

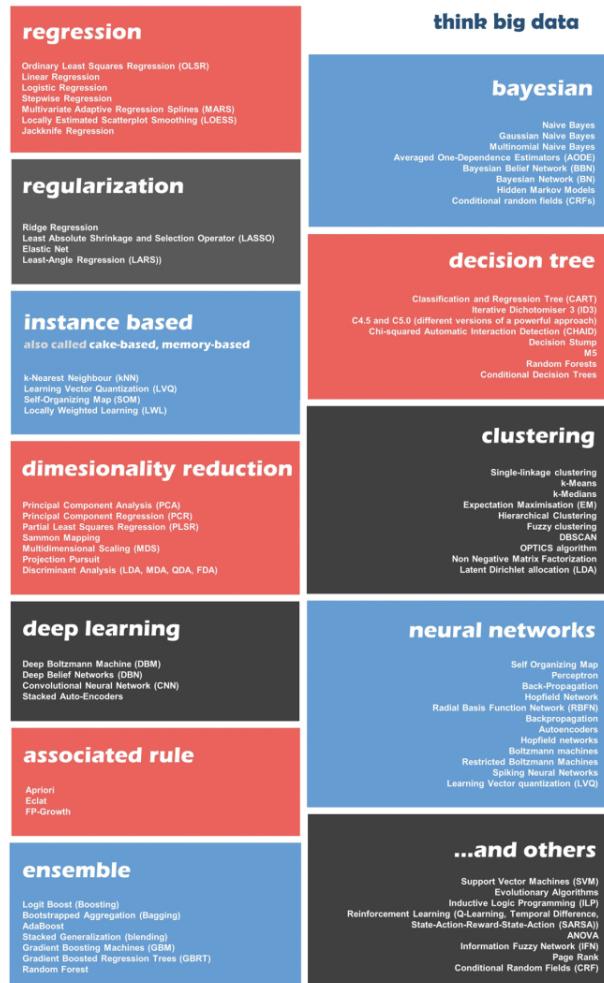


An introduction to Deep Learning

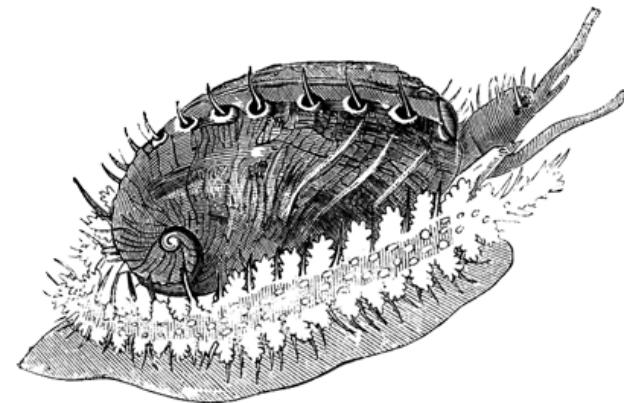
Frank Soboczenski

You may be: New to programming & new to machine learning

the world of machine learning algorithms – a summary



Documentation is for the weak



Programming by
Trial and Error

One Way or Another

O RLY?

/u/FractionalFunction

- Calculus
- Linear Algebra
- Statistics & Probabilities
- R/RStudio & Python
- Some SQL

COURSE STRUCTURE

PART I – INTRODUCTION

What Is Deep Learning?

Deep Learning & Artificial Intelligence

History & Background

Perceptron / Neuron how does it work?

Why Deep Learning for Finance?

PART II – MACHINE LEARNING BASICS

Linear regression

Classification

Overfitting / underfitting

Example Neuronal Networks

Stochastic gradient descent (SGD)

Loss Function

PART III – Deep Learning

Fully connected Deep Neural Network

Convolutional Neural Networks

Recurrent Neural Networks

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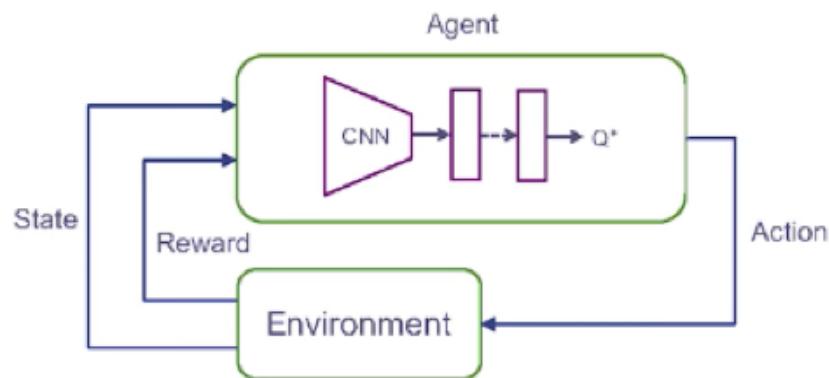
Convolutional Neural Networks

Recurrent Neural Networks

COURSE STRUCTURE



Deep Reinforcement Learning



Murray Shanahan

- An understanding of deep learning methods:
 Convolutional Neural Networks
 Recurrent Neural Networks
- How deep learning can help solving real-world problems
- Able to create & apply machine learning tools and techniques to real world problems
- In-depth experience in current state of the art tools



