Deep Learning

Intro

WELCOME!

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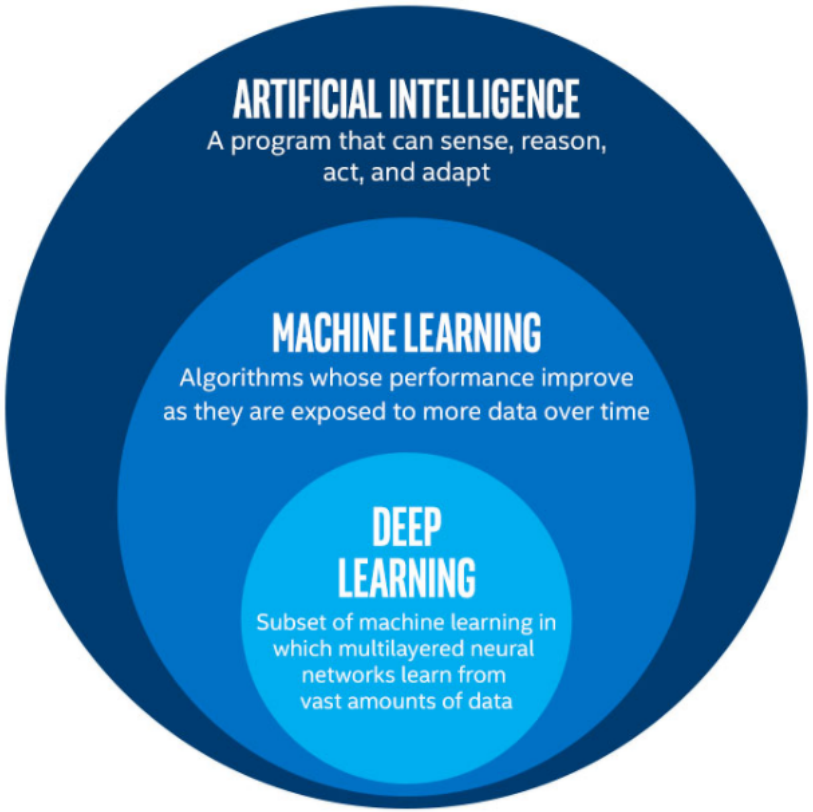
Outline

AI, ML, & DL, I

We commonly get to hear about Artificial Inteligence (AI), Machine Learning (ML), and Deep Learning (DL). But what are they actually?



AI, ML, & DL, II

AI

Giving machines the ability to process information and solve problems following a human-like approach.

Challenge. Solving those tasks that, for people, are easy to perform but hard to describe formally: problems that we solve intuitively and that feel like automatic to us. e.g., recognizing spoken words or faces in images.

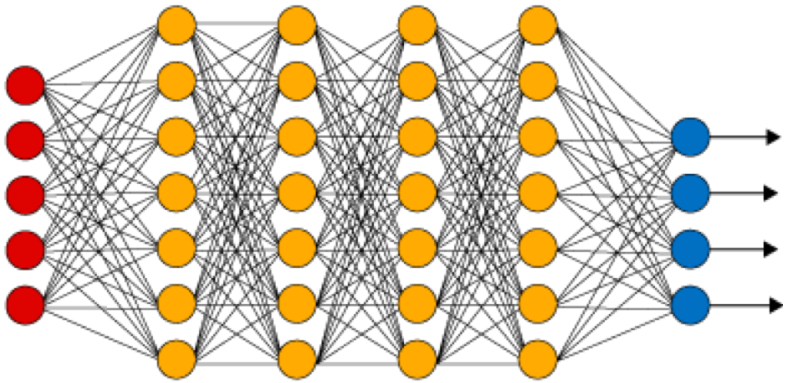
Machine Learning (ML)

A computer program is said to learn from experience E with respect to task T and performance measure P, if its performance at task T, as measured by P, improves with experience E. [Tom Mitchell].

AI, ML, & DL, III

Deep Learning

A subset of ML techniques based on the use of deep artificial neural networks.



Arguably, modeled to mimic human brain.

