

Data Science: Principles and Practice

Lecture 4: Deep Learning, Part I

Ekaterina Kochmar¹



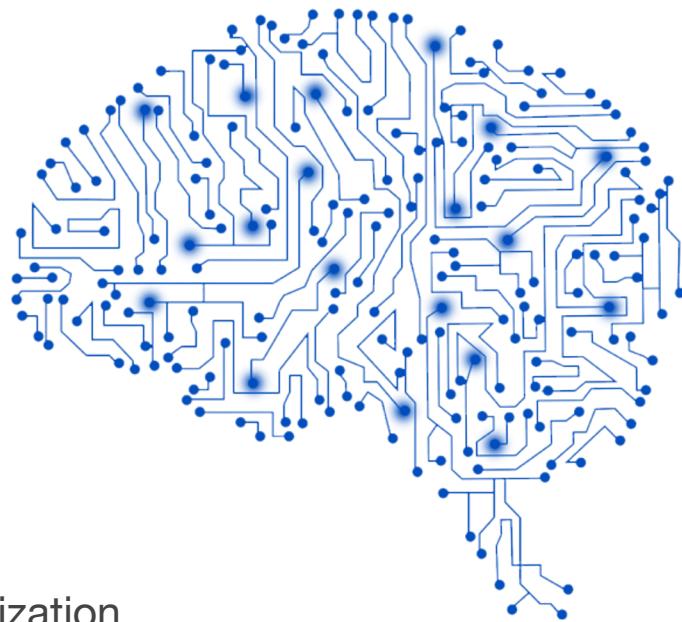
UNIVERSITY OF
CAMBRIDGE

¹ Based on slides by Marek Rei

What is Deep Learning?

Deep learning is a class of machine learning algorithms.

Neural network models with multiple hidden layers.



Today: The basics of neural network models, optimization

Next lecture: Implementing models with Tensorflow, network components, practical tips

Data Science: Principles and Practice

01

Introduction and motivation

02

Fundamentals of Neural Networks

03

Neural Network Optimization

The Rise of Deep Learning

BUSINESS INSIDER UK

TECH

Microsoft's voice-recognition tech is now better than even teams of humans at transcribing conversations

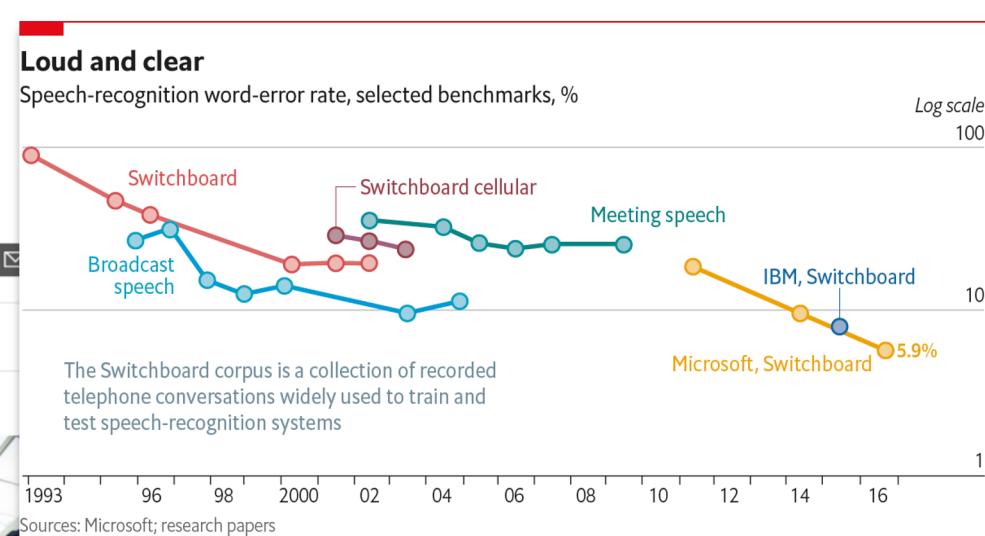


Matt Weinberger [✉](#) [🐦](#)
Aug. 21, 2017, 7:30 PM [667](#)

[FACEBOOK](#)[LINKEDIN](#)[TWITTER](#)

Follow Business Insider:

In October 2016, in a big milestone for artificial intelligence, Microsoft



The Rise of Deep Learning

AI

Google taps neural nets for better offline translation in 59 languages

KHARI JOHNSON @KHARIJOHNSON JUNE 12, 2018 10:16 AM

Above: Google Translate for iOS.
Image Credit: Jordan Novet / VentureBeat

Google's online translations have been p...
the company is rolling out its neural net...
for Google Translate iOS and Android ap...