<http://www.andrewng.org/>



<http://www.deeplearningbook.org/>



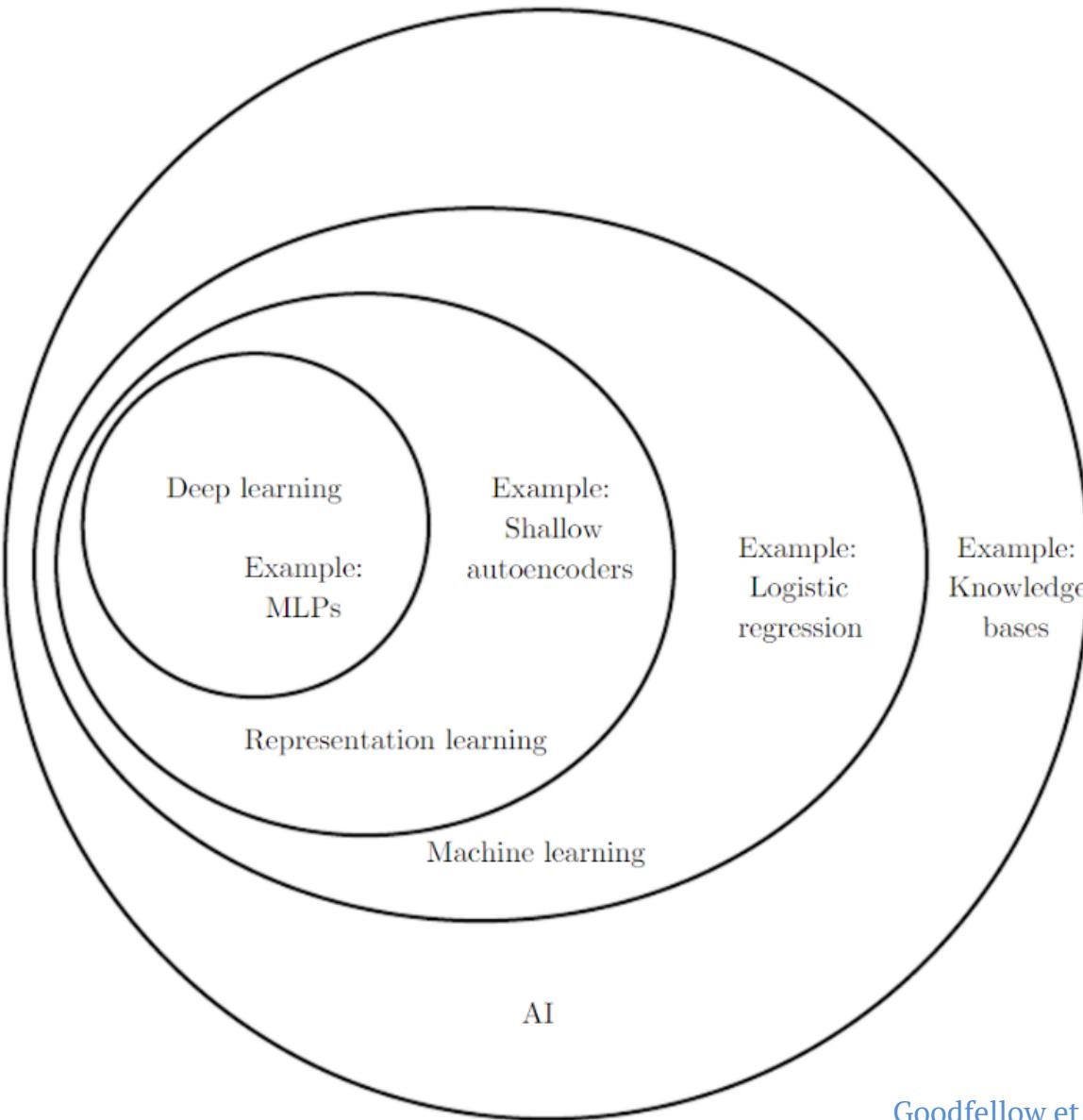
<http://localhost:8888/files/Rbook.pdf>



Example Jupyter Notebook

<http://localhost:8888/notebooks/Example1.ipynb>

PART I - INTRODUCTION

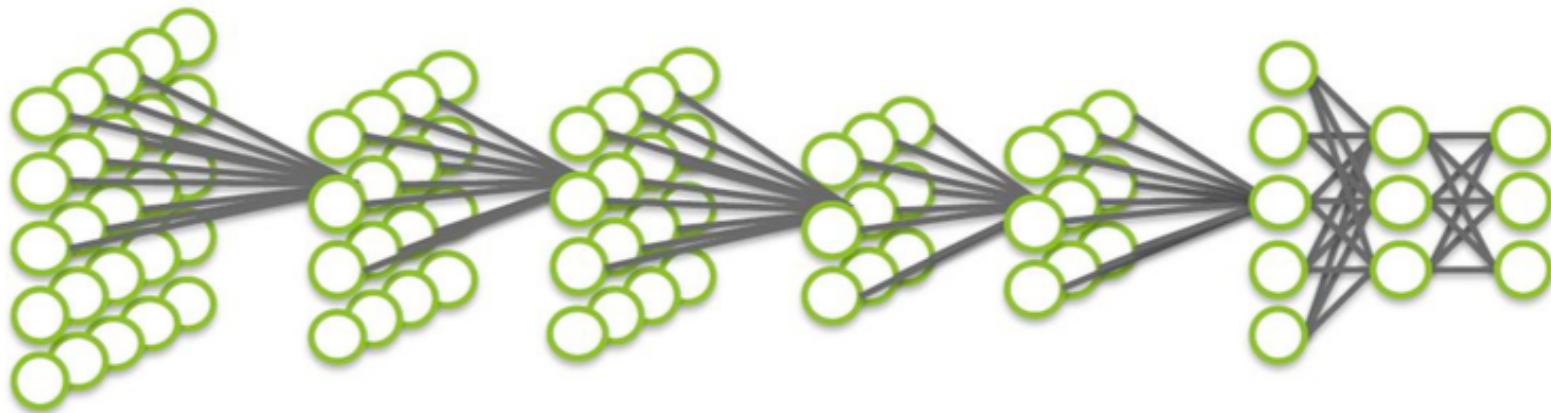


Goodfellow et al. "Deep learning." (2017)

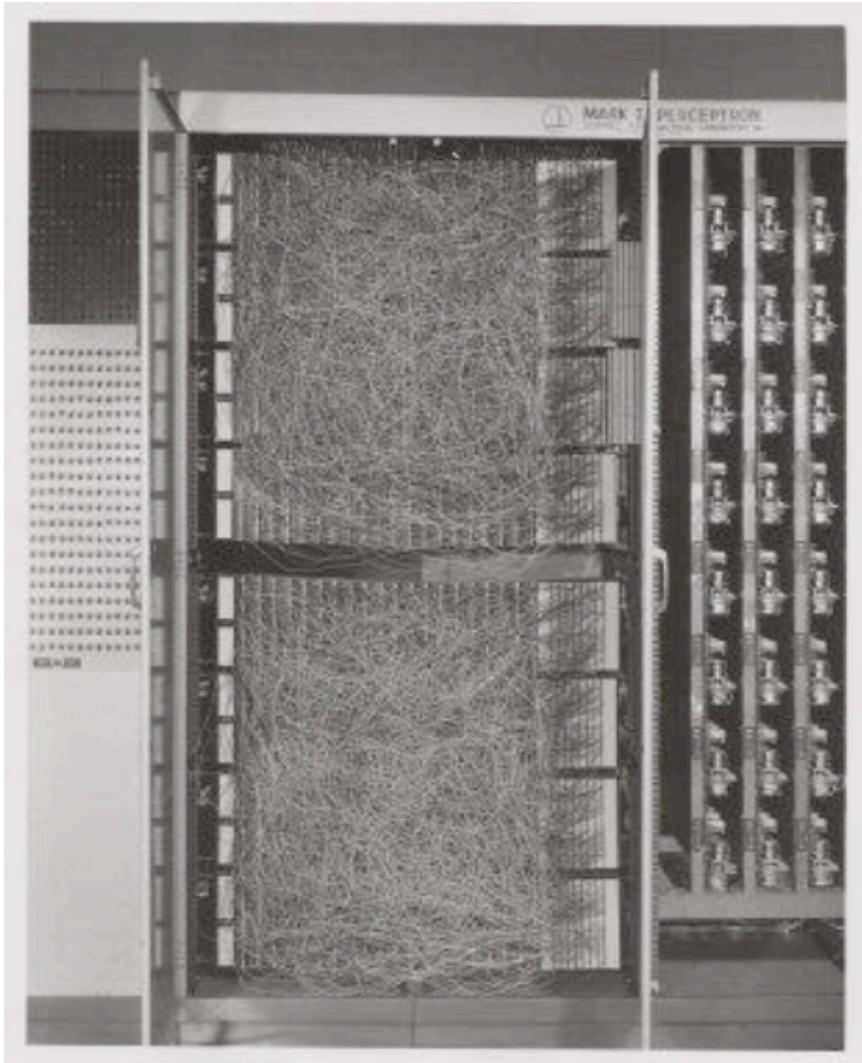
WHAT IS DEEP LEARNING?

Artificial Neural Network (ANN)

- class of machine learning technique
- consists of many **layers**
- **non-linear** information processing stages
- **hierarchical architectures**



HISTORY & BACKGROUND



Mark I Perceptron

The New York Times

NEW NAVY DEVICE LEARNS BY DOING

July 8, 1958

"The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence... Dr. Frank Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers"

Frank Rosenblatt

- 400 pixel image input
- Weights encoded in potentiometers
- Weight updated by electric motors



HISTORY & BACKGROUND

- 1950s: Artificial neural networks mimic the way the brain absorbs information and learns from it.
- 1960s: computer scientists: “a workable artificial intelligence system is just 10 years away!”
- 1966: failure of machine translation
- 1971-75: DARPA's frustration with the Speech Understanding Research program
- 1973: large decrease in AI research in the UK
- 1980s: a wave of commercial start-ups collapsed, leading to what some people called the “A.I. winter”
- 1990s: SVMs (Vapnik et al 1993)
- 2006: **Deep Learning**

Reducing the Dimensionality of Data with Neural Networks

G. E. Hinton* and R. R. Salakhutdinov



Keith Penner

2006: Geoffrey Hinton pioneers powerful new techniques for helping the artificial networks recognize patterns.

