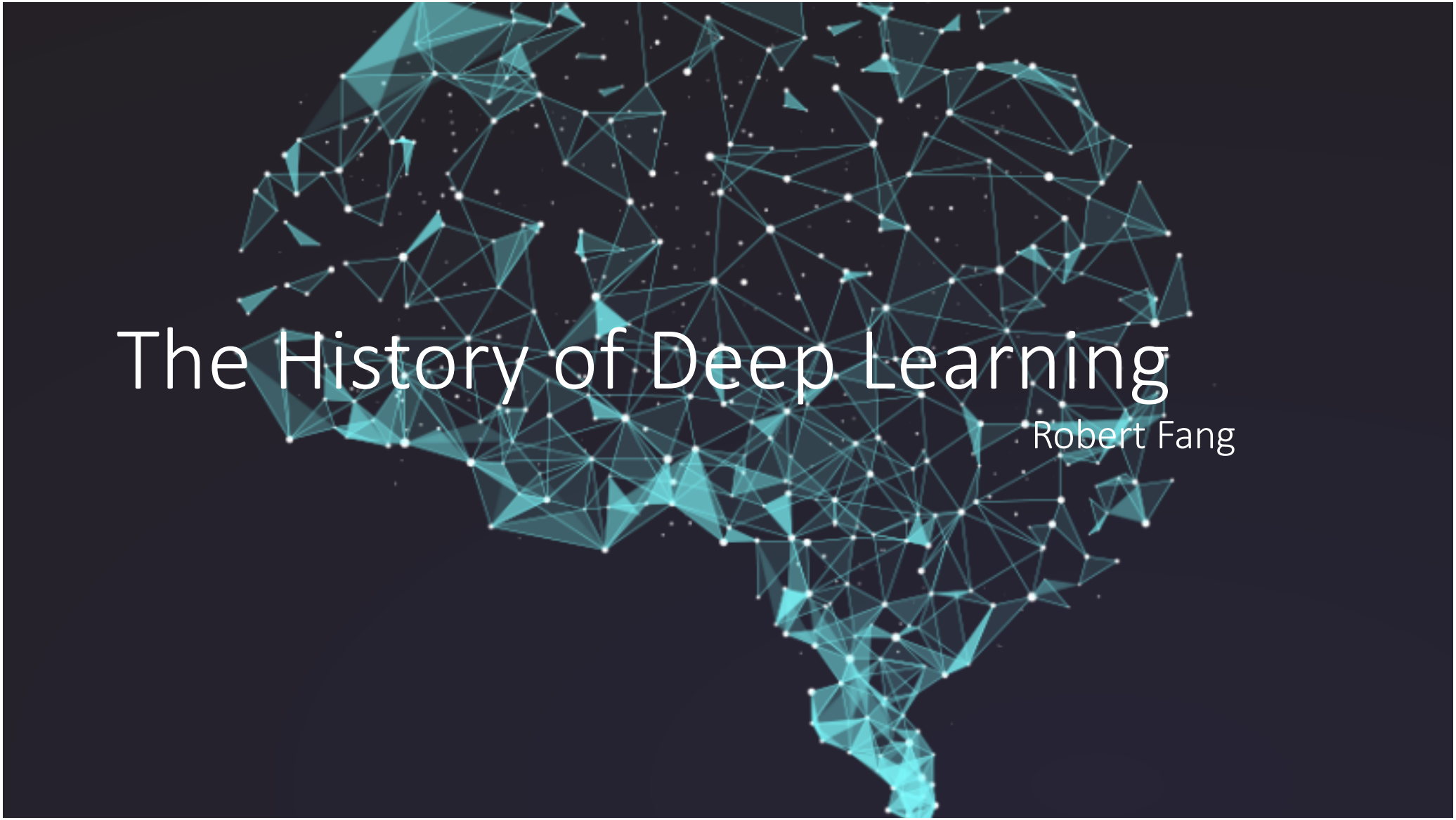
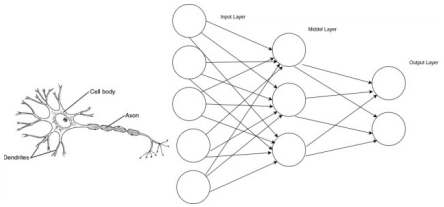


The History of Deep Learning

Robert Fang

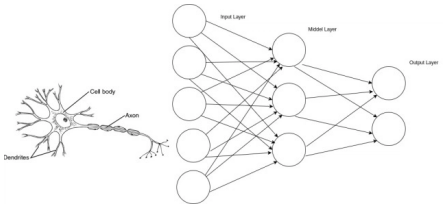


Artificial Intelligence

Technology Intelligence

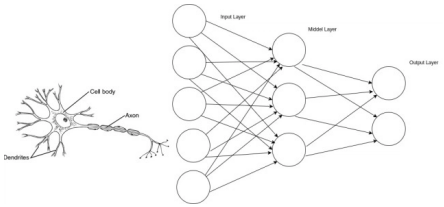
Uber IPO: Story behind the controversial taxi hailing app and 2019's biggest float

Microsoft makes a push to simplify **machine learning**
TechCrunch - May 2, 2019
Microsoft makes a push to simplify **machine learning** ... the processes, as well as a visual model builder, which grew out of the Azure ML **Studio**.



Artificial Intelligence

Mario Klingemann
MEMORIES OF PASSERSBY



Artificial Intelligence

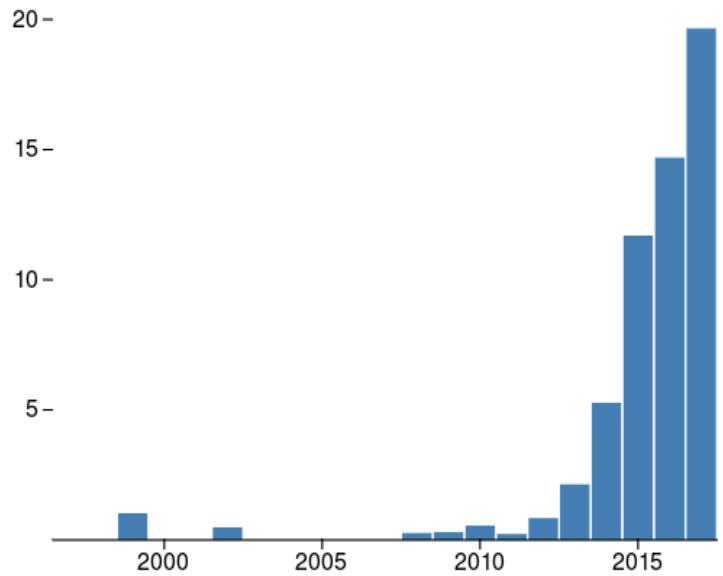
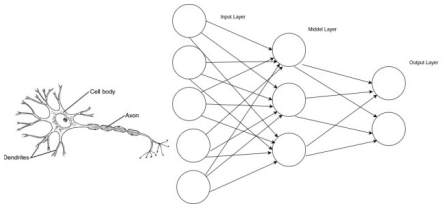
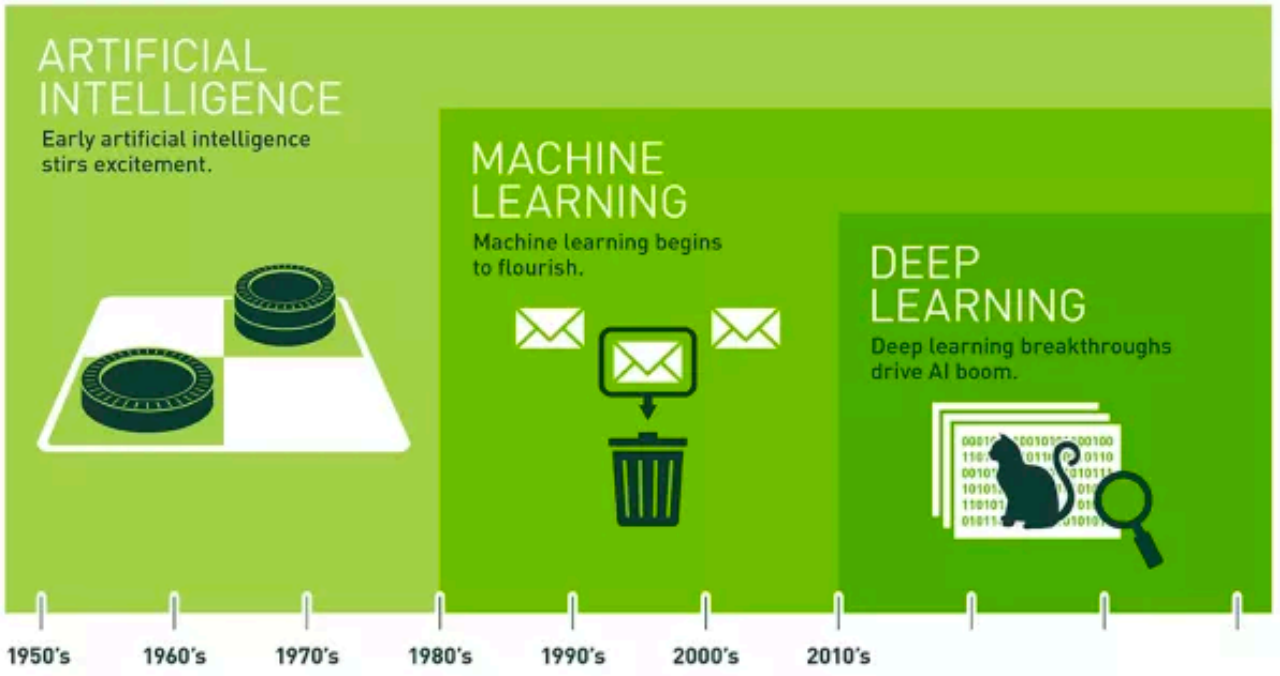


