

# Deep Learning



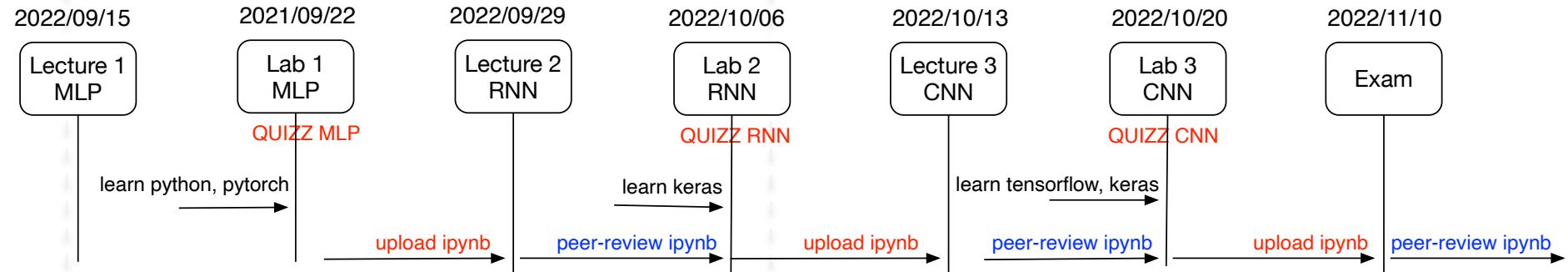
Geoffroy Peeters

contact: [geoffroy.peeters@telecom-paris.fr](mailto:geoffroy.peeters@telecom-paris.fr)