A student team led by the computer scientist Geoffrey E. Hinton used deep-learning technology to design software.

HISTORY & BACKGROUND

2006-present: Andrew Ng and others help popularize the method

2013: Google acquires Hinton's deep learning startup



HISTORY & BACKGROUND



DEEP TESLA

Localisation and Mapping:

Where am I?

Scene understanding:

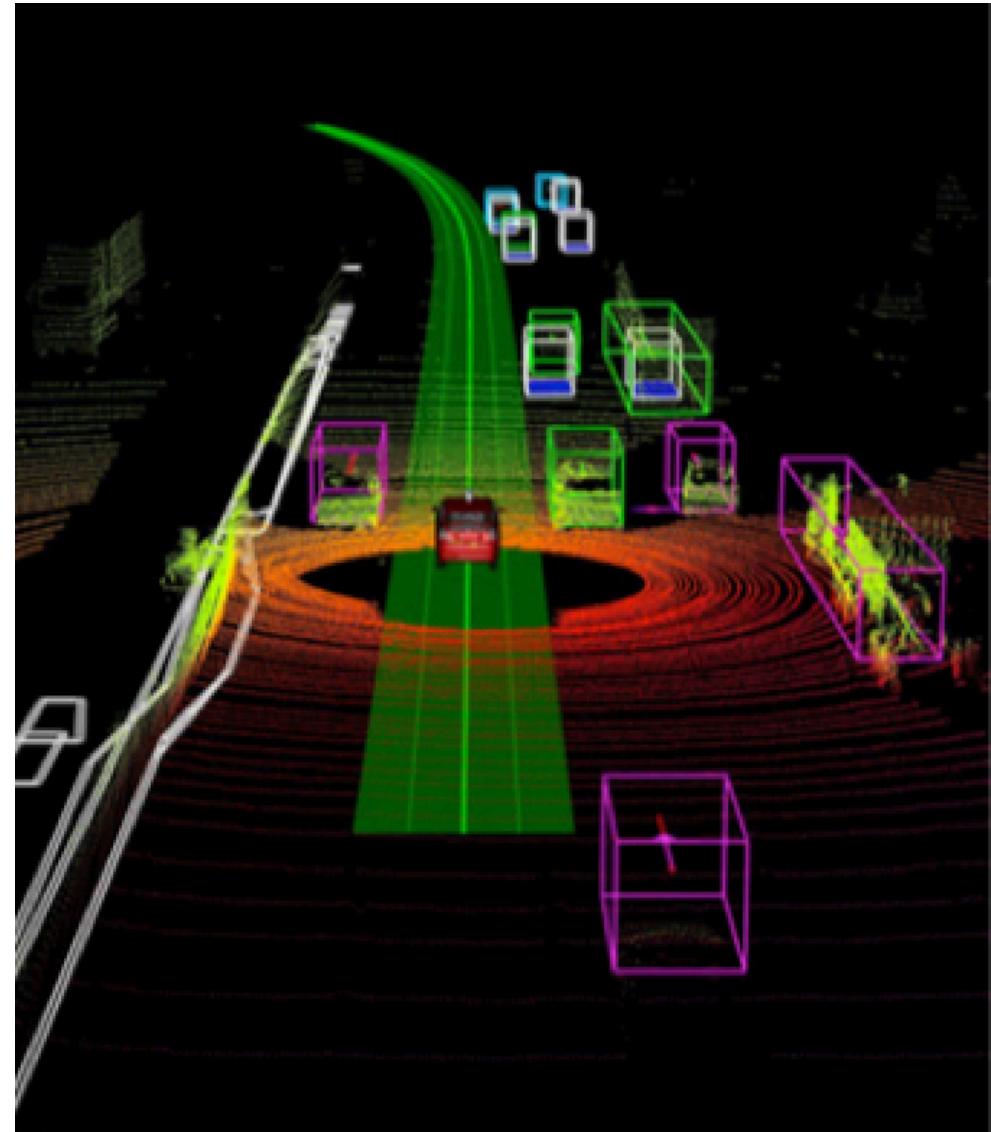
Where is everyone else?

Movement Planning:

How do I get from A to B?

Driver State:

What's the driver up to?



HISTORY & BACKGROUND



What Changed?

- Computation: CPUs, GPUs
- (Organised) large datasets: Imagenet, ...
- Algorithms & research: Backprop, CNN, LSTM
- Software & infrastructure: Git, Cloud ML, Amazon Mechanical Turk, TensorFlow, ...





Interface: **Python, (C++)**

- Automatic Differentiation
- Multi GPU, Cluster Support
- Currently most popular



Multi GPU Support (scales well)

- Interface: **Python, R, Julia, Scala, Go, Javascript ...**



Used by researchers doing lower level (closer to the details) neural network

- Interface: **Lua**
- Fragmented across different plugins **Torch**



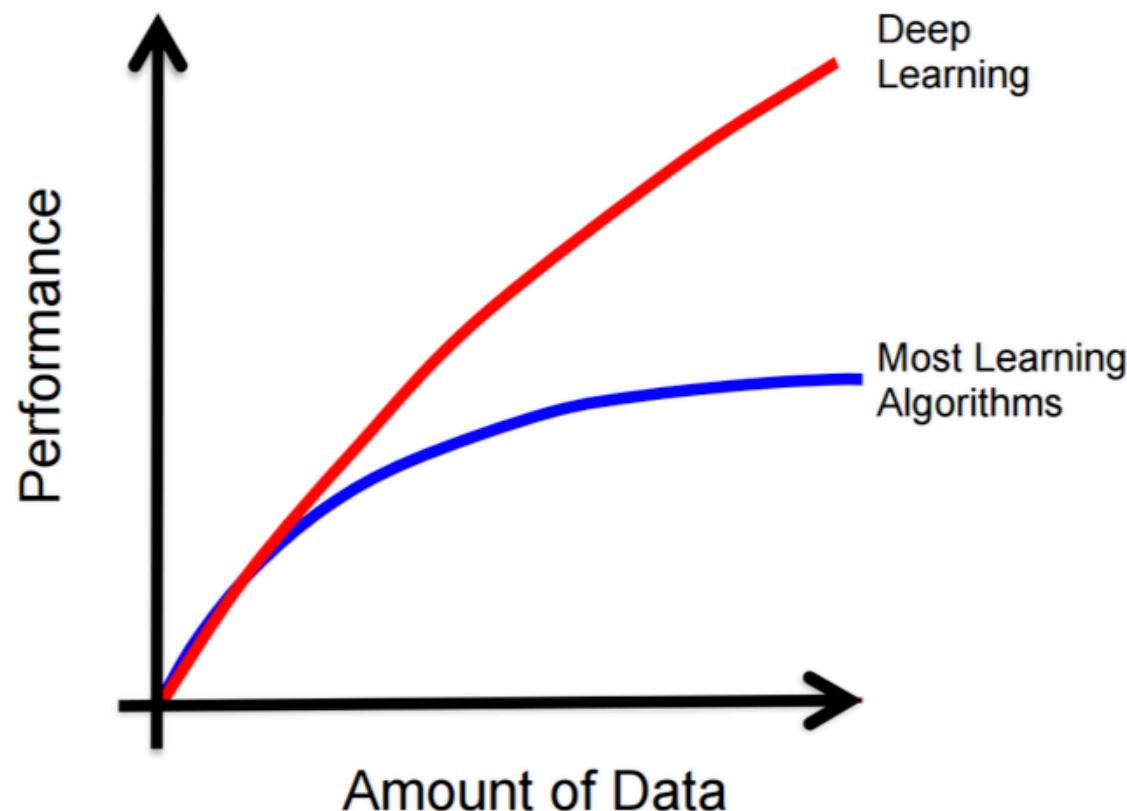
A library most frameworks use for doing the actual computation

