UNIVERSITY
of
GREENWICH

Neural Networks

An introduction

Dr. Mihai Polceanu

What is the lecture about?

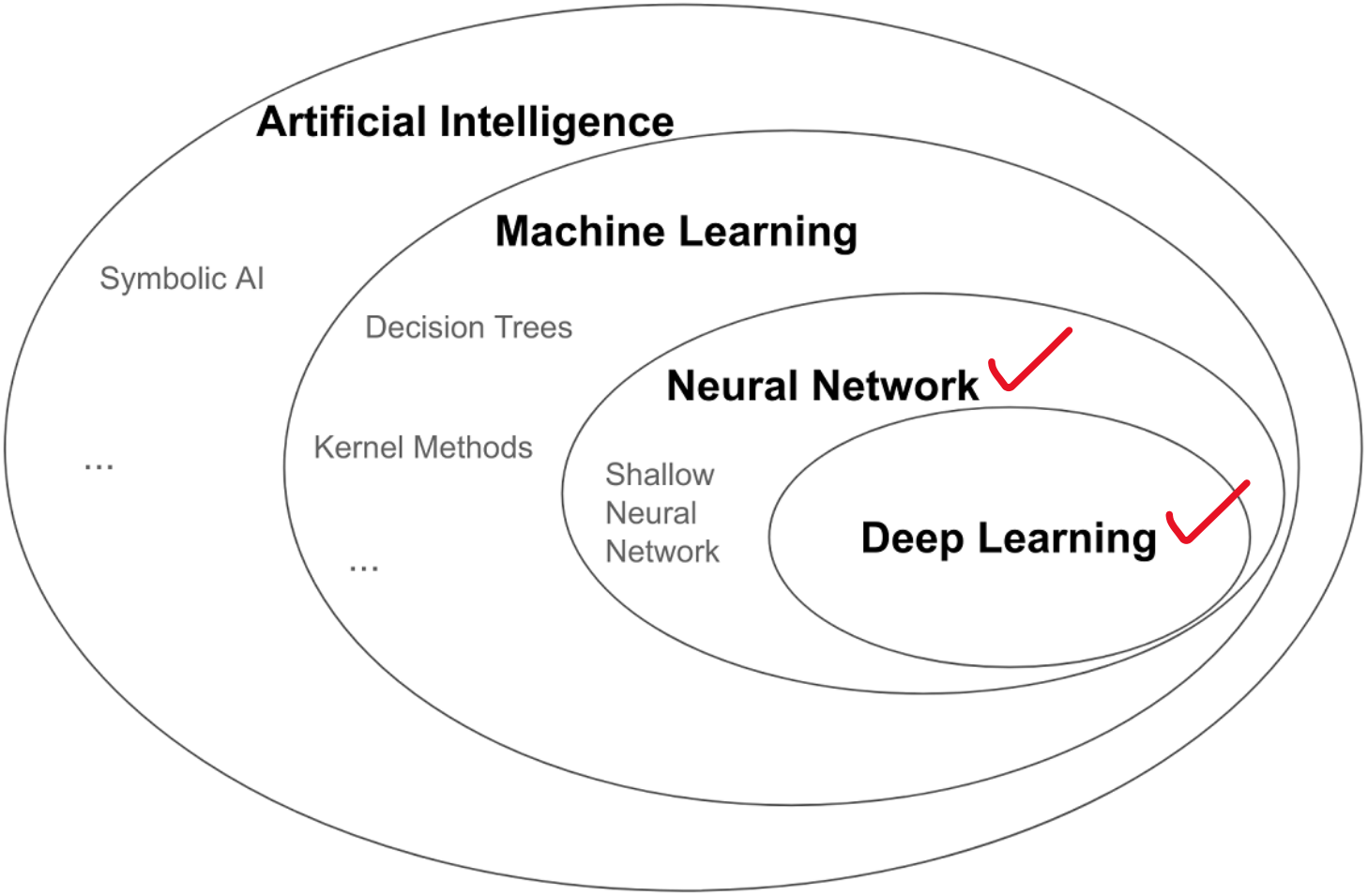

Image source: https://livebook.manning.com/book/deep-learning-with-javascript/chapter-1/v-7/13

What's the point?

