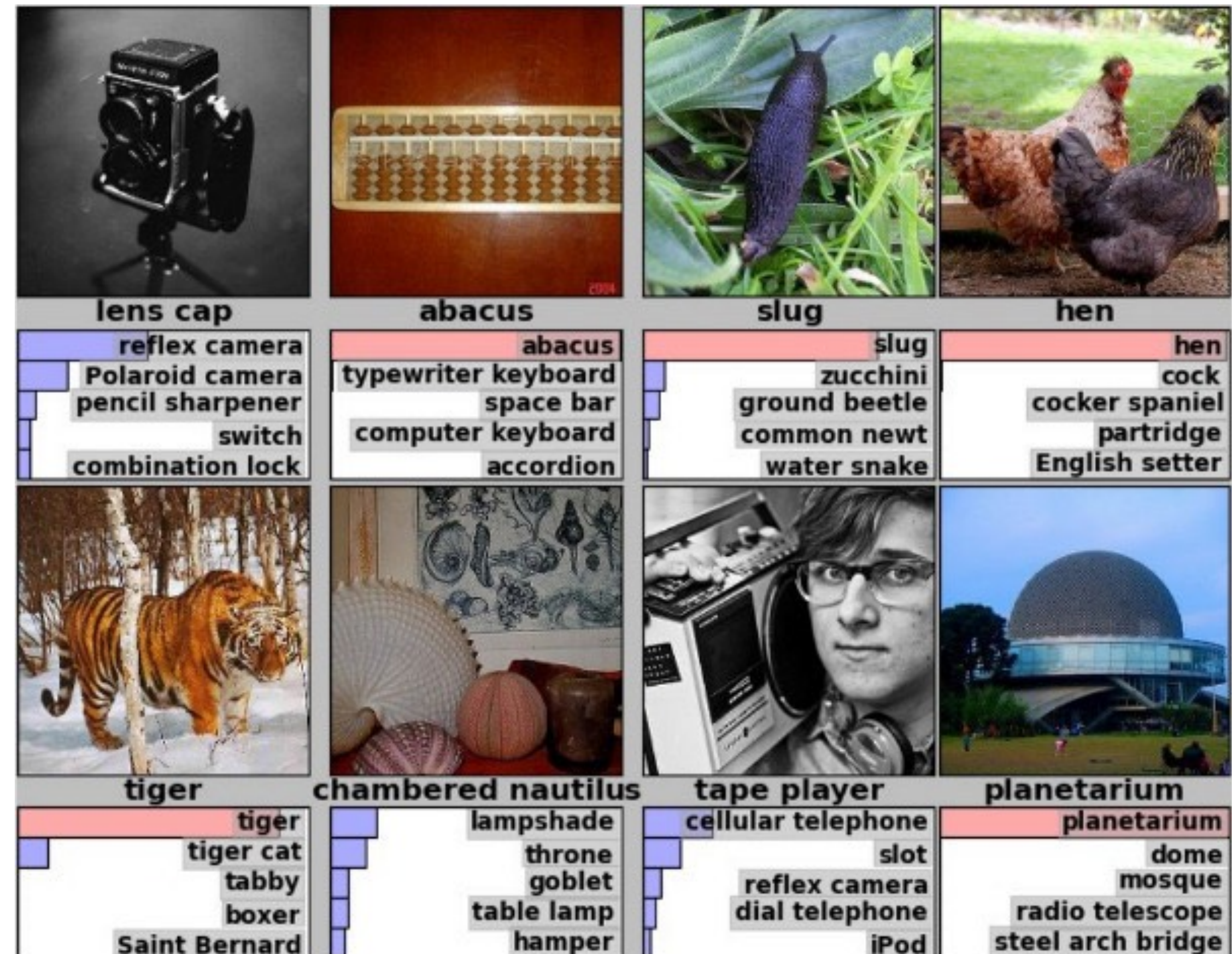
Apply machine learning with „deep“ neural networks



# Deep Learning Achievements - ImageNet

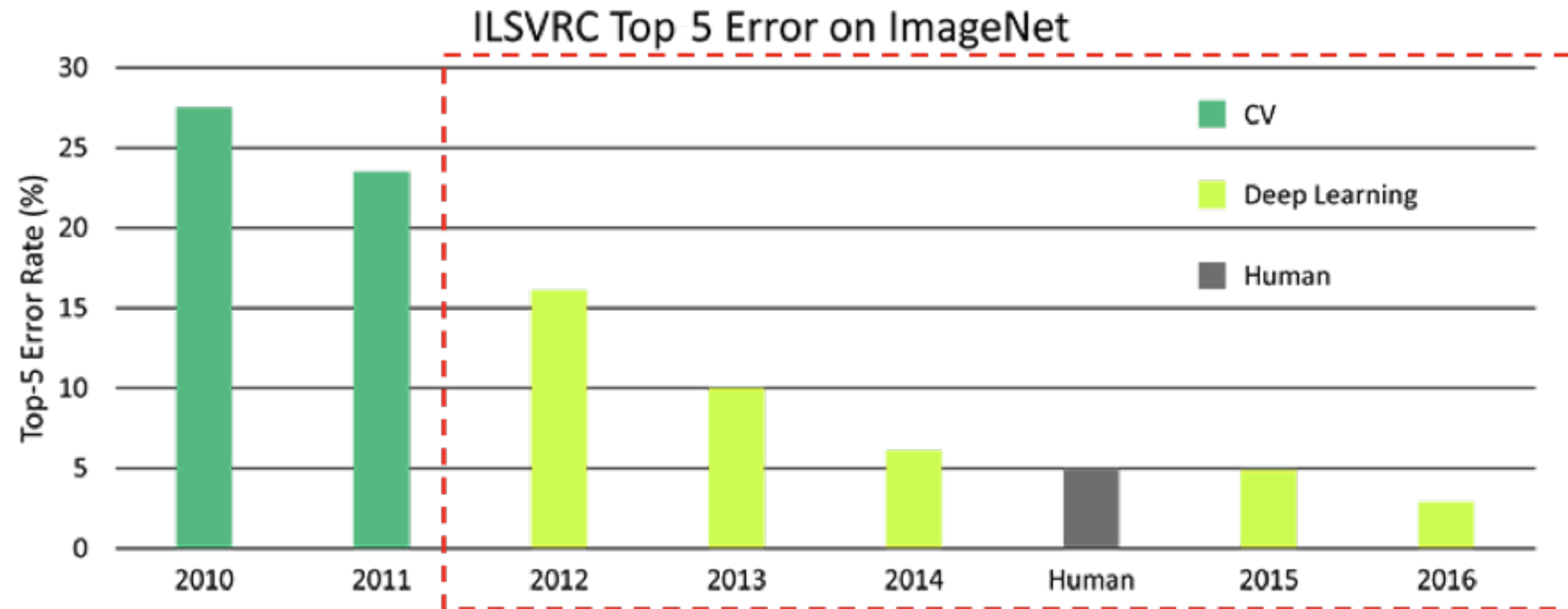


- 1000 categories
- train set: 1.2 M
- test set: 100 k



<https://medium.com/obvious-ventures/our-investment-in-darwinai-d5ea1a7af32e>

# Deep Learning Achievements - ImageNet



The introduction of Deep Learning techniques drove performance on image categorization from 30% error rates in 2010, down to <2% in 2017