Télécom-Paris, IP-Paris, France

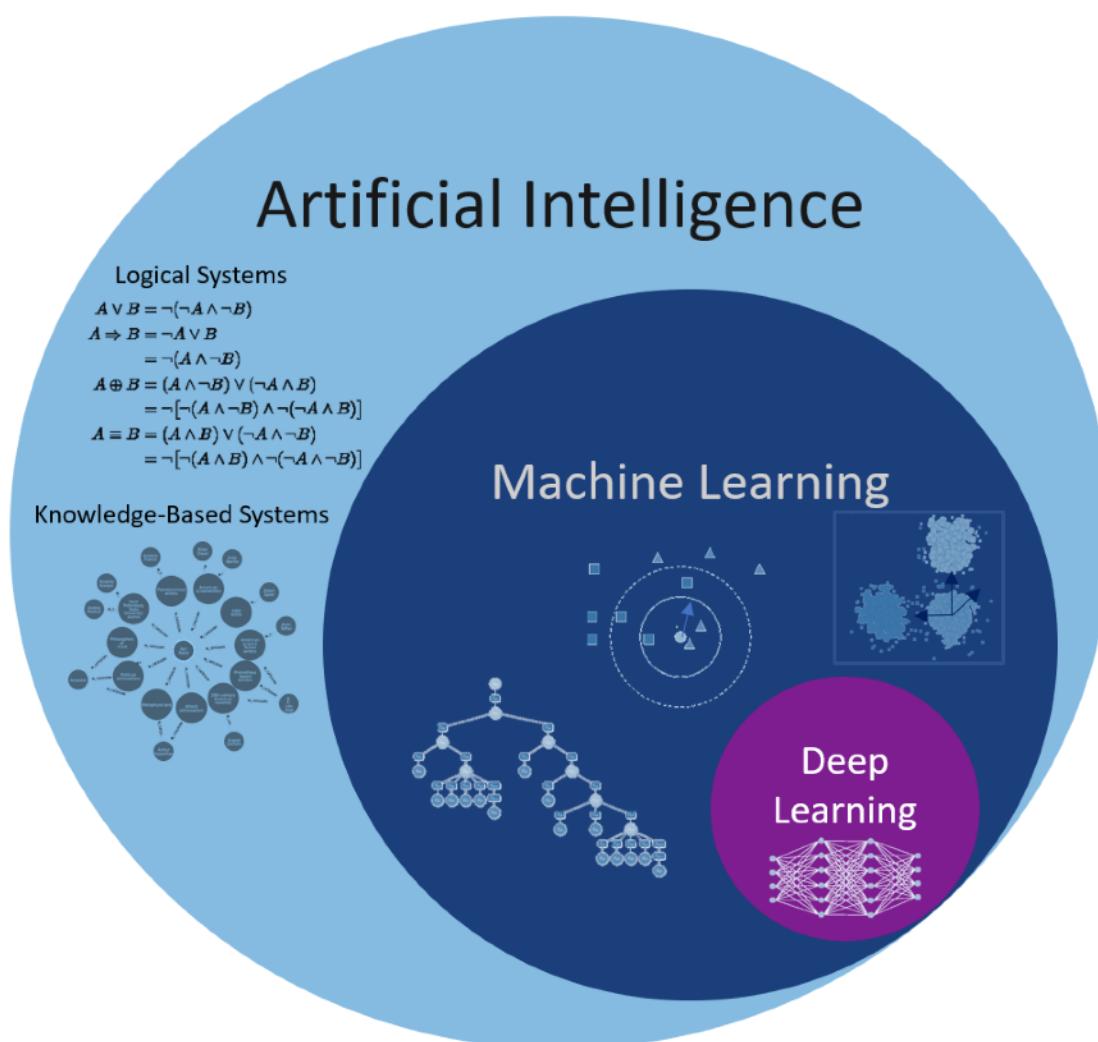
# Timetable/ Organisation

Date	Type	Content	Teacher(s)
September 15, 2022 / 14:00 - 18:00	Lesson	MLP	G. Peeters
September 22, 2022 / 14:00 - 18:00	Lab	MLP	G. Peeters, A. Newson + others
September 29, 2022 / 14:00 - 18:00	Lesson	RNN	G. Peeters
October 06, 2022 / 14:00 - 18:00	Lab	RNN	G. Peeters, A. Newson + others
October 13, 2022 / 14:00 - 18:00	Lesson	CNN	A. Newson
October 20, 2022 / 14:00 - 18:00	Lab	CNN	A. Newson, G. Peeters + others
November 10, 2022	Exam		