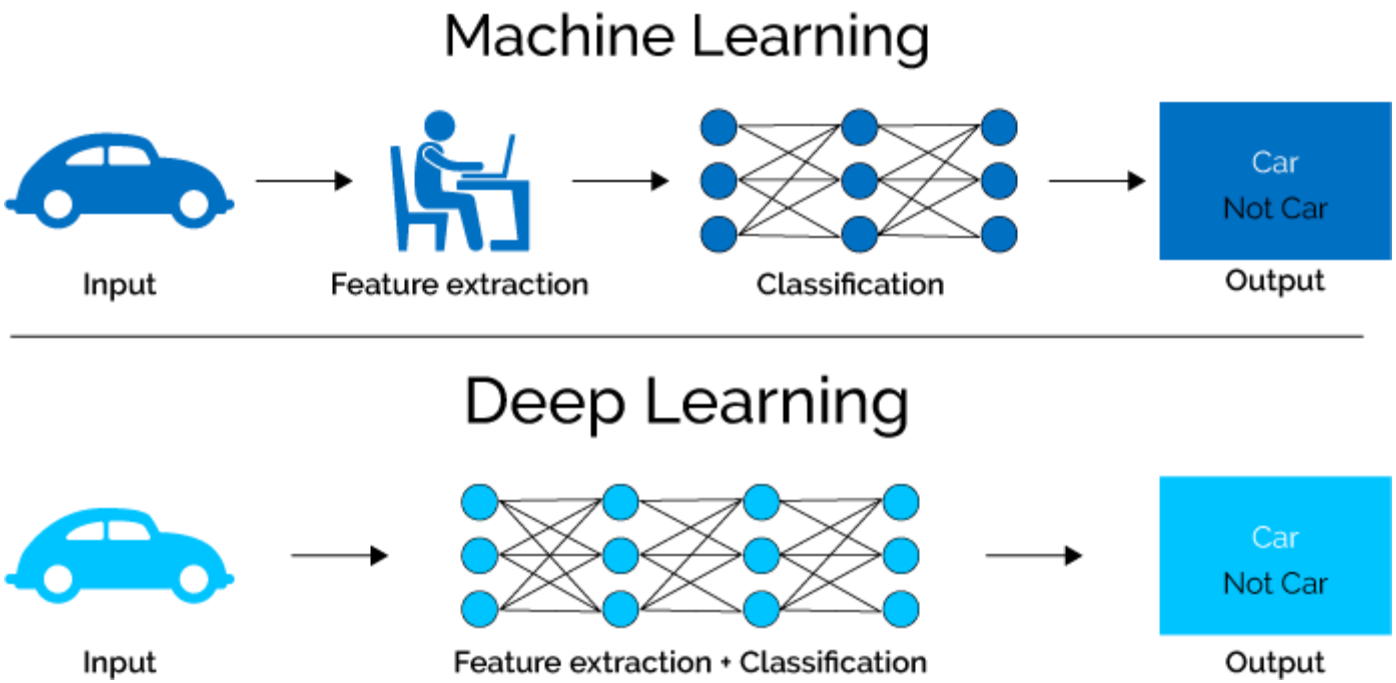

Image source: https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063

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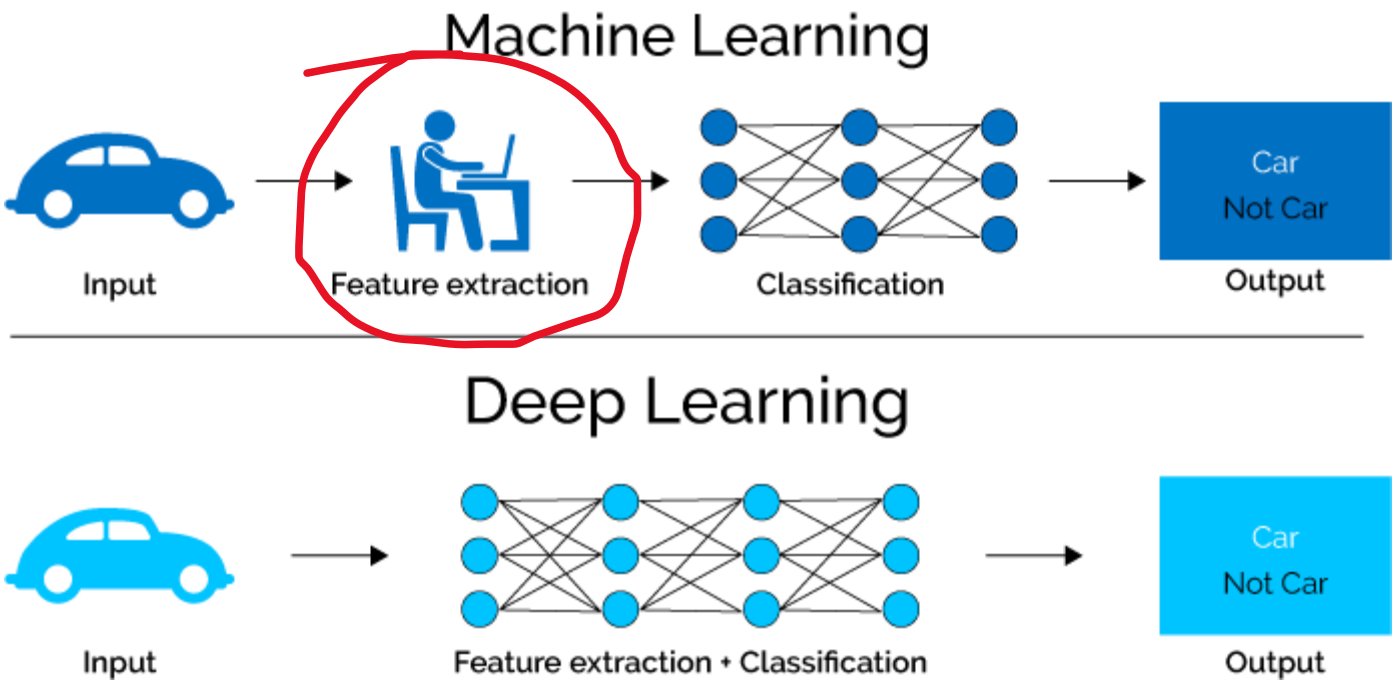
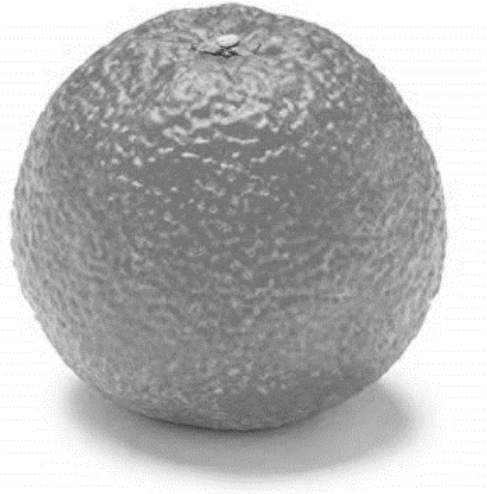


Image source: https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063

Feature Extraction

Orange or Apple ?

Feature Extraction

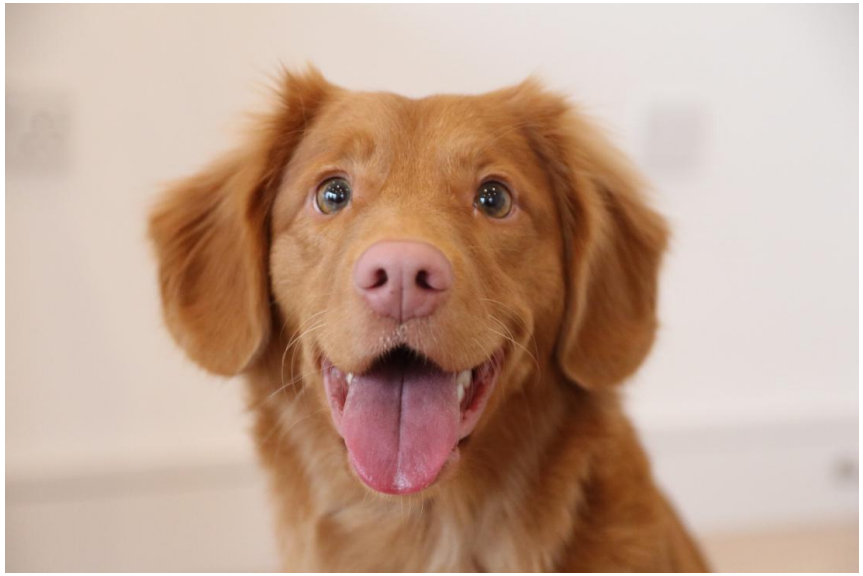


Orange or Apple ?

Feature Extraction

Orange, Apple or Lemon ?

Feature Extraction



Mop or Dog ?

Feature Extraction

Image source: https://www.beano.com/posts/sheepdog-or-mop

Mop or Dog ?

Image source: https://www.pinterest.de/pin/338332990726474128/
* Also, it looks like this meme is inaccurate ! Go ahead and check!

Feature Extraction

Image source: https://www.beano.com/posts/sheepdog-or-mop

Mop or Dog ?

Feature ?

Image source: https://www.pinterest.de/pin/338332990726474128/
* Also, it looks like this meme is inaccurate ! Go ahead and check!

Feature Extraction

Image source: https://www.beano.com/posts/sheepdog-or-mop

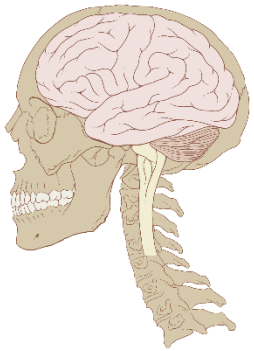
Mop or Dog ?

Feature ?

Actually taken from a carpet !

Image source: https://www.pinterest.de/pin/338332990726474128/
* Also, it looks like this meme is inaccurate ! Go ahead and check!