<https://medium.com/obvious-ventures/our-investment-in-darwinai-d5ea1a7af32e>

# Deep Learning Achievements - Autonomous Driving

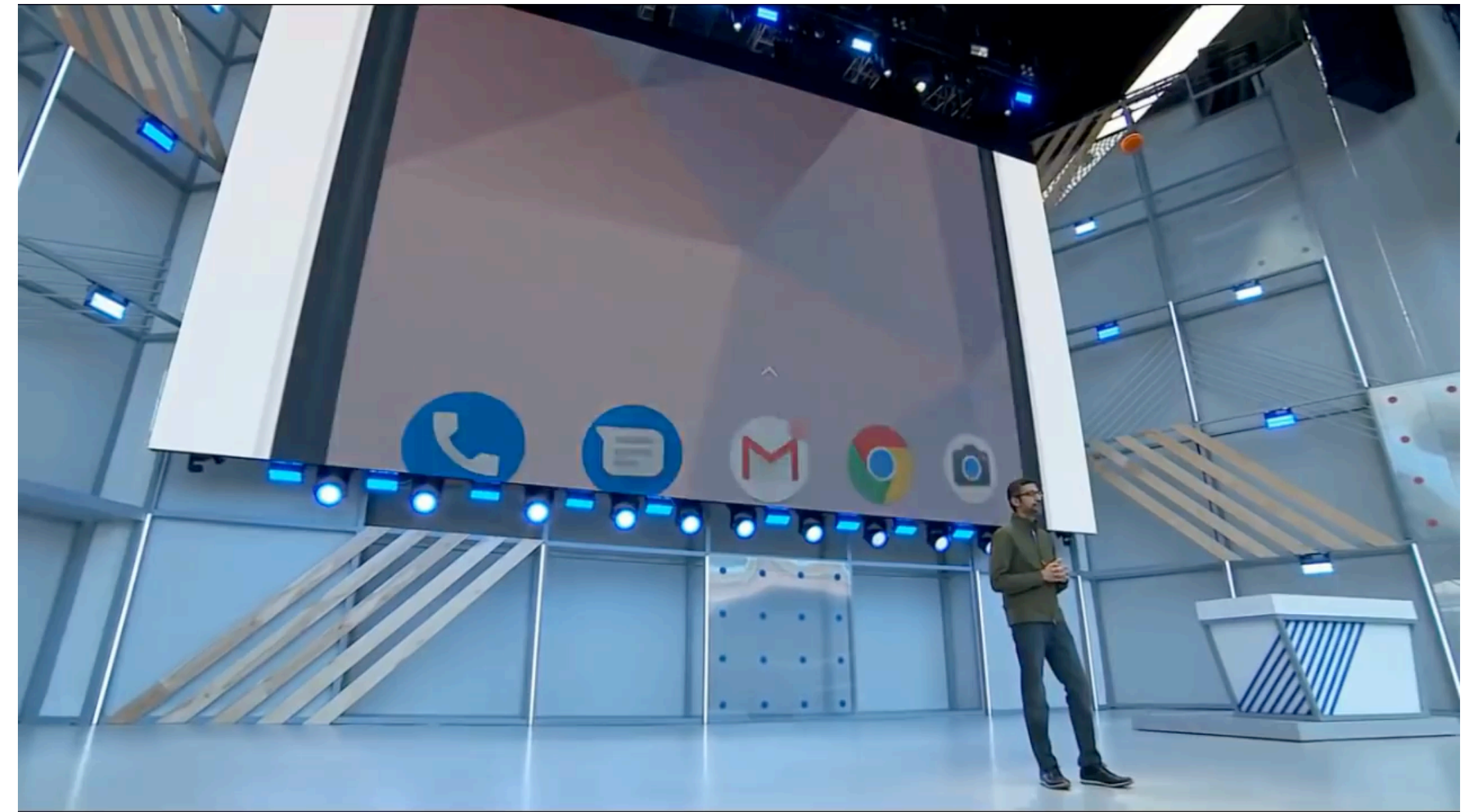


Example of Tesla's Autonomous Driving Pilot

# Deep Learning Achievements - Speech Recognition



2006  
Microsoft



2018  
Google



# Deep Learning Achievements - Strategic Knowledge

Chess



Deep Blue  
1997

GO



Deep Mind  
2017

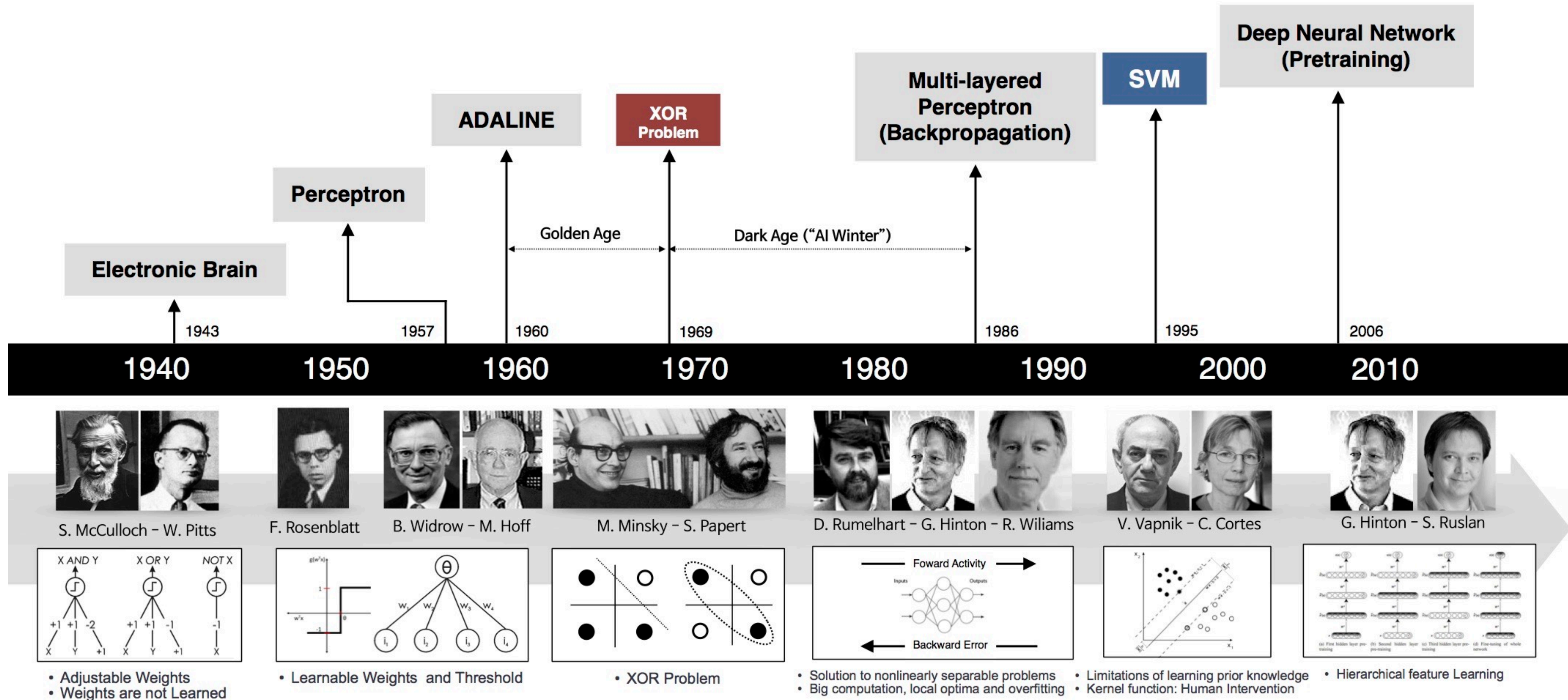
Dota2



OpenAI  
2018

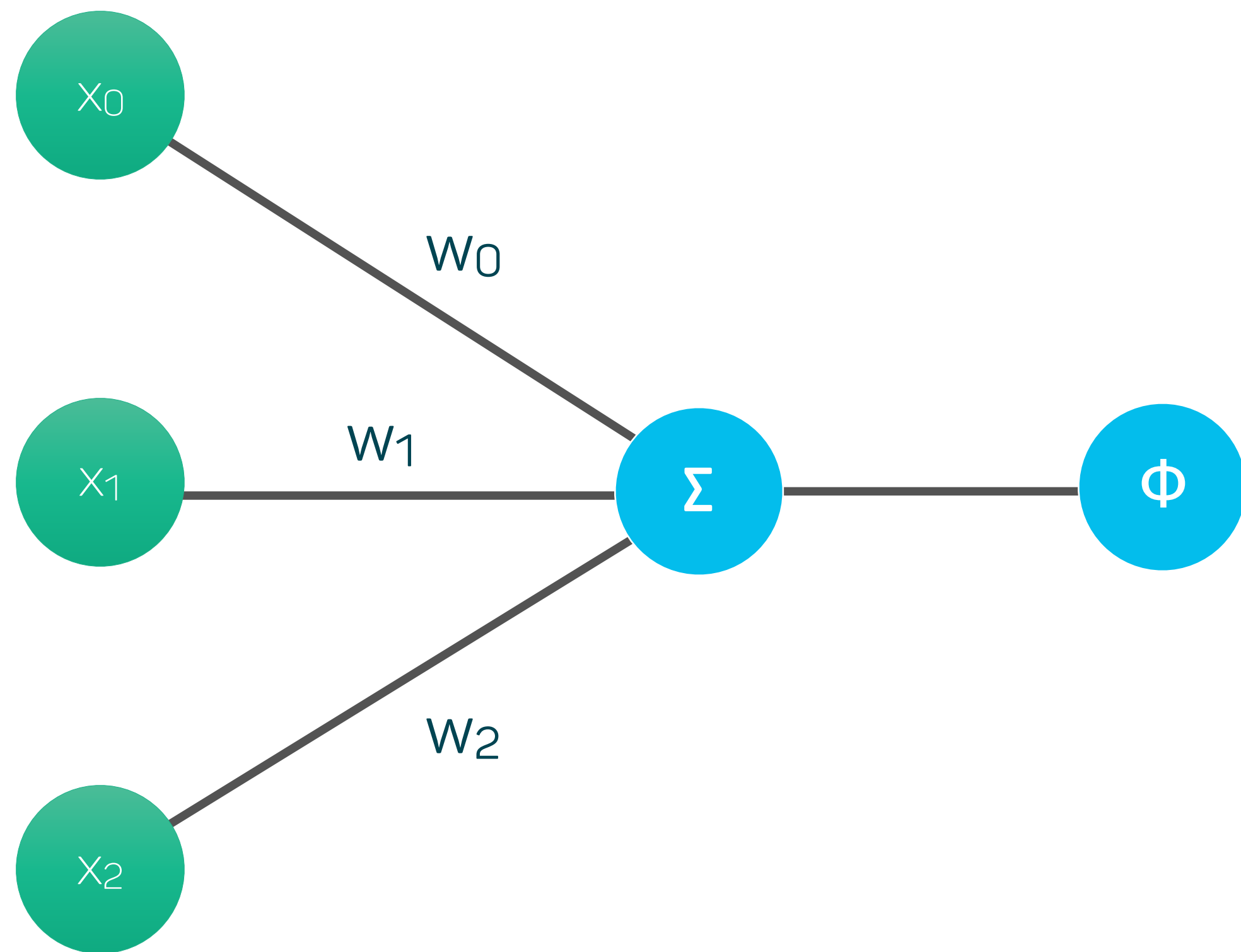
AI performs better than human

# History of Deep Learning



[https://beamandrew.github.io/deeplearning/2017/02/23/deep\\_learning\\_101\\_part1.html](https://beamandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html)

# Fundamentals of Deep Learning - Perceptron



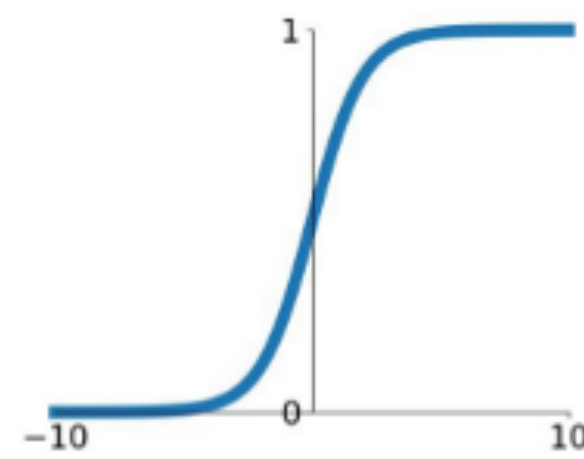
$$f(x) = \phi\left(\sum_i w_i x_i + b\right)$$

