

Artificial Intelligence and Deep Learning

NAE GAFOE Session 2019



NATIONAL ACADEMY OF ENGINEERING



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Stiftung/Foundation

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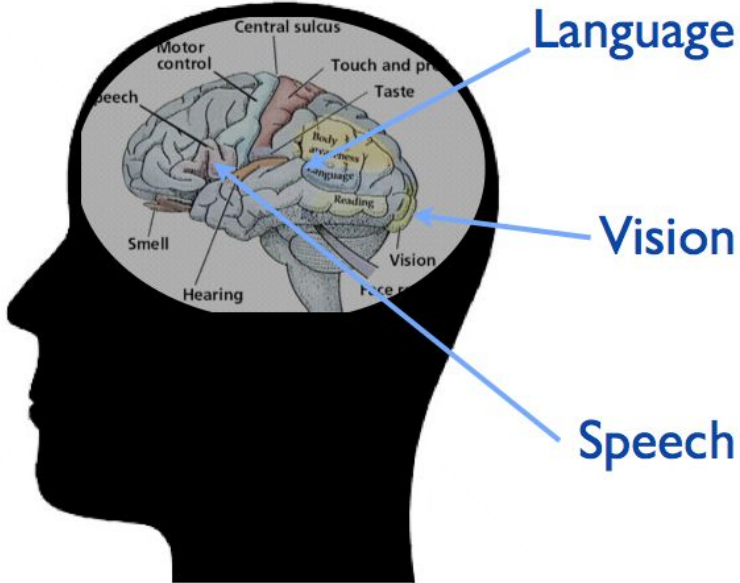
Sony Corporate Research

<https://uhlich.updog.co/>



Artificial Intelligence (AI)

Human Brain

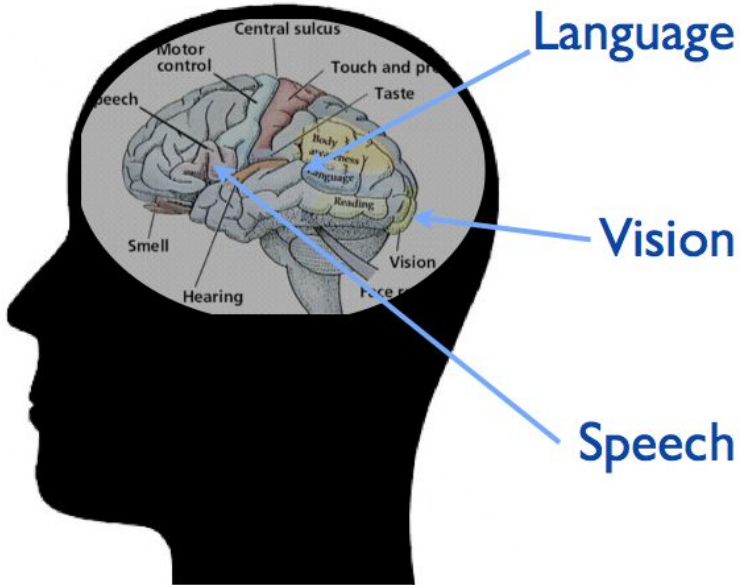


Machine Learning



Artificial Intelligence (AI)