A bit of history



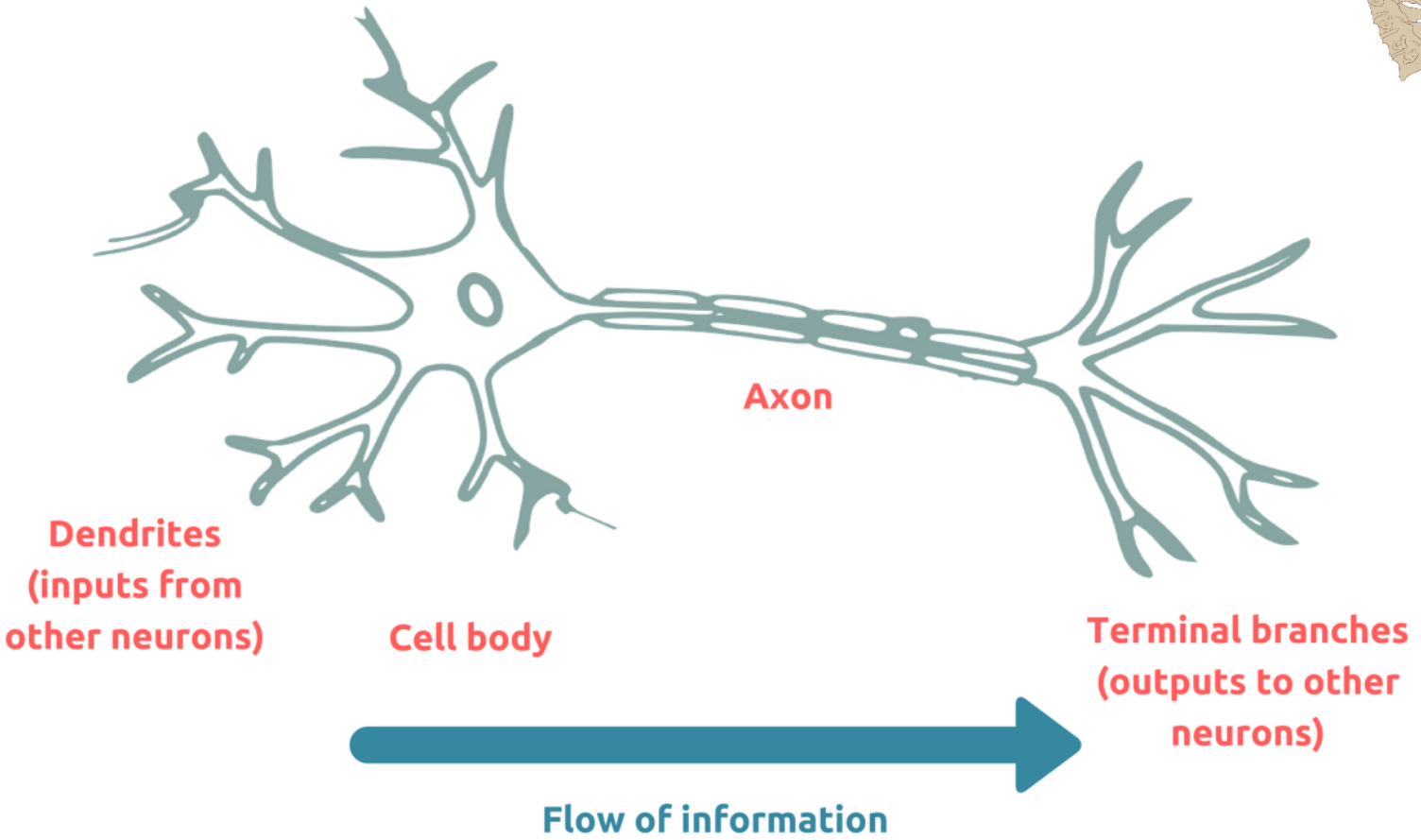


Image source: https://moral-robots.com/ai-society/what-is-a-neural-network-an-introduction-without-the-math/

A bit of history

Psychological Review
Vol. 65, No. 6, 1958

THE PERCEPTRON: A PROBABILISTIC MODEL FOR INFORMATION STORAGE AND ORGANIZATION IN THE BRAIN [1]