# Fundamentals of Deep Learning

## Activation Functions

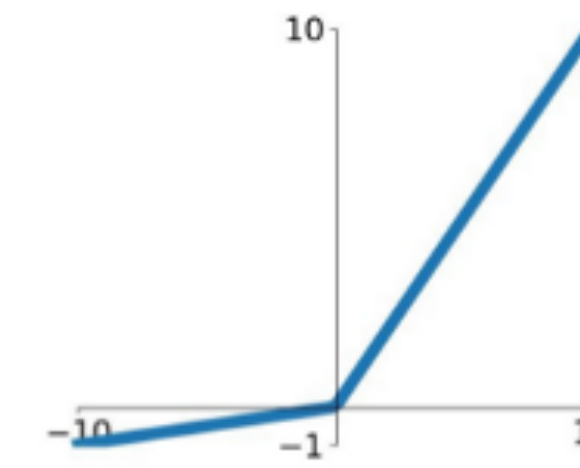
### Sigmoid

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



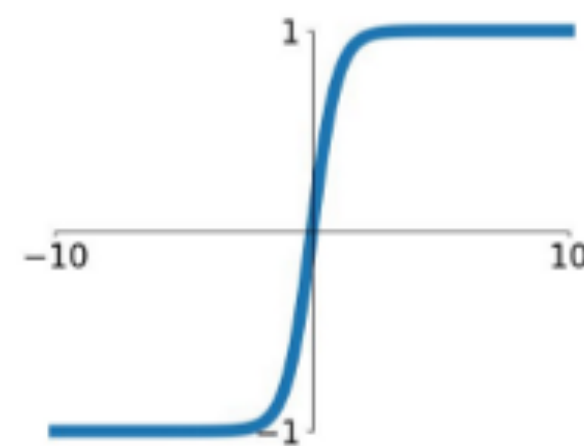
### Leaky ReLU

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



### tanh

$$\tanh(x)$$

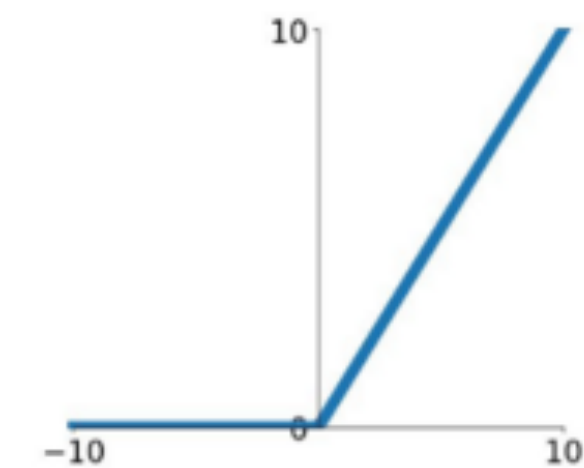


### Maxout

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

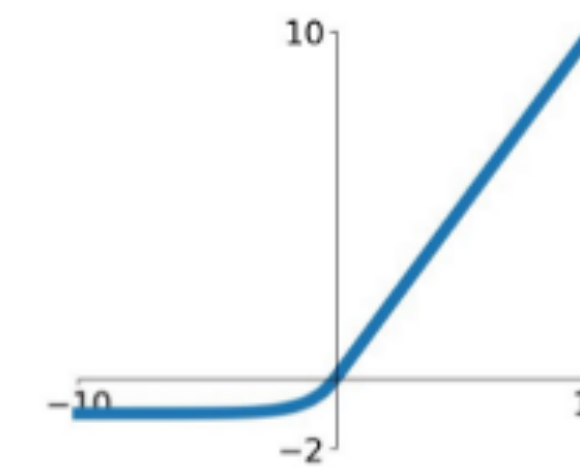
### ReLU

$$\max(0, x)$$



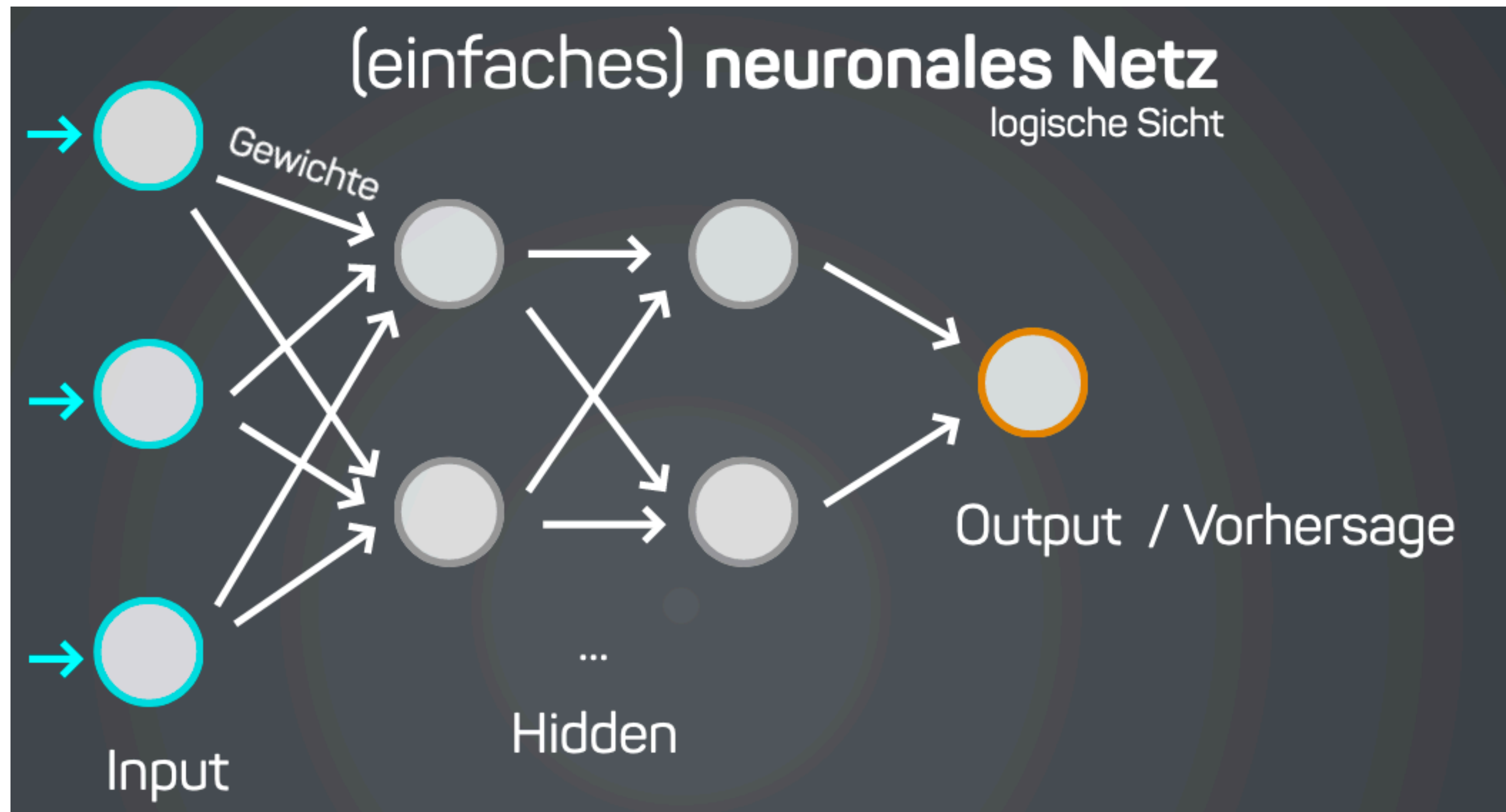
### ELU

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



[https://cdn-images-1.medium.com/max/1200/1\\*ZafDv3VUm60Eh100eJu1vw.png](https://cdn-images-1.medium.com/max/1200/1*ZafDv3VUm60Eh100eJu1vw.png)