Figure 5: Percentage of selected arXiv publications with either "deep", "adversarial" or "convolutional" in the title

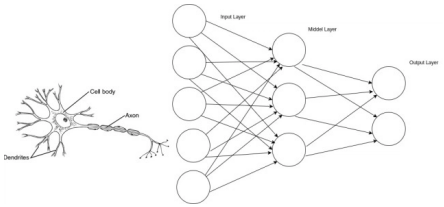
https://medium.com/digital-catapult/why-the-ai-revolution-is-really-a-deep-learning-revolution-23e45da2ba3a



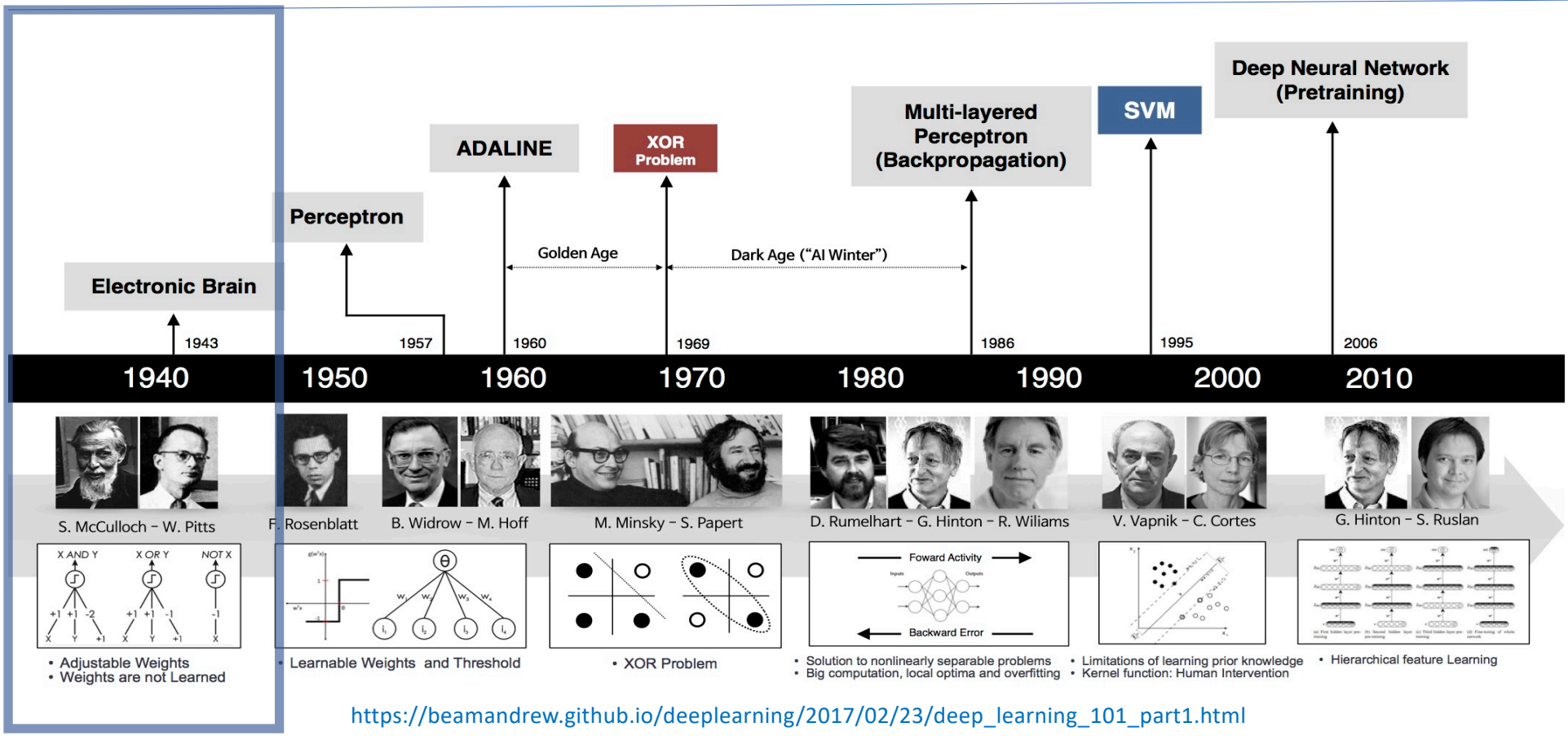
AI Hierarchy



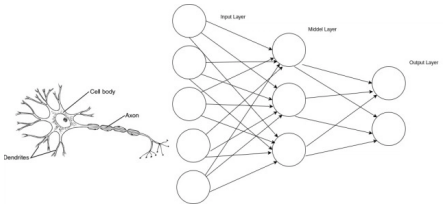
Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.