F. ROSENBLATT
Cornell Aeronautical Laboratory

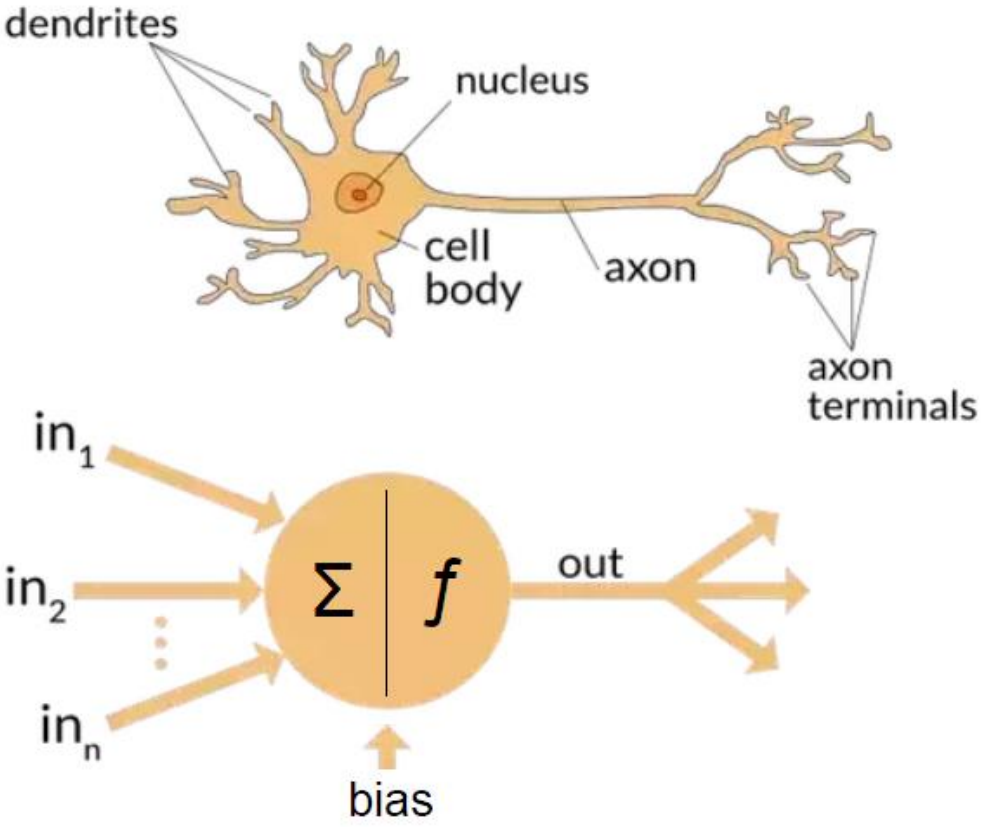


Image source: https://towardsdatascience.com/a8b46db828b7

A bit of history

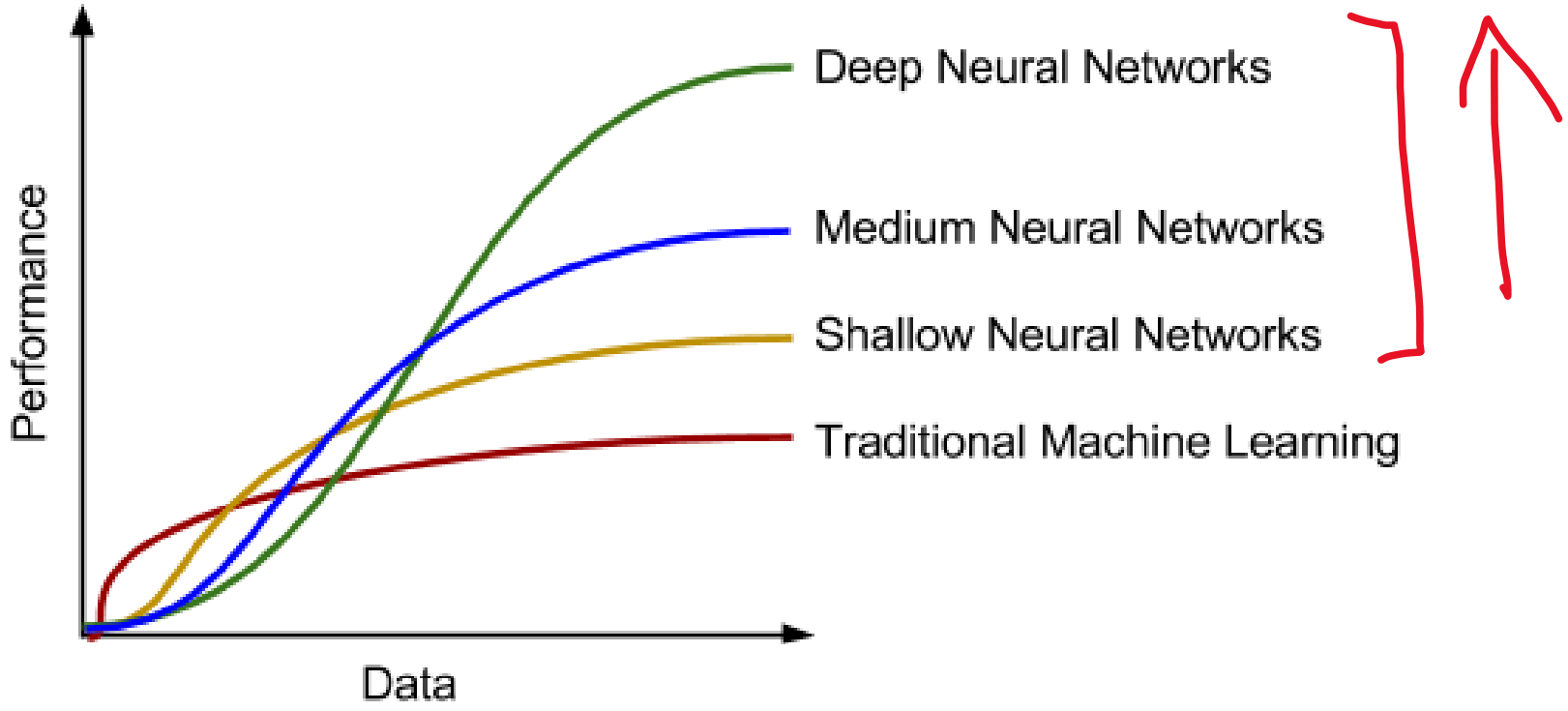
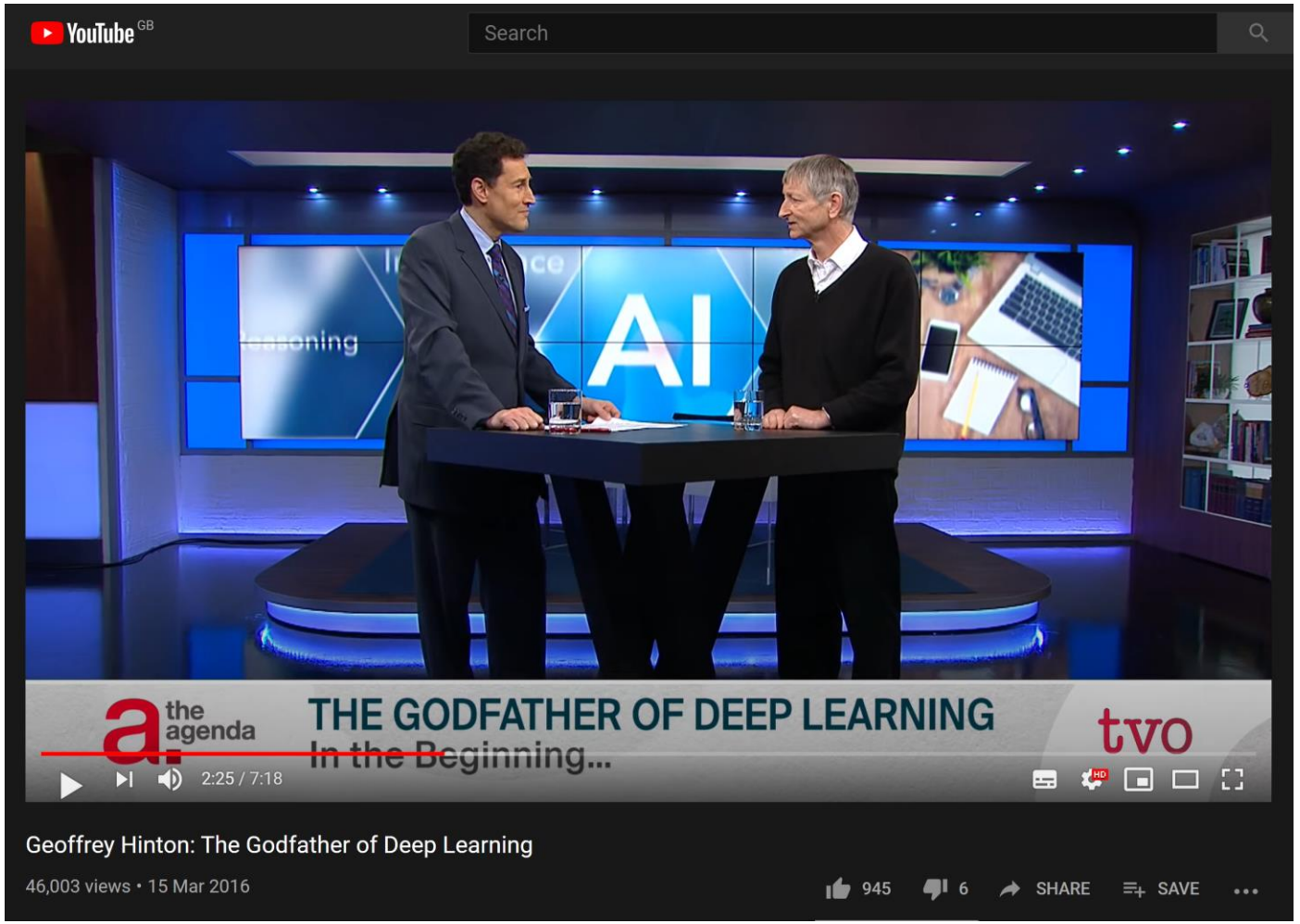


Image source: https://blog.easysol.net/building-ai-applications/

A bit of history



Video source: https://www.youtube.com/watch?v=uAu3jQWaN6E

What is a Neural Network?

(end of analogy)

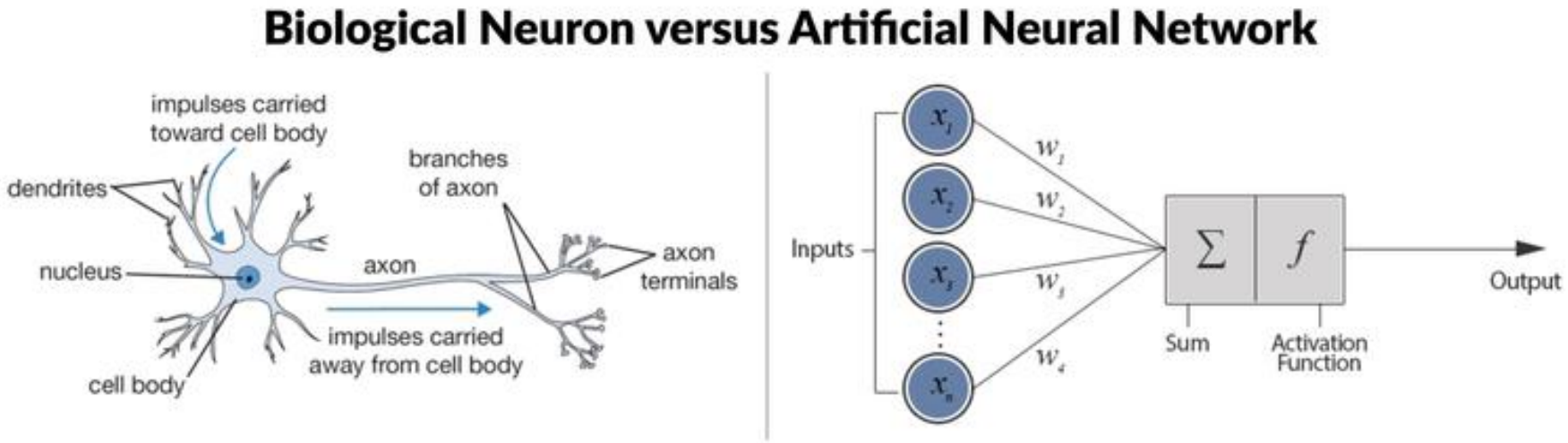


Image source: https://towardsdatascience.com/from-fiction-to-reality-a-beginners-guide-to-artificial-neural-networks-d0411777571b