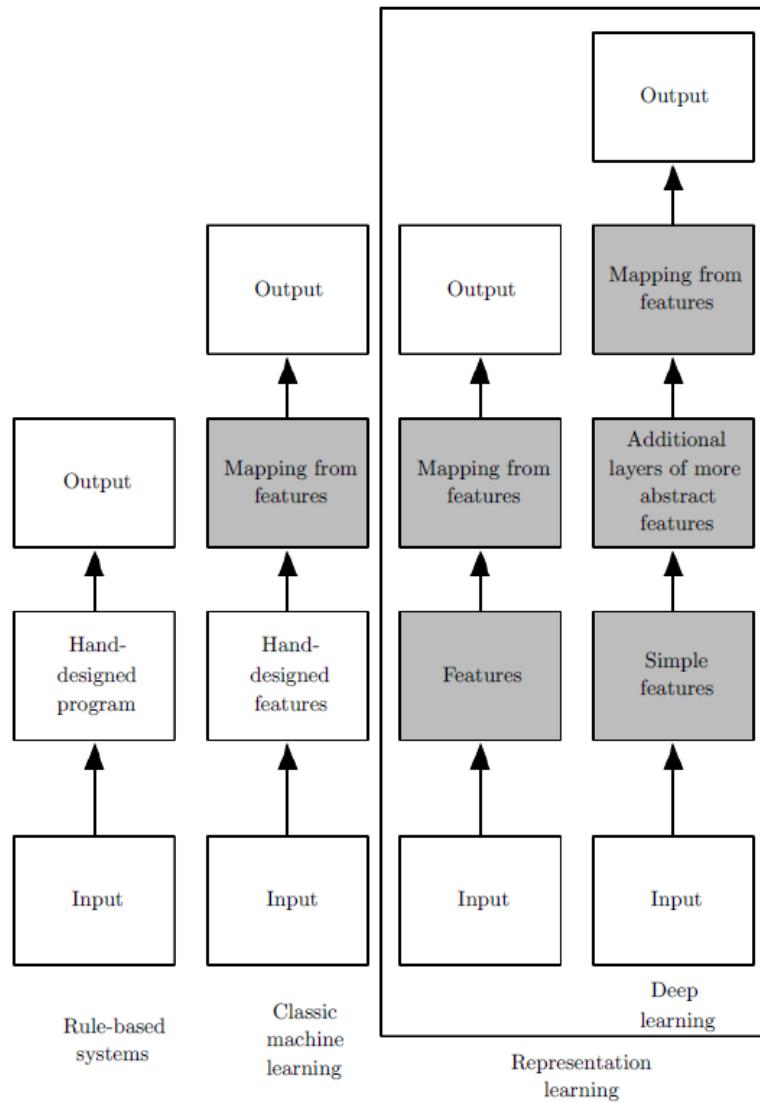


# Deep Learning and Neural Networks : History

# Deep learning (a subset of machine learning)

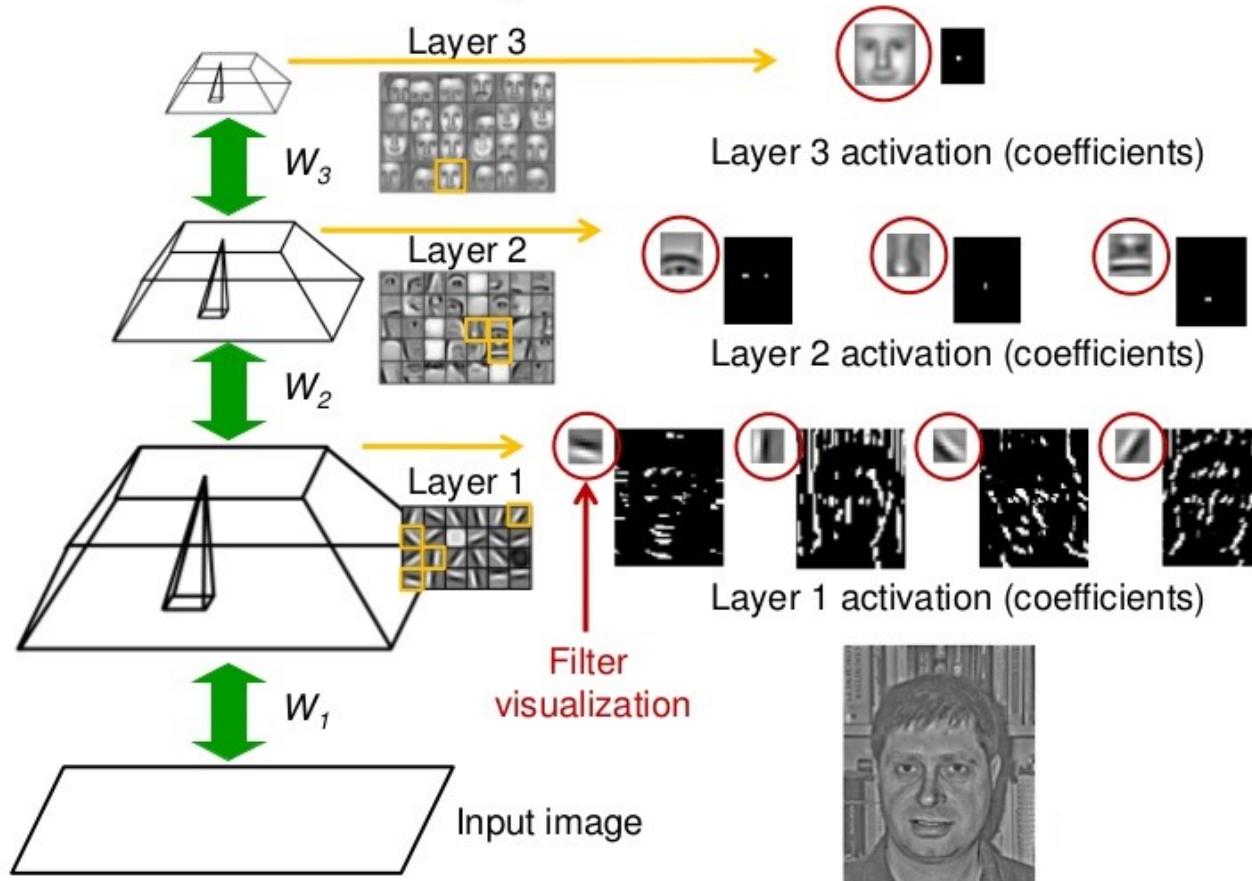


# Deep learning : learning hierarchical representations



# Feature learning examples

## Convolutional deep belief networks illustration



from Lee, Grosse, Ranganath and Ng, "Convolutional Deep Belief Networks", ICML, 2009  
[https://github.com/arthurmeyer/Convolutional\\_Deep\\_Belief\\_Network](https://github.com/arthurmeyer/Convolutional_Deep_Belief_Network)

# Deep Learning and Neural Networks : History

### ImageNet Classification Error (Top 5)

Year	Error (%)
2011 (XRCE)	26,0
2012 (AlexNet)	16,4
2013 (ZF)	11,7
2014 (VGG)	7,3
2014 (GoogLeNet)	6,7
HUMAN	5,0
2015 (ResNet)	3,6
2016 (GoogLeNet-v4)	3,1

