



UNIVERSITY
of
GREENWICH

Neural Networks

An introduction 

Dr. Mihai Polceanu

What is the lecture about?

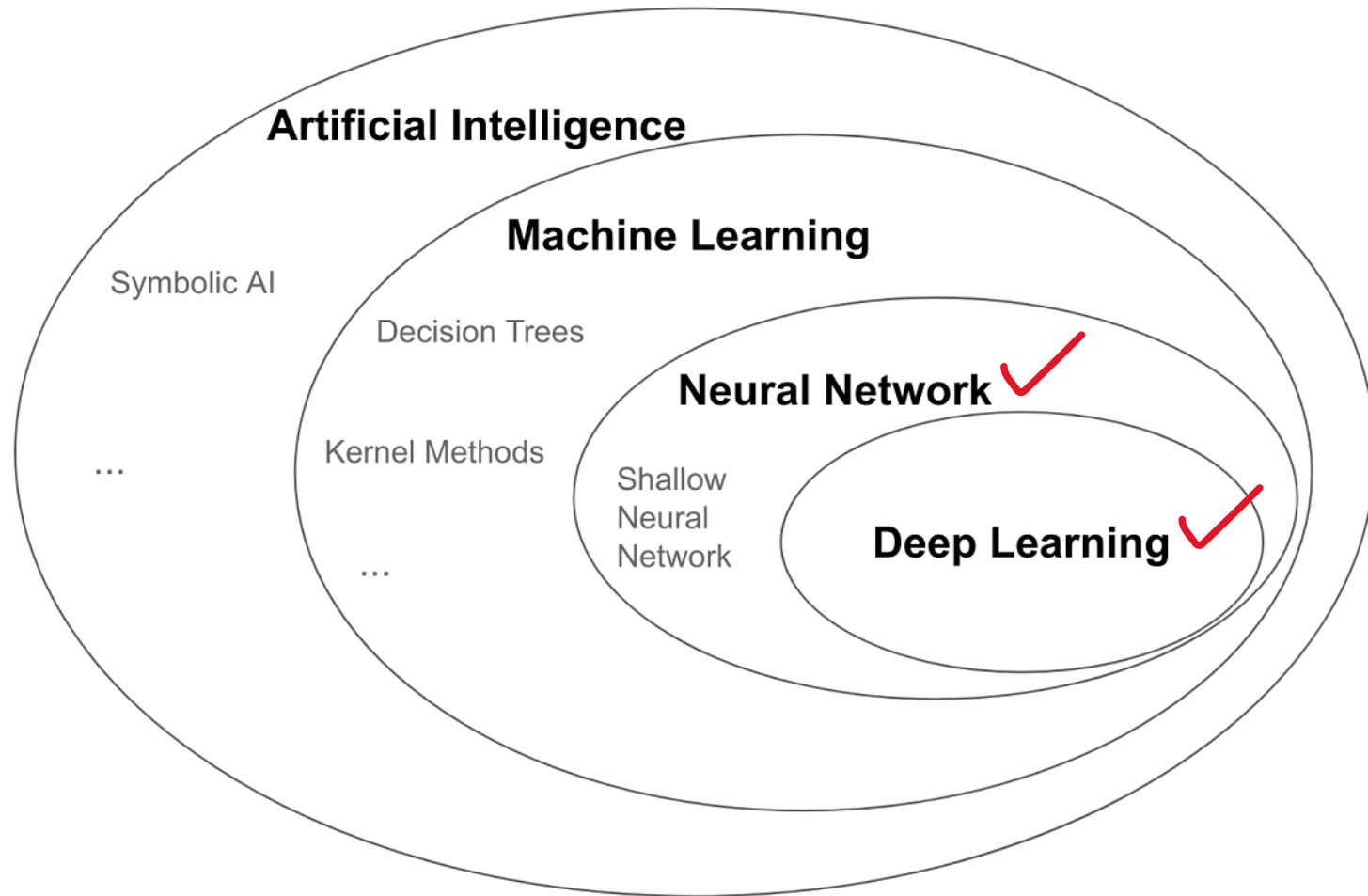


Image source: <https://livebook.manning.com/book/deep-learning-with-javascript/chapter-1/v-7/13>

What's the point?

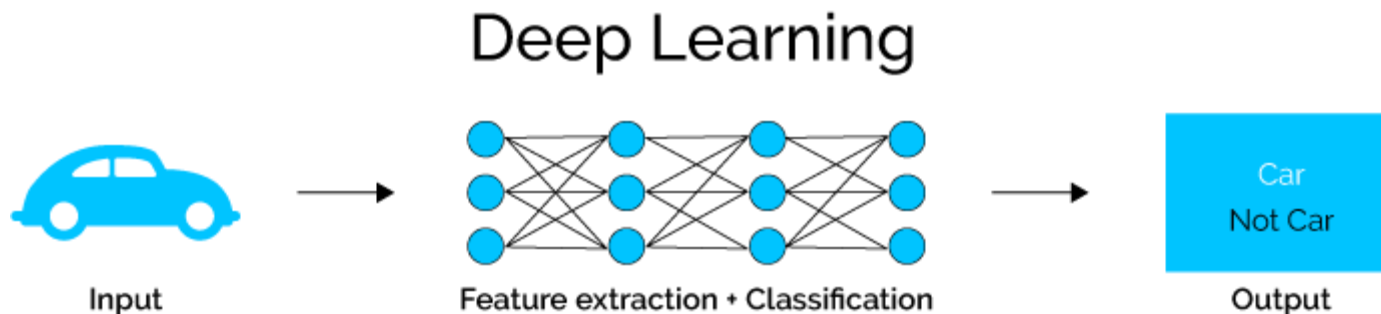
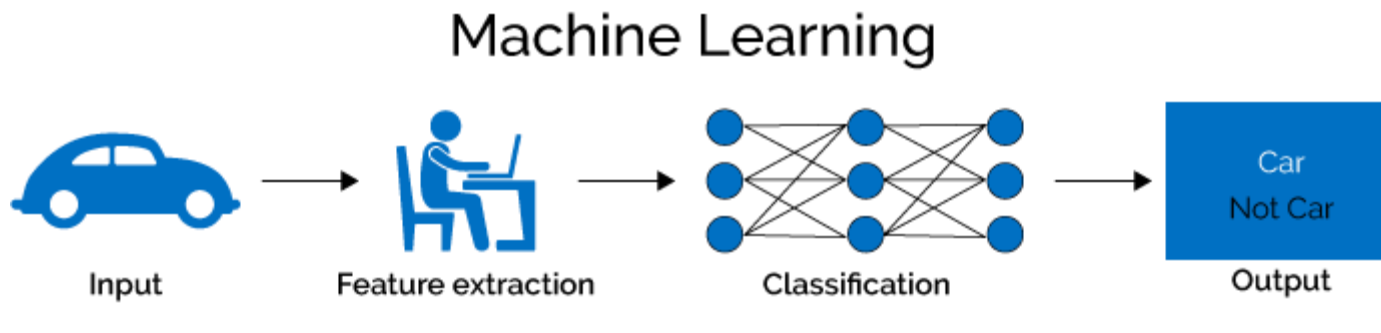


Image source: <https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063>

What's the point?