# Fundamentals of Deep Learning



# Fundamentals of Deep Learning



Neural Network

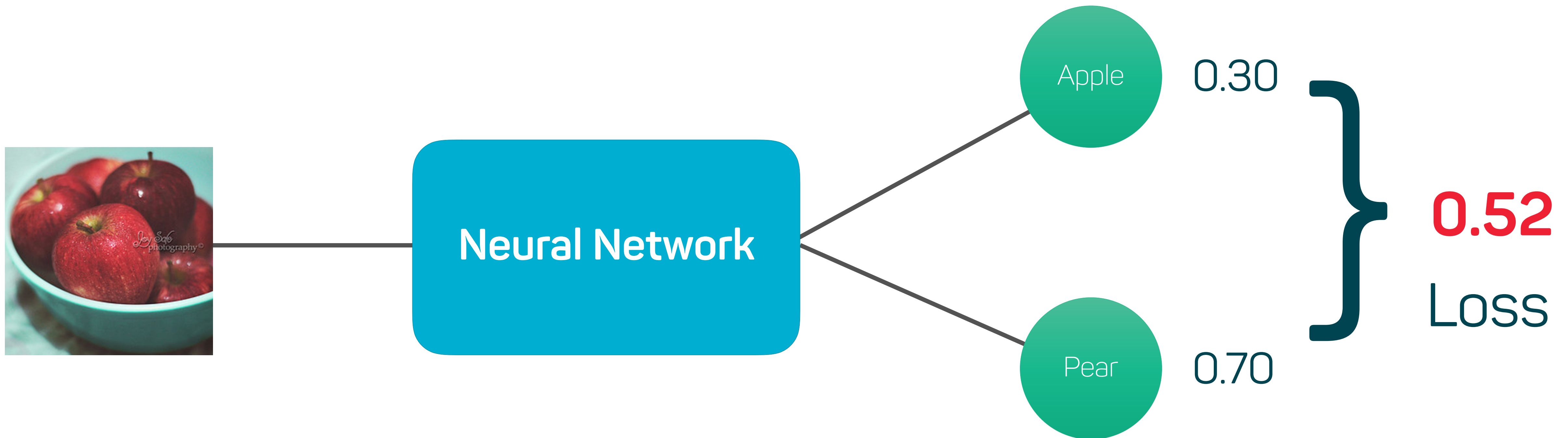
Apple

0.30

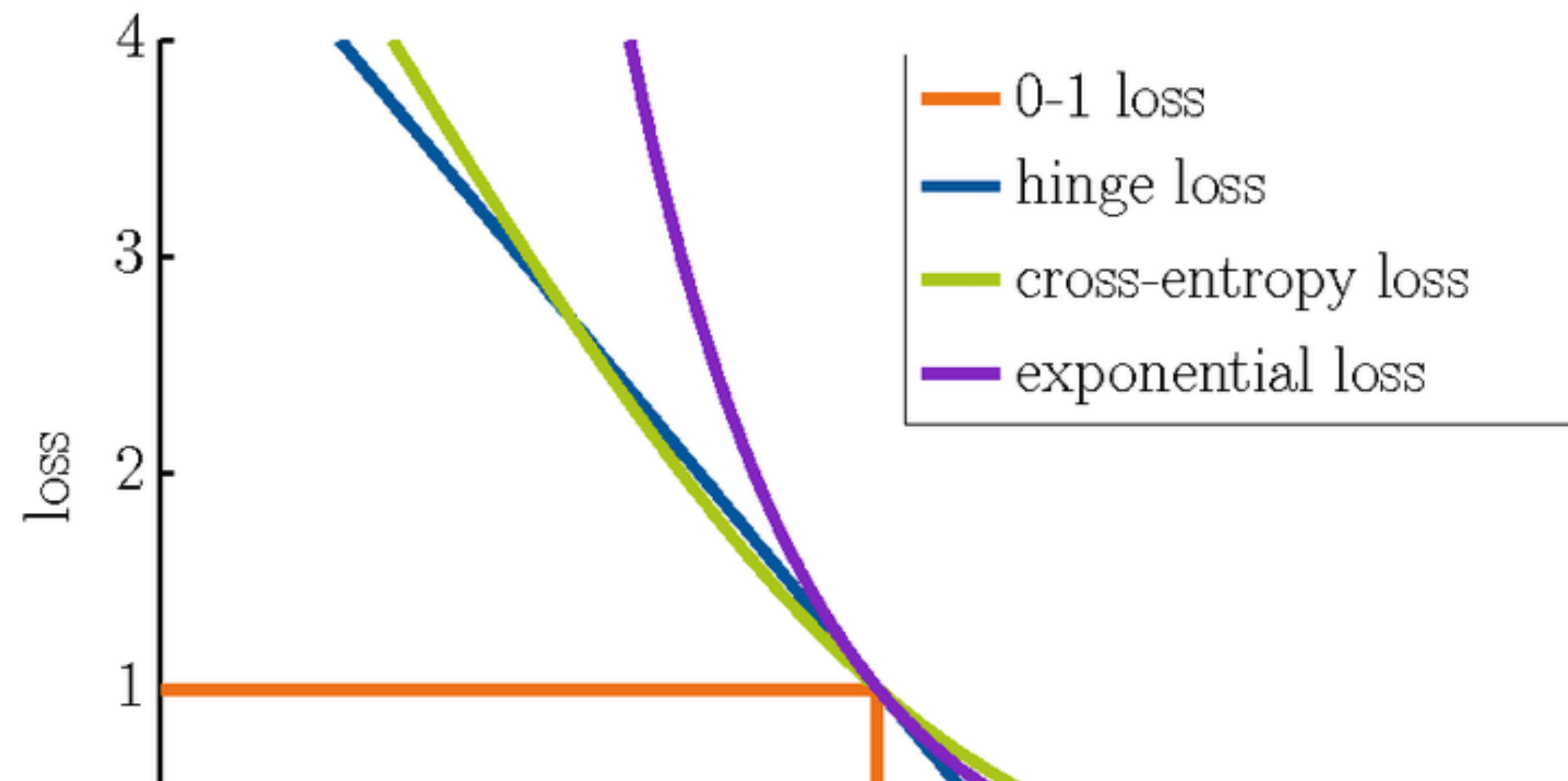
Pear

0.70

# Fundamentals of Deep Learning - Loss Function



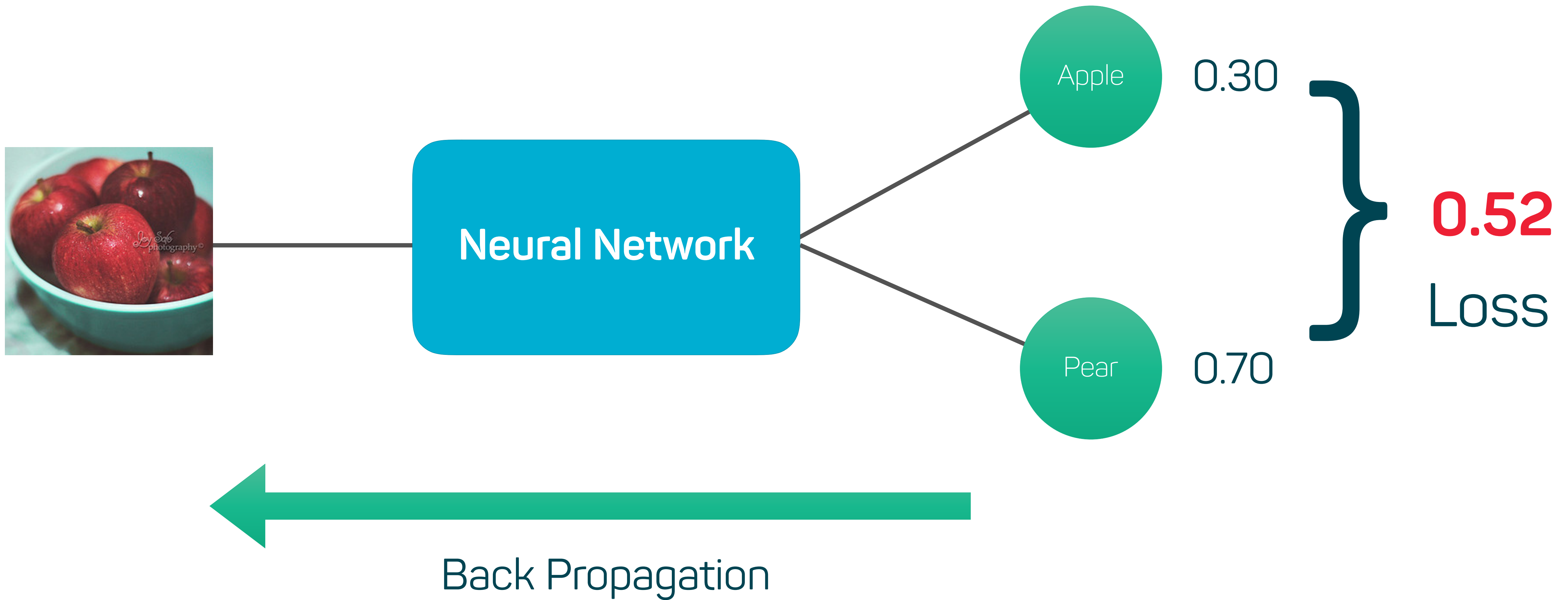
# Fundamentals of Deep Learning - Loss Functions



Any loss function returns a scalar value!