**Elect** 1950

S. McCulloch - W. Pitts

- Adjustable Weights
- Weights are not Learned

F. Rosenblatt

- Learnable Weights and Threshold

B. Widrow - M. Hoff

M. Minsky - S. Papert

- XOR Problem

D. Rumelhart - G. Hinton - R. Williams

- Forward Activity
- Backward Error

V. Vapnik - C. Cortes

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

G. Hinton - S. Ruslan

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

Geoffrey Hinton, Li Deng, Dong Yu, George Dahl, Abdel-rahman Mohamed, Navdeep Jaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Tara Sainath, and Brian Kingsbury

## Deep Neural Networks for Acoustic Modeling in Speech Recognition

[Four research groups share their views]

<YOU PLEASE CHECK THAT ADDED SUBTITLE IS OK AS GIVEN OR PLEASE SUPPLY SHORT ALTERNATIVE>

1986

1990

**INTRODUCTION**  
Recent advances in machine learning can lead to significant advances in automatic speech recognition (ASR). The biggest single advance occurred nearly four decades ago with the introduction of the expectation-maximization (EM) algorithm for training HMMs (see [1] and [2] for informative historical reviews of the introduction of HMMs). With the EM algorithm, it was possible to iteratively refine the state transition probabilities using the likelihood of GMMs [3] to represent the relationship between HMM states and the acoustic input. In these systems the acoustic input is typically represented as a sequence of short-term acoustic features (e.g., mel-frequency linear predictive coefficients (PLPs) [4] computed from the raw waveform and their first- and second-order temporal differences [5]). This nonadaptive but highly engineered representation of the acoustic signal does not contain any amount of information in its structure that is considered to be redundant for discrimination and to express the remaining information in a form that facilitates discrimination with GMM-HMMs.

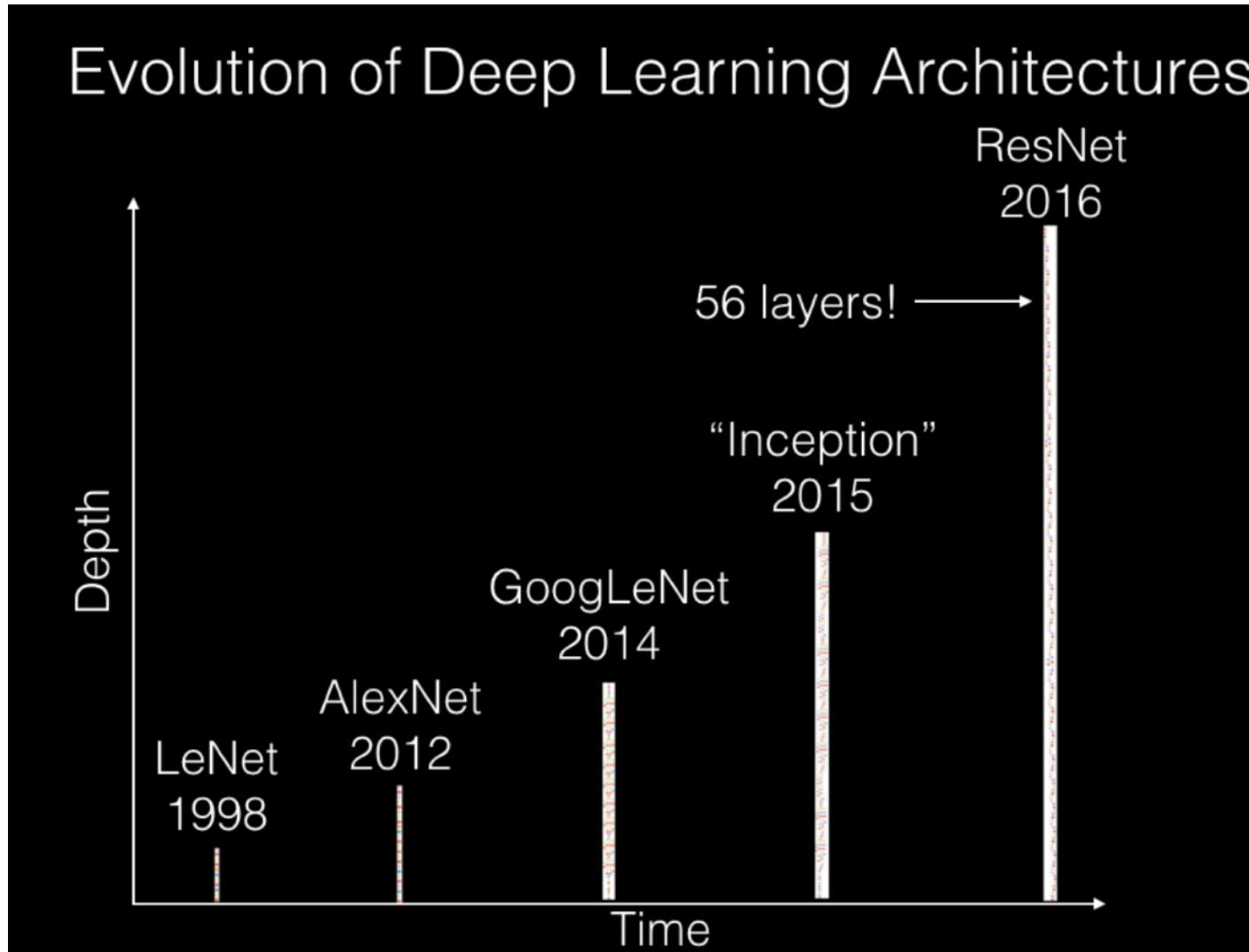
Digital Object Identifier 10.1109/SP.2012.6228929  
Date of publication 20 November 2012  
ISSN 1063-651X © 2012 IEEE  
1063-651X/12/111588-10\$31.00 © 2012 IEEE