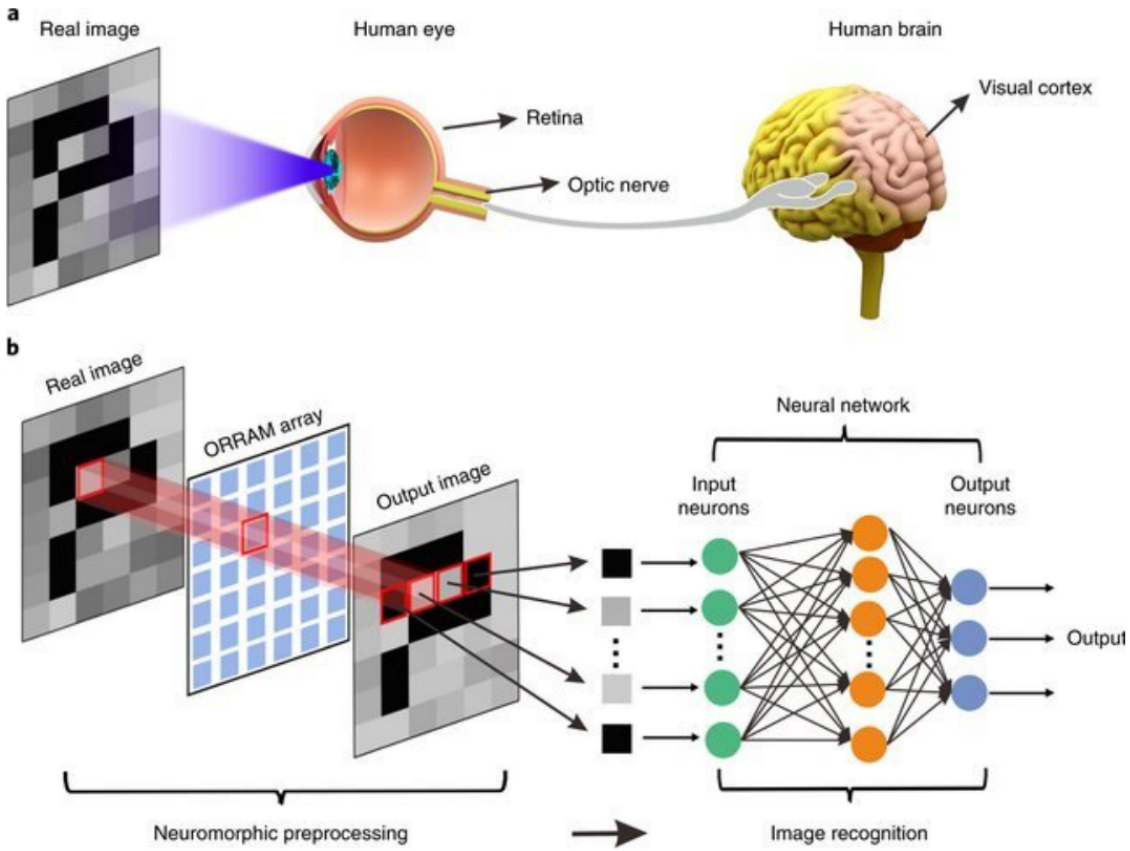
Deep Learning

Some definitions found here and there.

- Large deep neural networks.
  [Jeff Dean] (Google Senior Fellow, Google Brain, Tensorflow).
- Brain simulations.
  [Andrew Ng] (Stanford, Google Brain, Baidu, Coursera, deeplearning.ai).
- Hierarchical feature learning.
  [Yoshua Bengio] (U-Montreal, CIAR, DL book).
- A kind of learning where the representation you form have several levels of abstraction, rather than a direct input to output.
  [Peter Norvig] (Director of Research at Google).

DNN architecture

Data acquisition & Feature extraction & Decision making!



DL everywhere

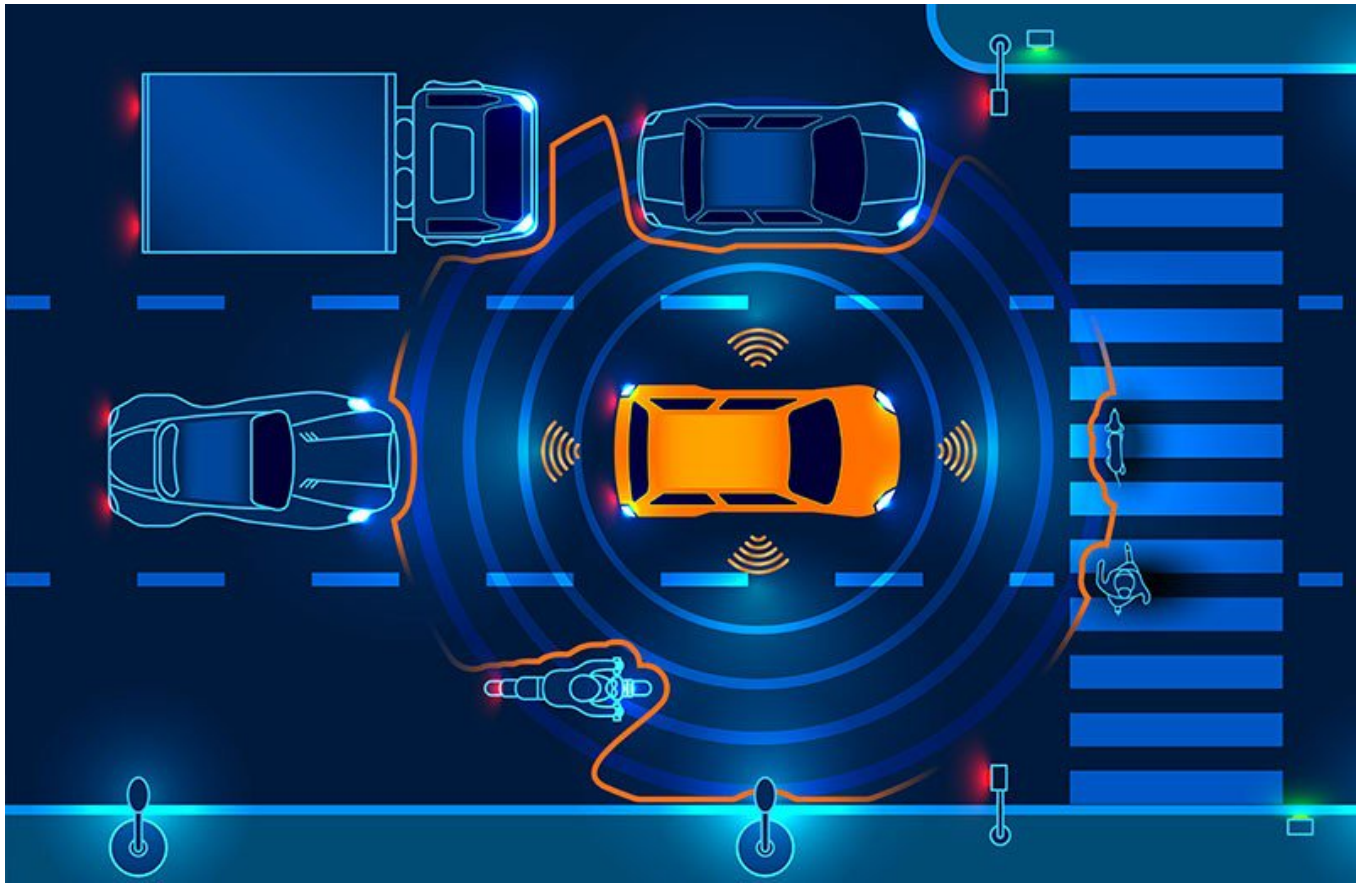
We can find application of DL almost everywhere nowadays.