Artificial neuron = a crude approximation of a biological neuron

Artificial Neural Network = a collection of artificial neurons

What's the point? (recap)

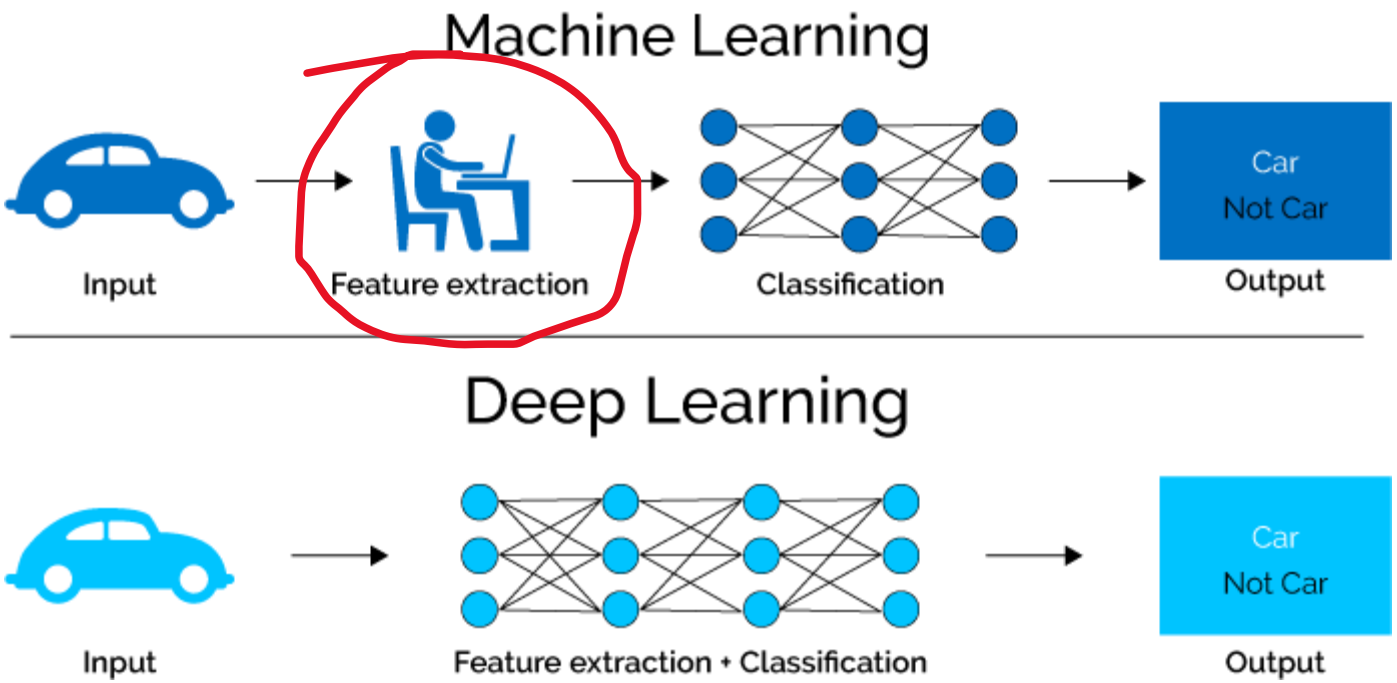
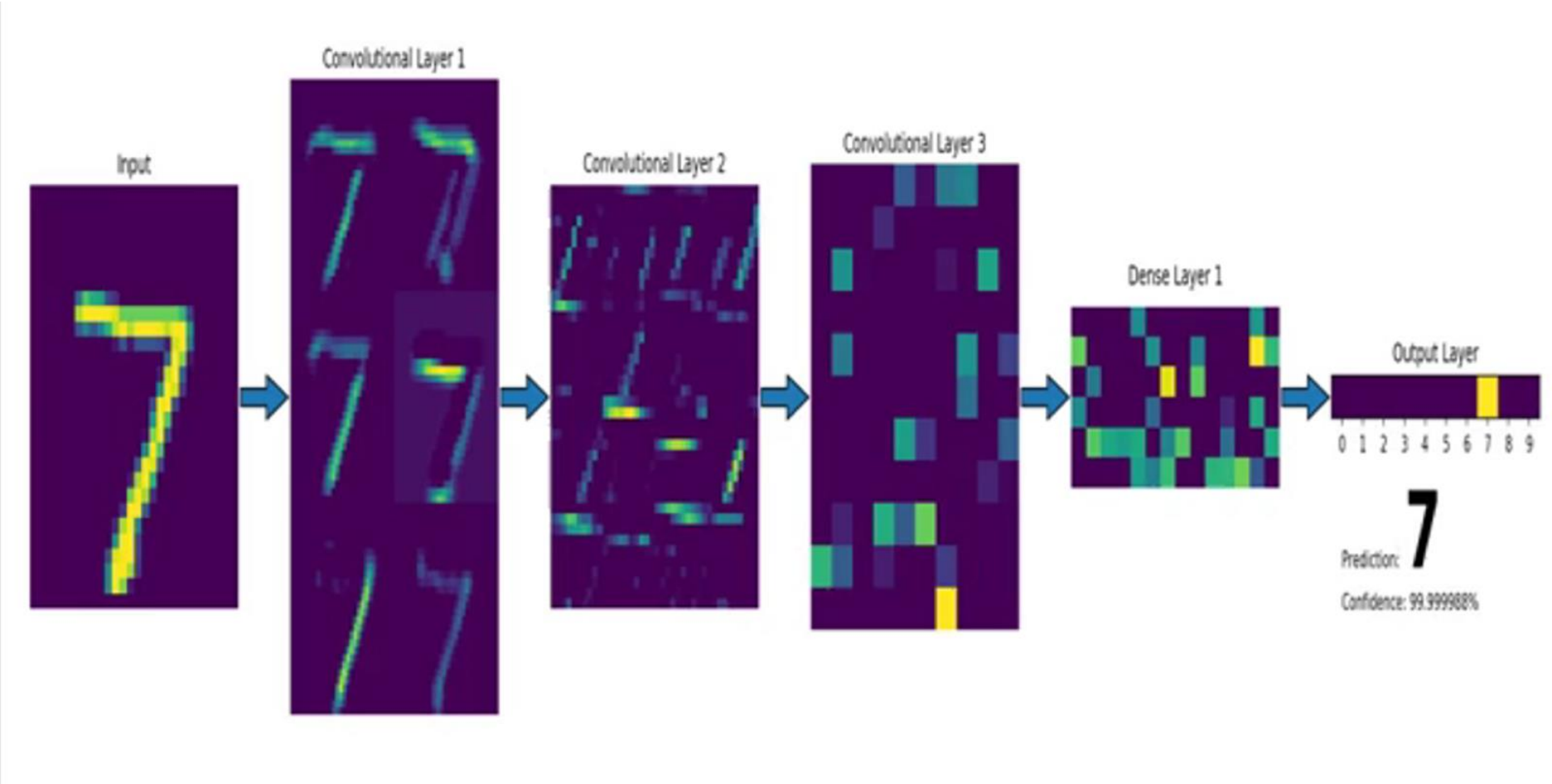