- Implements primitive neural network functions in **CUDA** on the GPU

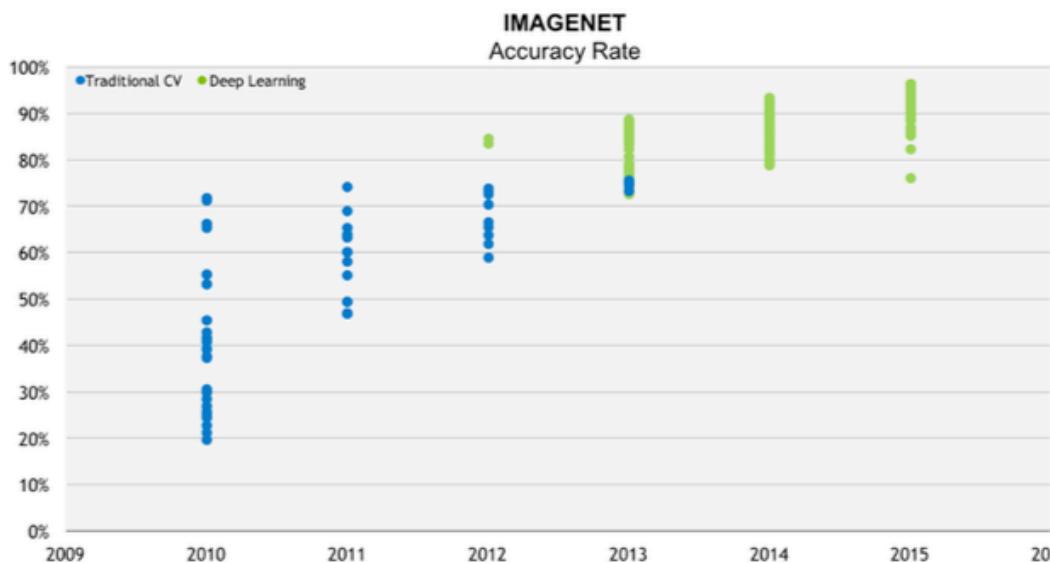
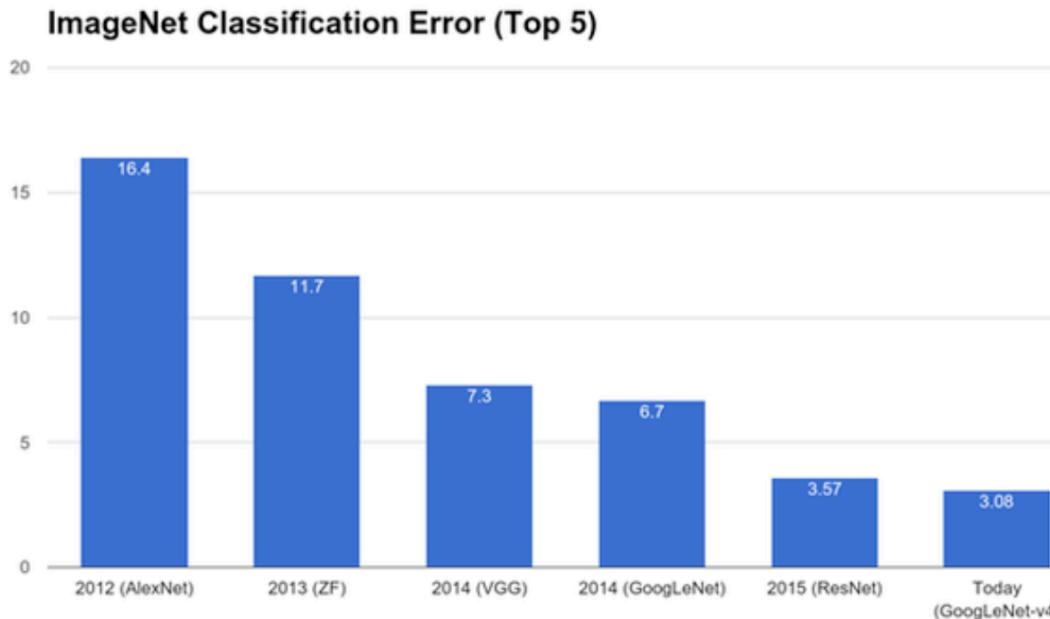


Interface: **Python** (tight NumPy integration)

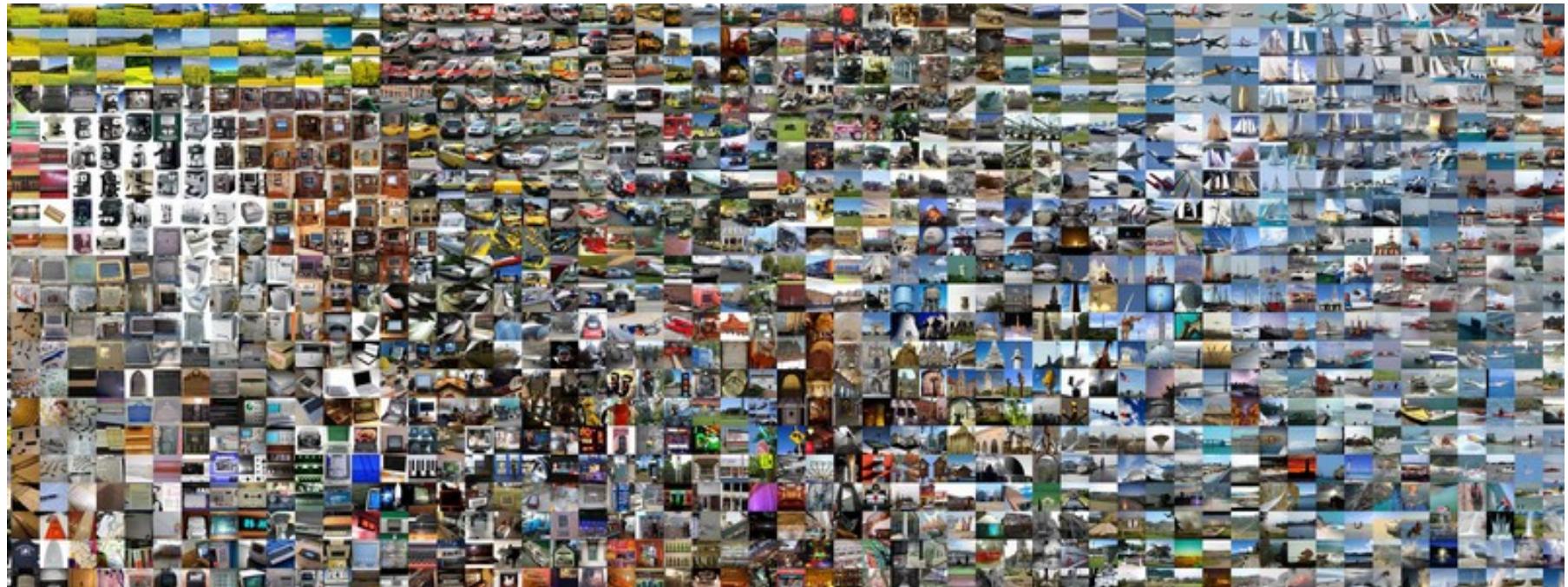
- One of the earlier frameworks with GPU support
- Encourages low-level tinkering