- Image recognition.
- Medical imaging.
- Text translation.
- Audio processing.
- Self-driving vehicles.
- Game playing.
- Stock price prediction.
- Cinema and entertainment.

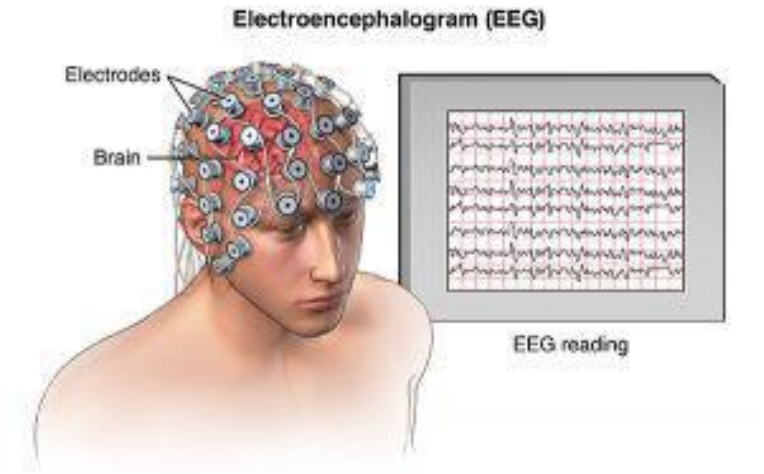
It is the state of the art in many areas!

Have you heard about specific examples?