[https://stateofther.github.io/post/deep\\_learning/deep-learning-history.html#2](https://stateofther.github.io/post/deep_learning/deep-learning-history.html#2)

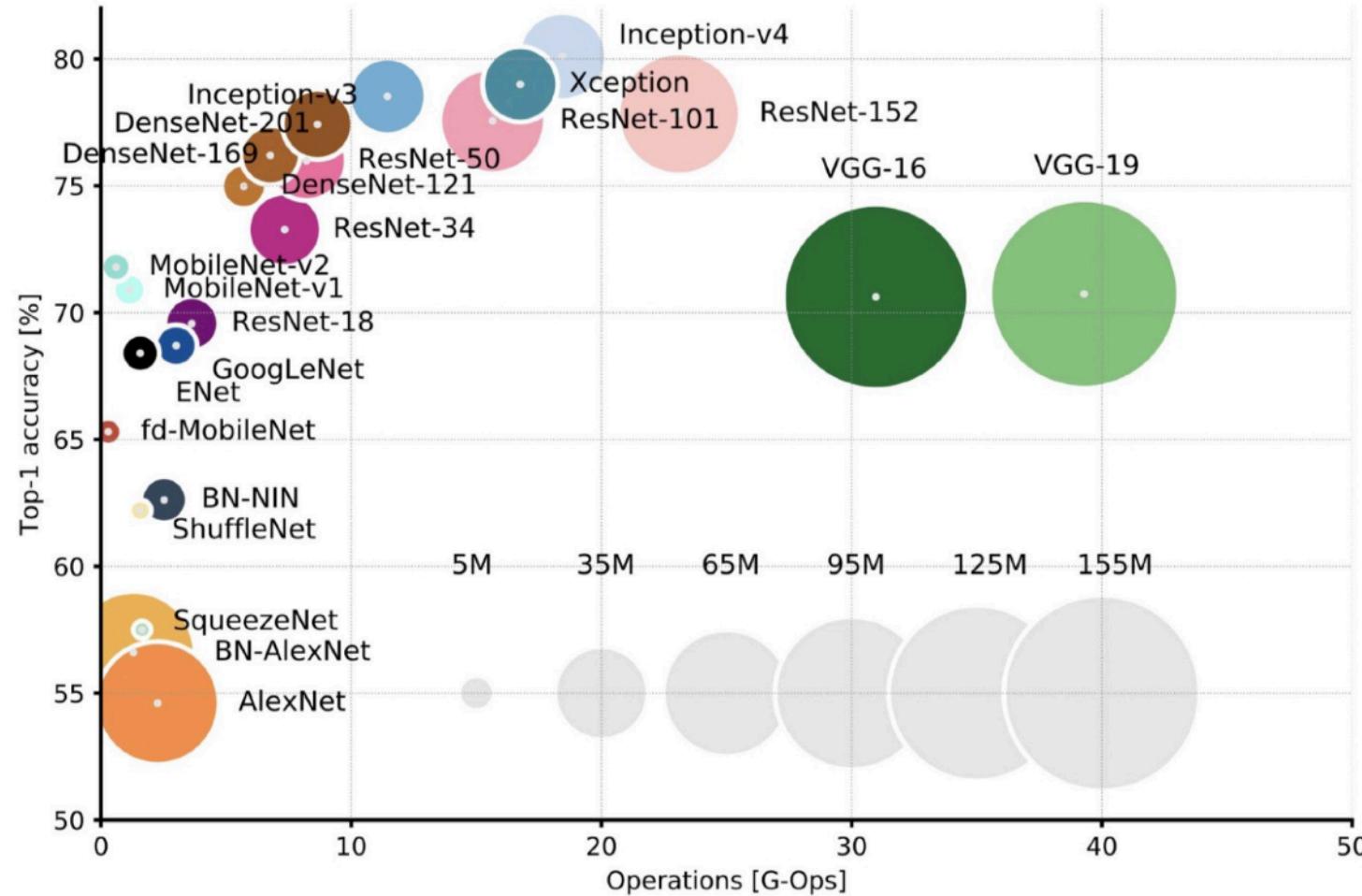
G. Peeters - Télécom Paris, IP-Paris

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# Deep Learning and Neural Networks : History

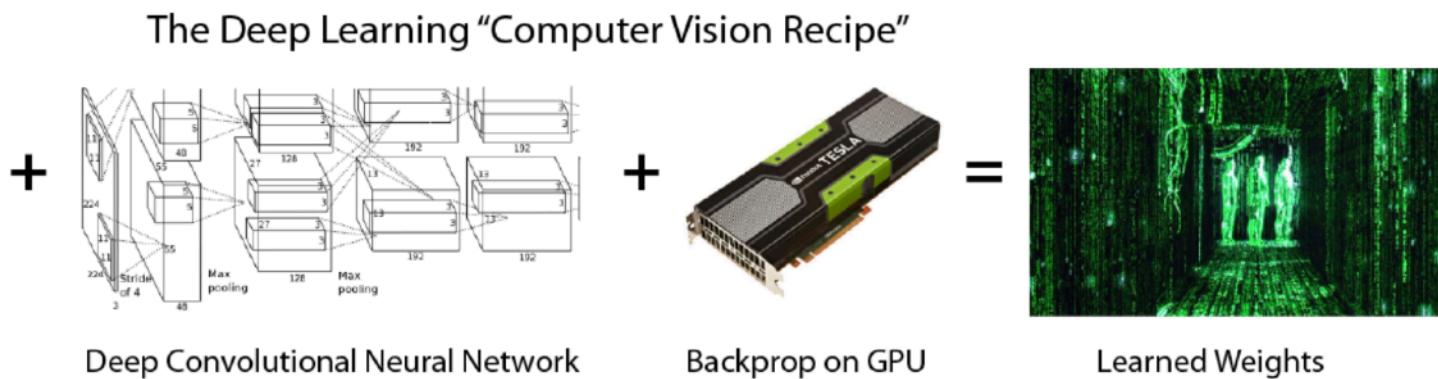


# Deep Learning and Neural Networks : History



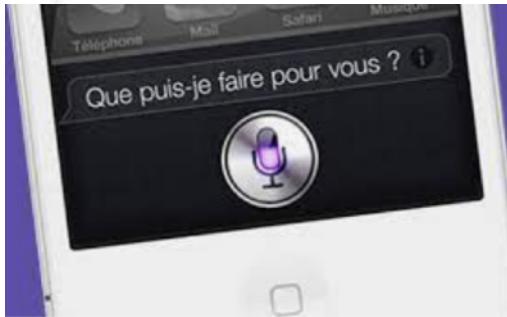
# Deep Learning and Neural Networks : History

***Deep Learning =  
Lots of training data + Parallel Computation + Scalable, smart algorithms***

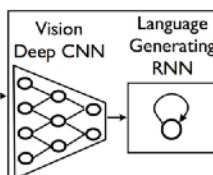
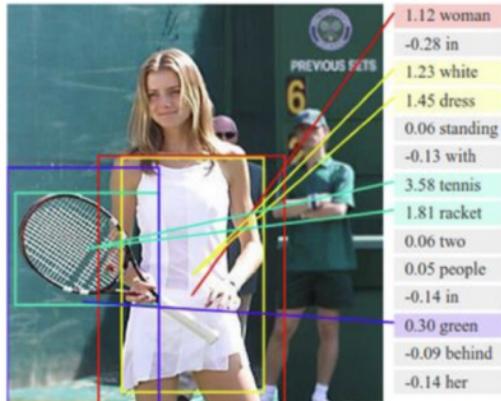


# Applications

## Automatic Speech Recognition



## Automatic picture captioning



A group shopping at an outdoor market.  
There are many vegetables at the fruit stand.