# Fundamentals of Deep Learning



# Fundamentals of Deep Learning



Neural Network

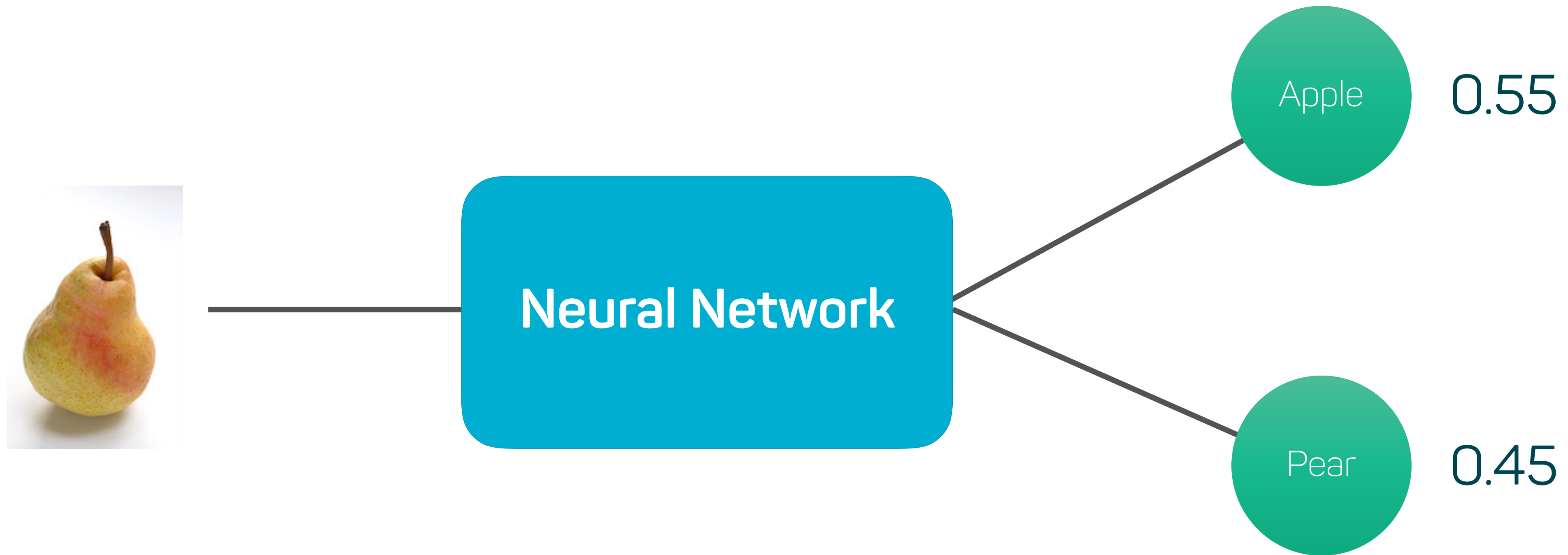
Apple

0.35

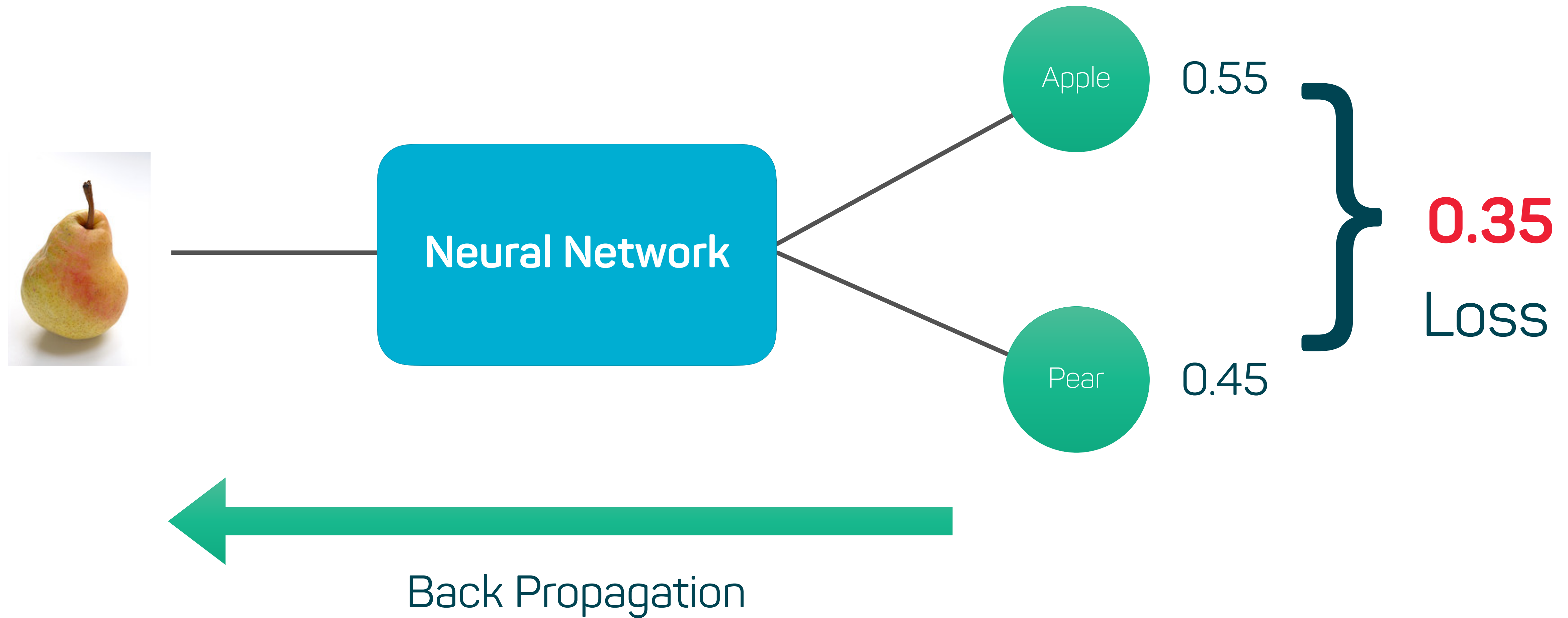
Pear

0.65

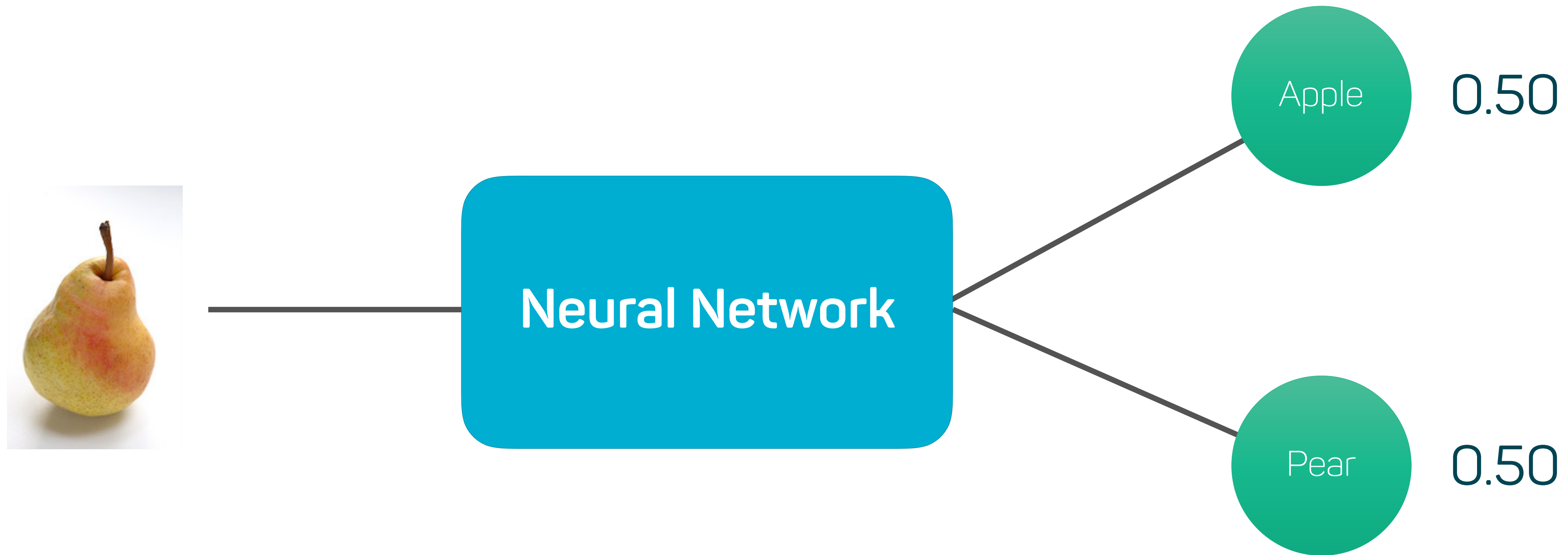
# Fundamentals of Deep Learning



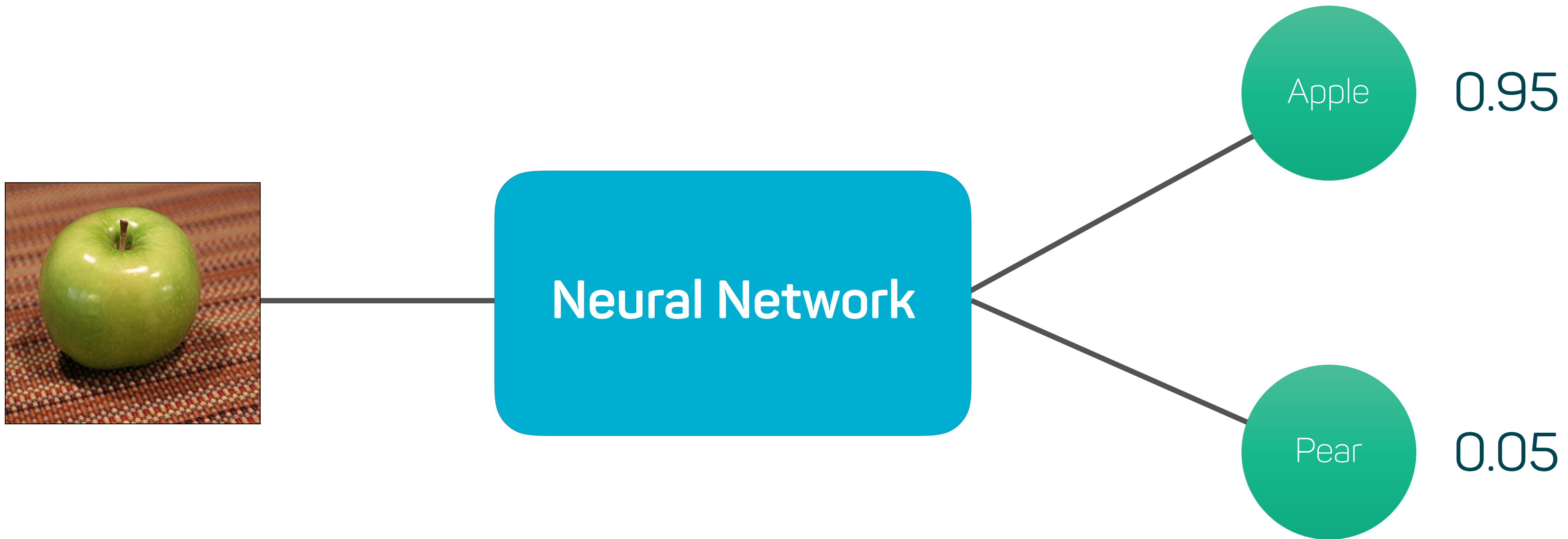
# Fundamentals of Deep Learning



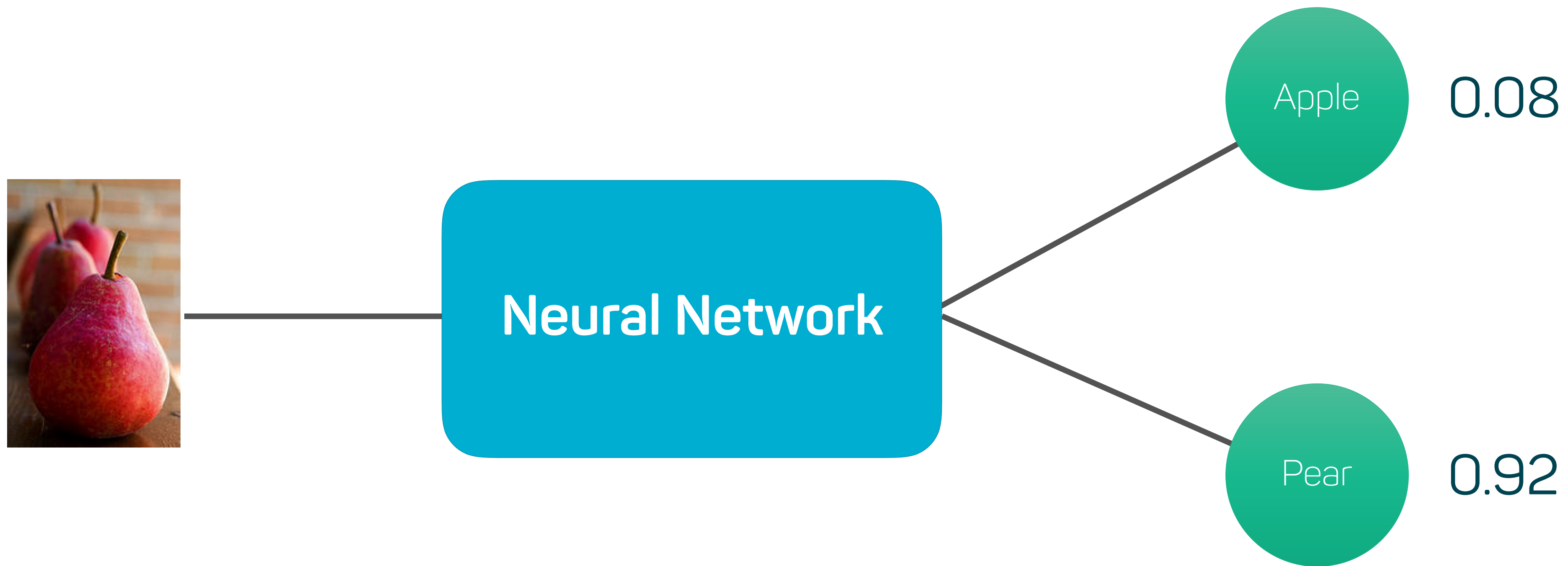
# Fundamentals of Deep Learning



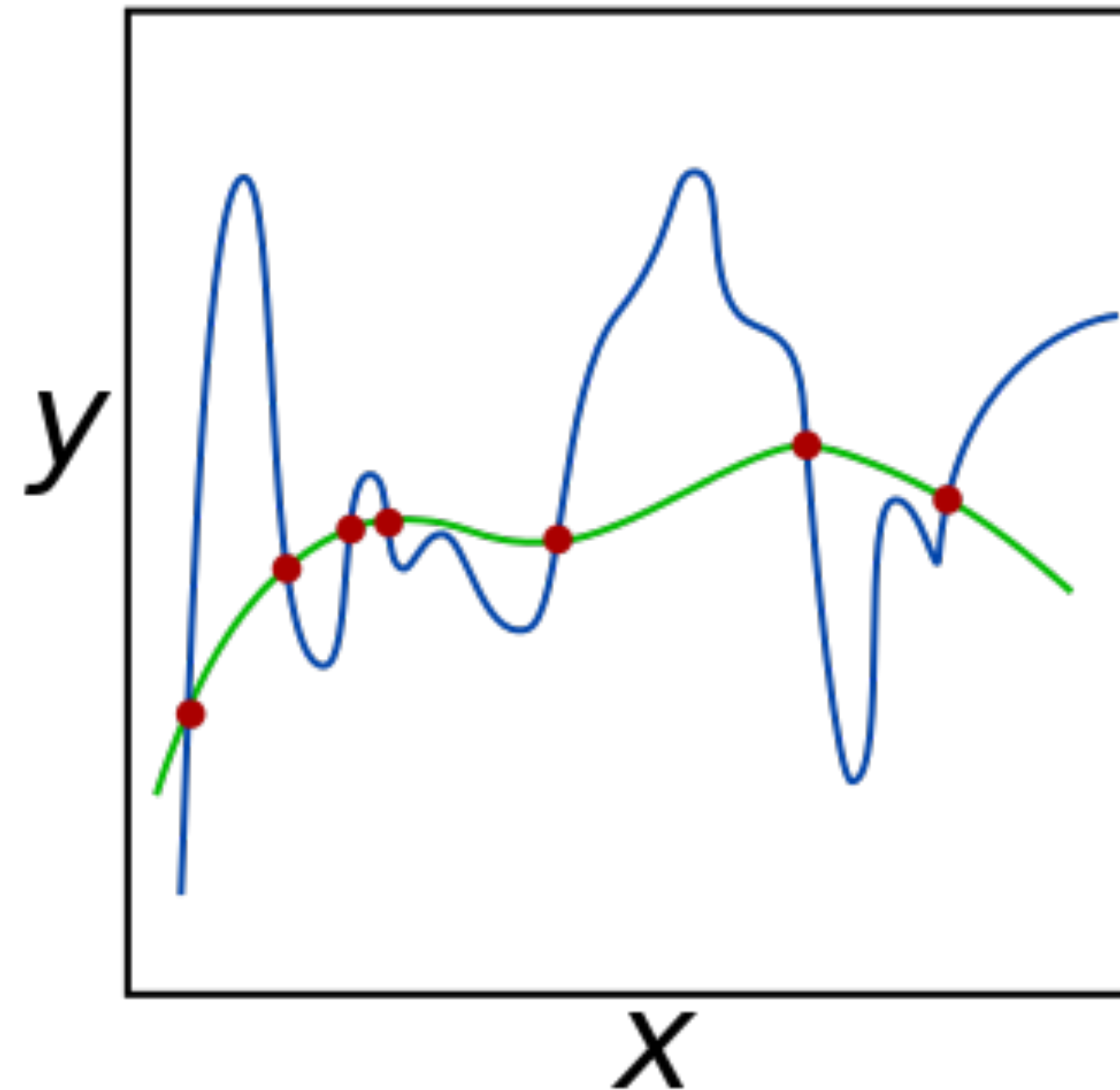
# Fundamentals of Deep Learning



# Fundamentals of Deep Learning



# Fundamentals of Deep Learning - Overfitting

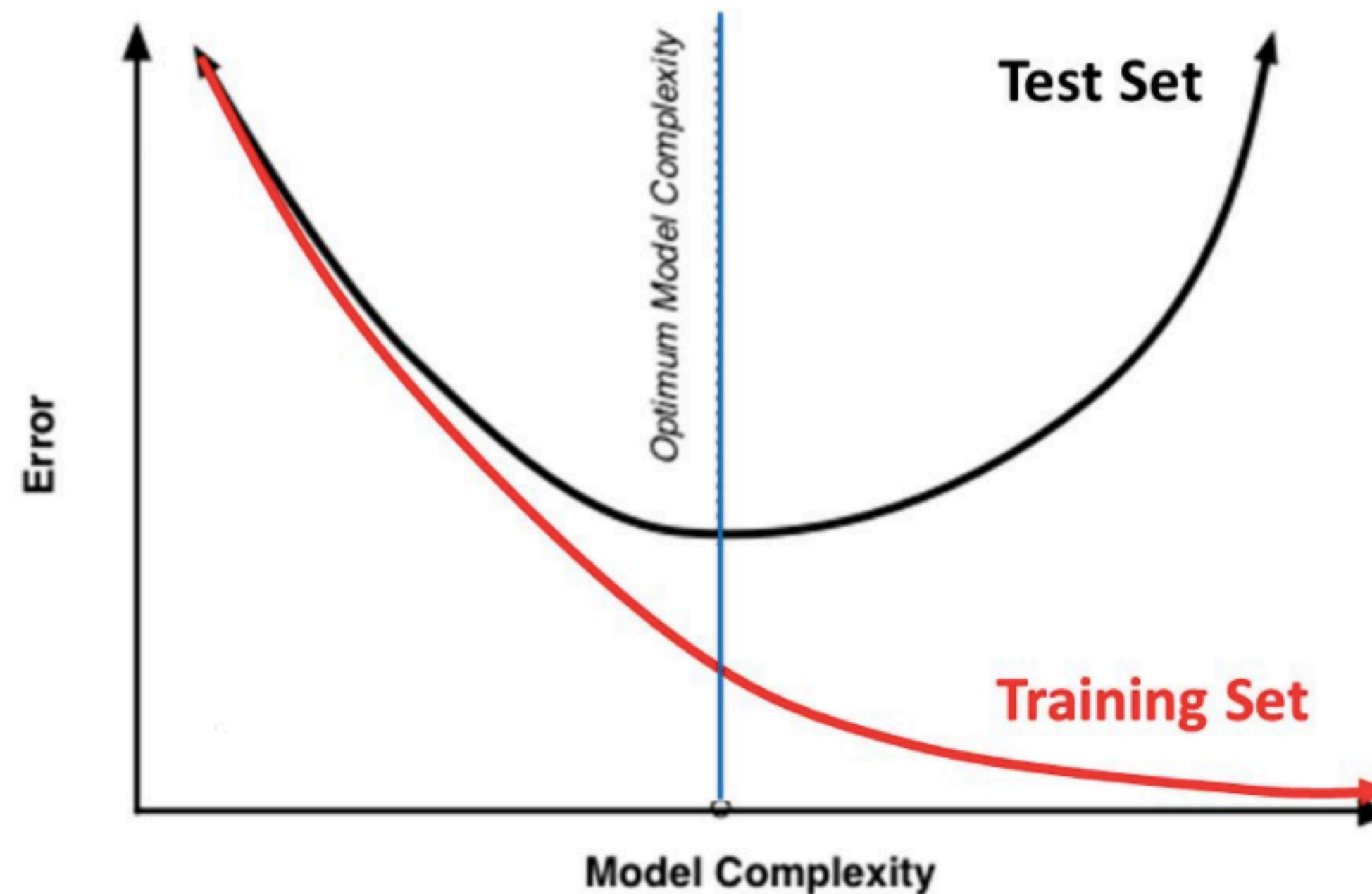