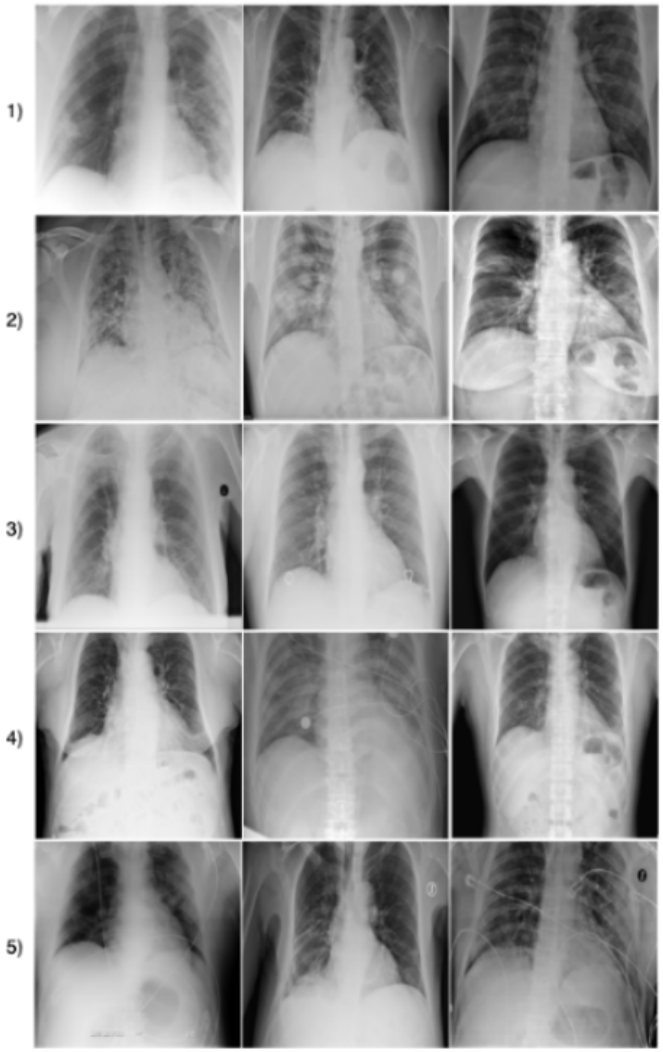
Autonomous driving

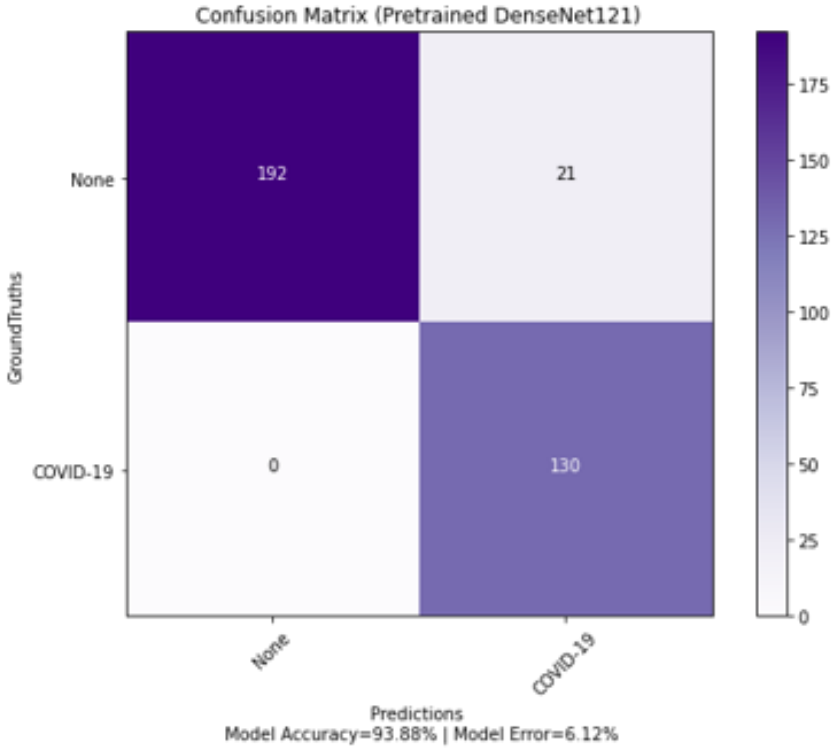


Signal processing



Covid detection





Deep fakes

Translation

Input: it is also pressing, especially in the lead up to the copenhagen conference, that the eu and other international actors articulate their policies on international trade, climate change, humanitarian aid and development.

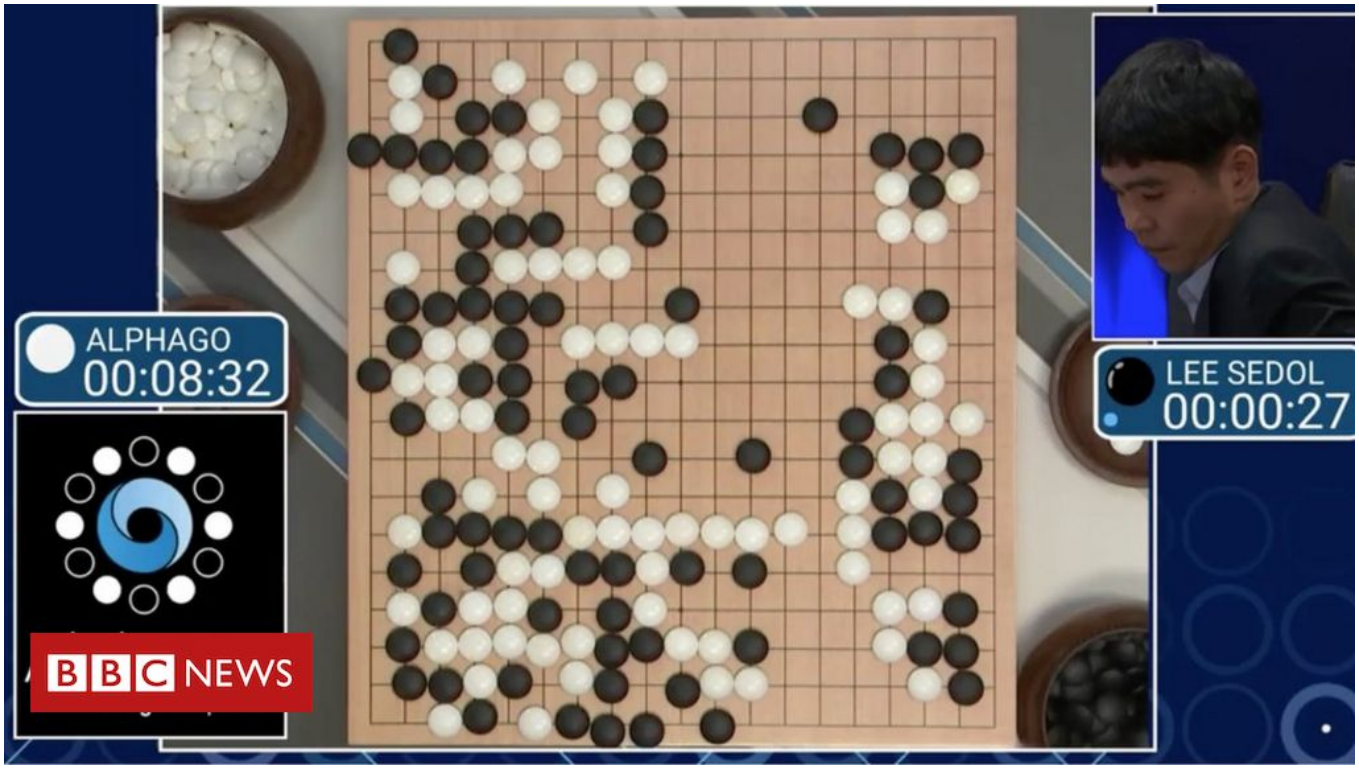
↓

Translator Output (TO): Il est également urgent, en particulier dans la perspective de la conférence de copenhague, que l'ue et d' autres acteurs internationaux définissent leurs politiques en matière de commerce international, de changement climatique, d' aide humanitaire et de développement.