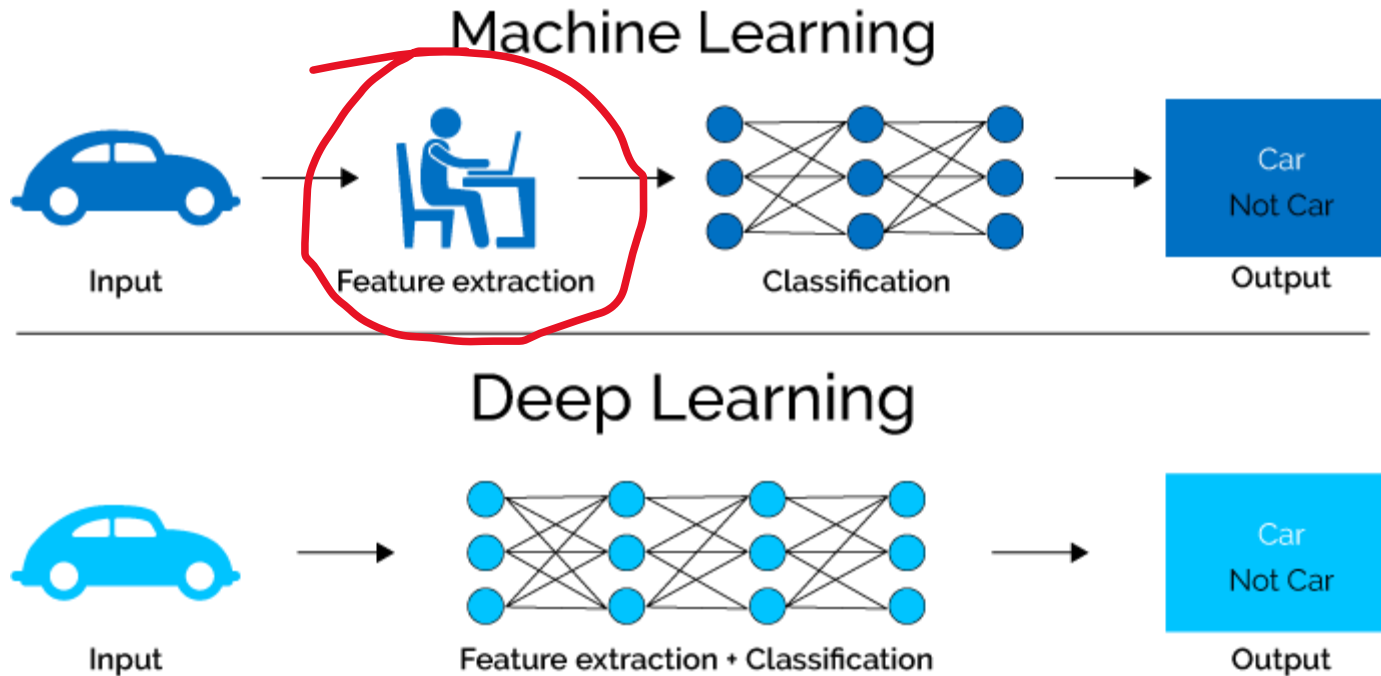


Image source: <https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063>

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 ?



**DO YOU
FEEL
LUCKY....
PUNK?**



**WELL....
DO YA?**

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 !

**DO YOU
FEEL
LUCKY....
PUNK?**

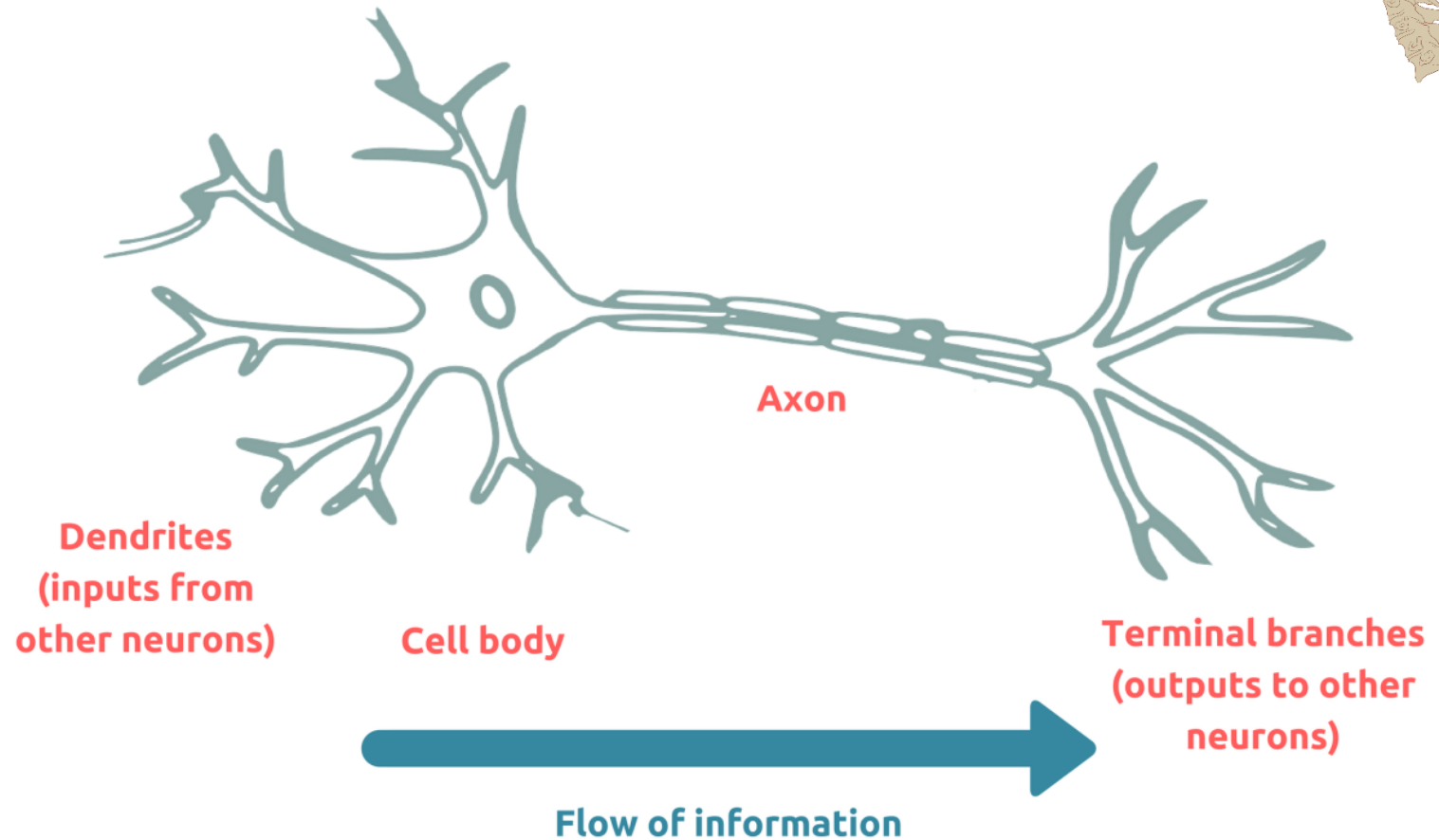
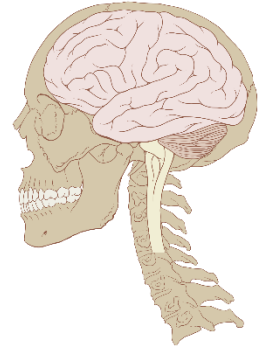