Offline NMT was made by the Translate...
Google product manager Julie Cattiau to...
95 percent of Google Translate's user ba...
Indonesia, Cattiau said.

The image shows three side-by-side screenshots of the Google Translate app on iOS. Each screenshot displays a French sentence in the top left and its English translation in the bottom right. The interface includes language selection buttons ('FRENCH' and 'ENGLISH') and a double-headed arrow icon between them. A blue status bar at the bottom indicates the device is 'offline'. The three sections are:

- On-device PBMT:** Shows the French sentence "Un sourire coûte moins cher que l'électricité, mais donne autant de lumière" and the English translation "A smile costs less expensive than electricity, but gives as many light". The word "light" is misspelled as "many".
- On-device NMT:** Shows the same French sentence and English translation, but the English sentence is correctly translated as "A smile costs cheaper than electricity, but gives as much light".
- Online NMT:** Shows the same French sentence and English translation, but the English sentence is correctly translated as "A smile costs less than electricity, but gives as much light".

The Rise of Deep Learning

Artificial intelligence / Machine learning

Facebook Creates Software That Matches Faces Almost as Well as You Do

Facebook's new AI research group reports a major improvement in face-processing software.

by Tom Simonite

March 17, 2014

Asked whether two unfamiliar photos of faces show the same person, a human being will get it right 97.53 percent of the time. New software developed by researchers at Facebook can score 97.25 percent on the same challenge, regardless of variations in lighting or whether the person in the picture is directly facing the camera.

<https://www.technologyreview.com/2014/03/17/13822/facebook-creates-software-that-matches-faces-almost-as-well-as-you-do/>

PUBLICATION

DeepFace: Closing the Gap to Human-Level Performance in Face Verification

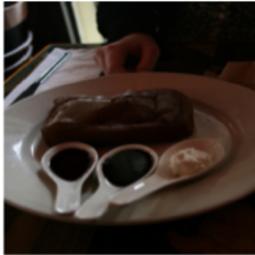
Conference on Computer Vision and Pattern Recognition (CVPR)

<https://research.fb.com/publications/deepface-closing-the-gap-to-human-level-performance-in-face-verification/>

The Rise of Deep Learning



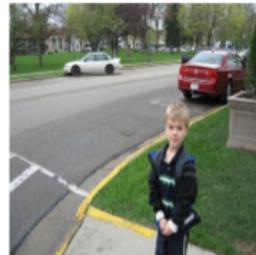
there is a cat
sitting on a shelf .



a plate with a fork
and a piece of cake .



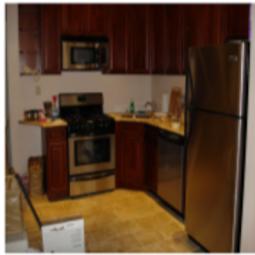
a black and white
photo of a window .



a young boy standing
on a parking lot
next to cars .



a wooden table
and chairs arranged
in a room .



a kitchen with
stainless steel
appliances .



this is a herd
of cattle out
in the field .



a car is parked
in the middle
of nowhere .



a ferry boat on
a marina with a
group of people .



a little boy with
a bunch of friends
on the street .

The Rise of Deep Learning



- day + night =



- flying + sailing =

- bowl + box =

- box + bowl =

The Rise of Deep Learning

 **ars** TECHNICA

SUBSCRIPTIONS   SIGN IN 

TECH —

Google's AlphaGo AI beats world's best human Go player

Ke Jie tried to use AlphaGo's own moves and lost.