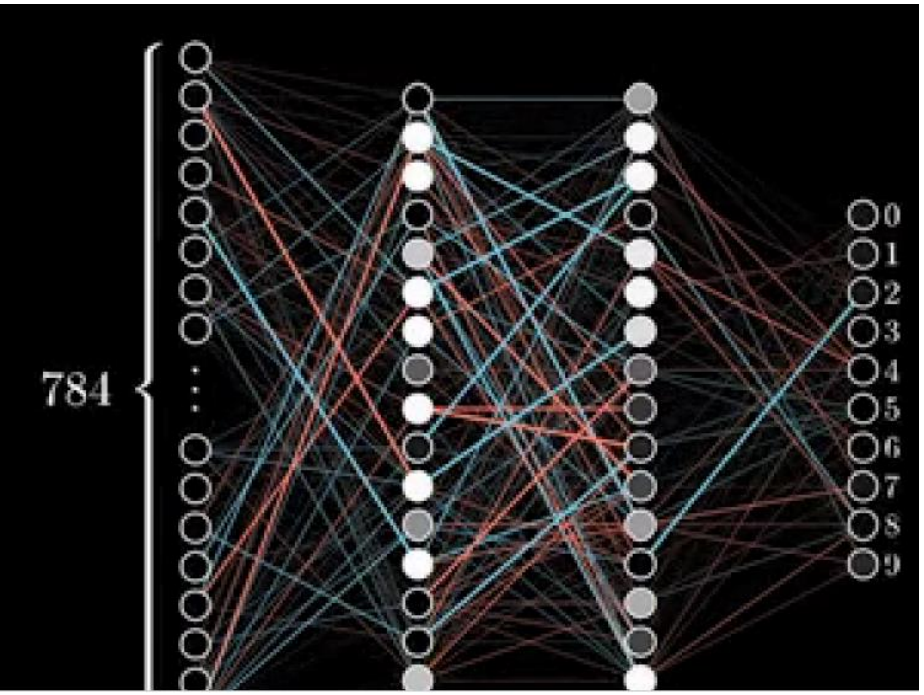
Image source: https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063

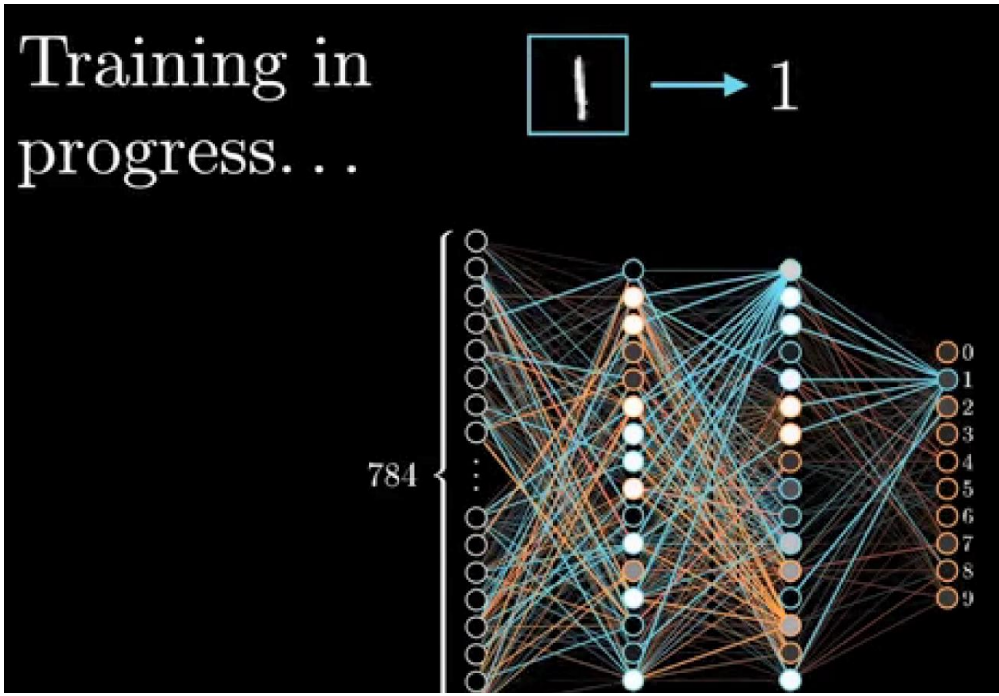
What is a Neural Network? (features)



Video source: https://gfycat.com/helpfulconstantkite-three-blue-one-brown-machine-learning

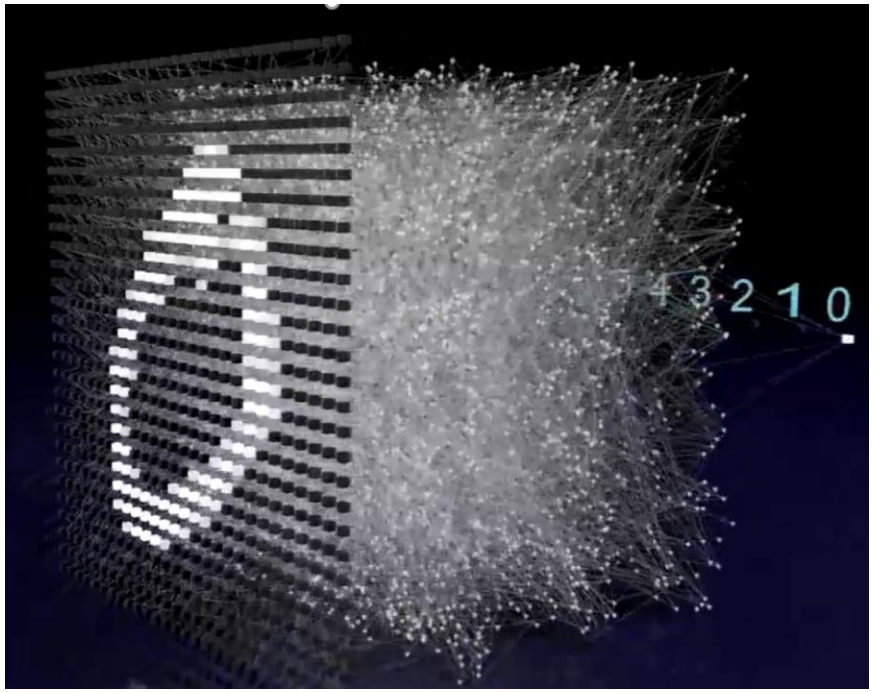
What is a Neural Network? (training)