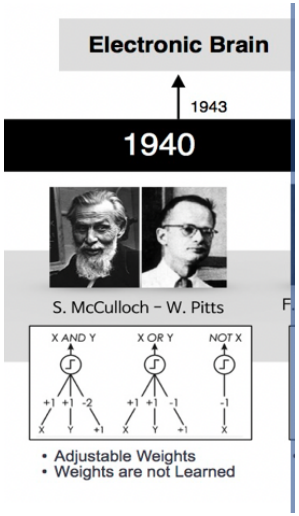
Milestones



https://beamandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html

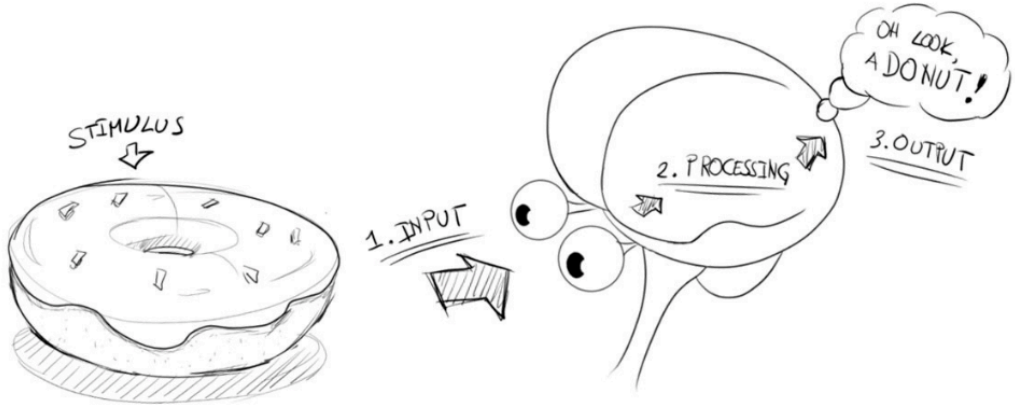


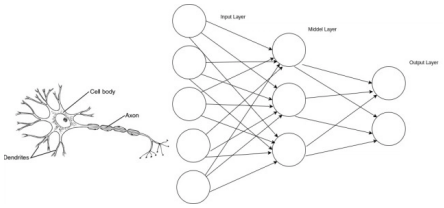
Early Work



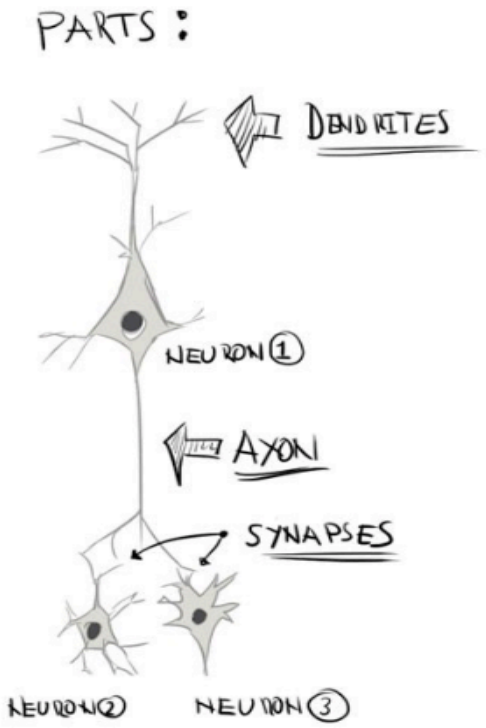
Walter Pitts and Warren McCulloch

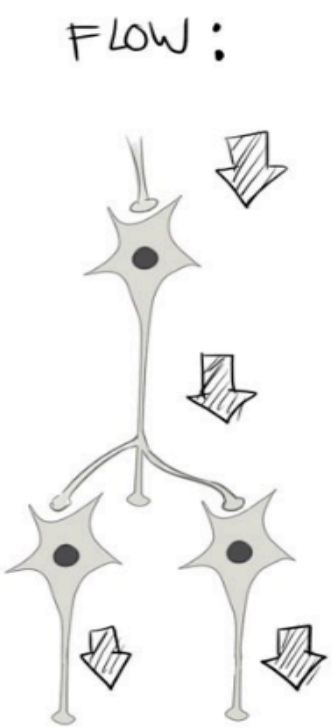
- "Thresholded Logic Unit"
- Based on research in neurology

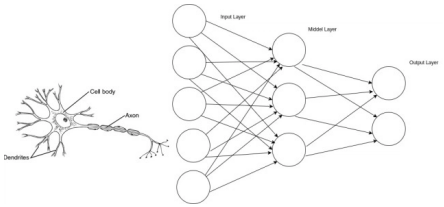



Input Layer
Middel Layer
Output Layer
Cell body
Axon
Dendrites

Early Work


PARTS:
DENDRITES
NEURON (1)
AXON
SYNAPSES
NEURON (2)
NEURON (3)

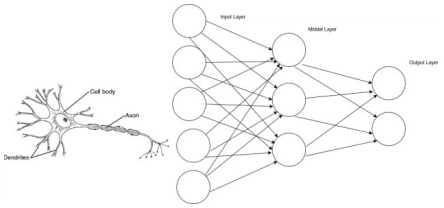

FLOW:



1955 - Birth of AI

John McCarthy's Proposal

"We propose that a 2-month, 10-man study of ***artificial intelligence*** *be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that* ***every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it.*** *An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer. "*

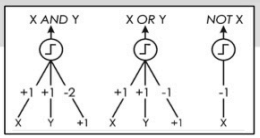


Milestones

Electronic Brain

1943

S. McCulloch – W. Pitts

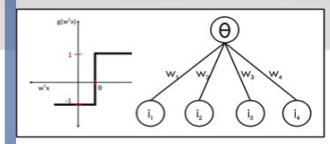


- Adjustable Weights
- Weights are not Learned

Perceptron

1957

F. Rosenblatt



- Learnable Weights and Threshold

ADALINE

1960

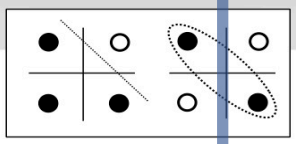
B. Widrow – M. Hoff

Golden Age

XOR Problem

1969

M. Minsky – S. Papert



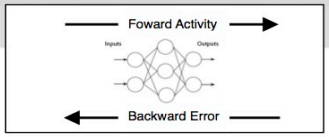
- XOR Problem

Dark Age ("AI Winter")

Multi-layered Perceptron (Backpropagation)

1986

D. Rumelhart – G. Hinton – R. Wiliams

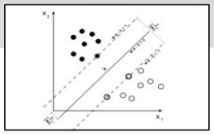


- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting

SVM

1995

V. Vapnik – C. Cortes

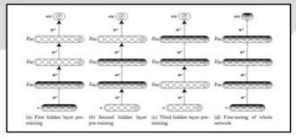


- Limitations of learning prior knowledge
- Kernel function: Human Intervention

Deep Neural Network (Pretraining)