## Self Driving Cars



## DEEP LEARNING HAS MASTERED GO Google Alpha Go

nature | International weekly journal of science  
Home | News & Comment | Research | Careers & Jobs | Current Issue | Archives | Audio & Video | Photo  
AlphaGo | Volume 541 | Issue 798 | News | Article  
JOURNAL | NEWS  
Google reveals secret test of AI bot to beat top Go players  
Updated version of DeepMind's AlphaGo program behind mystery online competitor.

Mastering the game of Go with deep neural networks and tree search  
David Silver, Aja Huang, Chris J. Maddison, Arthur Guez, Laurent Bilev, George van den Driessche, Julian Schrittwieser, Ioannis Antonoglou, Veda Panneershelvam, Marc Lanctot, Harald Heinecke, Dominik Grabs, John Mnih, Noritaka Konda, Ilya Sutskever, Timothy Lillicrap, Maksimilian Leiserson, Karen Kavukcuoglu, Thore Graepel & Demis Hassabis  
Nature 509, 484–489 (28 January 2014) | doi:10.1038/nature13191  
Received 1 November 2013 | Accepted 05 January 2014 | Published online 27 January 2014

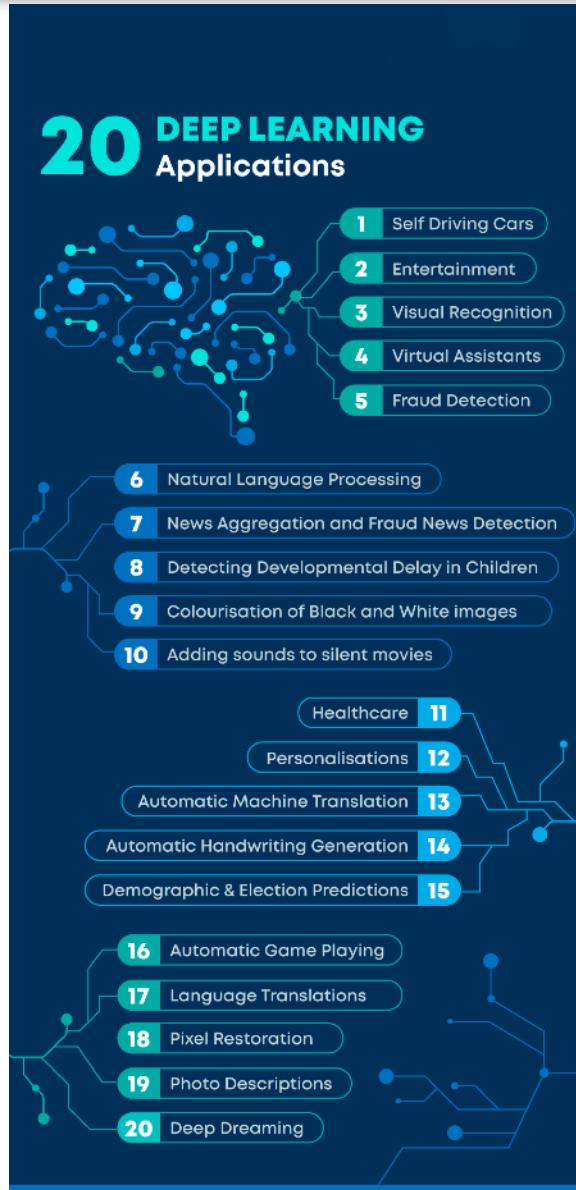


## Neural Machine Translation

DeepL Traducteur DeepL Pro Connexion Découvrir DeepL Pro  
Anglais (langue détectée) ▾ Fr... ▾ formel/informel ▾ Glossaire  
Deep learning (also known as deep structured learning) is part of a broader family of machine learning methods based on artificial neural networks with representation learning. Learning can be supervised, semi-supervised or unsupervised.  
L'apprentissage profond (également appelé apprentissage structuré profond) fait partie d'une famille plus large de méthodes d'apprentissage automatique basées sur les réseaux neuronaux artificiels avec apprentissage par représentation. L'apprentissage peut être supervisé, semi-supervisé ou non supervisé.