Human Brain



Machine Learning

Natural Language Processing

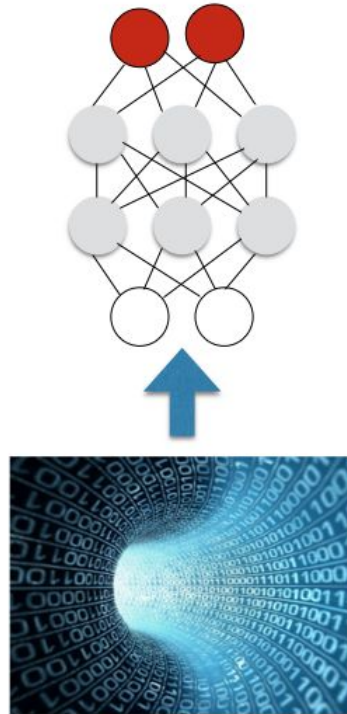
Computer Vision

Automatic Speech Processing

Deep Learning



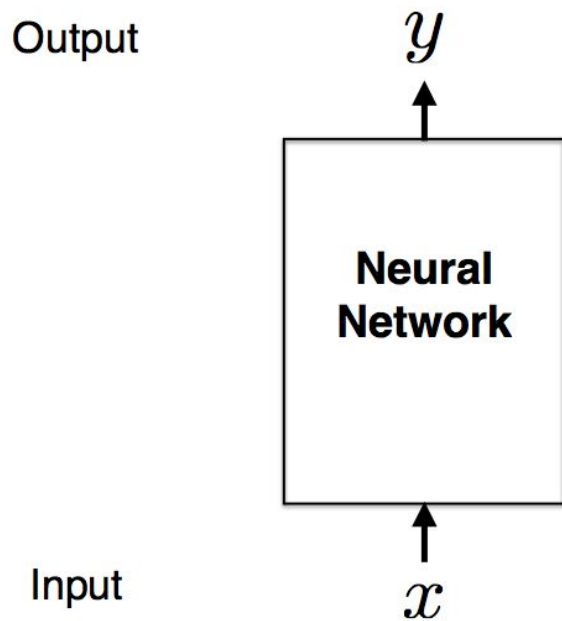
Deep Learning



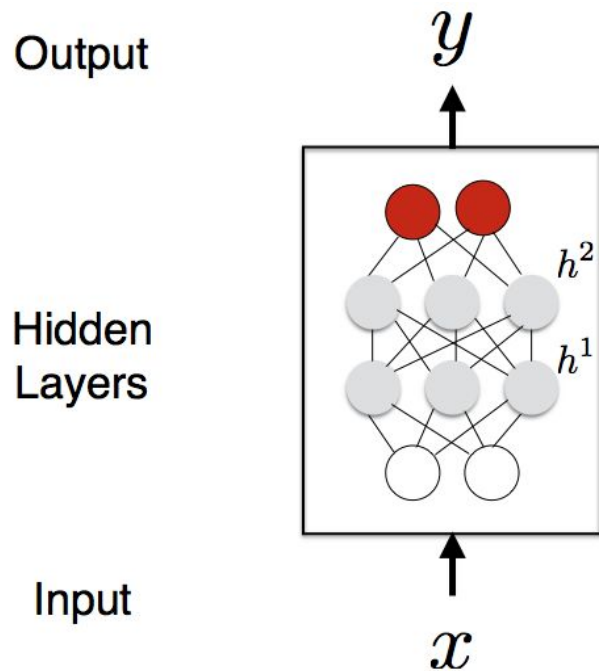
Neural
Networks

Data

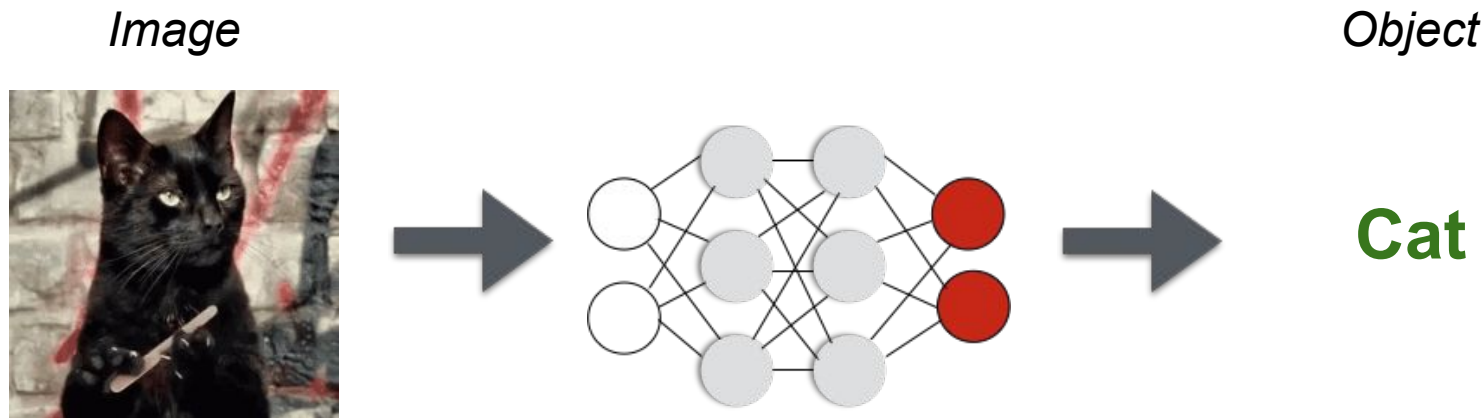
Neural Networks are good *function approximators*