**WELL....
DO YA?**

Image source: <https://www.pinterest.de/pin/338332990726474128/>

* Also, it looks like this meme is inaccurate ! Go ahead and check!

A bit of history



A bit of history

Psychological Review
Vol. 65, No. 6, 1958

THE PERCEPTRON: A PROBABILISTIC MODEL FOR INFORMATION STORAGE AND ORGANIZATION IN THE BRAIN¹

F. ROSENBLATT

Cornell Aeronautical Laboratory

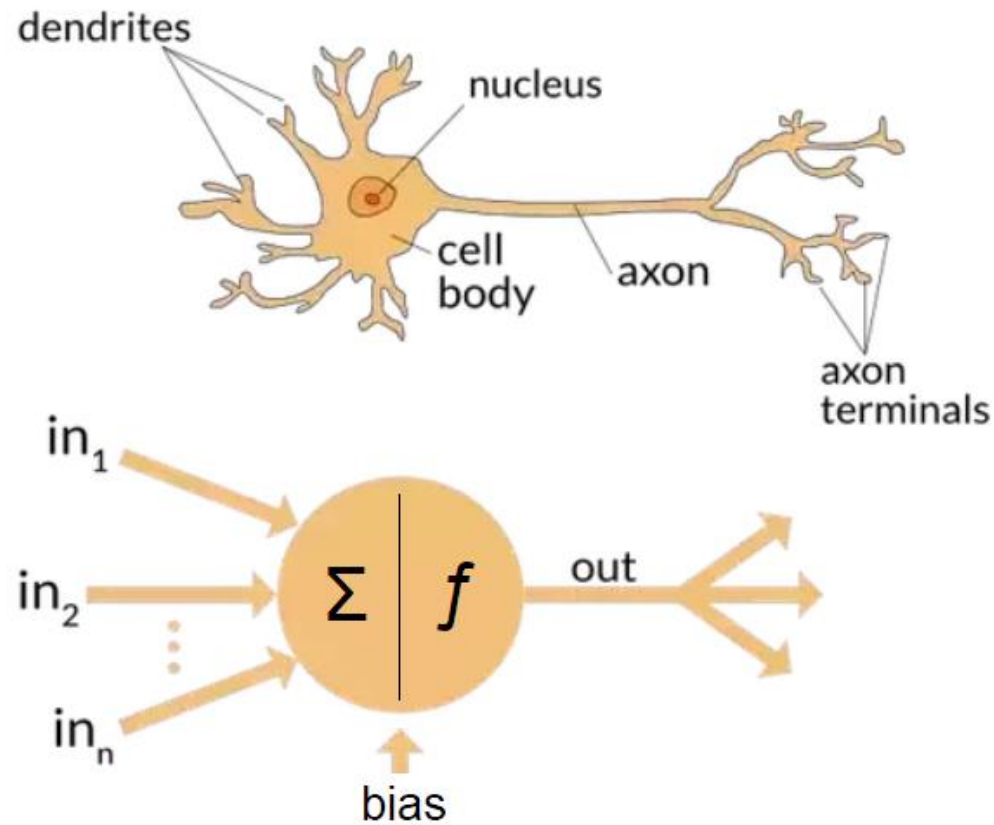
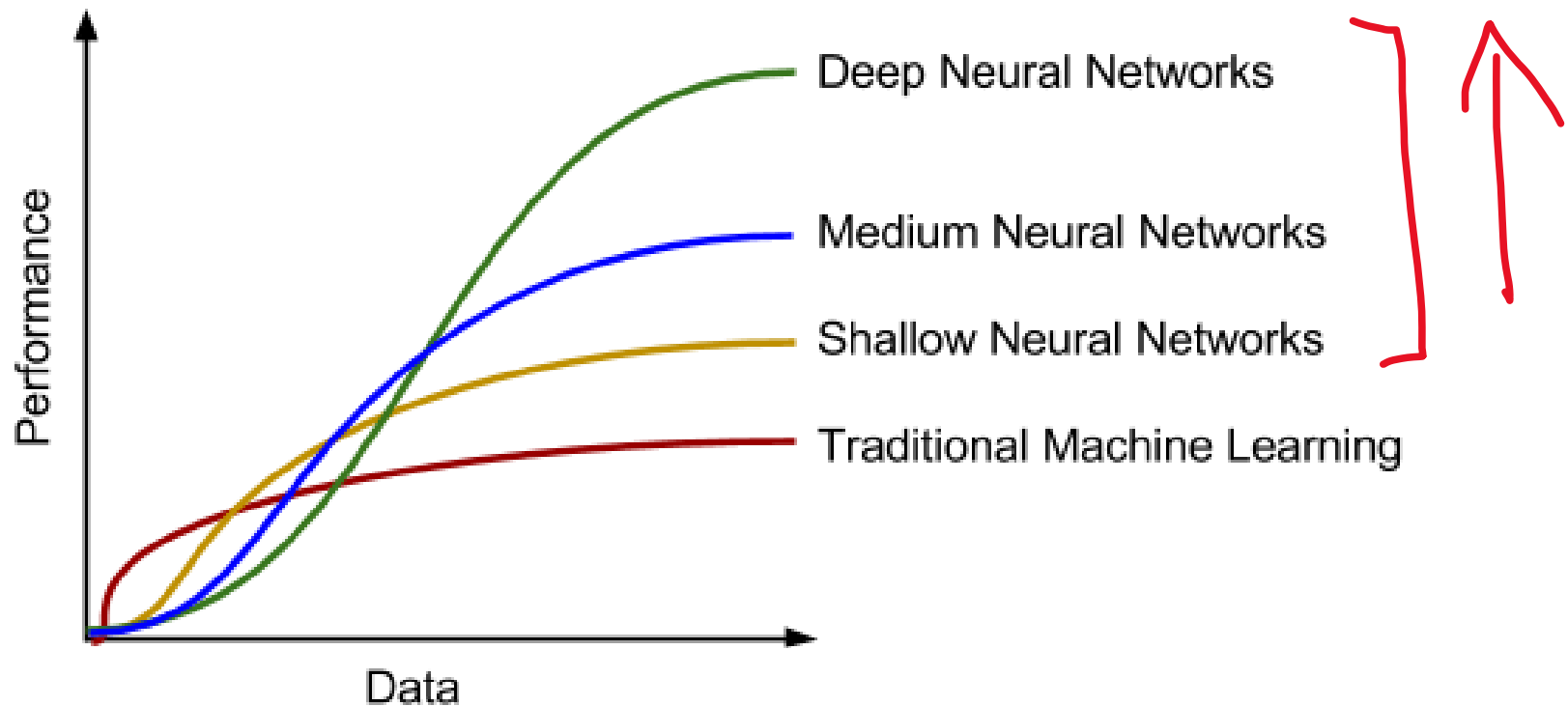
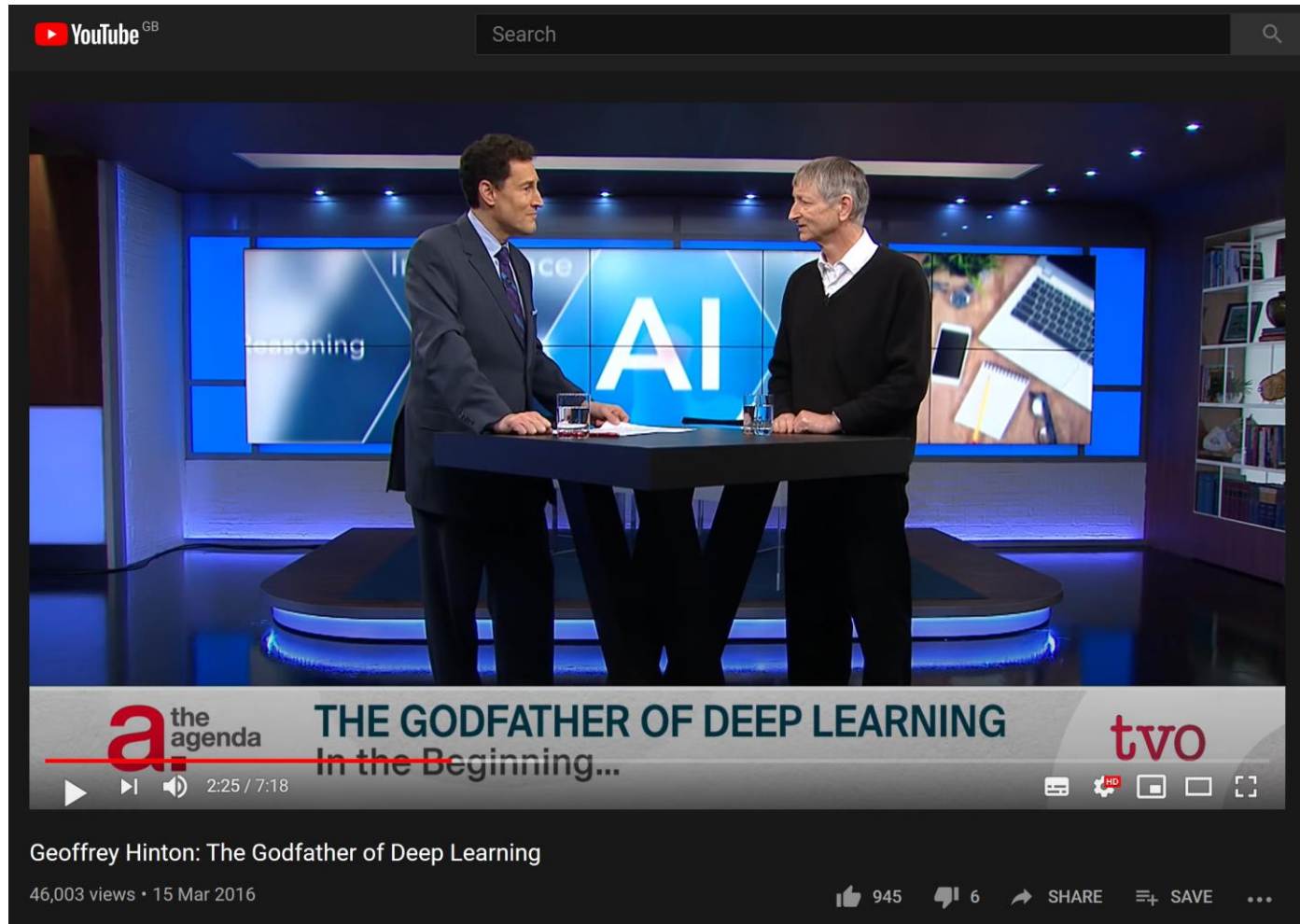


Image source: <https://towardsdatascience.com/a8b46db828b7>

A bit of history



A bit of history



What is a Neural Network?