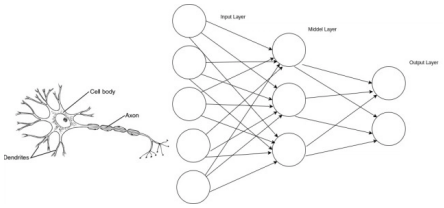
2006

G. Hinton – S. Ruslan

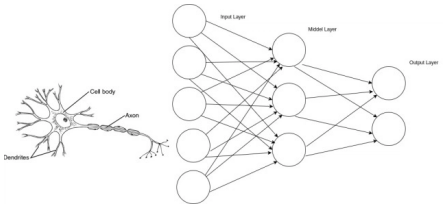


- Hierarchical feature Learning

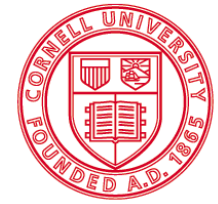
1940 1950 1960 1970 1980 1990 2000 2010



Enter the Perceptron

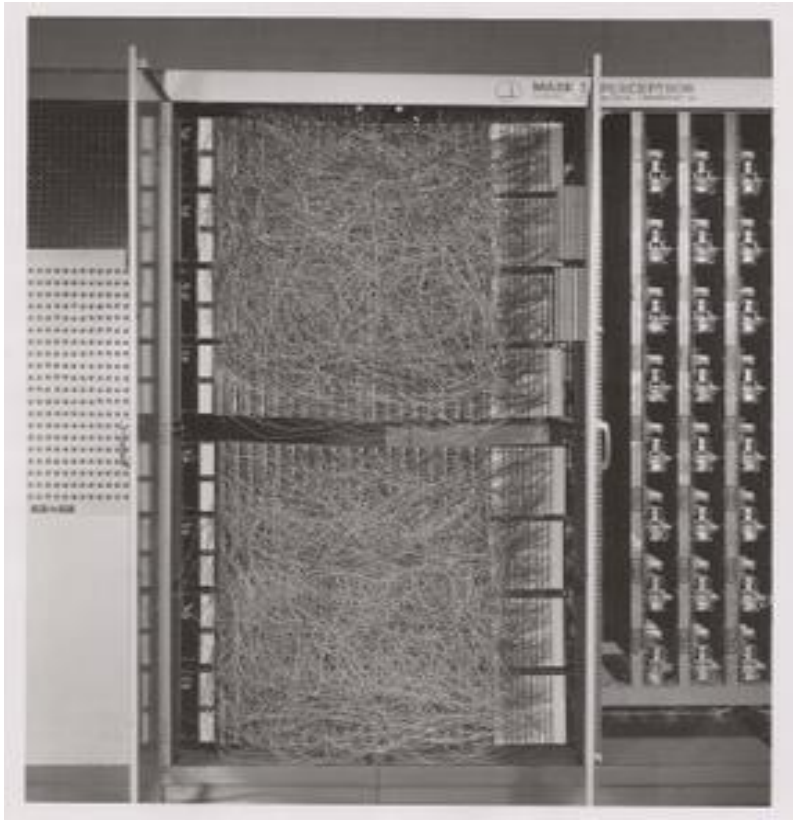


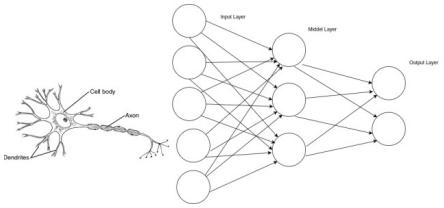
Enter the Perceptron



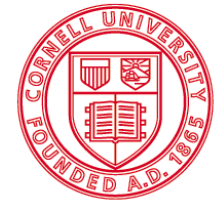
Cornell University

1957 Perceptron algorithm
by Frank Rosenblatt





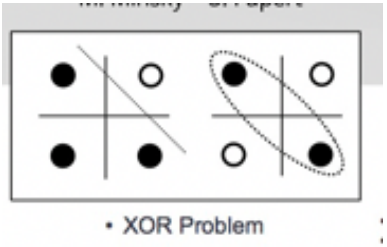
Enter the Perceptron

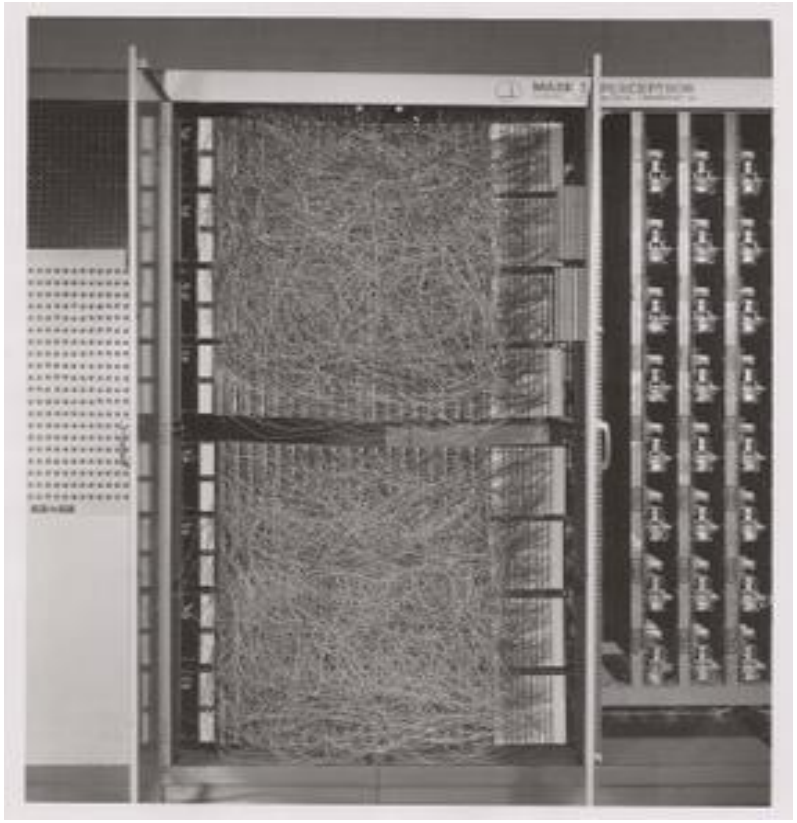


Cornell University

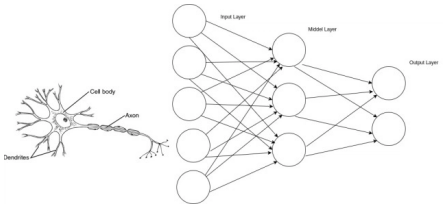
1957 Perceptron algorithm
by Frank Rosenblatt

1969 - Publication of
Minsky and Papert's book
Perceptrons

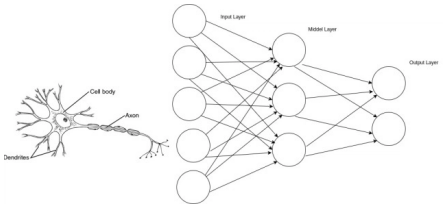




https://en.wikipedia.org/wiki/Perceptron



The First AI Winter (1969)



Thaw of Winter

Electronic Brain
1943
S. McCulloch – W. Pitts

Perceptron
1957
F. Rosenblatt

ADALINE
1960
B. Widrow – M. Hoff

XOR Problem
1969
M. Minsky – S. Papert

Golden Age

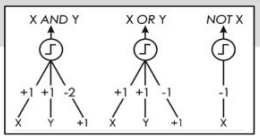
Dark Age ("AI Winter")

Multi-layered Perceptron (Backpropagation)
1986
D. Rumelhart – G. Hinton – R. Wiliams

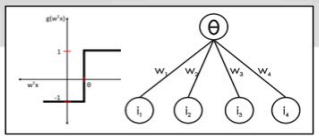
SVM
1995
V. Vapnik – C. Cortes

Deep Neural Network (Pretraining)
2006
G. Hinton – S. Ruslan

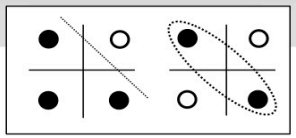
1940 1950 1960 1970 1980 1990 2000 2010



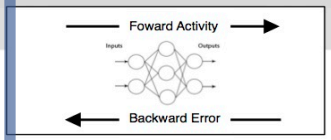
- Adjustable Weights
- Weights are not Learned



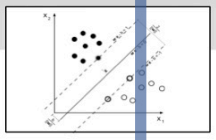
- Learnable Weights and Threshold



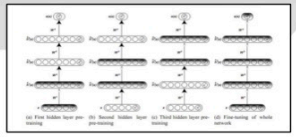
- XOR Problem



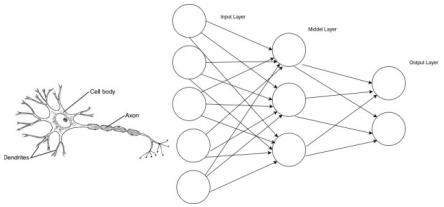
- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting



- Limitations of learning prior knowledge
- Kernel function: Human Intervention

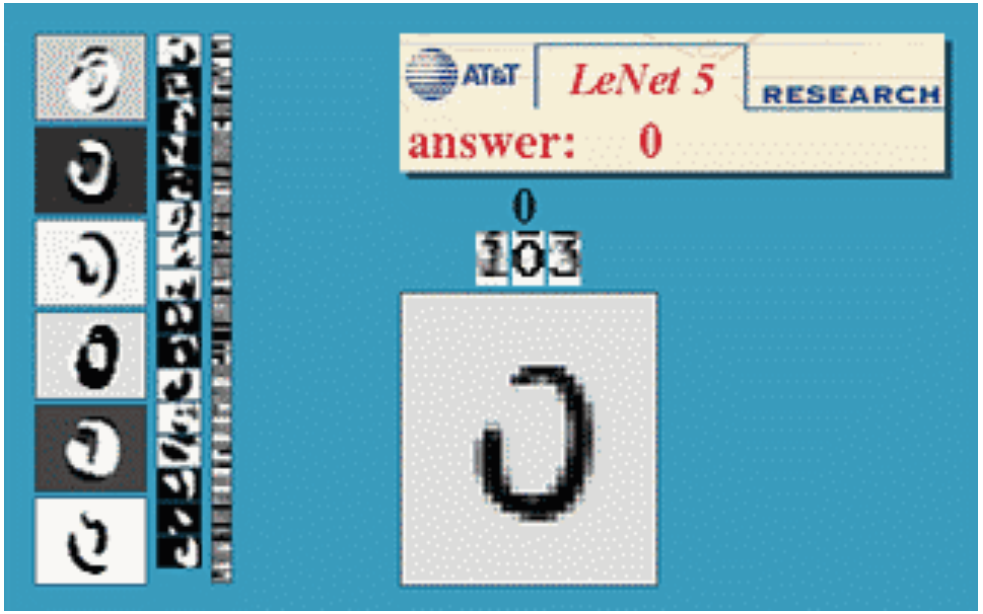


- Hierarchical feature Learning

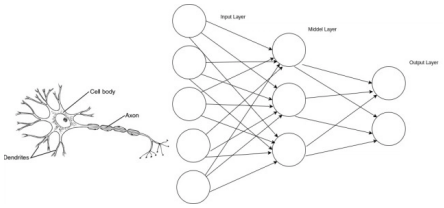


Rise of the Multilayer System

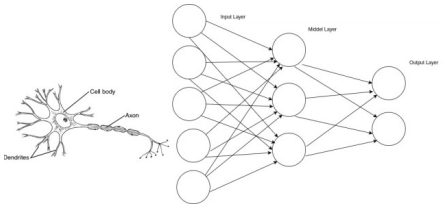
- 1986 Geoff Hinton, David Rumelhart and Ronald Williams
  - "Learning representations by back-propagating errors"
- Convolutional Neural Networks



http://yann.lecun.com/exdb/lenet/



The Second AI Winter



Birth of Deep Learning

Electronic Brain — 1943

Perceptron — 1957

ADALINE — 1960

XOR Problem — 1969

Golden Age

Dark Age ("AI Winter")

Multi-layered Perceptron (Backpropagation) — 1986

SVM — 1995

Deep Neural Network (Pretraining) — 2006

1940 1950 1960 1970 1980 1990 2000 2010

S. McCulloch – W. Pitts

F. Rosenblatt

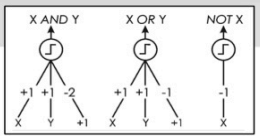
B. Widrow – M. Hoff

M. Minsky – S. Papert

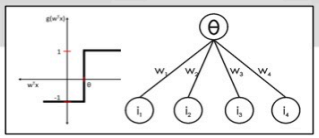
D. Rumelhart – G. Hinton – R. Wiliams

V. Vapnik – C. Cortes

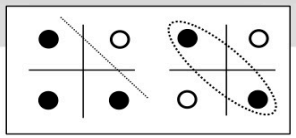
G. Hinton – S. Ruslan



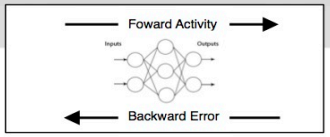
- Adjustable Weights
- Weights are not Learned



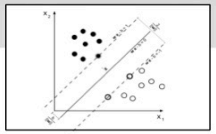
- Learnable Weights and Threshold



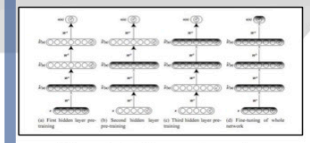
- XOR Problem



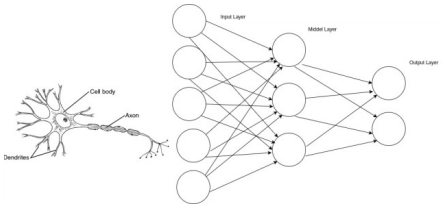
- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting



- Limitations of learning prior knowledge
- Kernel function: Human Intervention



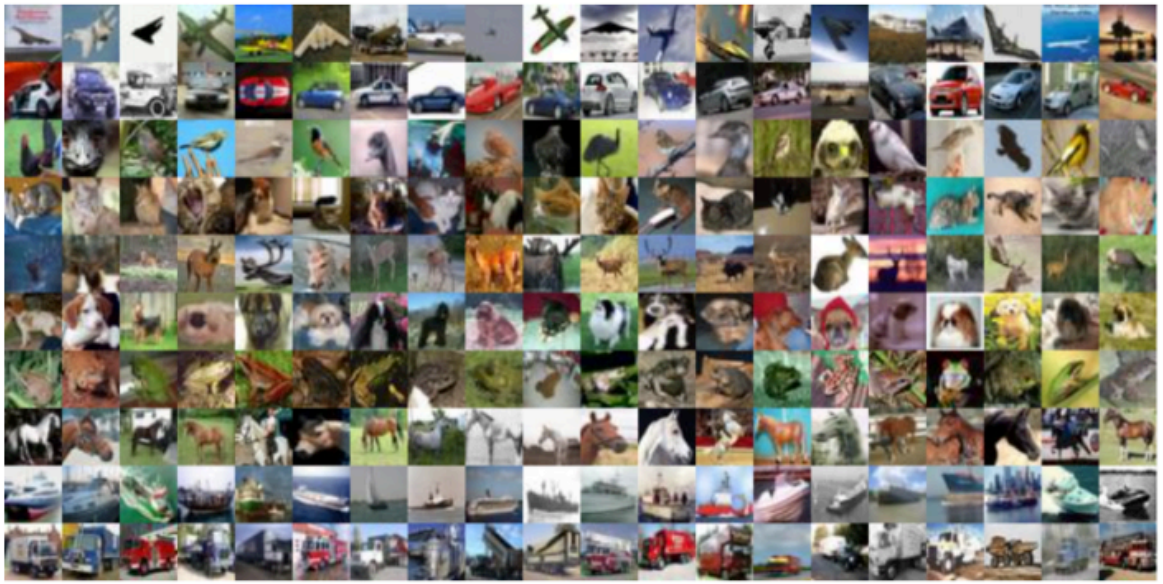
- Hierarchical feature Learning



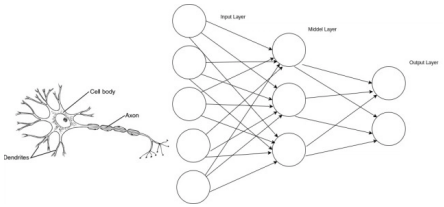
Battle of LSVRC

IMAGENET

The **ImageNet** project is a large visual database designed for use in visual object recognition software research