Neural Networks are good *function approximators*



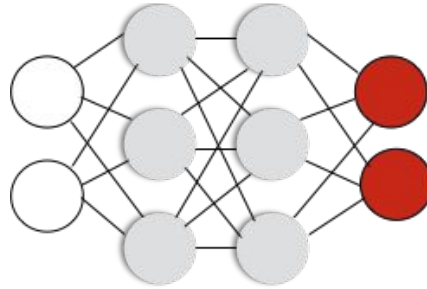
Neural Networks that *see* & *understand images*



Surpasses human-level performance for recognizing thousands of object categories (ILSVRC 2014 task)

Neural Networks that *see* & *understand images*

Image

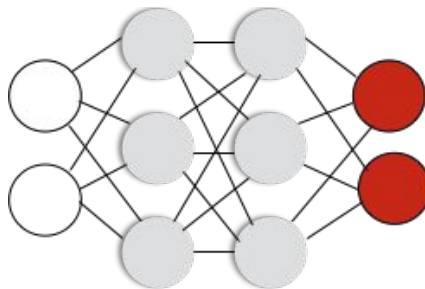


Concept

Dessert

Neural Networks that *hear* & *understand speech*

Acoustic input



Text output

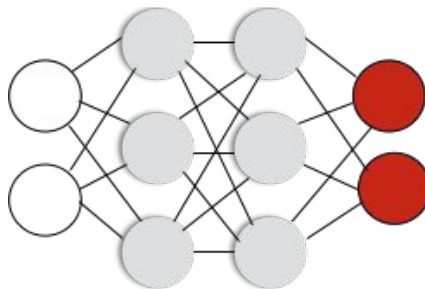
**Words /
Sentences**

Reduced word errors in speech recognition by >30%

Neural Networks that *read* & *understand text*

German text

**Ich liebe
Hamburg**



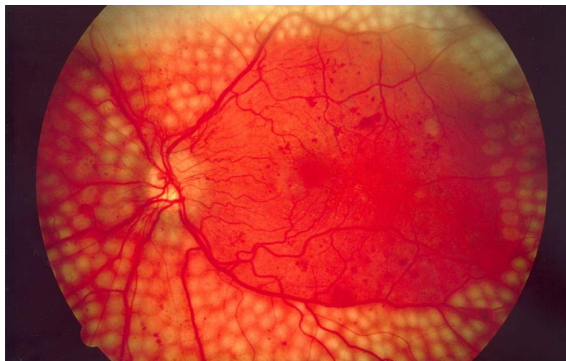
English translation

**I love
Hamburg**

Neural machine translation achieves state-of-the-art performance

And applications beyond...

Health



Self-driving / Automotive



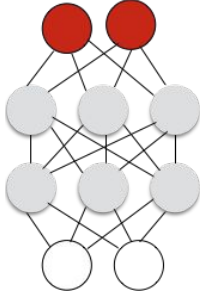
Games



...

Image source: Wikipedia

Why is Deep Learning Effective?