(end of analogy)

Biological Neuron versus Artificial Neural Network

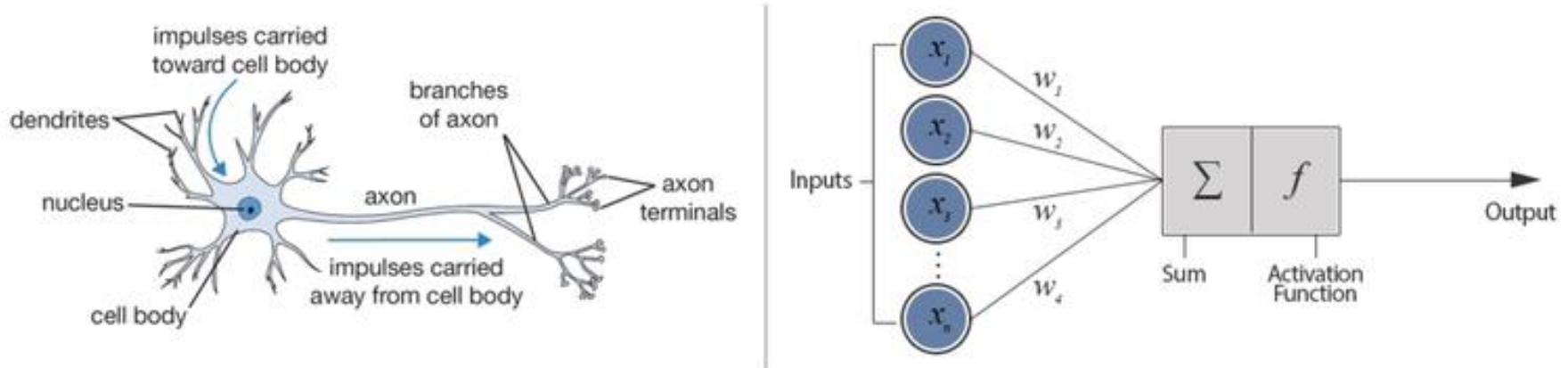


Image source: <https://towardsdatascience.com/from-fiction-to-reality-a-beginners-guide-to-artificial-neural-networks-d0411777571b>

Artificial neuron = a **crude approximation** of a biological neuron

Artificial Neural Network = a collection of **artificial neurons**

What's the point? (recap)

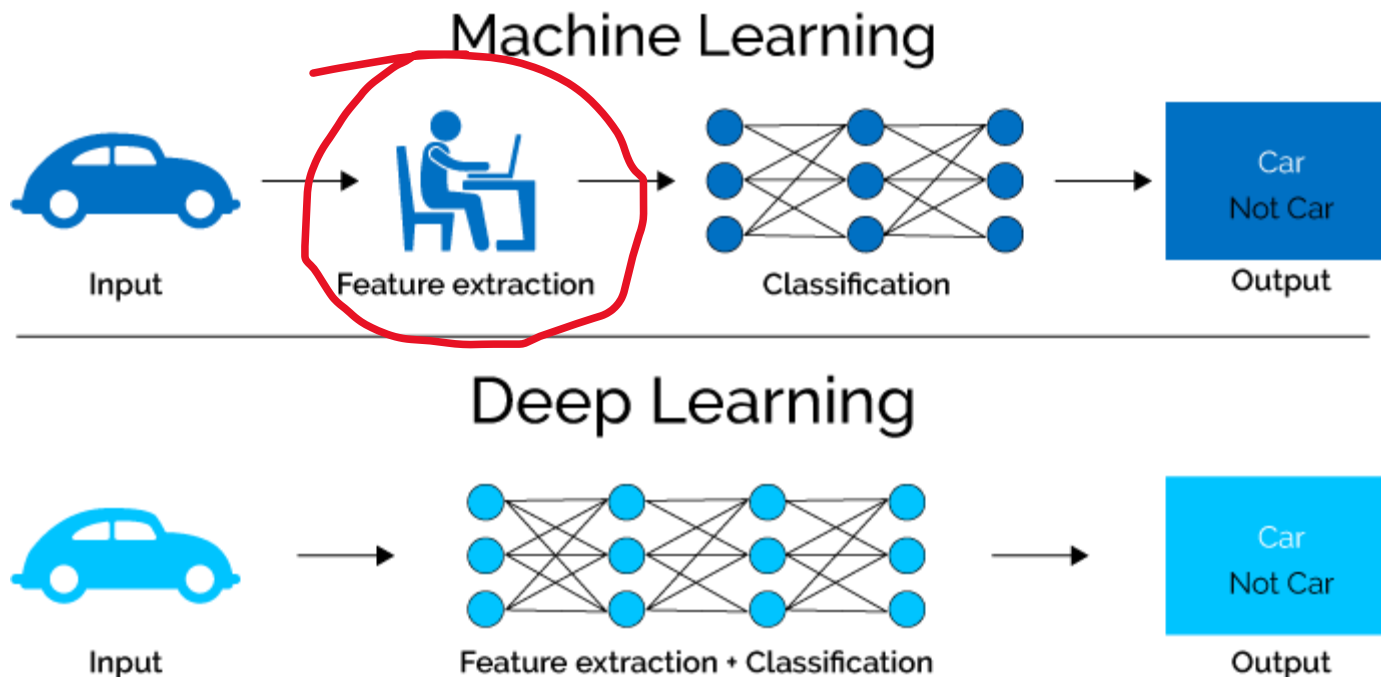
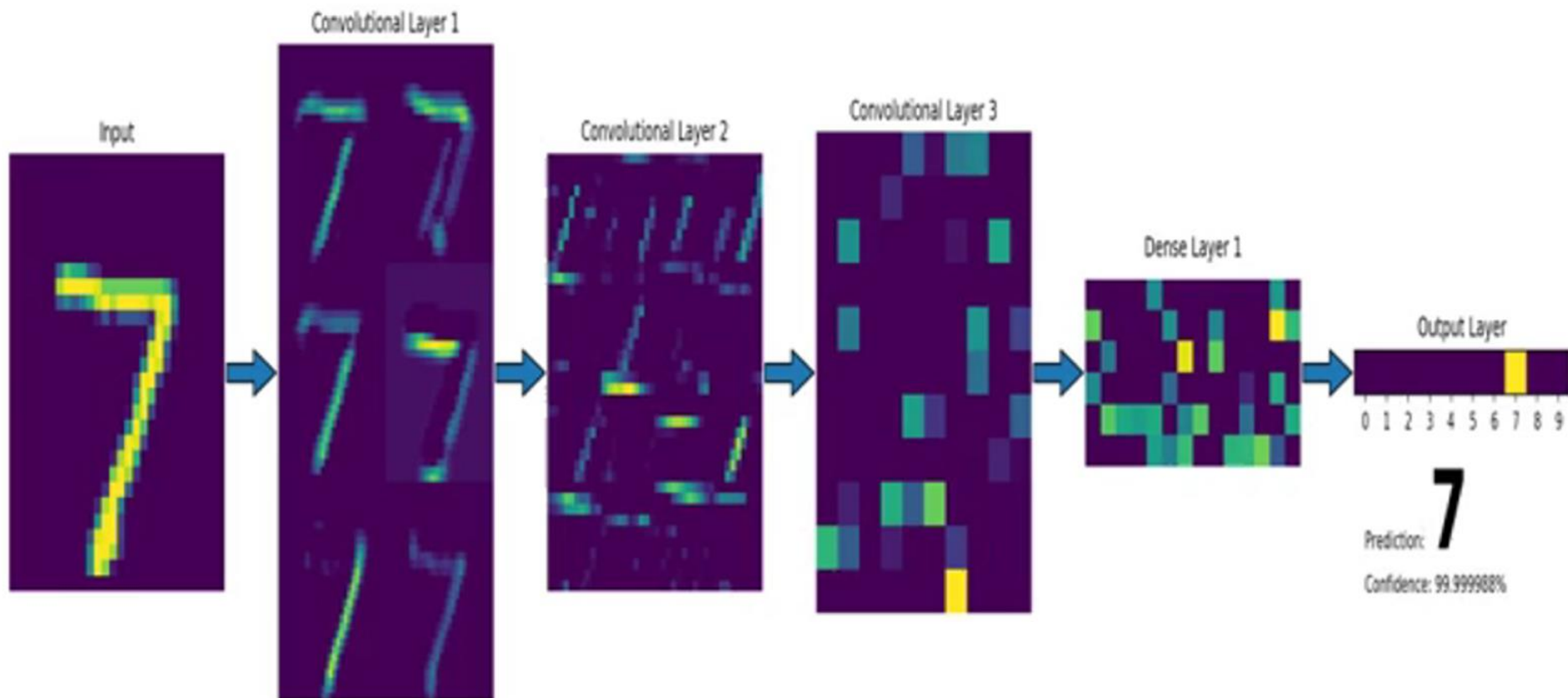