HISTORY & BACKGROUND



HISTORY & BACKGROUND



HISTORY & BACKGROUND



HISTORY & BACKGROUND

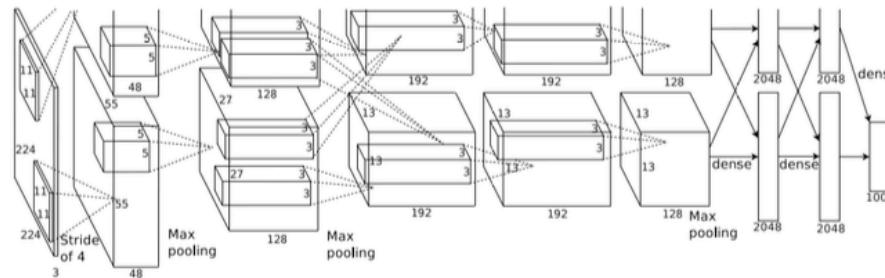


mite

container ship

motor scooter

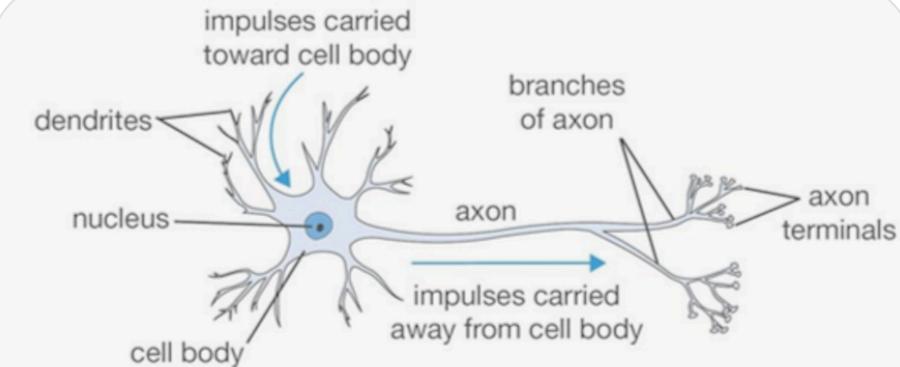
leopard



How does it work?

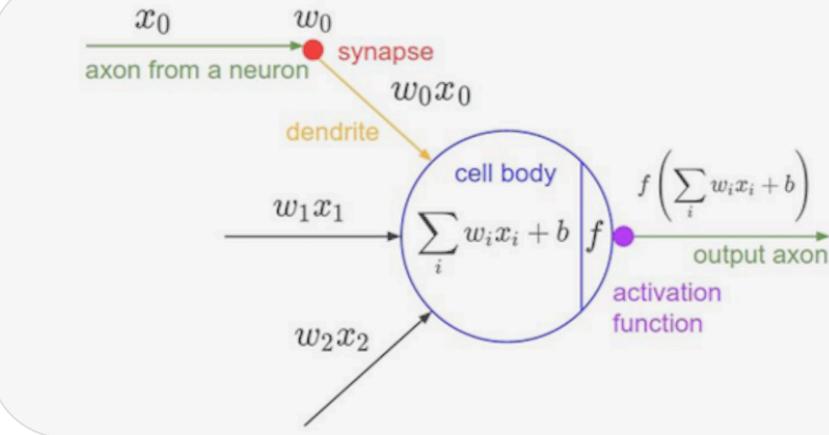
Neuron:

computational building block
for the brain

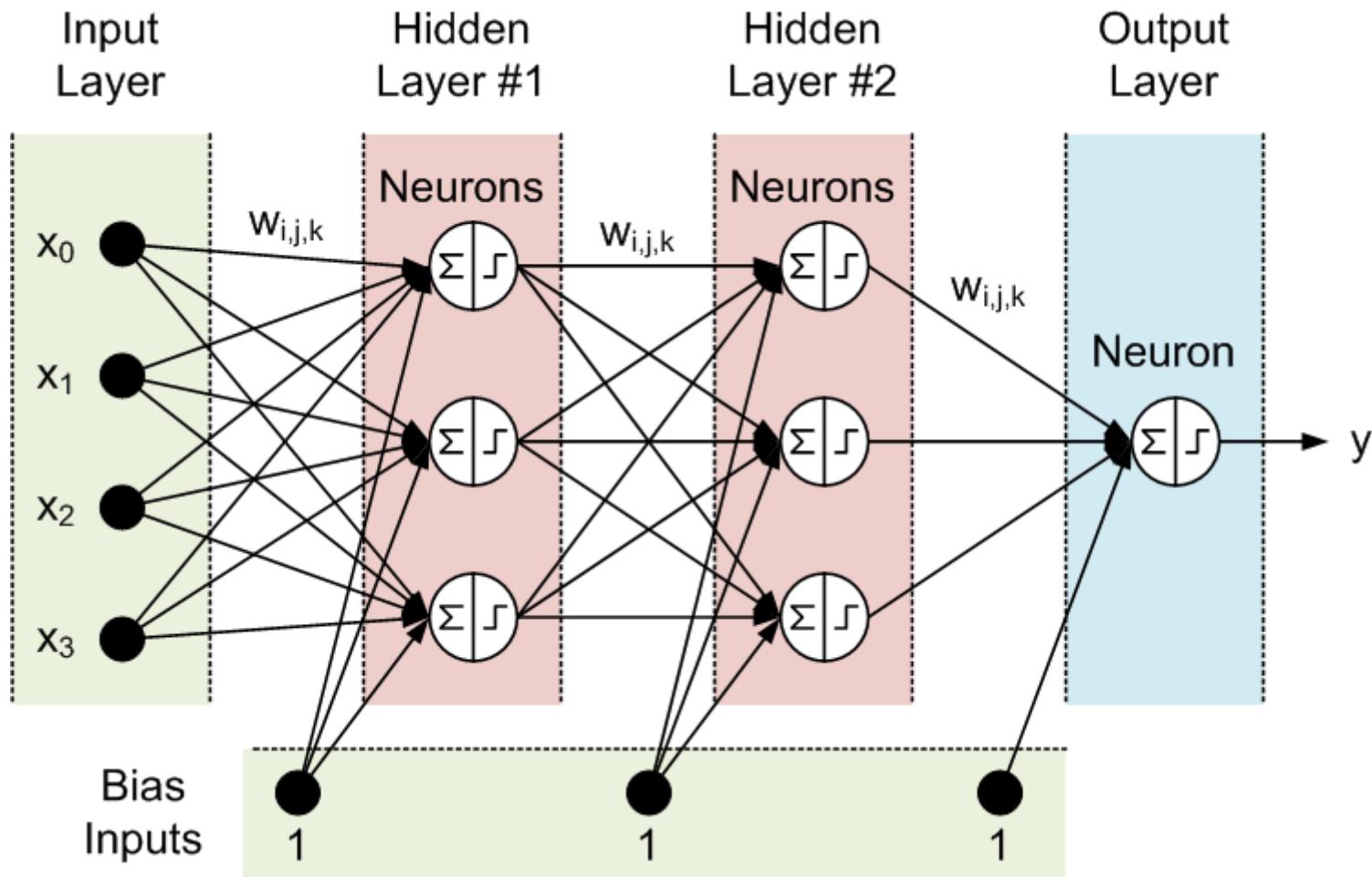


Artificial Neuron:

computational building block
for the Neural Network

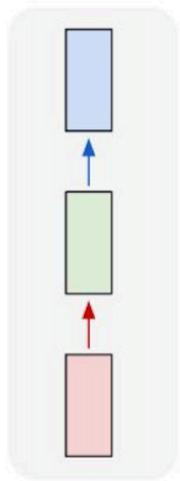


HISTORY & BACKGROUND

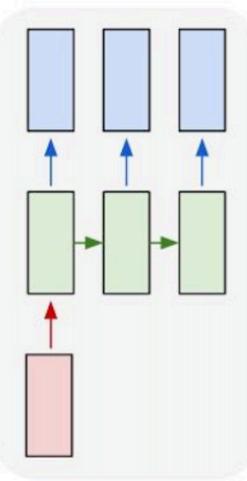


HISTORY & BACKGROUND

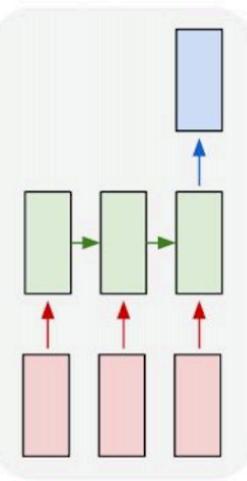
one to one



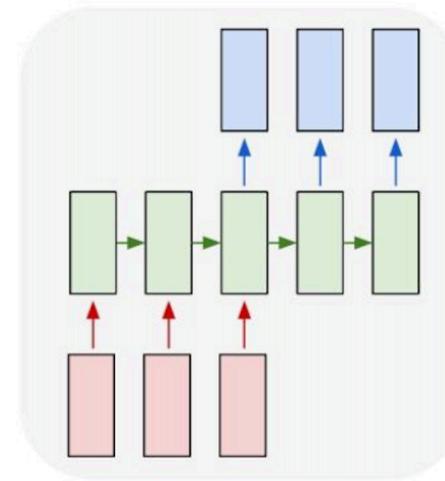
one to many



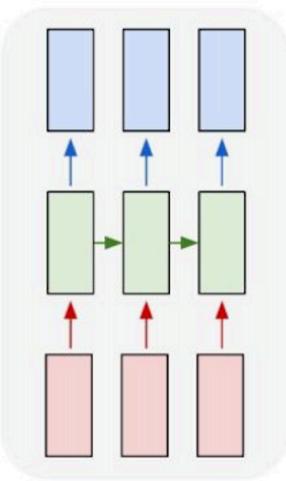
many to one



many to many



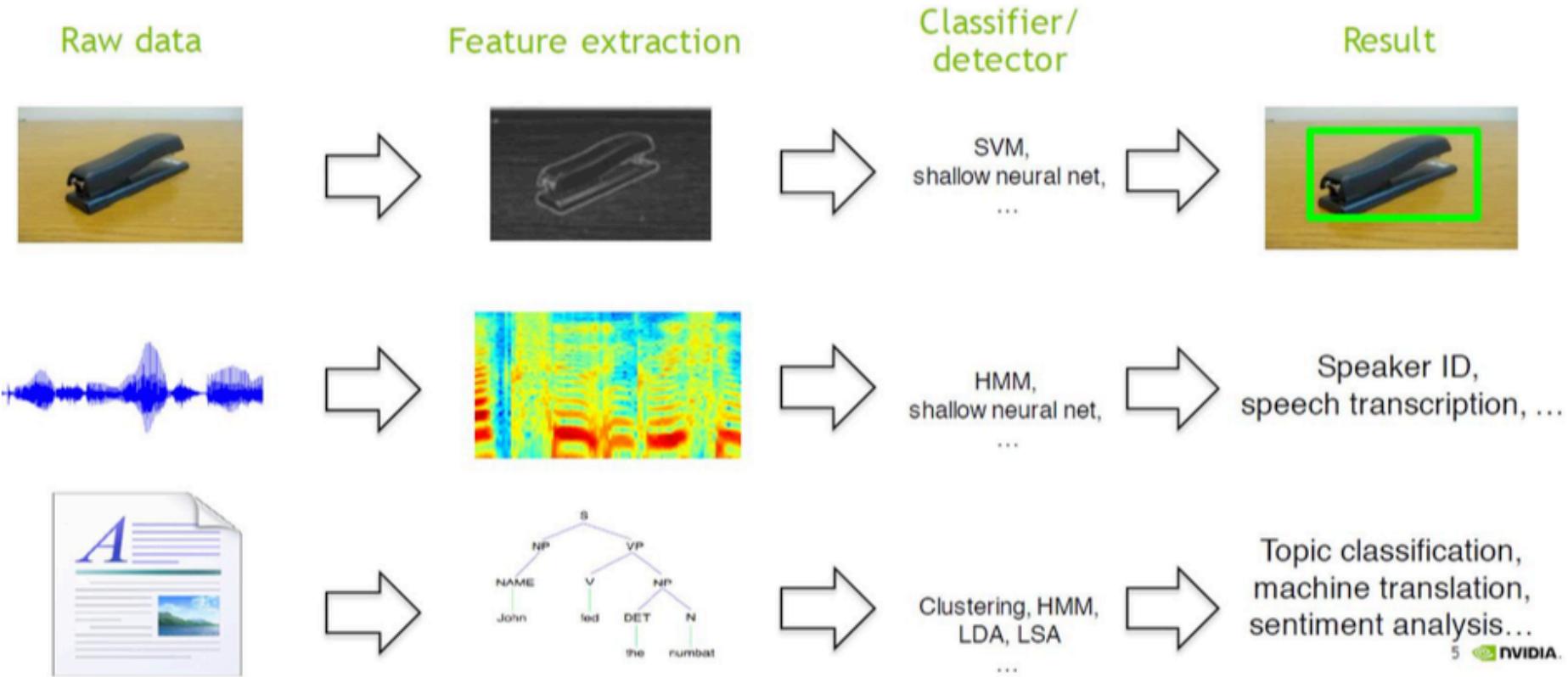
many to many



Vanilla
NN

Karpathy et al. 2015

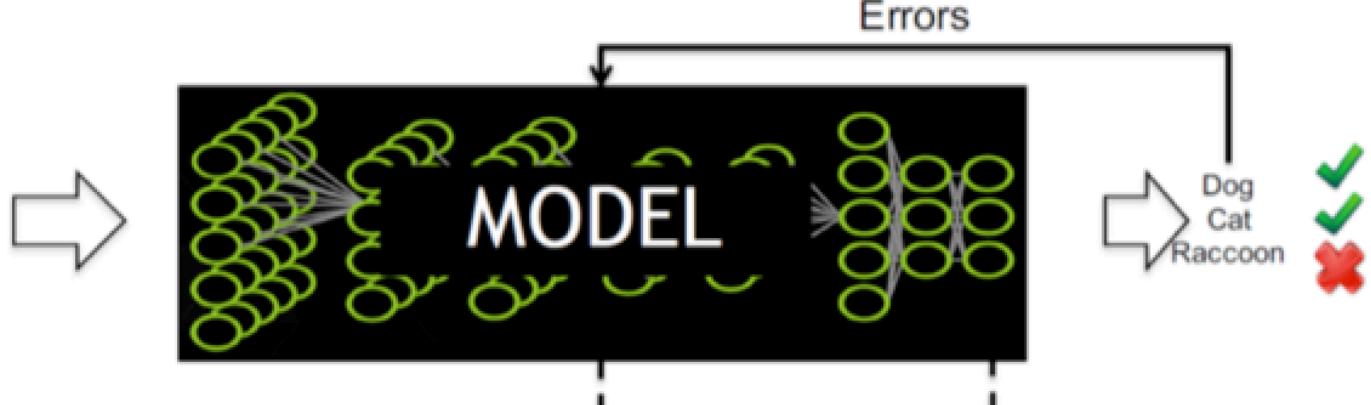
HISTORY & BACKGROUND



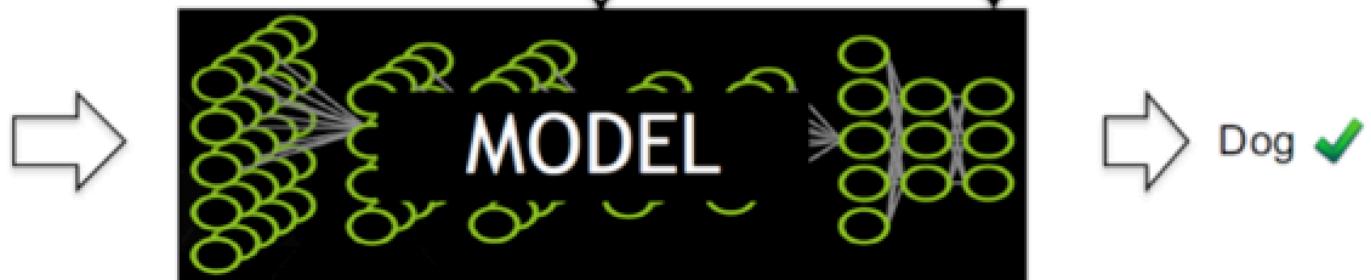
Entropy	Chi Square	Arithmetic Mean	Monte Carlo	Serial Correlation	File Size	Class
7.999858	266.08	127.3956	3.134137686	0.001004	135266	Compressed
7.999655	254.47	127.3902	3.134215118	-0.002434	533013	Encrypted
7.999971	272.2	127.5566	3.140796241	0.000621	6870783	Compressed
7.999695	225.39	127.3806	3.144481342	-0.000465	533013	Encrypted
7.999695	225.39	127.3806	3.144481342	-0.000465	533013	Encrypted