[https://en.wikipedia.org/wiki/Regularization\\_\(mathematics\)](https://en.wikipedia.org/wiki/Regularization_(mathematics))



# Fundamentals of Deep Learning - Overfitting

Training Vs. Test Set Error



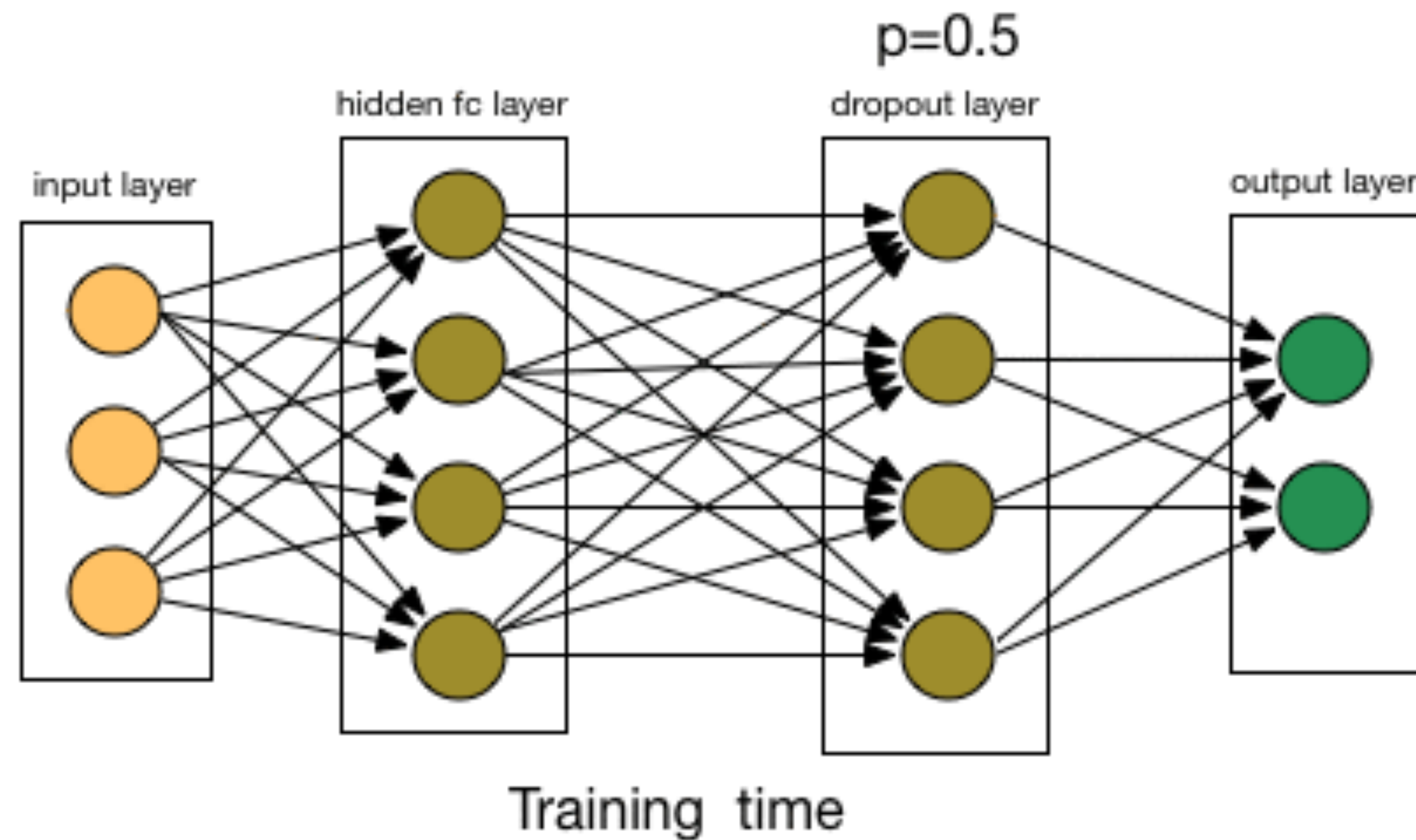
<https://www.analyticsvidhya.com/blog/2018/04/fundamentals-deep-learning-regularization-techniques/>

# Fundamentals of Deep Learning - Data Augmentation



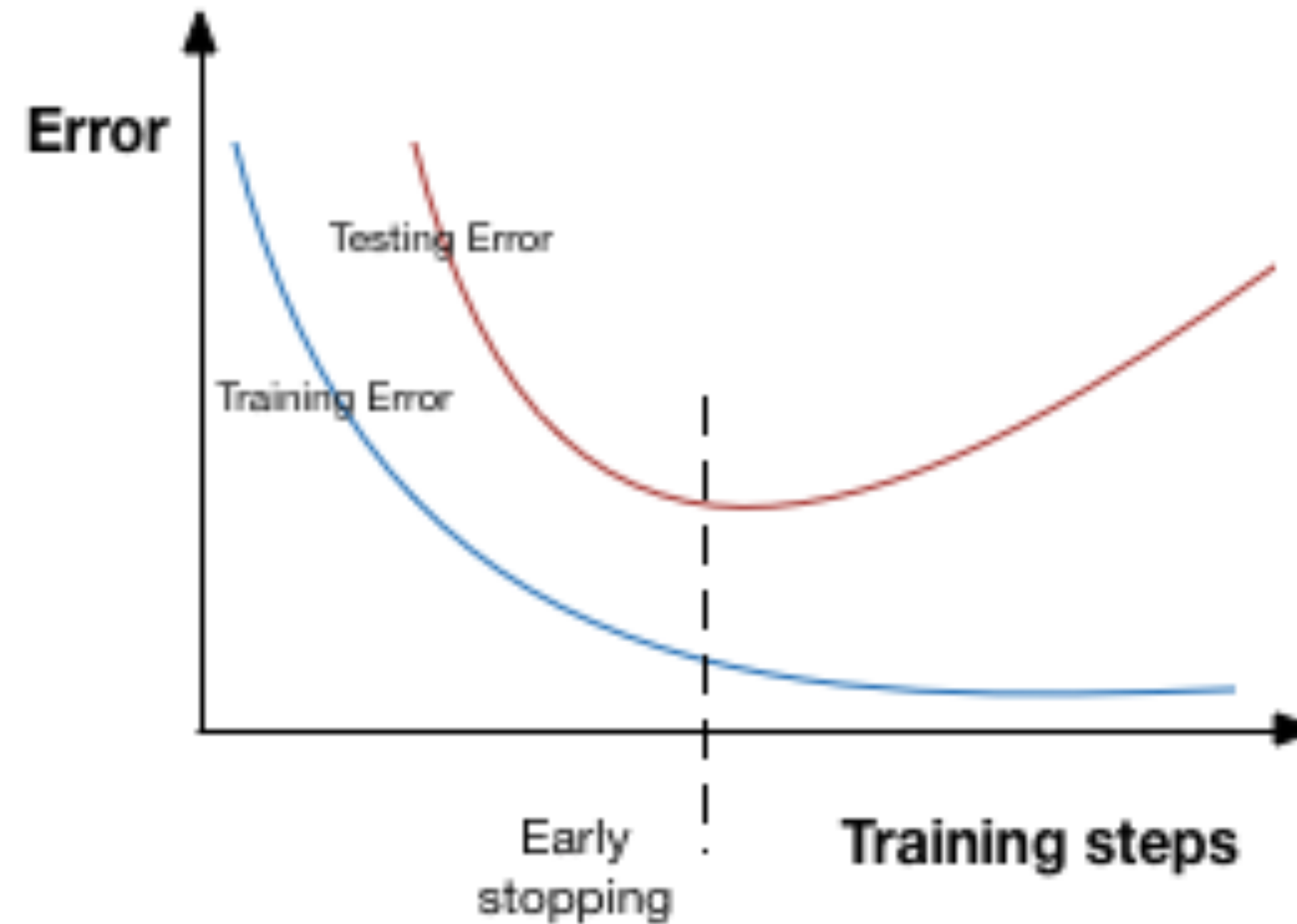
<https://www.analyticsvidhya.com/blog/2018/04/fundamentals-deep-learning-regularization-techniques/>