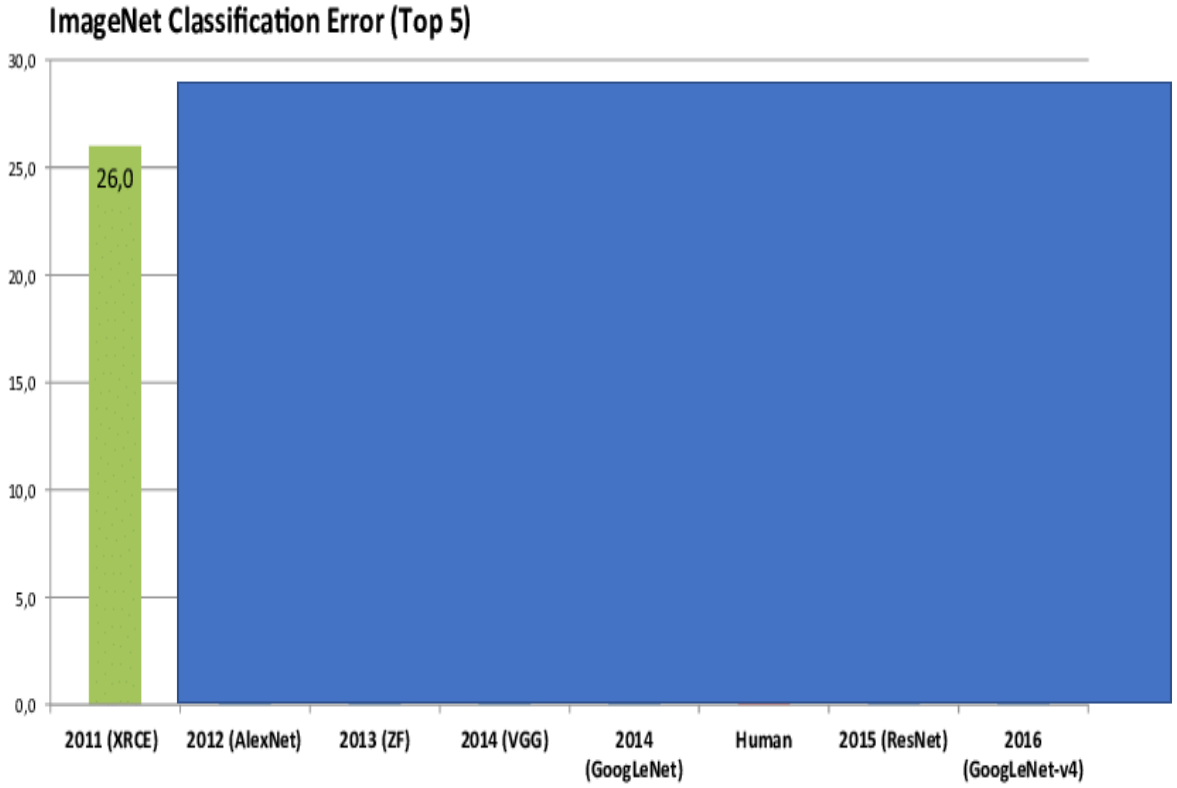


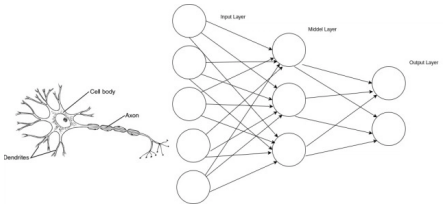
15 millions of images



Battle of LSVRC

IMAGENET

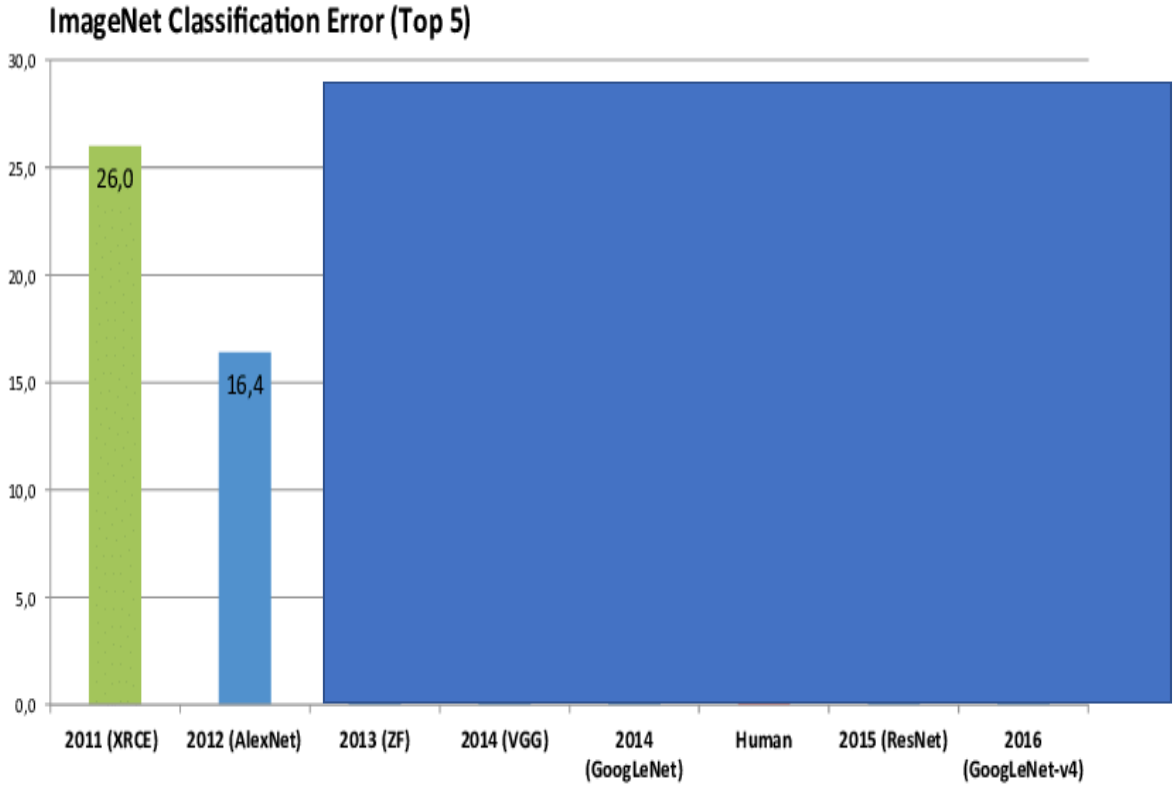


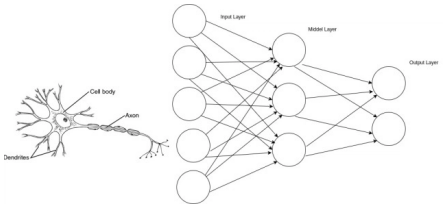


Battle of LSVRC

IMAGENET

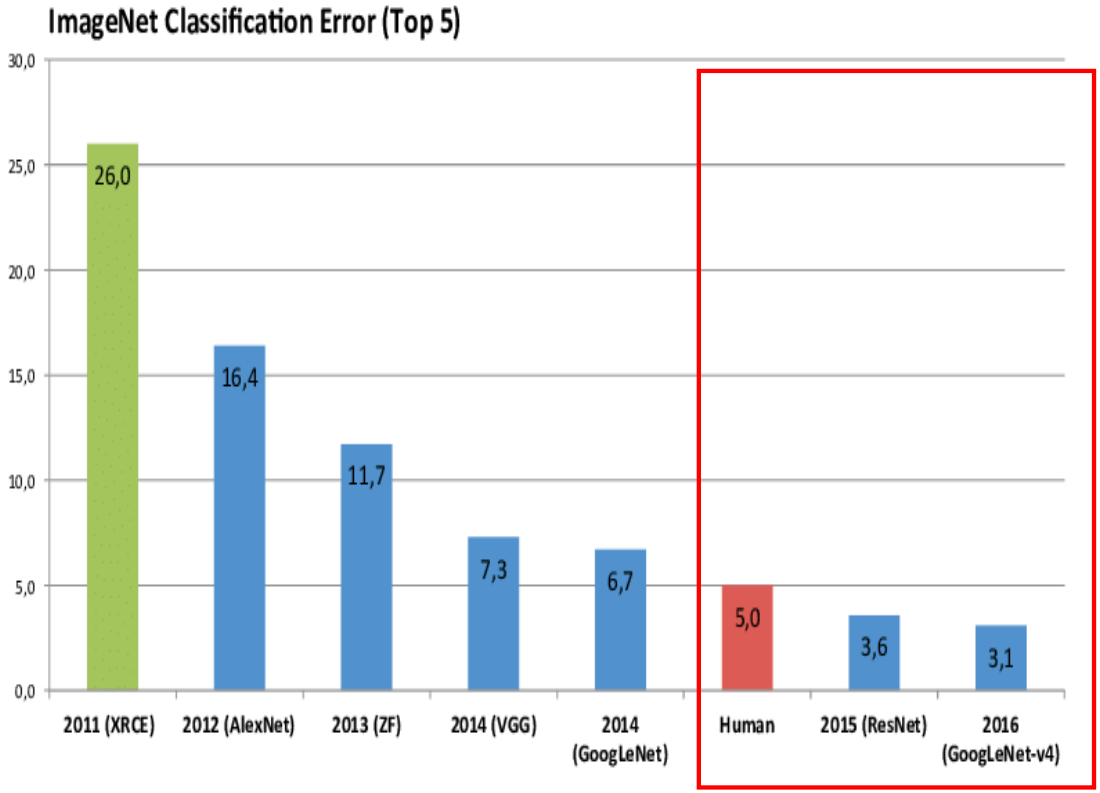
2012, Alex Krizhevsky, Ilya Sutskever, and Geoff Hinton entered a submission that would halve the existing error rate to **16%.**