Data

Large

Computing

Fast

Models

Powerful

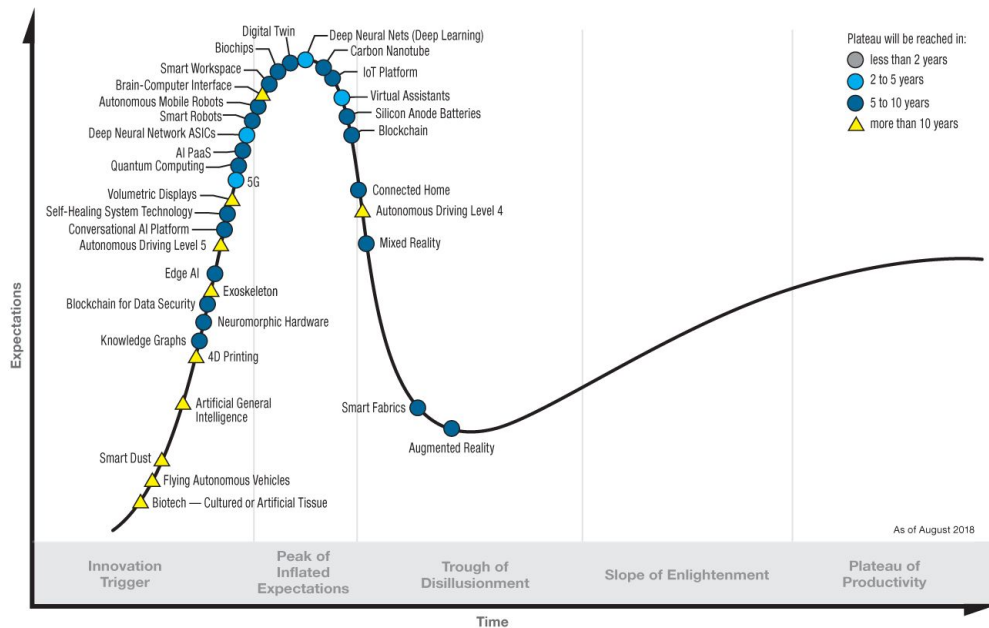
Tools

Easy-to-use

Why now?

- Simple neurons/networks have been around since ~1950s
- Why is deep learning trending now?

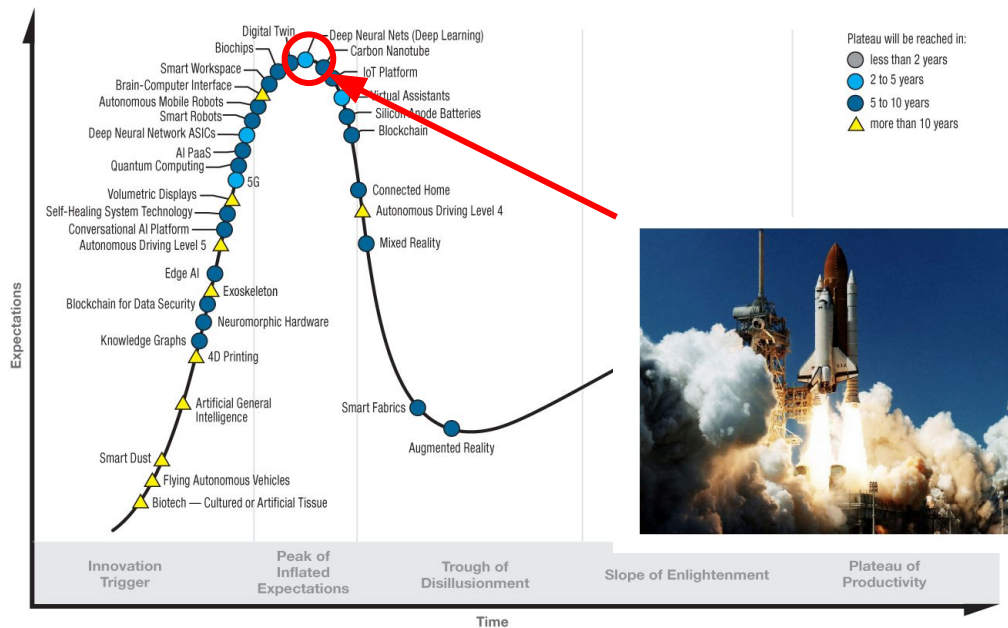
Hype Cycle for Emerging Technologies, 2018



Why now?

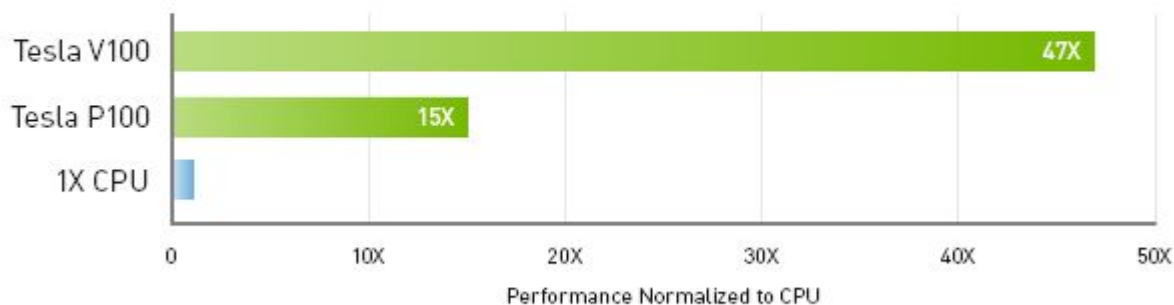
- Simple neurons/networks have been around since ~1950s
- Why is deep learning trending now?