# Fundamentals of Deep Learning - Dropout



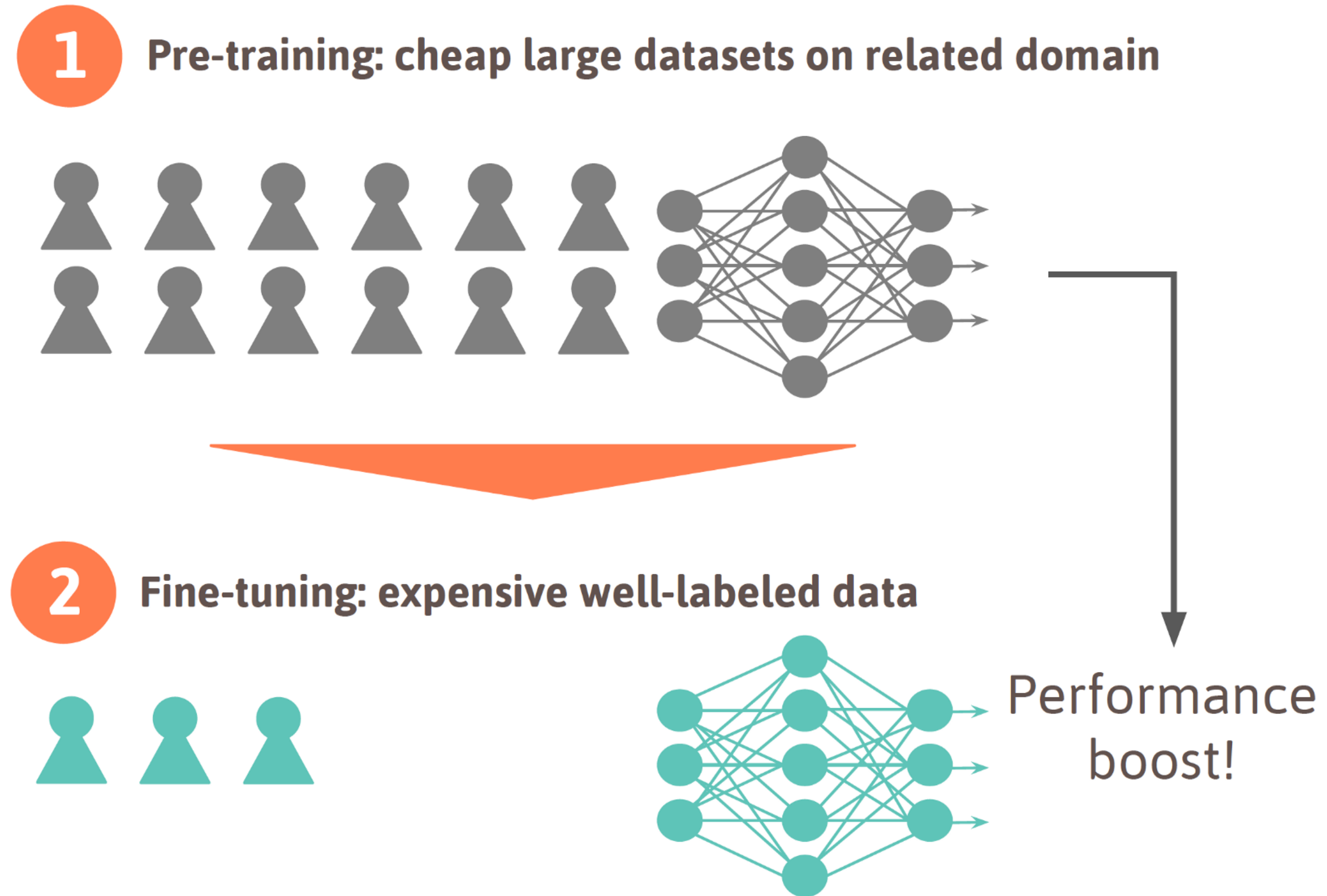
<https://www.analyticsvidhya.com/blog/2018/04/fundamentals-deep-learning-regularization-techniques/>

# Fundamentals of Deep Learning - Early Stopping



<https://www.analyticsvidhya.com/blog/2018/04/fundamentals-deep-learning-regularization-techniques/>

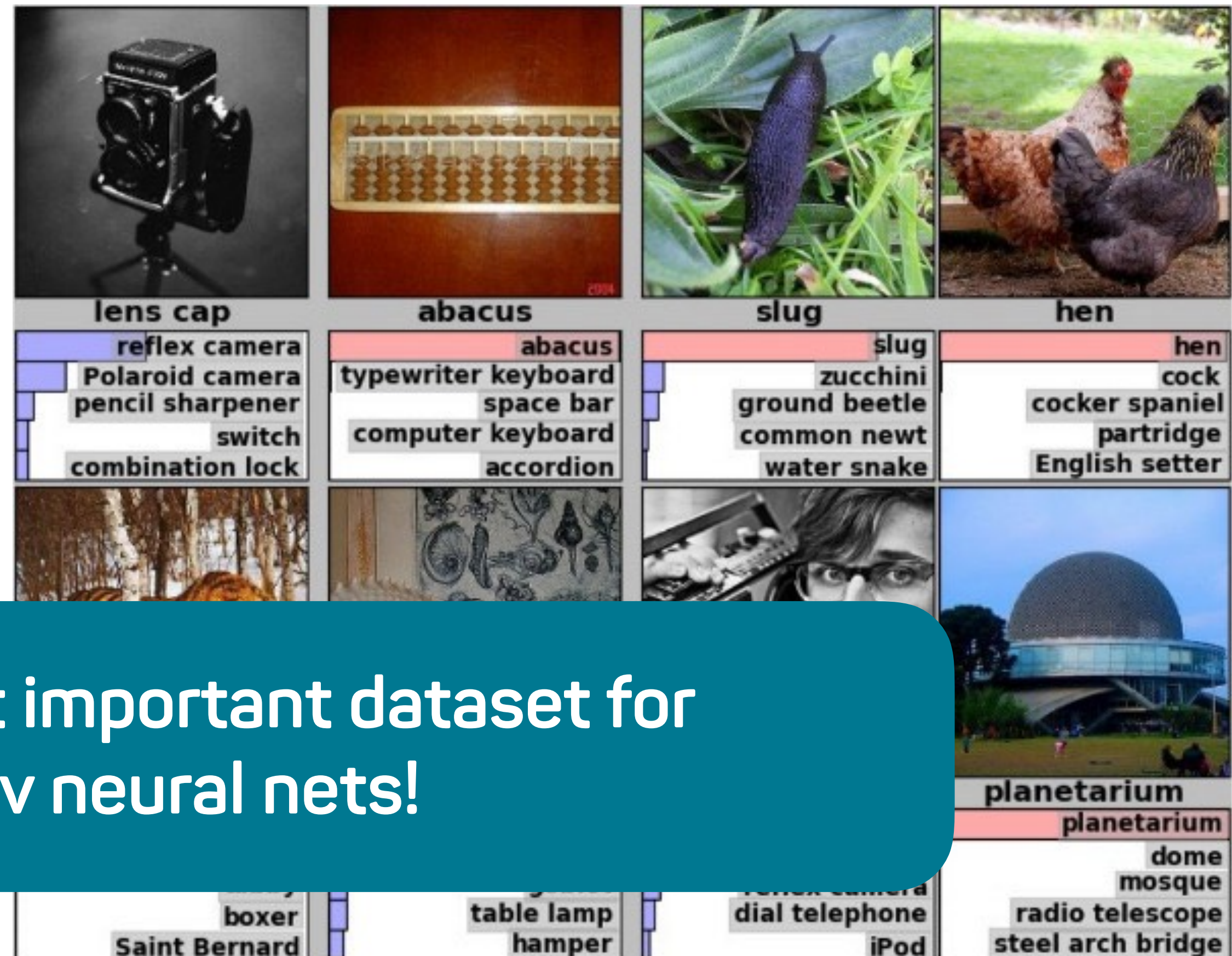
# Fundamentals of Deep Learning - Pretraining



<https://medium.com/merantix/applying-deep-learning-to-real-world-problems-ba2d86ac5837>

# Deep Learning Achievements - Pretraining

IMAGENET

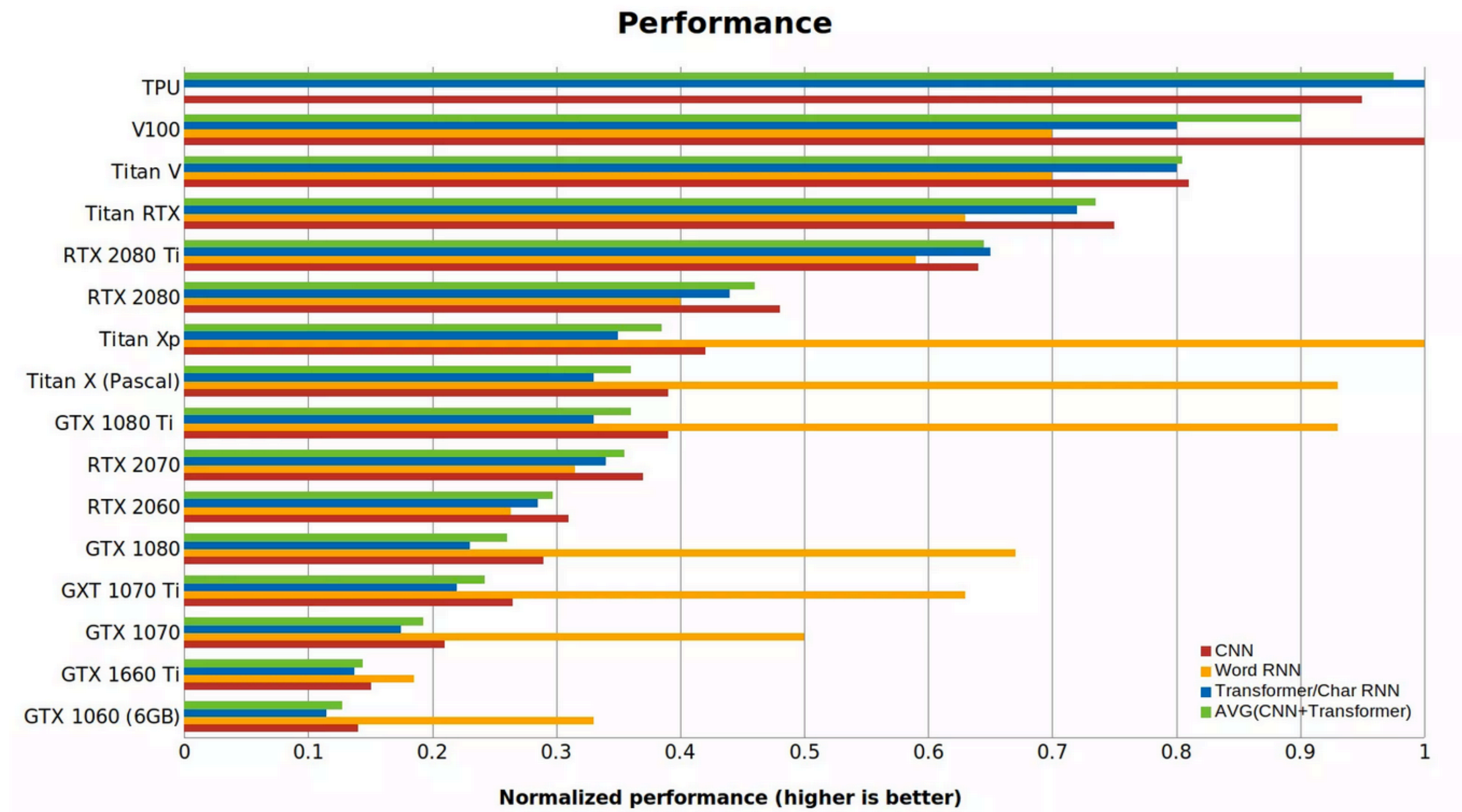


- 1000 categories
- train
- test

ImageNet is the most important dataset for pretraining cv neural nets!