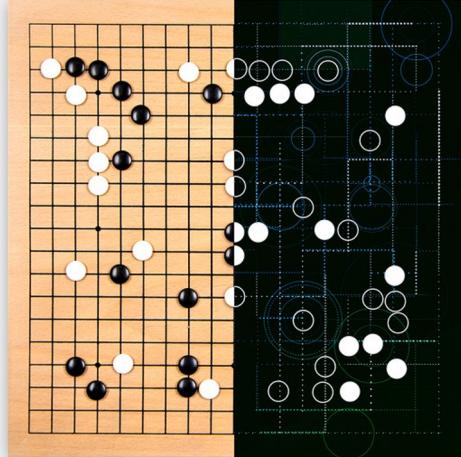
SEBASTIAN ANTHONY - 5/23/2017, 2:20 PM

 STR/AFP/Getty Images

[Enlarge](#) / China's 19-year-old Go player Ke Jie (L) prepares to make a move during the first match against Google's artificial intelligence program AlphaGo in Wuzhen, east China's Zhejiang province on May 23, 2017.

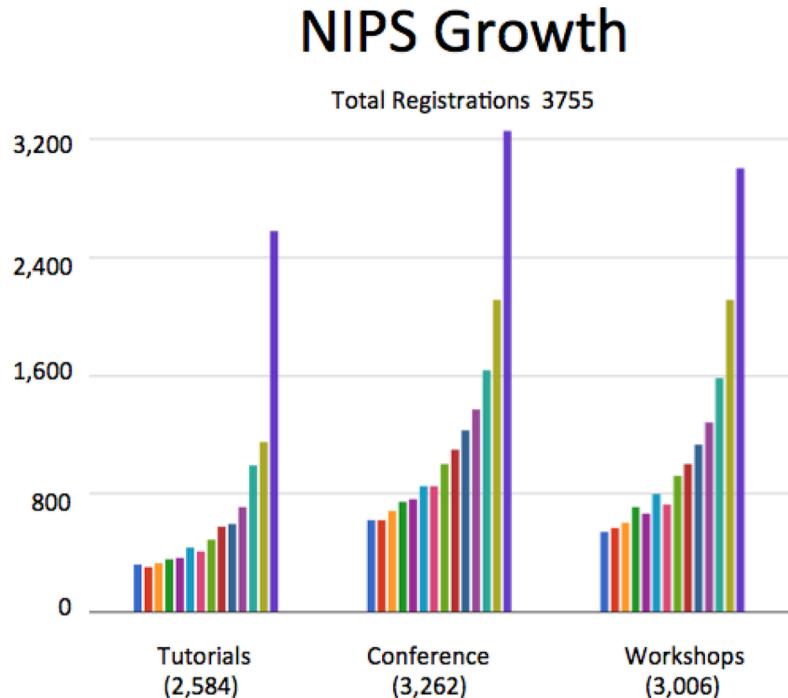
DeepMind's AlphaGo AI has defeated Ke Jie in the first round of a best-of-three Go match in China. A video of the match is embedded below. Ke Jie was defeated by just a half a point—the closest margin possible—but scoring versus a computer is disingenuous: DeepMind's AI doesn't try to win by a large margin; it just plots the surest route to victory, even if it's only a half-point.

Ke Jie is generally considered to be the world's best human Go player, but he wasn't expected to win; AlphaGo beat a Chinese 19-year-old earlier in the year during [an unbeaten online 60-match victory streak](#).



The Rise of Deep Learning

Conference on Neural Information Processing Systems (NeurIPS, formerly NIPS) – one of the main conferences on deep learning and machine learning.



The Hype Train of Deep Learning



This guy didn't know
about neural networks
(a.k.a deep learning)



This guy learned
about neural networks
(a.k.a deep learning)

<http://deeplearning.cs.cmu.edu>

- “Deep learning” is often used as a buzzword, even without understanding it.
- Be mindful - it’s a powerful class of machine learning algorithms, but not a magic solution to every problem.
- Deep Learning is particularly successful in solving complex problems: breakthroughs in natural language processing, computer vision, board game programs.

But Why Now?

2012 - AlexNet wins ImageNet, Krizhevsky

2006 - Restricted Boltzmann Machine, Hinton

1998 - ConvNets for OCR, LeCun

1997 - LSTM, Hochreiter & Schmidhuber

1974 - backpropagation, Werbos

1958 - perceptrons, Rosenblatt

The theory was there before, but the conditions are now better for putting it into action.