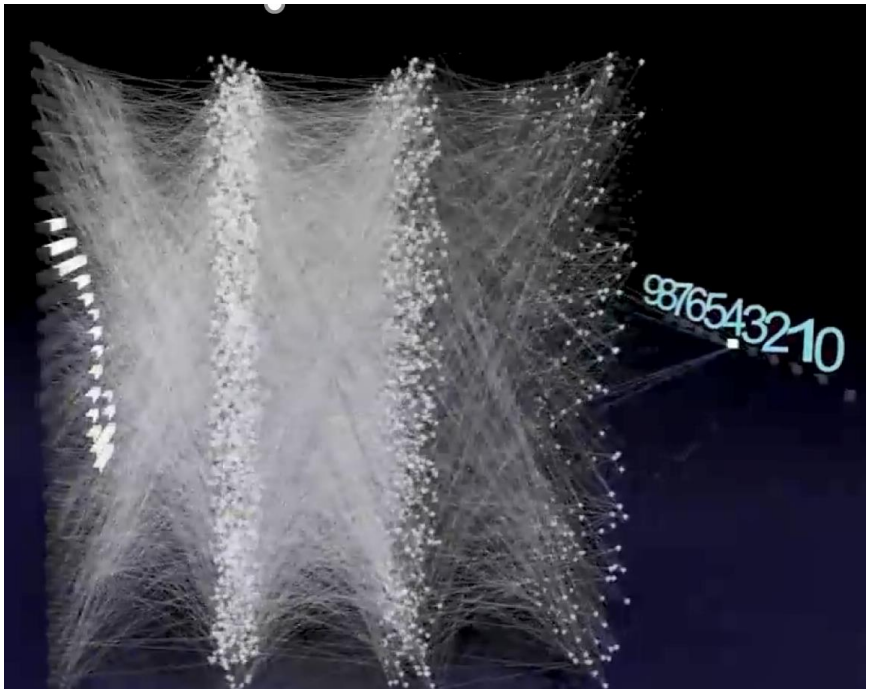




Video source: https://gfycat.com/helpfulconstantkite-three-blue-one-brown-machine-learning

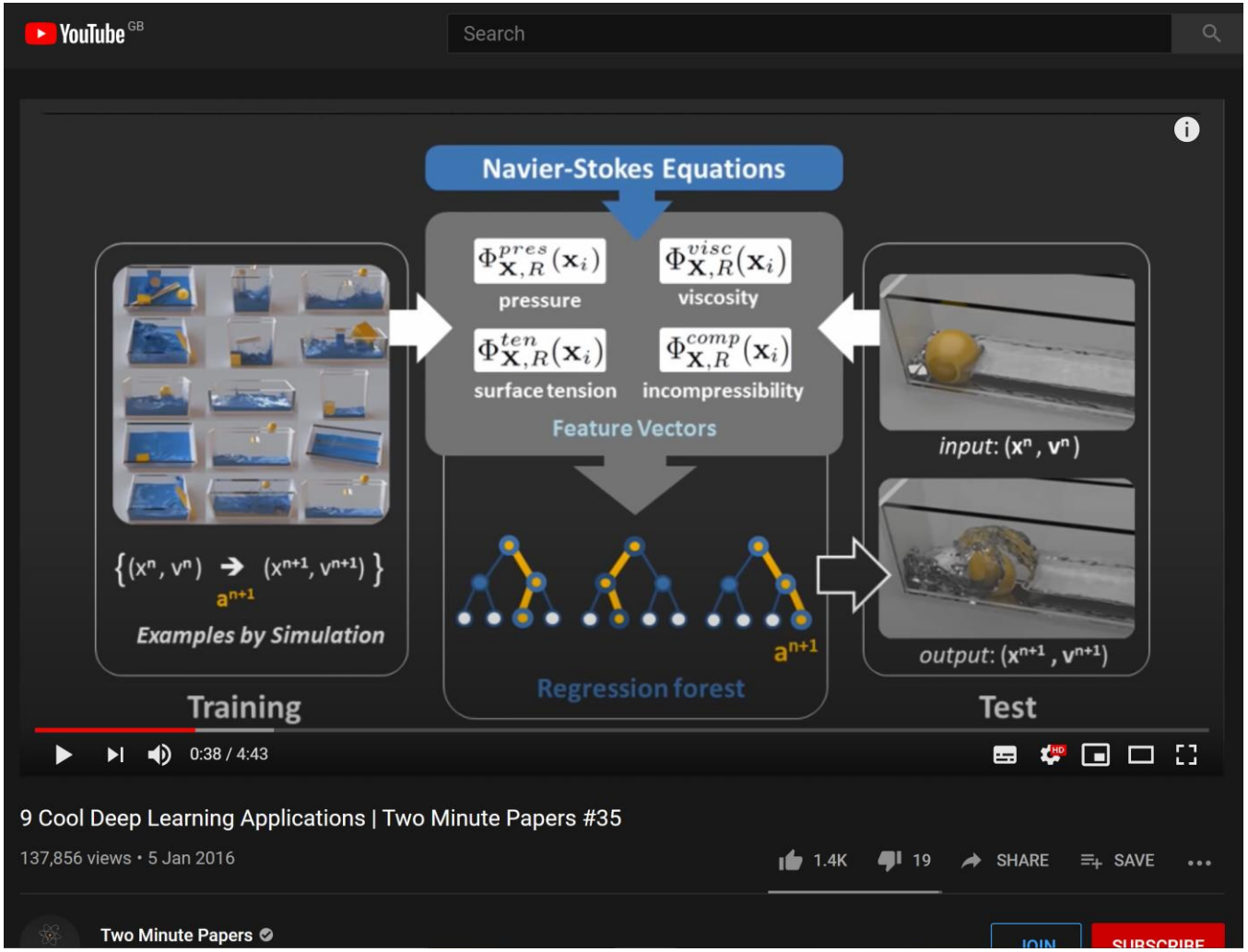
What is a Neural Network? (result)





Video source: https://gfycat.com/handsomemerryhyena-artificial-neural-networks-convolutional-networks

Applications?