Image source: <https://towardsdatascience.com/why-deep-learning-is-needed-over-traditional-machine-learning-1b6a99177063>

What is a Neural Network? (features)

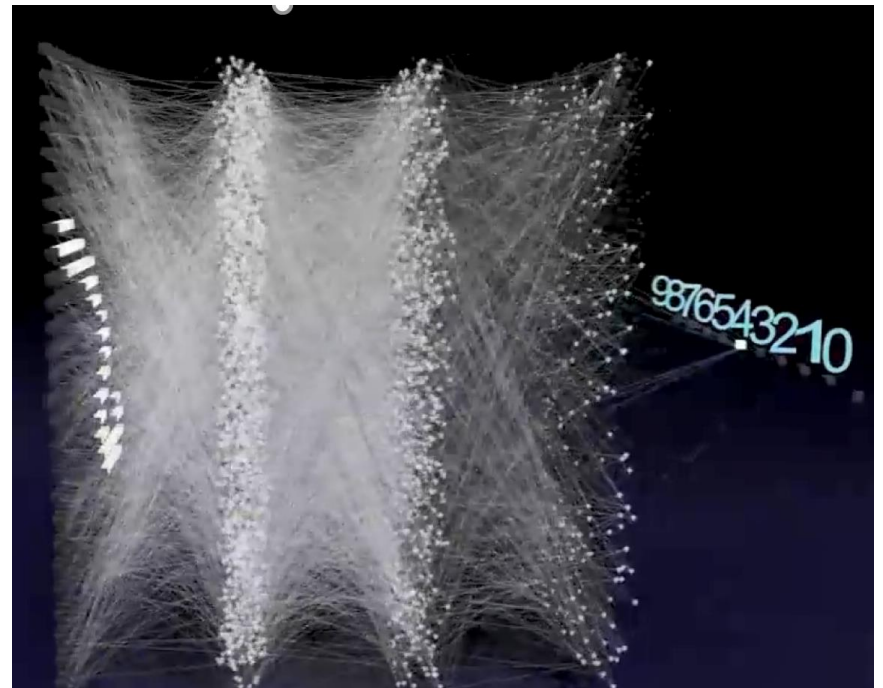
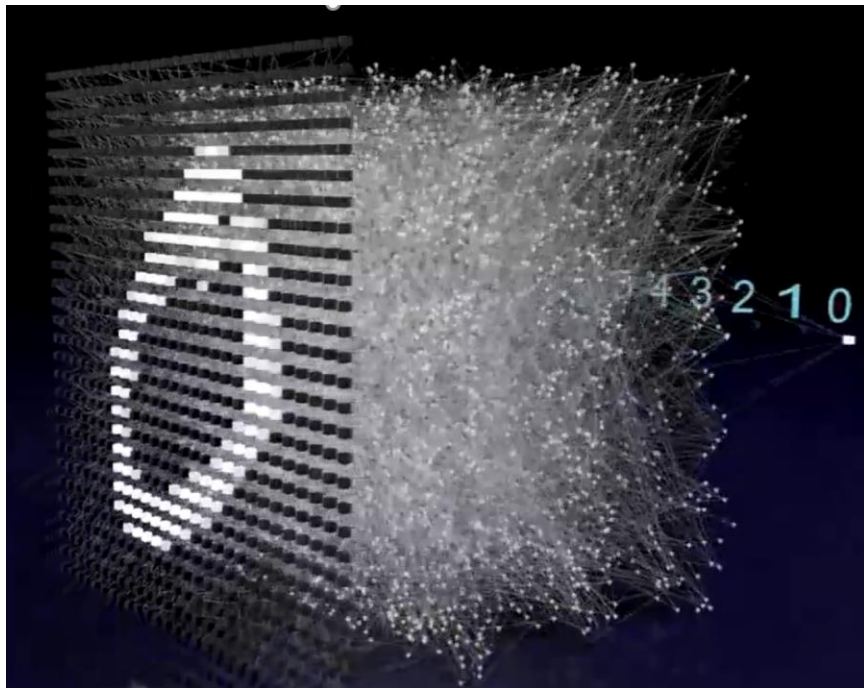


What is a Neural Network? (training)



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?