True Translation: il est aussi urgent, surtout à l'approche de la conférence de copenhague, que l' union européenne et d' autres acteurs internationaux articulent leurs politiques en matière de commerce international, de changement climatique, d'aide humanitaire et de développement.

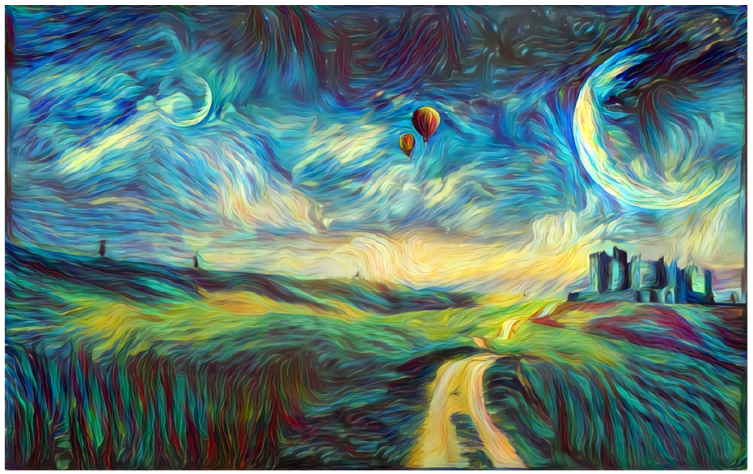
Molecular desing

Go paying

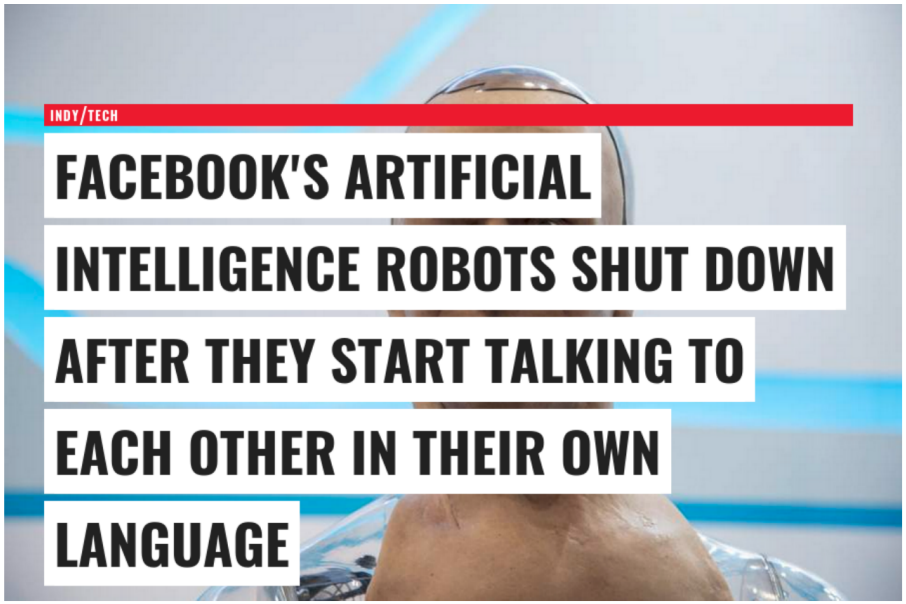


Deep dreams

Creepy. Very, very creepy.