# Applications



# Deep learning: famous people

- **Turing price (ACM Turing Award), 2018**



Geoffrey Hinton (1947, canadian)

*Google Brain  
University of Toronto*



Yann LeCun (1960, french)

*Facebook AI Research (Paris)  
University of New-York*



Yoshua Bengio (1964, canadian)

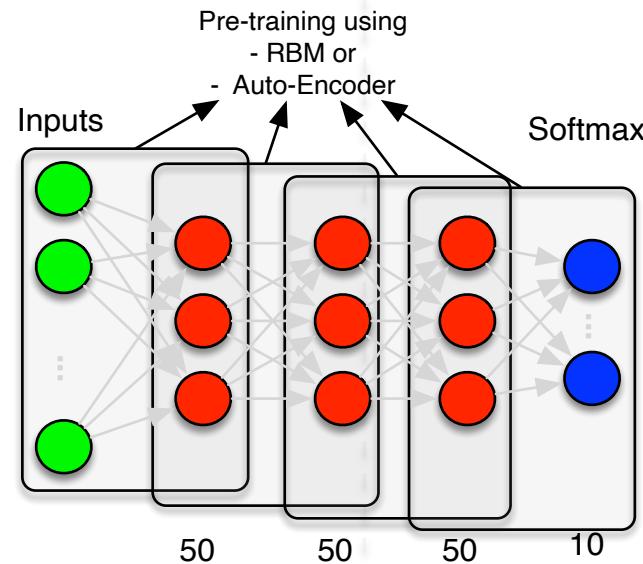
*MILA (University of Montreal)*

# Three main types of Nets

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## Multi Layers Perceptron (MLP), Fully-Connected (FC), Feed-Forward

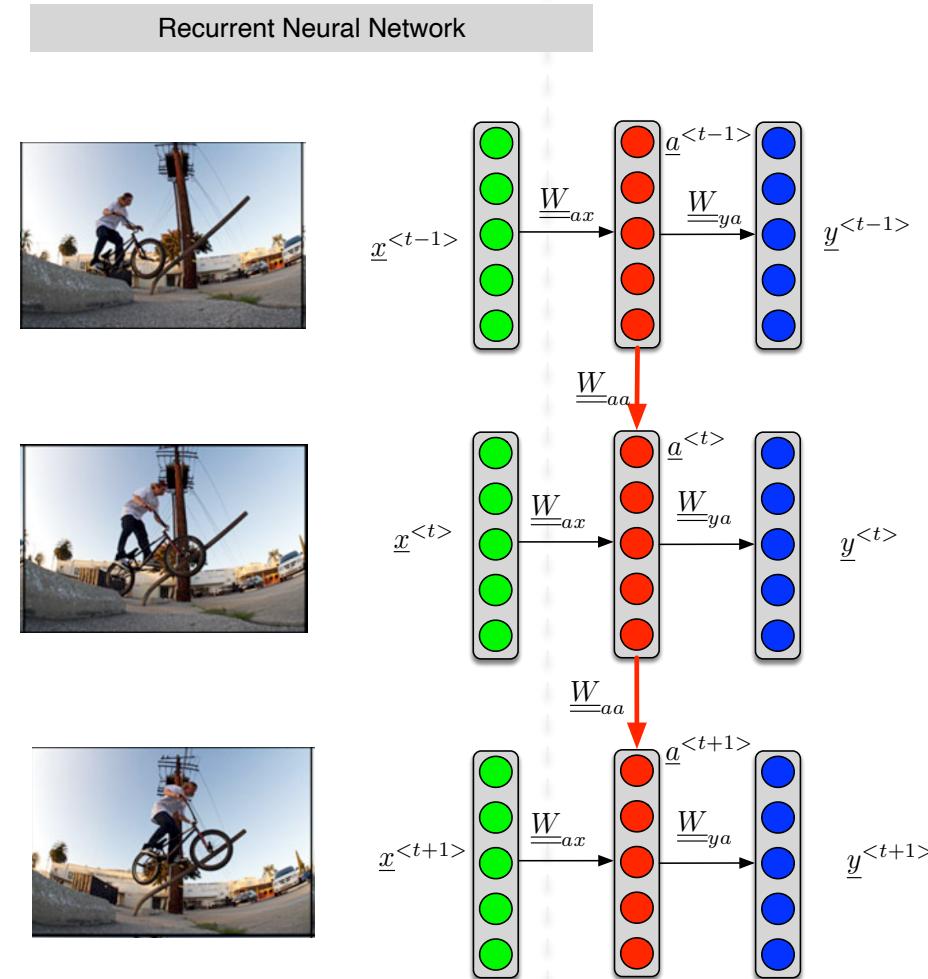
### Multi Layers Perceptron (Fully Connected)



$$\begin{aligned}\underline{z}^{[l]} &= \underline{W}^{[l]} \underline{a}^{[l-1]} + \underline{b}^{[l]} \\ \underline{a}^{[l]} &= g^{[l]}(\underline{z}^{[l]})\end{aligned}$$

# Three main types of Nets

## Recurrent Neural Networks (RNN)



# Three main types of Nets

## Convolutional Neural Networks (CNN)