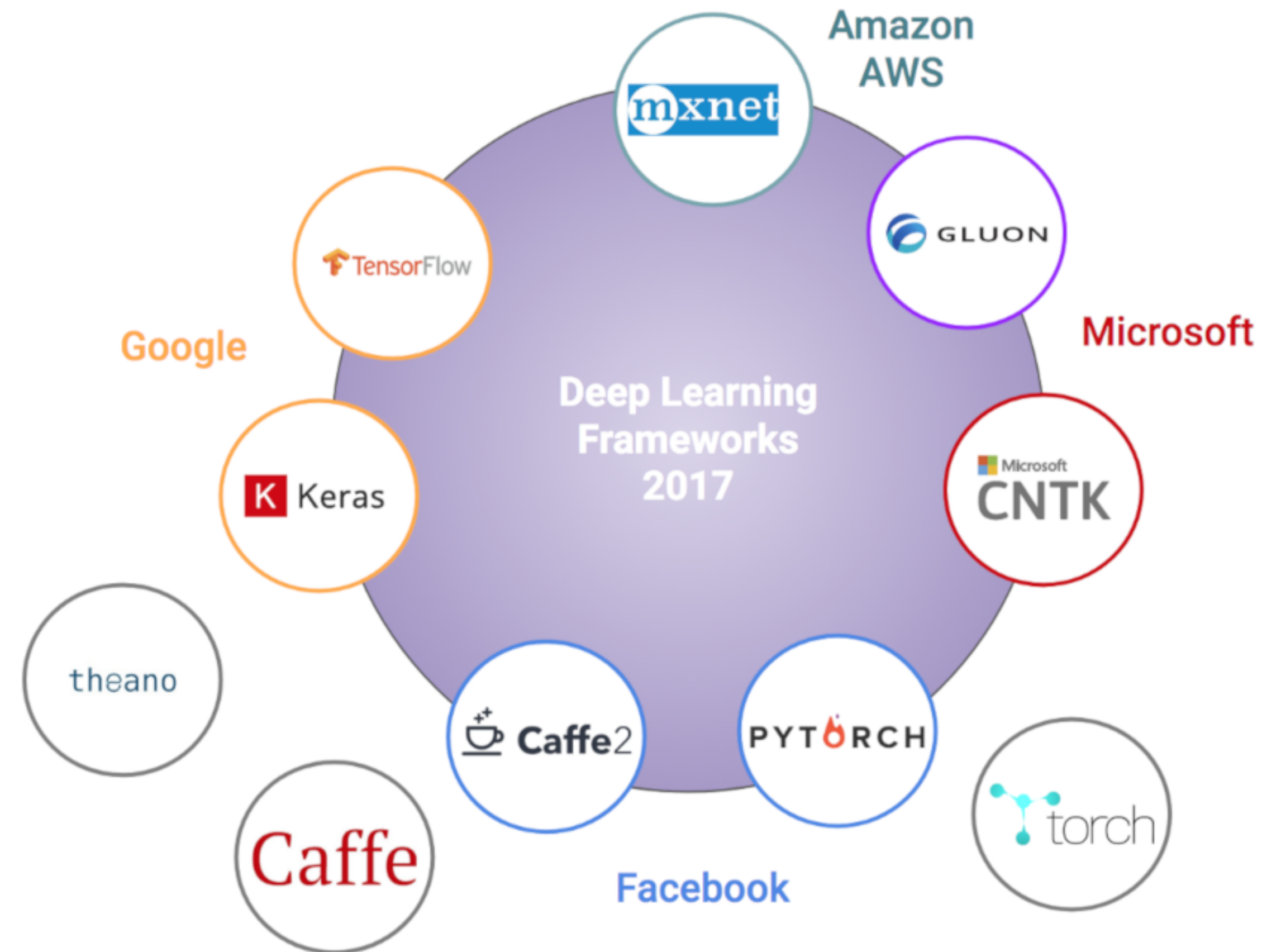
<https://medium.com/obvious-ventures/our-investment-in-darwinai-d5ea1a7af32e>

# Practical Deep Learning - Hardware



<https://timdettmers.com/2019/04/03/which-gpu-for-deep-learning/>

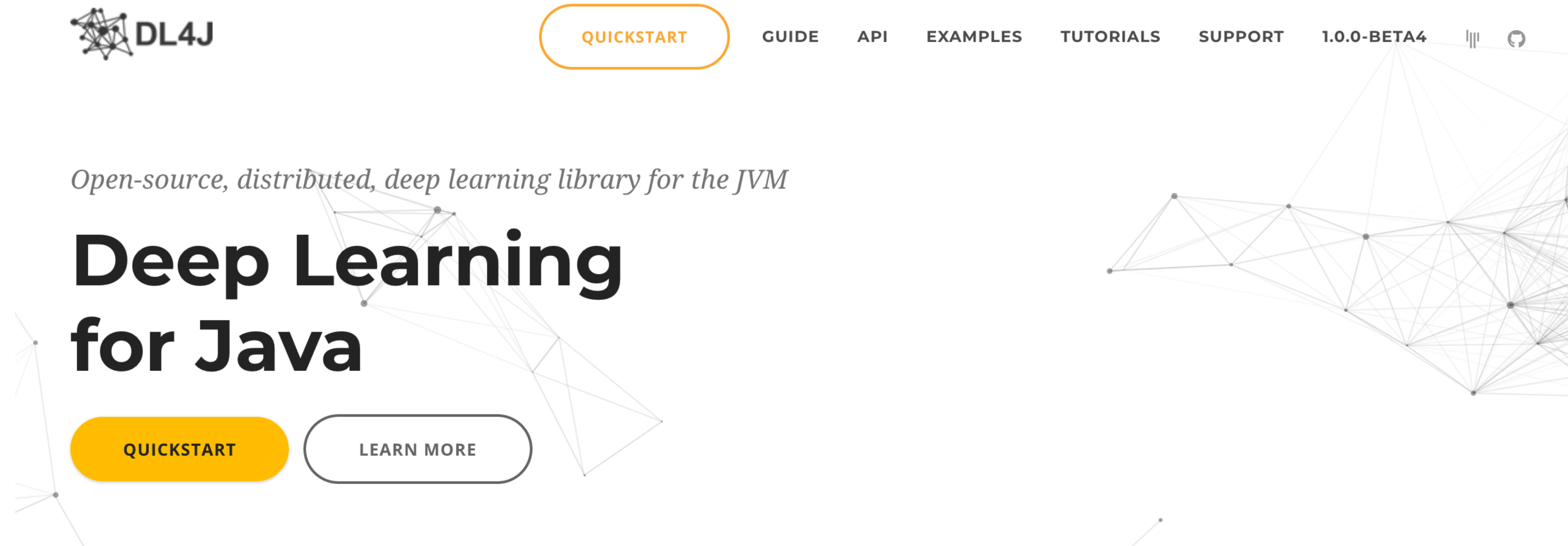
# Practical Deep Learning - Software



<https://devopedia.org/deep-learning-frameworks>



# Practical Deep Learning - Software



The image shows a screenshot of the DL4J website homepage. At the top left is the DL4J logo, which consists of a stylized neural network icon followed by the text 'DL4J'. To the right of the logo is a navigation menu with several items: 'QUICKSTART' (highlighted with an orange border), 'GUIDE', 'API', 'EXAMPLES', 'TUTORIALS', 'SUPPORT', and '1.0.0-BETA4'. There are also icons for a hamburger menu and a search icon. Below the navigation menu is the tagline 'Open-source, distributed, deep learning library for the JVM'. The main heading is 'Deep Learning for Java' in a large, bold, black font. Below the heading are two buttons: 'QUICKSTART' (a yellow button) and 'LEARN MORE' (a white button with a black border). The background of the page features a faint, light gray neural network diagram.

<https://deeplearning4j.org/>

# Practical Deep Learning - Data

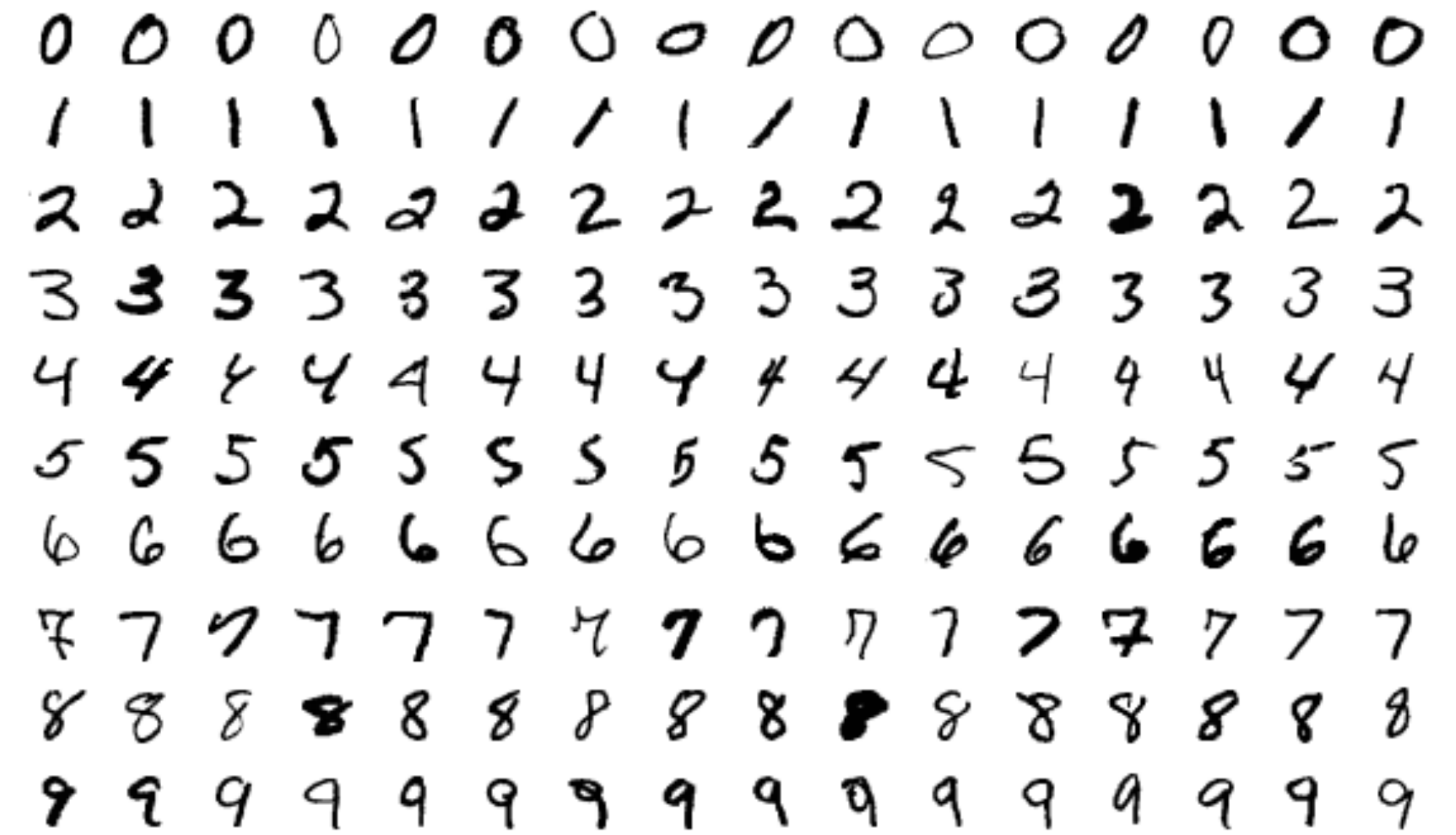


<https://www.kaggle.com/datasets>

<https://www.analyticsvidhya.com/blog/2018/03/comprehensive-collection-deep-learning-datasets/>

# Practical Deep Learning - MNIST

- 60.000 train images
- 10.000 test images
- handwritten digits
- 28 x 28 greyscale



By Josef Steppan - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=64810040>

# Coding Example

<https://colab.research.google.com>

**google:** keras mnist cnn notebook

**OR:** <https://colab.research.google.com/github/csc-training/intro-to-dl/blob/master/day1/keras-mnist-cnn.ipynb>

# bootcamp.codecentric.ai - free online course

@codecentric.AI    Für wen? | Lernziele | Module | Dozenten | Firmen Deep-Dive    Login    Register

## ARTIFICIAL INTELLIGENCE BOOTCAMP

Um Grundlagen der künstlichen Intelligenz und des Machine Learning zu beherrschen, braucht man keinen Doktor in Mathematik! Mit unserem codecentric.AI Bootcamp geben wir dir einen komprimierten Schnelldurchlauf durch ML, Deep Learning, Computer Vision und Co. – hands-on und kostenlos.

**KOSTENLOS TEILNEHMEN**

# Thank you!

Stay connected!

Am Mittelhafen 14, 48155 Münster

Denis Stalz-John

[denis.stalz-john@codecentric.de](mailto:denis.stalz-john@codecentric.de)