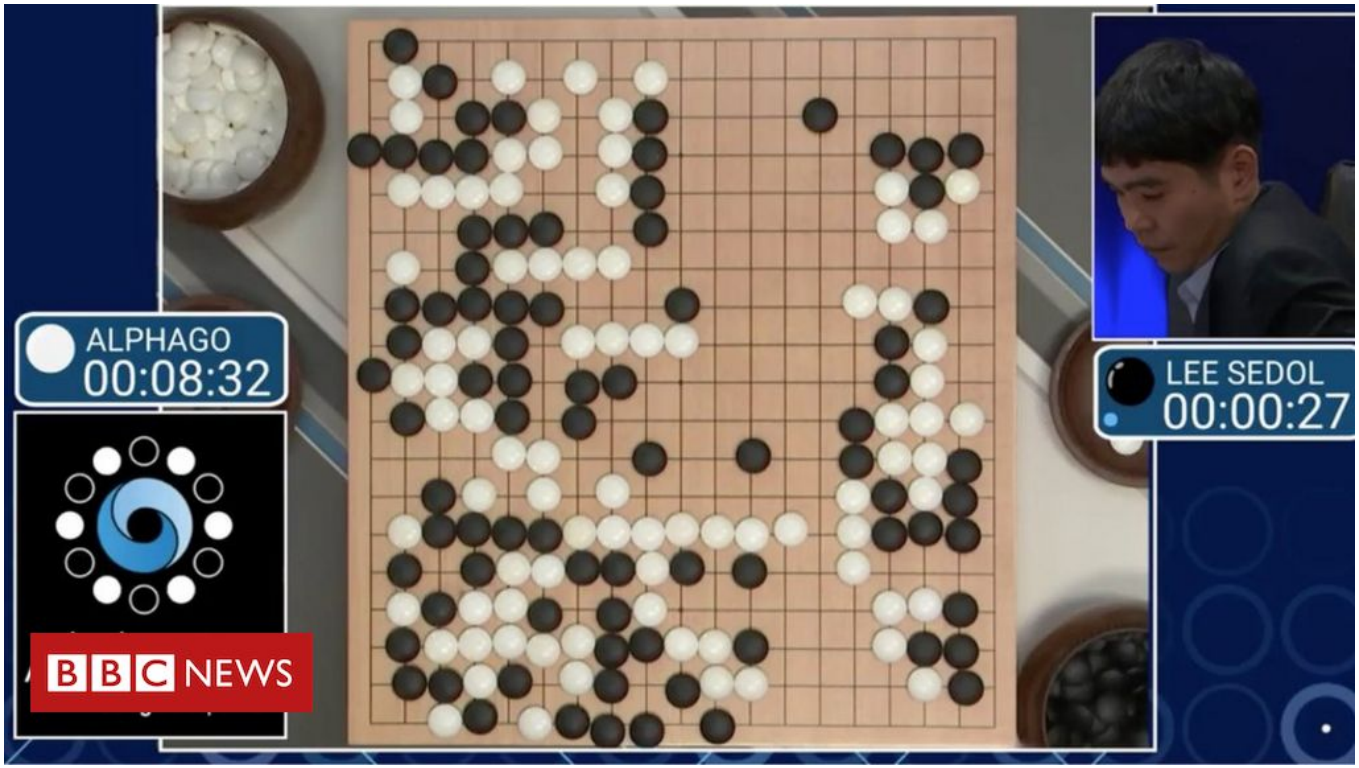


Scary



That's how everything started back in 1997!