1. Big Data

- Large datasets for training
- Better methods for storing and managing data



WIKIPEDIA
The Free Encyclopedia

2. Faster Hardware

- Graphics Processing Units (GPUs)
- Faster CPUs
- More affordable

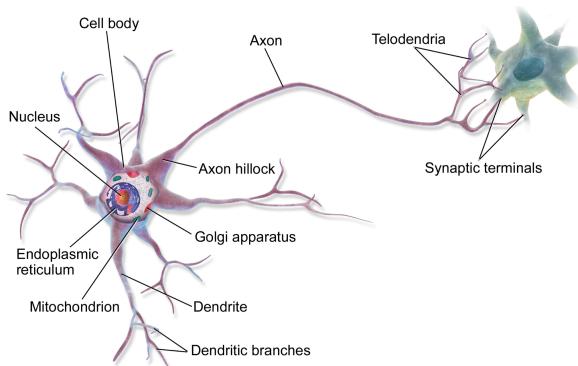
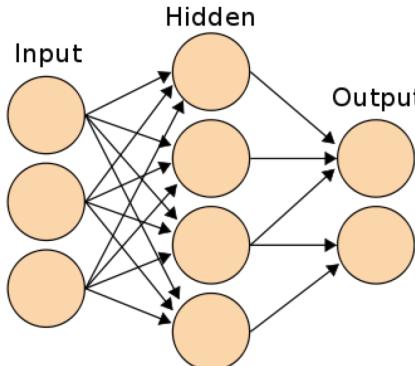
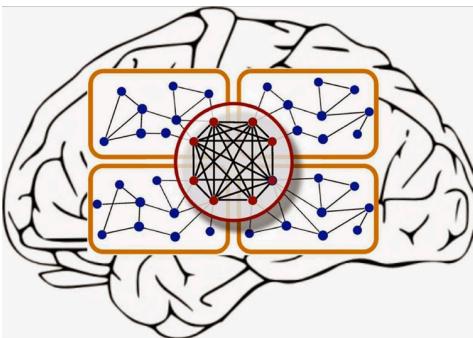


3. Better Software

- Better Optimization Algorithms
- Automatic Differentiation Libraries

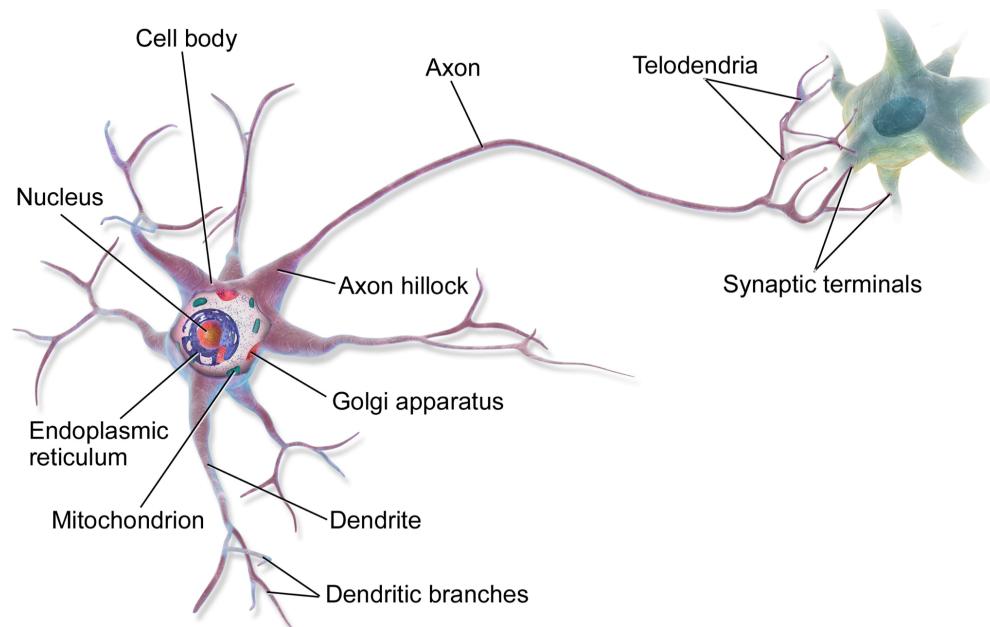


Biological Inspiration



- Often, artificial neural networks (ANNs) are said to be (loosely) based on biological neural networks.
- For instance, Perceptron algorithm was largely inspired by *Hebb's rule*: “Cells that fire together, wire together”.
- Inspiration doesn't mean exact copy: there are notable differences between the two.

Biological Inspiration



“If the human brain were so simple that we could understand it, we would be so simple that we couldn’t.”

Emerson W. Pugh