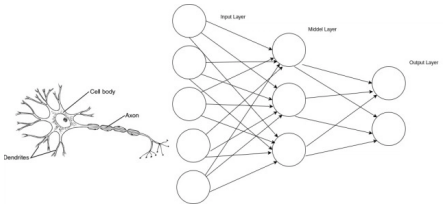


Battle of LSVRC

IMAGENET

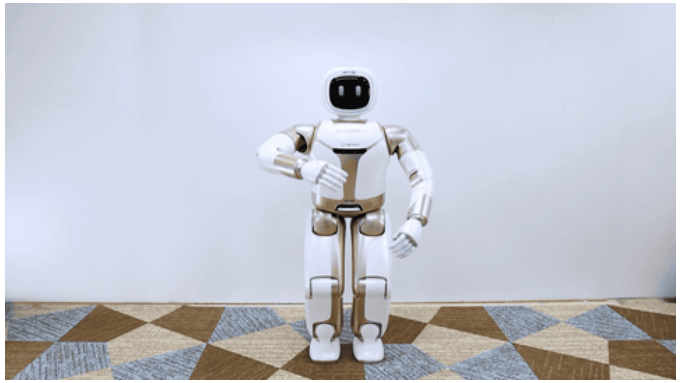


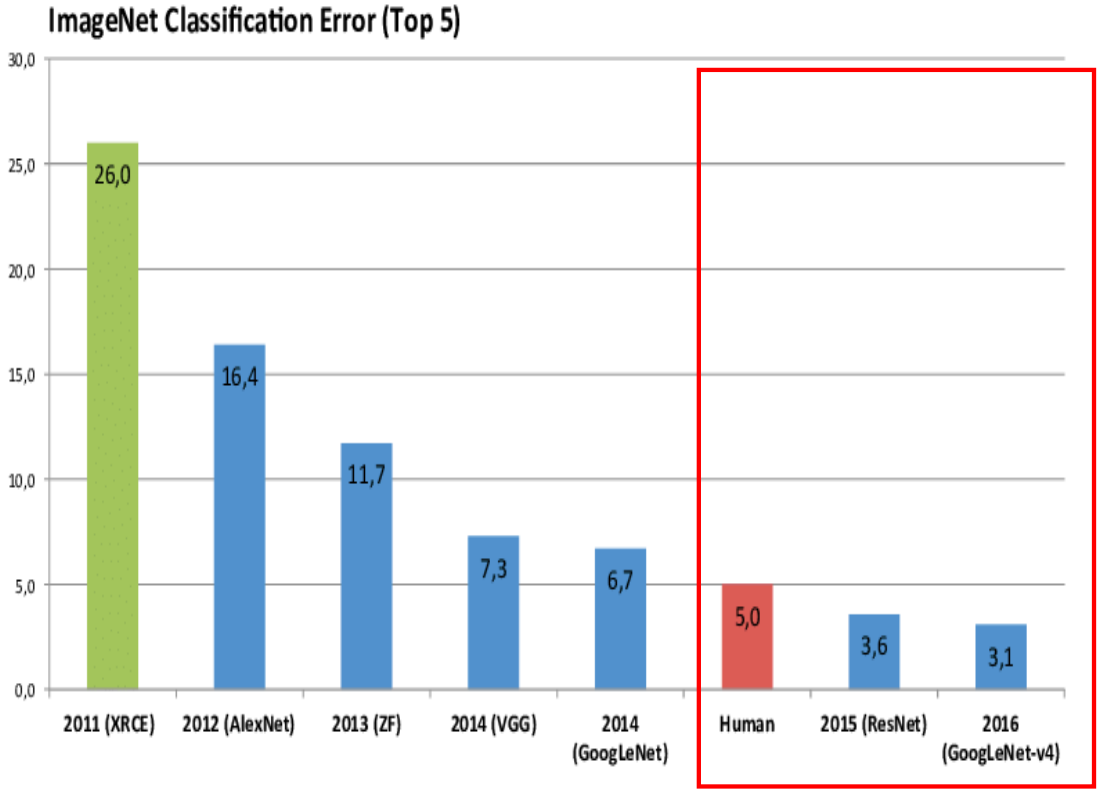
https://www.youtube.com/watch?v=rk2HKwQcfvU&t=151s%29