Go paying



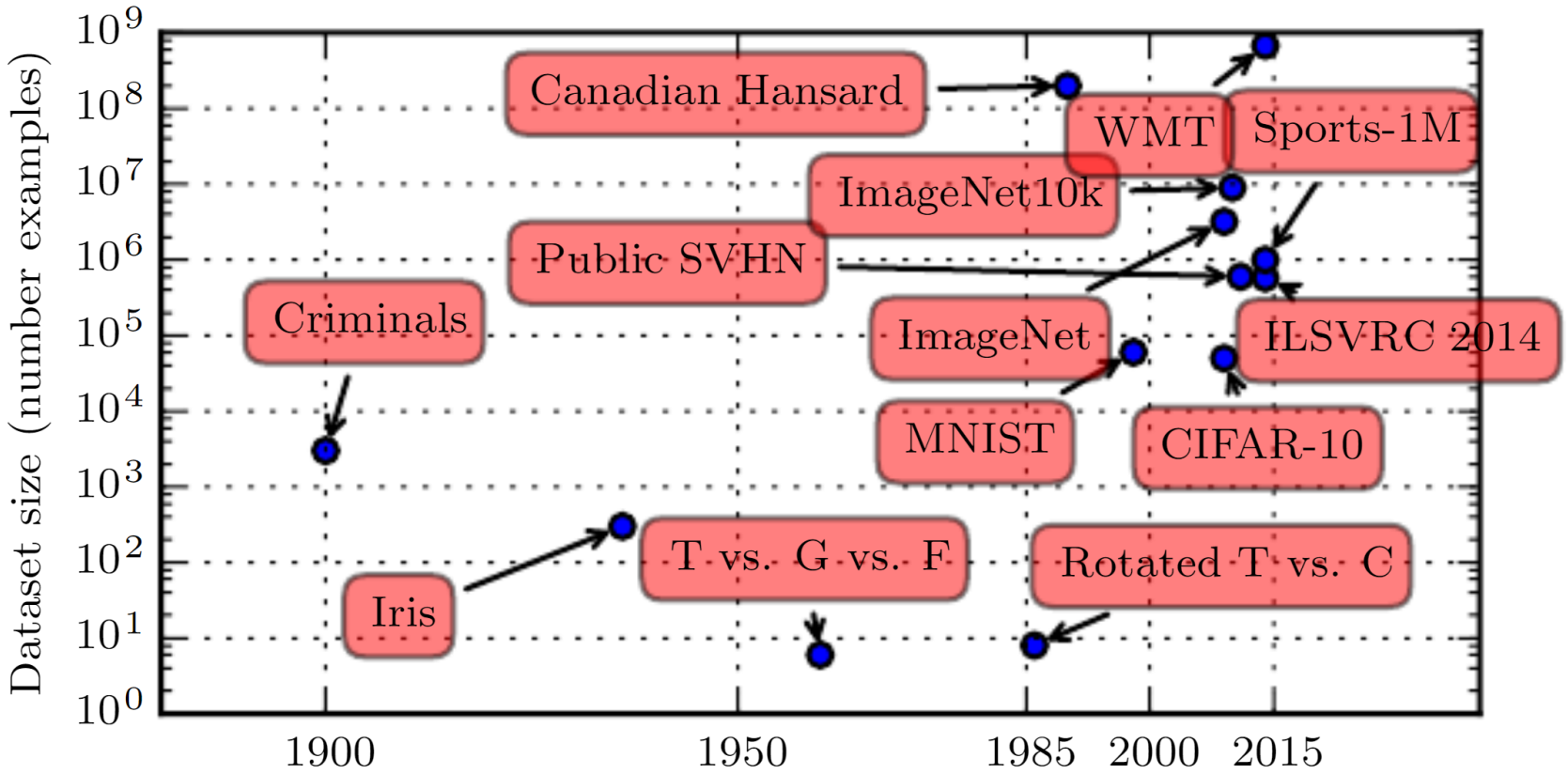
Outline

Enabling DL

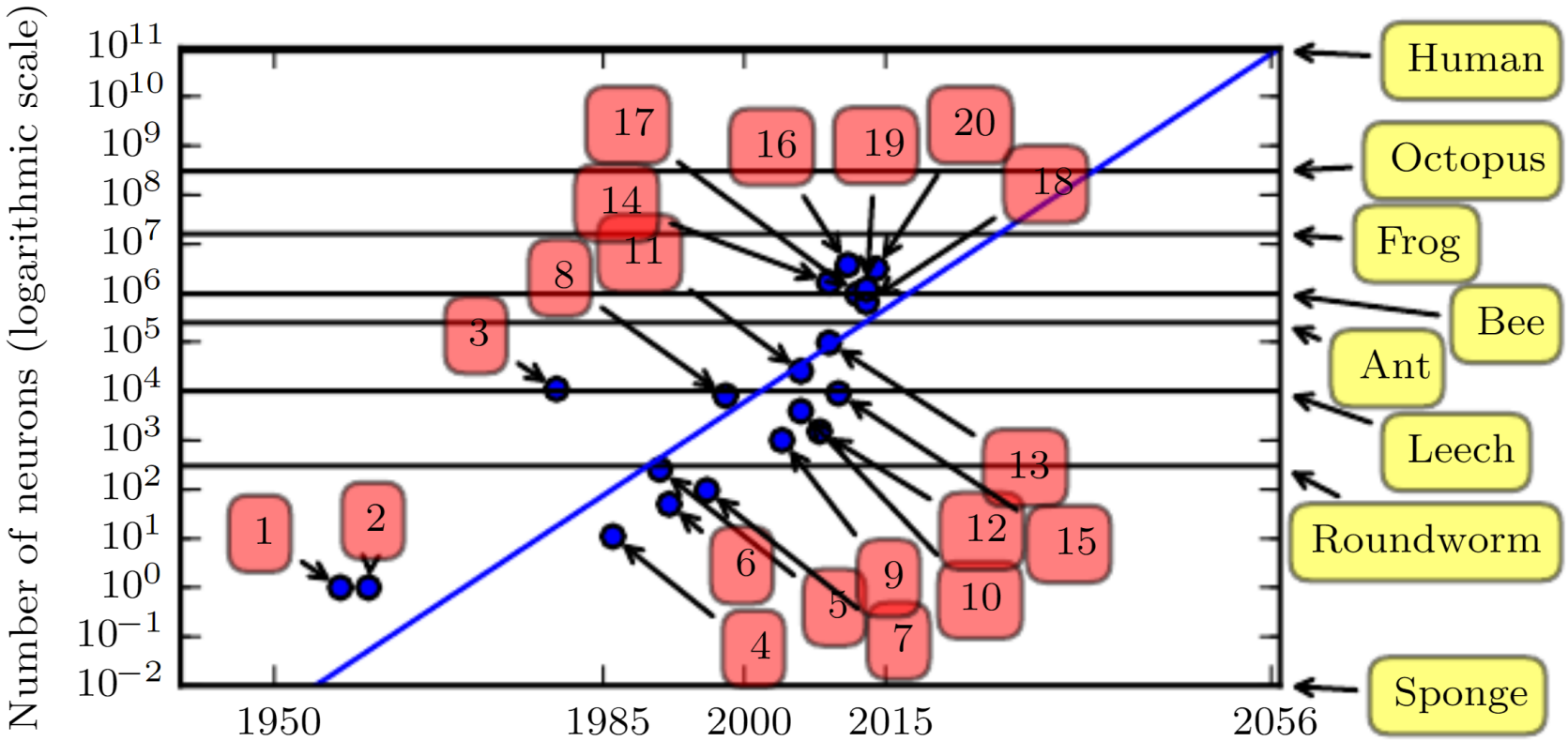
Why do we have deep learning now?

- 5 decades of research.
- Lots of data (Internet).
- Computing power (GPU).
- Representation learning.
- Culture of collaborative science.
- Resources from large corporations, (fB, Google, Amazon, Apple, etc).