Deep learning is automatic feature discovery

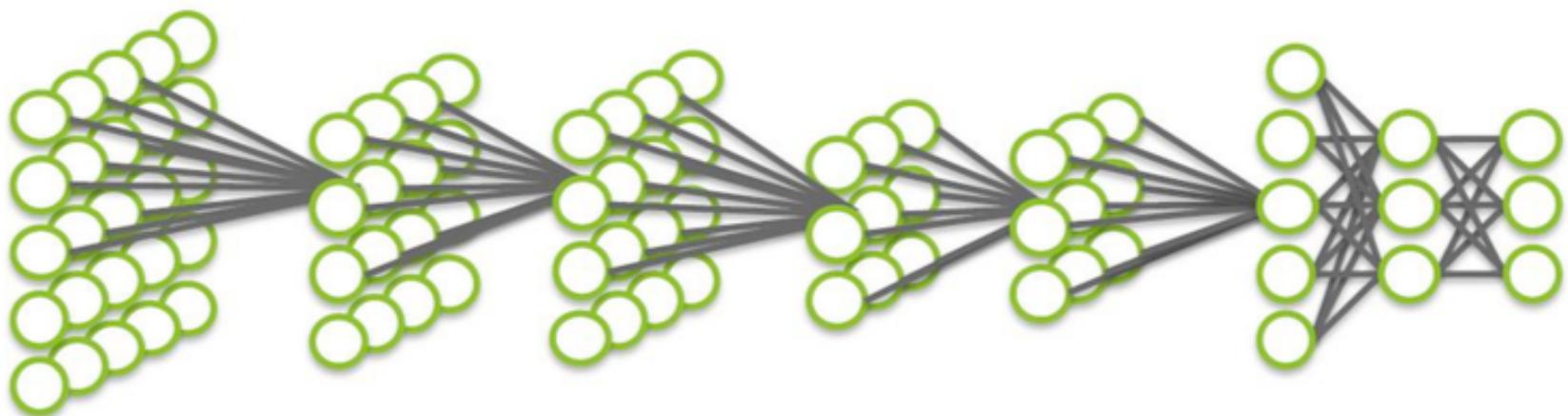
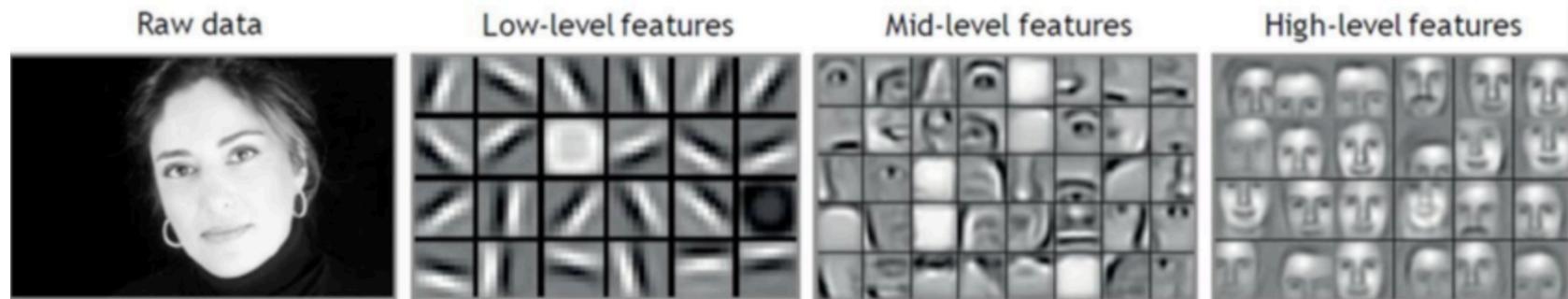
Train:



Deploy:



HISTORY & BACKGROUND



Deep Learning & Finance ?

HISTORY & BACKGROUND

Batres-Estrada, B. (2015). Deep learning for multivariate financial time series.

Ding, X., Zhang, Y., Liu, T., & Duan, J. (2015, June). Deep learning for event-driven stock prediction. In Proceedings of the Twenty-Fourth International Joint Conference on Artificial Intelligence (ICJAI) (pp. 2327-2333).

Dixon, M. F., Klabjan, D., & Bang, J. H. (2016). Classification-based Financial Markets Prediction using Deep Neural Networks.

Fehrer, R., & Feuerriegel, S. (2015). Improving Decision Analytics with Deep Learning: The Case of Financial Disclosures.

Heaton, J. B., Polson, N. G., & Witte, J. H. (2016). Deep Portfolio Theory.

Rönnqvist, S., & Sarlin, P. (2016). Bank distress in the news: Describing events through deep learning.

Sharang, A., & Rao, C. (2015). Using machine learning for medium frequency derivative portfolio trading.

Sirignano, J. A. (2016). Deep Learning for Limit Order Books.

Takeuchi, L., Lee, Y. (2013). Applying Deep Learning to Enhance Momentum Trading Strategies in Stocks.

Xiong, R., Nicholas, E. P., & Shen, Y. (2015). Deep Learning Stock Volatilities with Google Domestic Trends.

Zhu, C., Yin, J., & Li, Q. (2014). A stock decision support system based on DBNs. Journal of Computational Information Systems, 10(2), 883-893.

Deep learning is one of the most powerful machine learning tool you have available nowadays.