Hype Cycle for Emerging Technologies, 2018



Why now?

- ***Massive parallel processing on GPUs/TPUs***
 - Allows us to train large networks on large datasets



Workload: ResNet-50 | CPU: 1X Xeon E5-2690v4 @ 2.6 GHz | GPU: Add 1X Tesla P100 or V100

Source: <https://www.nvidia.com/de-de/data-center/tesla-v100/>

GPU ... Graphics processing unit
TPU ... Tensor processing unit

Why now?

- ***Access to huge datasets***
 - Image, Video, Audio, Text/NLP, ...



1.2M images, 1K classes

{ ||||| } AudioSet

5.8 thousand hours of audio, 527 classes

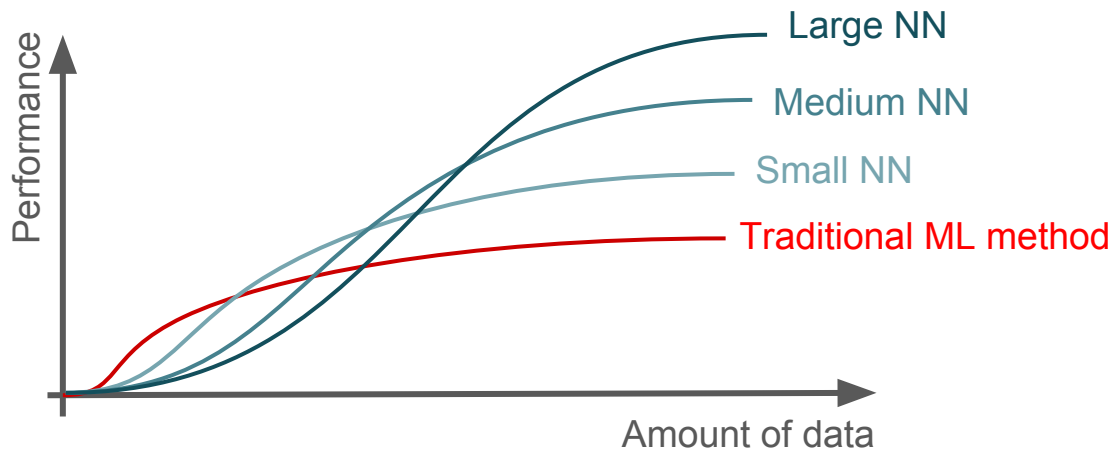
YouTube | 8M

350K hours (= 40 years), ~4K classes

[YouTube-100M: 600 years of video - more than one human will see in his lifetime]

Why now?

- ***Access to huge datasets***
 - Deep neural networks (DNNs) nicely scale with more data



Why now?

- ***Open-source software + ArXiv/ArXiv sanity***
 - Open-source DNN toolboxes available: Tensorflow, PyTorch, ...
 - Many papers come with source code on Github
 - Timely access to latest results

→ Fast progress



So - everything is solved?

No - there are still many open problems that need to be tackled ...

- Fairness in machine learning (avoid to learn biases from datasets)
- Robustness against adversarial samples/adversarial users
- Explanations for decisions from a deep neural network/ML algorithm
- Learning from noisy labels
- (General) AI still not available
- ...

→ Session presentations

Session Program

Software 2.0: Machine Learning is Changing Software

Chris Re, Stanford University



Teaching Machines to Communicate with People using Deep Learning

Zornitsa Kozareva, Google



Deep Learning for Visual and Virtual Worlds

Eleonora Vig, German Aerospace Center (DLR)



Artificial Intelligence in Cognitive Neural Engineering

Moritz Grosse-Wentrup, University of Vienna