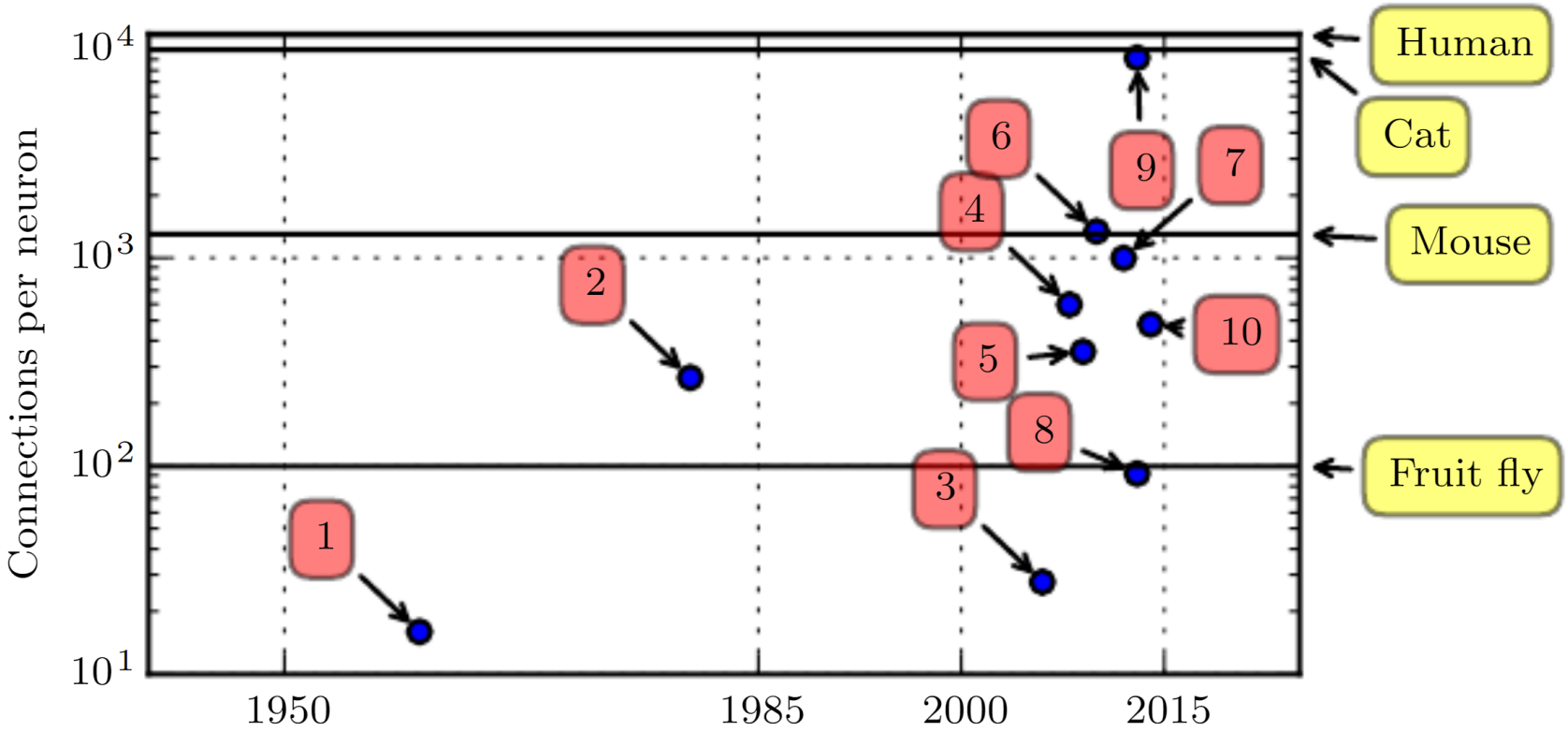
Data


Dataset size (number examples)
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
1900
1950
1985
2000
2015
Canadian Hansard
WMT
Sports-1M
ImageNet10k
Public SVHN
Criminals
ImageNet
ILSVRC 2014
MNIST
CIFAR-10
T vs. G vs. F
Rotated T vs. C
Iris

Number of neurons



Number of connections



Beginnings (40's – 60's): cybernetics

- 1943 – W. McCullogh and W. Pitts (electrical engineers): "A Logical Calculus of the Ideas Immanent in Nervous Activity".
- 1949 – D. Hebb: Hebbian Learning principle (plasticity).
- 1951 – M. Minsky: 1st ANN (Hebbian learning, 40 neurons).
- 1958 – F. Rosenblatt: Perceptron (classify images, 20×20).
- 1959 – D.H. Hubel and T. Wiesel: demonstrate orientation selectivity and columnar organization in the cat's visual cortex.
- 1969 – Minsky and Papert. States this works only for linearly separable problems. **1st winter**.

80's – 90's: connectionism

- 1974 – P. Werbos: Back-propagation.
- 1980 – Fukushima: Neocognitron.
- 1986 – D.E. Rumelhart: 2-layers NN with backpropagation.
- 1986 – Hinton: Shared weights and distributed representations.
- 1994 – Bengio:Fundamental mathematical difficulties in modeling long sequences.
- 1997 – Hochreiter and Schmidhuber: Long short-term memory (LSTM).
- 1998 – LeCun: digit recognition.

Impractical at the time. **2nd winter**.

2006 – current: deep learning

- 2006 – Hinton: Greedy layer-wise pre-training.
- 2012 – Krizhevsky: AlexNet. Image recognition.
  Distributed hardware.
- 2014 – Szegedy: GoogleLeNet.
  Image classification (ILSVRC: 1M+ images, 1000 classes).
  Only 6.7% classification error.
- 2014 – Goodfellow: GAN's.
- 2015 – He: ResNet. Only 3.6% classification error.
- 2015 – Google: Tensorflow.
- 2016 – Facebook: PyTorch.
- 2017 – Polosukhin: Transformers.

Q&A

Thank you!

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