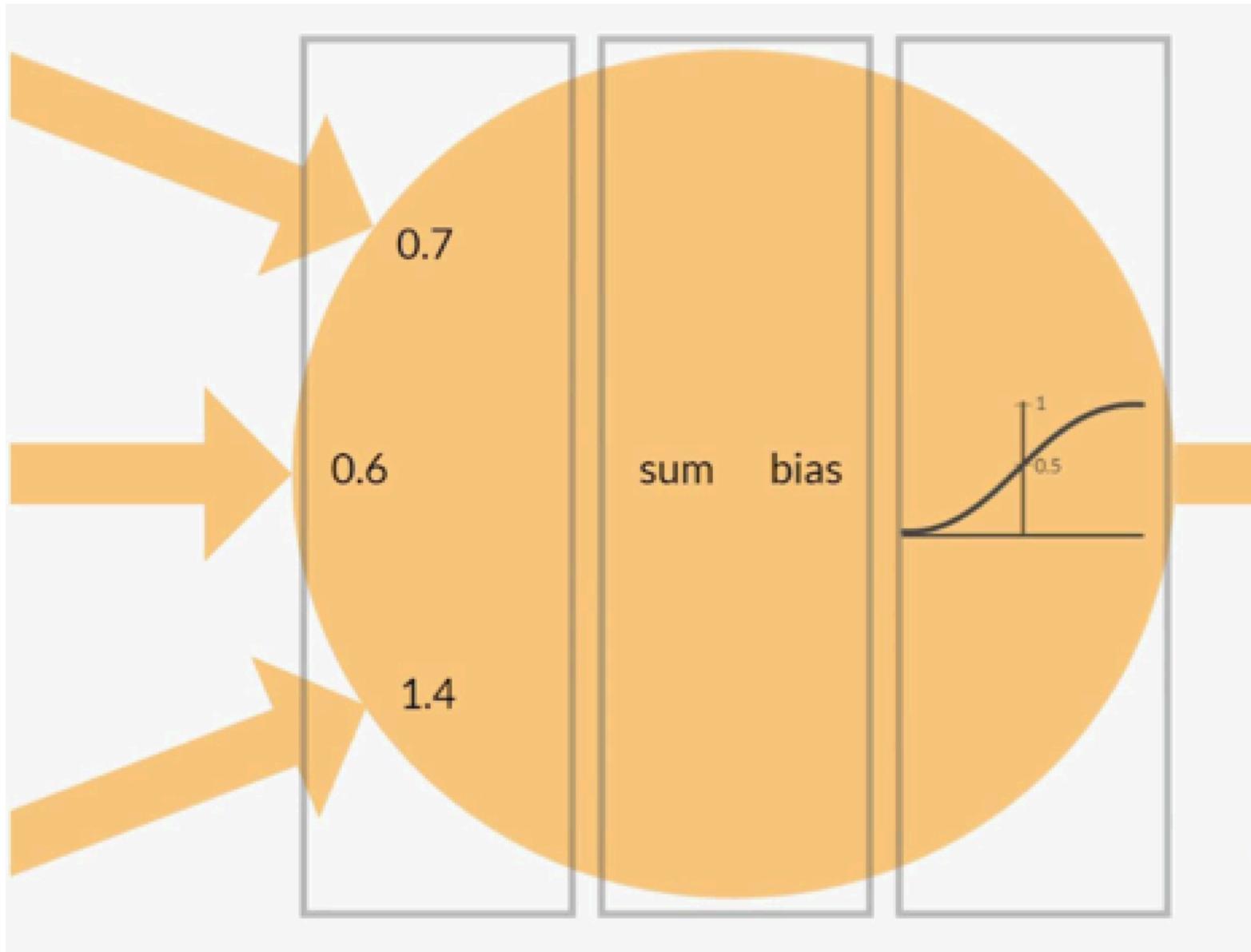
- You can find several deep learning methods that are well suited for your problem.
- **Not much work in financial data analysis**

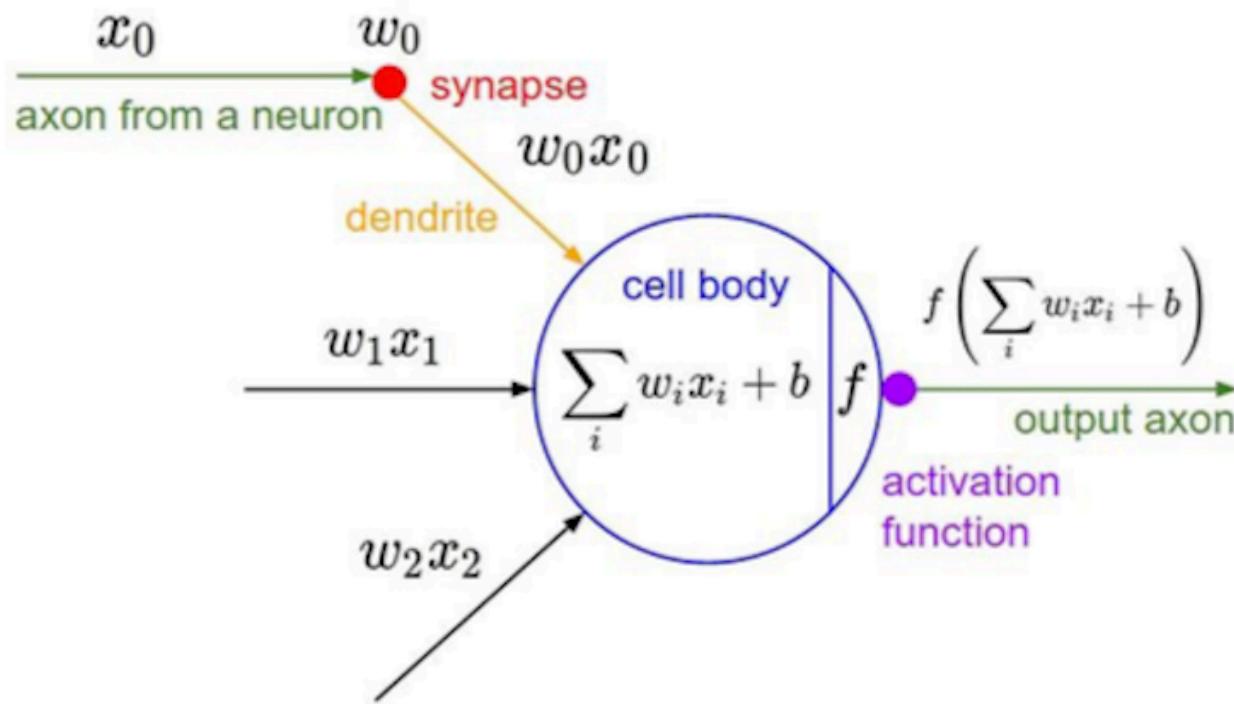
PRACTICAL 1

Tools & Classification

HISTORY & BACKGROUND

HISTORY & BACKGROUND





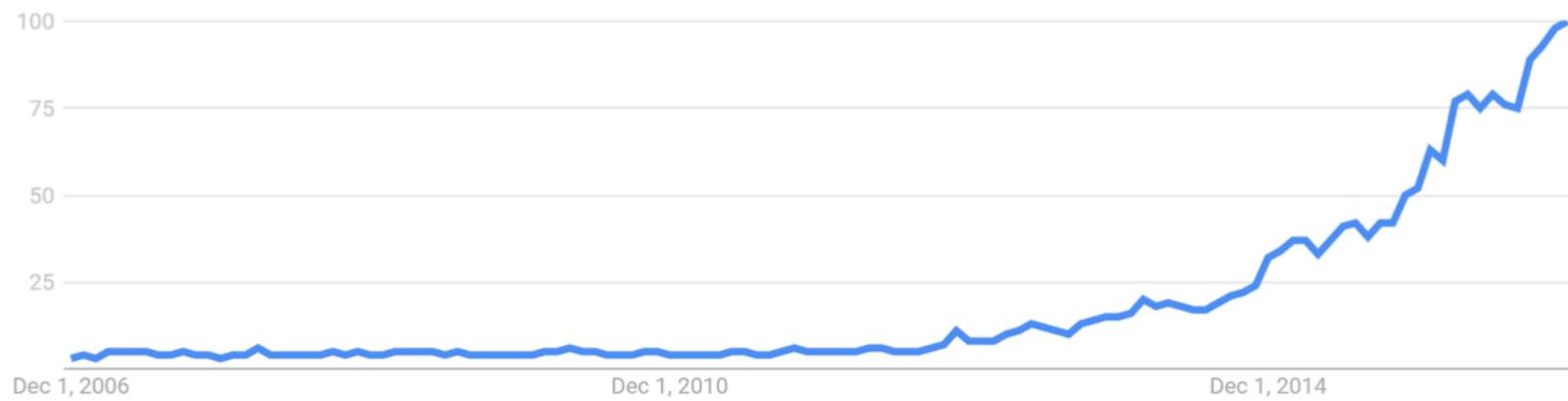
Universality: For any arbitrary function $f(x)$ there exists a neural network that closely approximates it for any input x !

Holds for just 1 layer !

HISTORY & BACKGROUND

Interest over time [?](#)

⋮



Google trends: “Deep Learning”