Video source: https://www.youtube.com/watch?v=Bui3DWs02h4

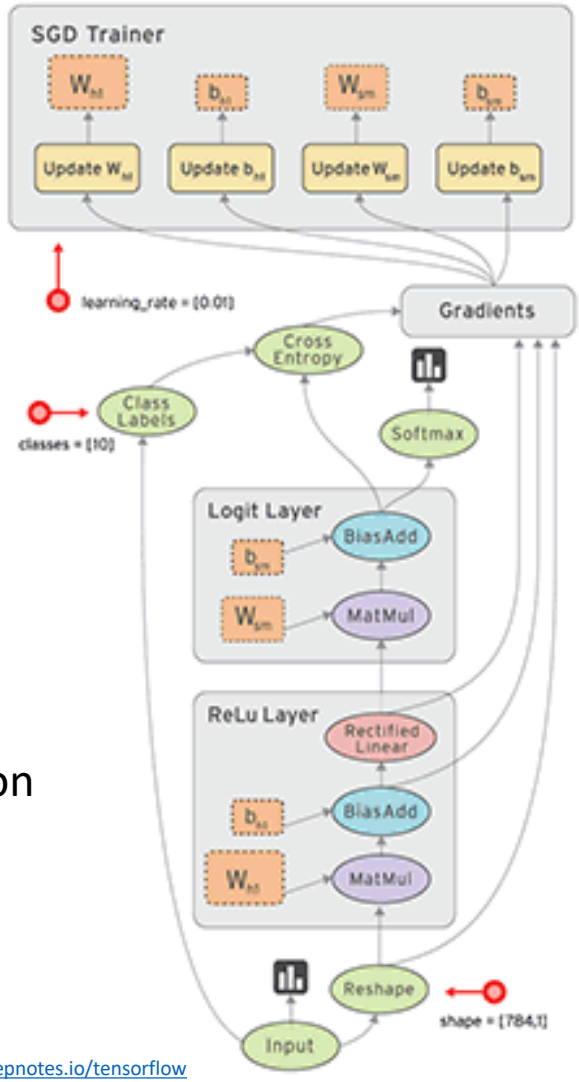
Training with Gradient Descent

Imagine this function – the altitude given the location on the ground

Training with Gradient Descent

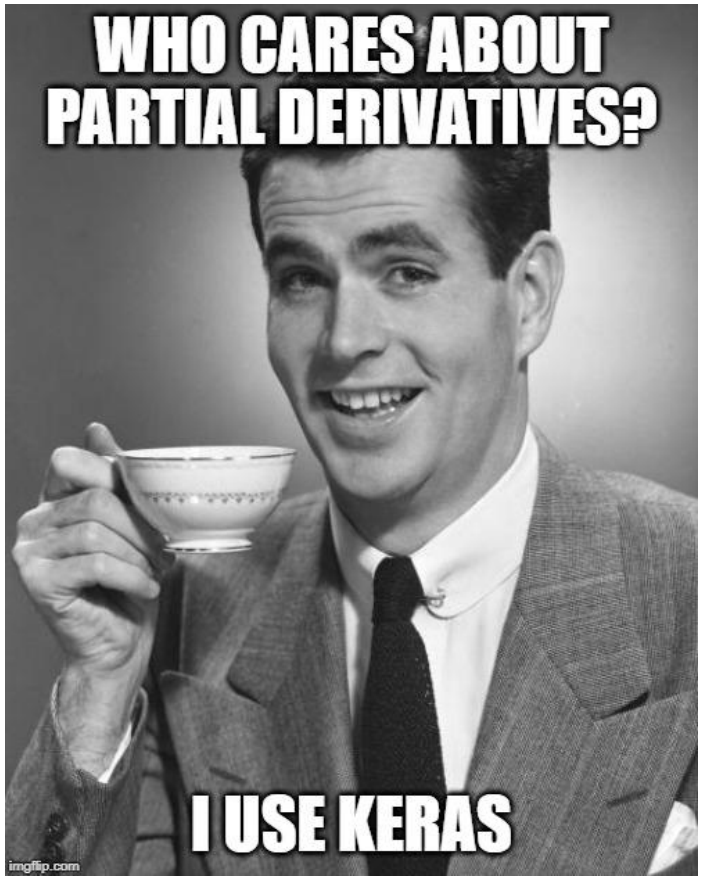
The function value is high if the network is wrong, and low if it is performing well

Automatic differentiation



Computation graph

Image source: https://deepnotes.io/tensorflow



Video source: https://imgflip.com/memegenerator

Gradient-based Optimisation algorithms

Good news:

- Even though SGD ends up in **local** minima, they are quite reasonable
- Adam seems to work well for most cases
  - Less trouble with tuning the learning rate
  - See newer variants too:
    AdamW, Radam, …
- The process is efficient !!
  - even more so when using GPUs

Video source: https://imgflip.com/memegenerator

Other ways to train neural nets

Derivative free optimisation

- **Genetic algorithms**
- Contrastive Divergence (Restricted Boltzmann Machines)
- Evolution strategies
- Neuroevolution
- Particle Swarm optimisation
- Simulated annealing
- Grid/Random search
- Subgradient method
- …

Video source: https://imgflip.com/memegenerator

Other ways to train neural nets

Derivative free optimisation

- **Genetic algorithms**

Video source: https://gfycat.com/cavernousfirmboaconstrictor

Summary

- This brief introduction presented:
  - An overview of neural nets
  - A brief history of neural networks
  - The way they are trained
  - The building blocks of neural nets
  - Intuitions on how neural nets could be scaled up

The lab:

Building Neural Nets (Keras)

- Logistic Regression
- Optimizers
- Learning rates
- …

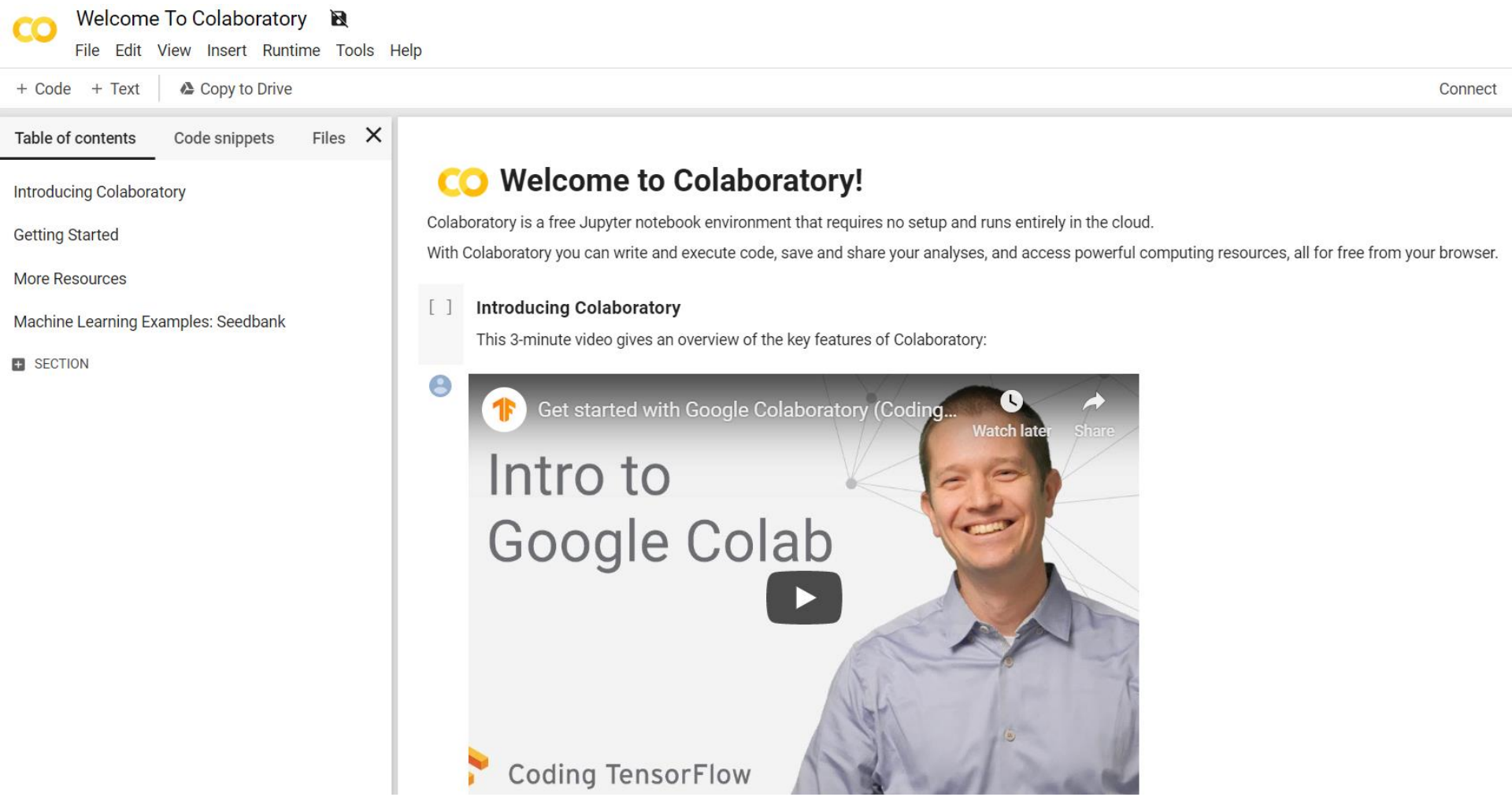
Next time:

Scaling up neural nets

- Problems that come with deeper models
- … and how to solve them

Image source: https://www.inference.vc/deep-learning-is-easy/

Free CPU/GPU !! ☺ (if you don't have one)



URL: https://colab.research.google.com

Resources

- **Keras (Python & R)**

  https://keras.io/

  https://keras.rstudio.com/

- **Anaconda (Python & R)**

  https://www.anaconda.com/distribution/