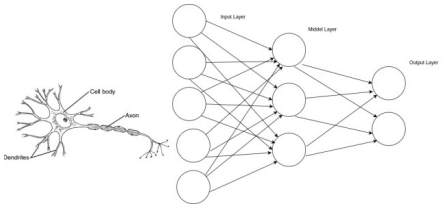
Battle of LSVRC

IMAGENET

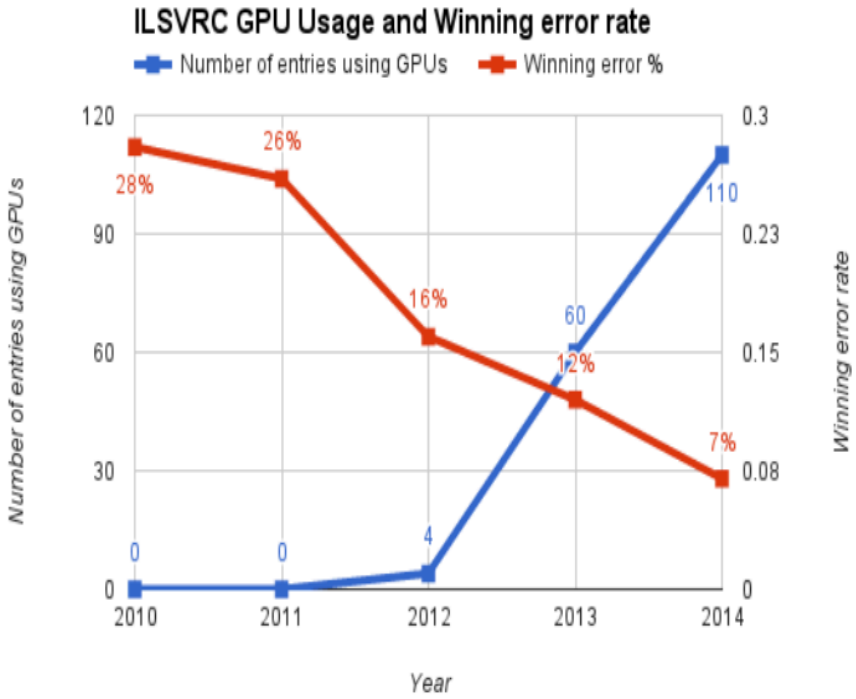


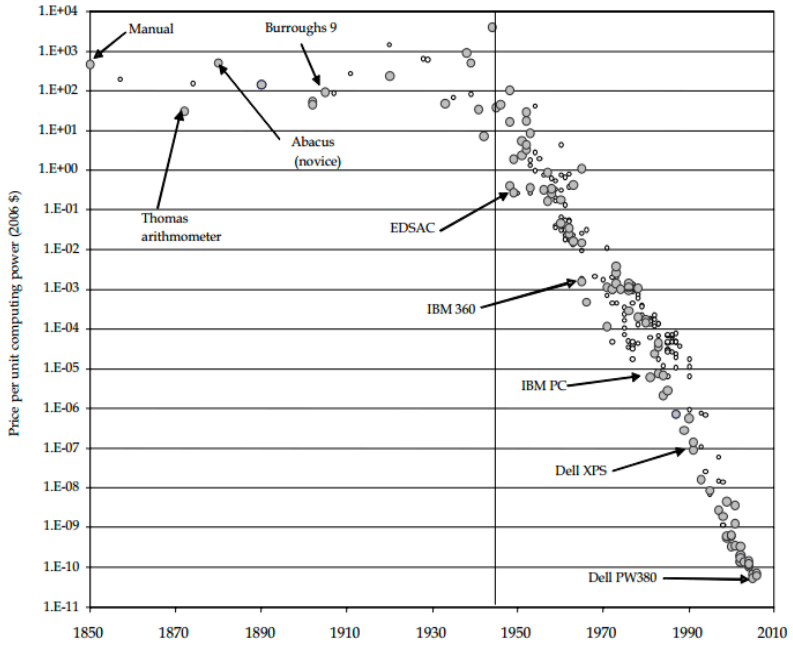


https://www.youtube.com/watch?v=rk2HKwQcfvU&t=151s%29

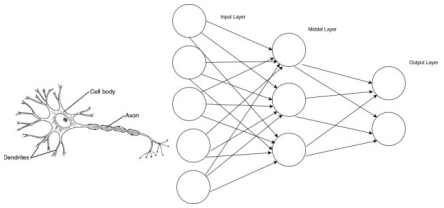


Why Now?



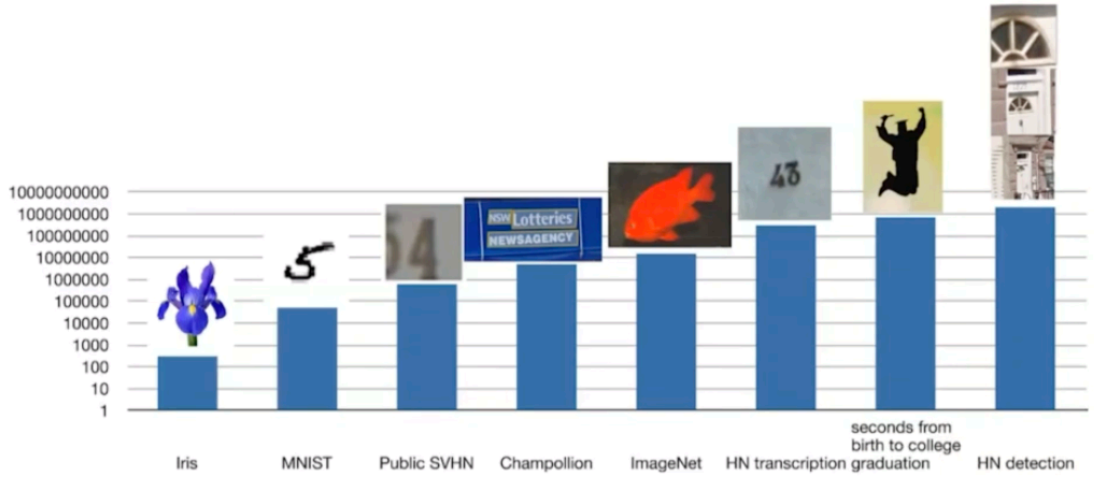


http://www.andreykurenkov.com/writing/a-brief-history-of-neural-nets-and-deep-learning/



Dataset Growth

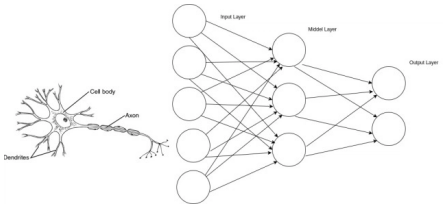
Dataset size and quality (circa 2013)



Waymo | Confidential & Proprietary

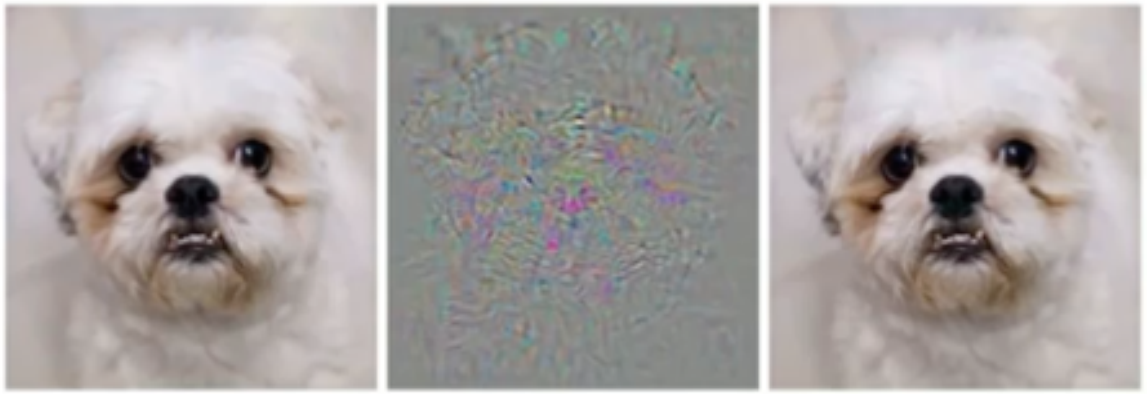
MIT Self-Driving Cars: Sacha Arnoud, Director of Engineering, Waymo

https://www.youtube.com/watch?v=rk2HKwQcfvU&t=151s%29



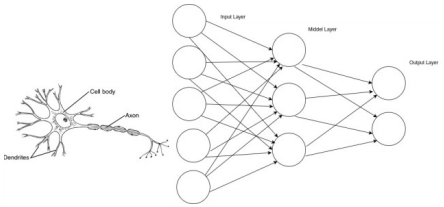
Not quite there yet

AlexNet Adverserial Examples



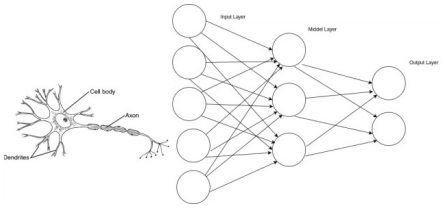
dog ostrich

https://arxiv.org/pdf/1312.6199.pdf - Intriguing properties of neural networks



Not quite there yet

https://vimeo.com/208642358



Additional Resources

Deep Learning - Beam Andrew - A well put together overview of basic of deep learning

https://www.youtube.com/watch?v=rk2HKwQcfvU&t=151s%29 – Deep Learning 101 by MissingLink

https://en.wikipedia.org/wiki/Neural_network

Deep Learning in a Nutshell: History and Training from NVIDIA

A Concise History of Neural Networks - A well-written summary from Jaspreet Sandhu of the major milestones in the development of neural networks

A 'Brief' History of Neural Nets and Deep Learning - An epic, multipart series from Andrey Kurenkov on the history of deep learning that I highly recommend