YouTube GB

Search

Navier-Stokes Equations

$\Phi_{\mathbf{X},R}^{pres}(\mathbf{x}_i)$ pressure
 $\Phi_{\mathbf{X},R}^{visc}(\mathbf{x}_i)$ viscosity
 $\Phi_{\mathbf{X},R}^{ten}(\mathbf{x}_i)$ surface tension
 $\Phi_{\mathbf{X},R}^{comp}(\mathbf{x}_i)$ incompressibility
Feature Vectors

$\{(x^n, v^n) \rightarrow (x^{n+1}, v^{n+1})\}$
 a^{n+1}
Examples by Simulation

Regression forest

a^{n+1}

input: (x^n, v^n)

output: (x^{n+1}, v^{n+1})

Training

Test

0:38 / 4:43

9 Cool Deep Learning Applications | Two Minute Papers #35

137,856 views • 5 Jan 2016

1.4K 19 SHARE SAVE

Two Minute Papers

JOIN SUBSCRIBE

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

Training with Gradient Descent

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

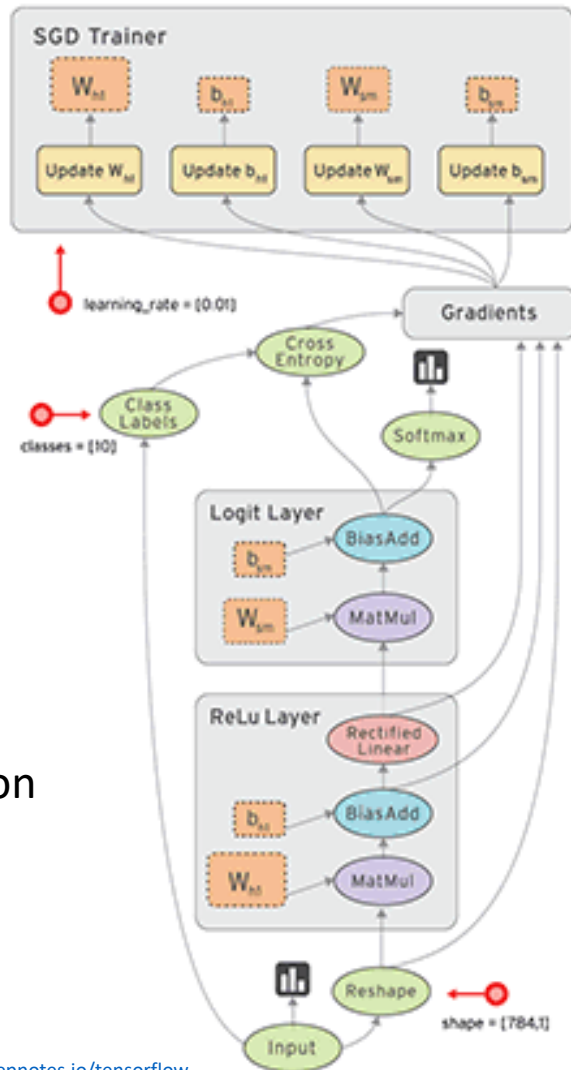
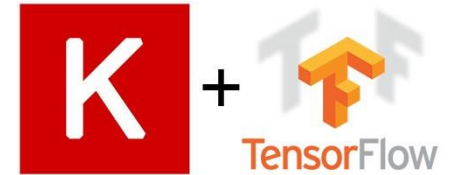


Training with Gradient Descent

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

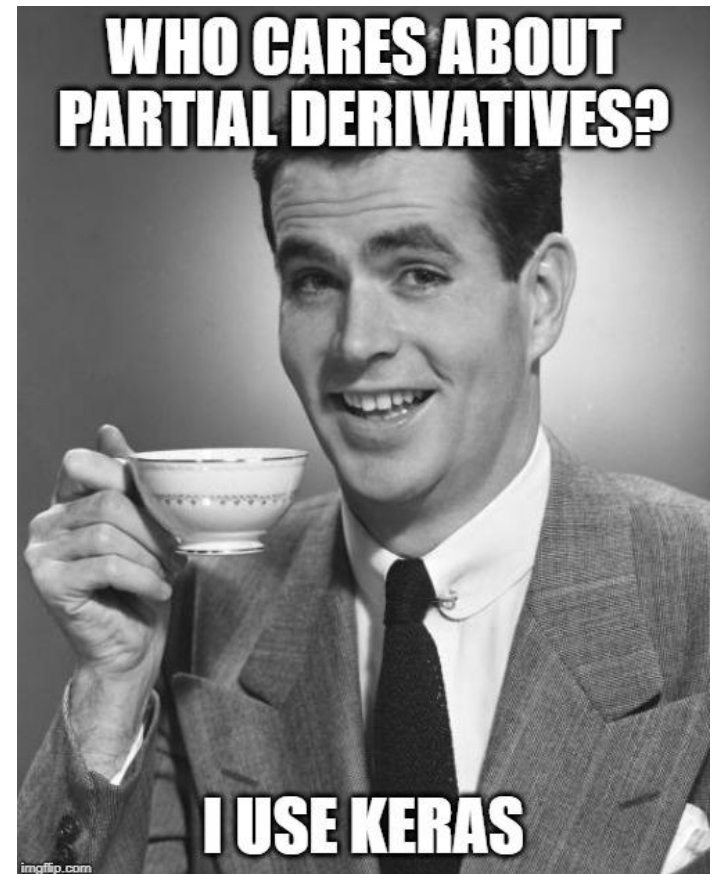


Automatic differentiation



Computation
graph

Image source: <https://deeppnotes.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

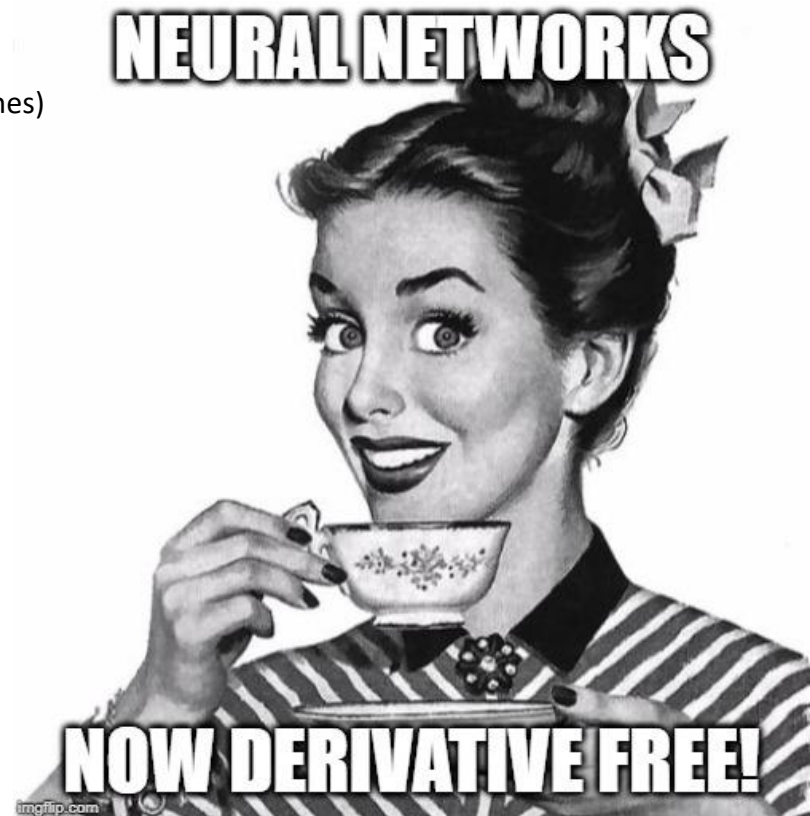


Video source: <https://imgflip.com/memegenerator>

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:

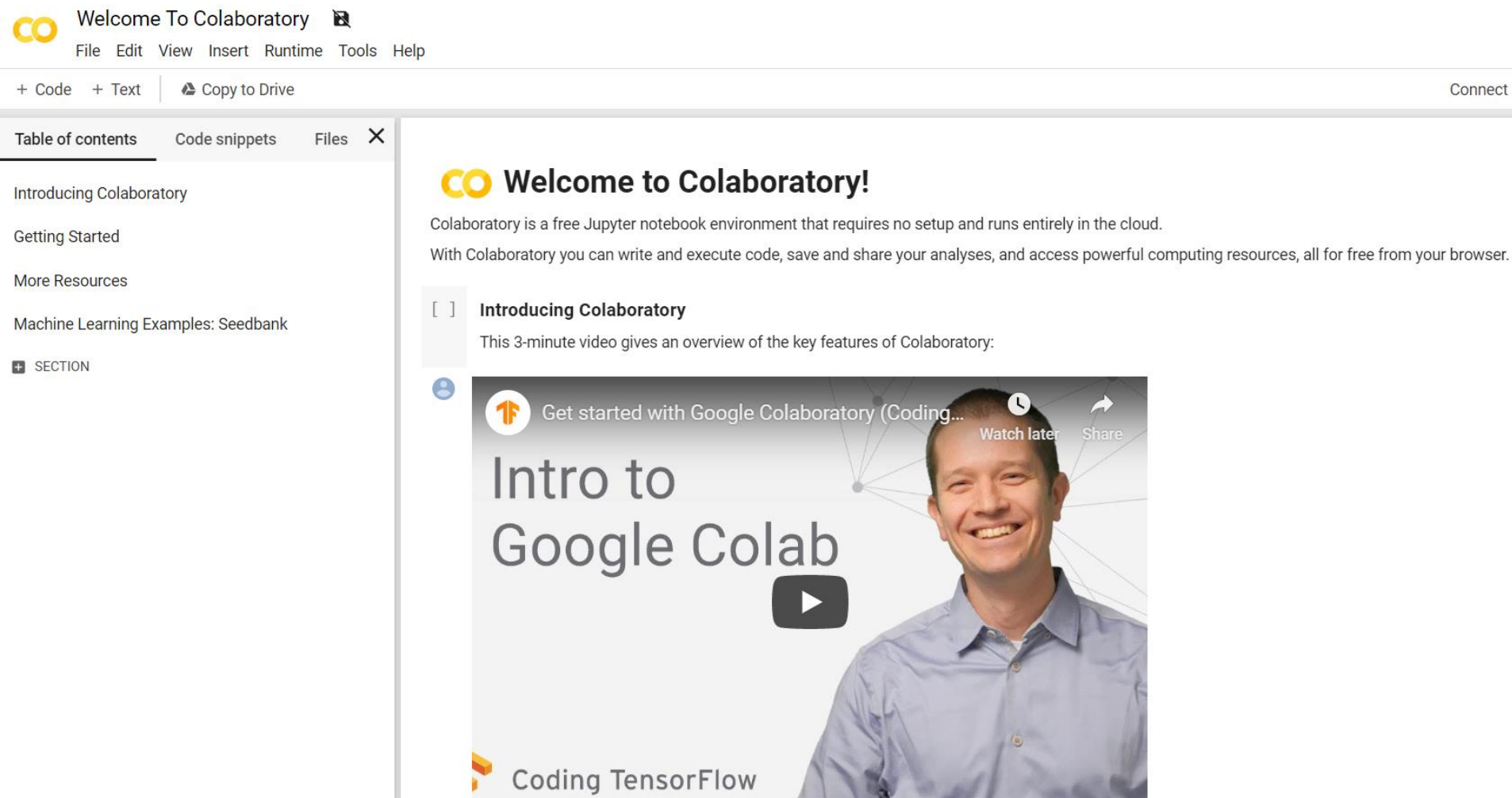
Scaling up neural nets

- 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)



The screenshot displays the Google Colaboratory web interface. At the top, there's a navigation bar with the Colab logo, a 'Welcome To Colaboratory' message, and a menu with options: File, Edit, View, Insert, Runtime, Tools, and Help. Below this is a secondary bar with '+ Code', '+ Text', and 'Copy to Drive' buttons, along with a 'Connect' button on the right. A left sidebar contains a 'Table of contents' section with links to 'Introducing Colaboratory', 'Getting Started', 'More Resources', and 'Machine Learning Examples: Seedbank'. The main content area features a 'Welcome to Colaboratory!' heading, followed by a paragraph explaining that Colab is a free Jupyter notebook environment running in the cloud. Below this text is a video player titled 'Introducing Colaboratory' with a description: 'This 3-minute video gives an overview of the key features of Colaboratory:'. The video player shows a thumbnail with the text 'Intro to Google Colab' and a play button. The video title bar includes 'Get started with Google Colaboratory (Coding...', 'Watch later', and 'Share' options. The bottom of the video player shows 'Coding TensorFlow'.

Welcome To Colaboratory

File Edit View Insert Runtime Tools Help

+ Code + Text Copy to Drive

Connect

Table of contents Code snippets Files

Introducing Colaboratory

Getting Started

More Resources

Machine Learning Examples: Seedbank

SECTION

Welcome to Colaboratory!

Colaboratory is a free Jupyter notebook environment that requires no setup and runs entirely in the cloud.

With Colaboratory you can write and execute code, save and share your analyses, and access powerful computing resources, all for free from your browser.

Introducing Colaboratory

This 3-minute video gives an overview of the key features of Colaboratory:

Get started with Google Colaboratory (Coding... Watch later Share

Intro to Google Colab

Coding TensorFlow

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/>