

CS5242 : Neural Networks and Deep Learning

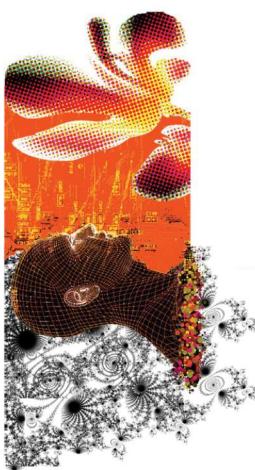
Lecture 1: Introduction to Deep Learning

Semester 1 2021/22

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Outline

- AI/DL case studies
- A brief history of AI/DL
- 2012 DL breakthrough
- DL is a universal learning technique
- Terminology AI/ML/DL
- Key ingredients of DL
- AI is the new electricity
- Limitations of AI

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Deep learning case studies

- AI/DL is more and more present in our daily life:

- Voice recognition/synthesis
- AI assistant
- Machine translation
- Object recognition
- Self-driving cars
- Games
- Robots
- Face recognition
- Healthcare
- Drug discovery

Google search

- Voice recognition - Q&A - voice synthesis : 3 neural networks



Example: What is deep learning?

AI assistant

- Google AI assistant : Voice recognition - Q&A – voice synthesis



Google's May
2018 I/O
developers
conference

Turing test passed?

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

Machine translation

- Harry Potter and The Chamber of Secrets : English ⇒ French ⇒ English

The screenshot shows the Google Translate interface. The source text is in English:

As Harry ~~s'énervait~~ along the deserted corridor he came across somebody who looked just as preoccupied as he was. Nearly Headless Nick, the ghost of Gryffindor Tower, was staring morosely out of a window, muttering under his breath, "... don't fulfill their requirements ... half an inch, if that..." "Hello, Nick," said Harry.

The target language is French:

Alors que Harry ~~s'énervait~~ dans le couloir désert, il tomba sur quelqu'un qui semblait aussi préoccupé que lui. Presque sans tête Nick, le fantôme de la Tour de Gryffondor, regardait moralement par une fenêtre, murmurant dans sa barbe, "... ne remplir pas leurs exigences ... un demi-pouce, si cela..." "Bonjour, Nick," dit Harry.

Below the text, there are edit controls and a note: "336/5000".

The screenshot shows a French-to-English translation interface. The source text is in French:

As Harry ~~walked away~~ into the deserted corridor, he came across someone who seemed ~~as preoccupied as he was~~. Almost headless Nick, the ghost of the Gryffindor Tower, was looking morally through a window, whispering in his beard, "... does not meet their demands ... half an inch, if that..."

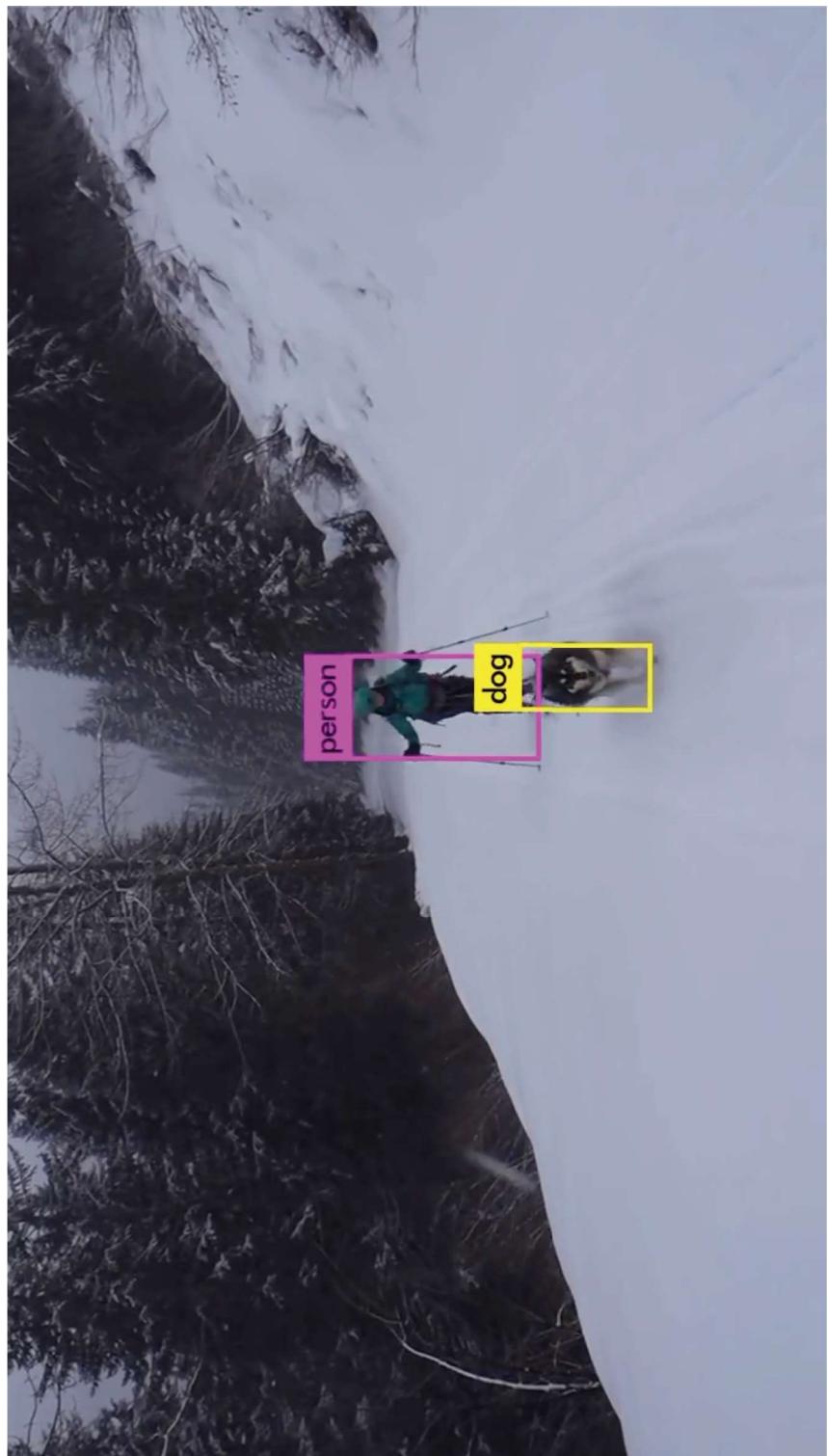
"Hello, Nick," Harry said.

Below the text, there are edit controls and a note: "Suggest an edit".

Still far from professional translators, but some translators use it as first draft.

Object recognition

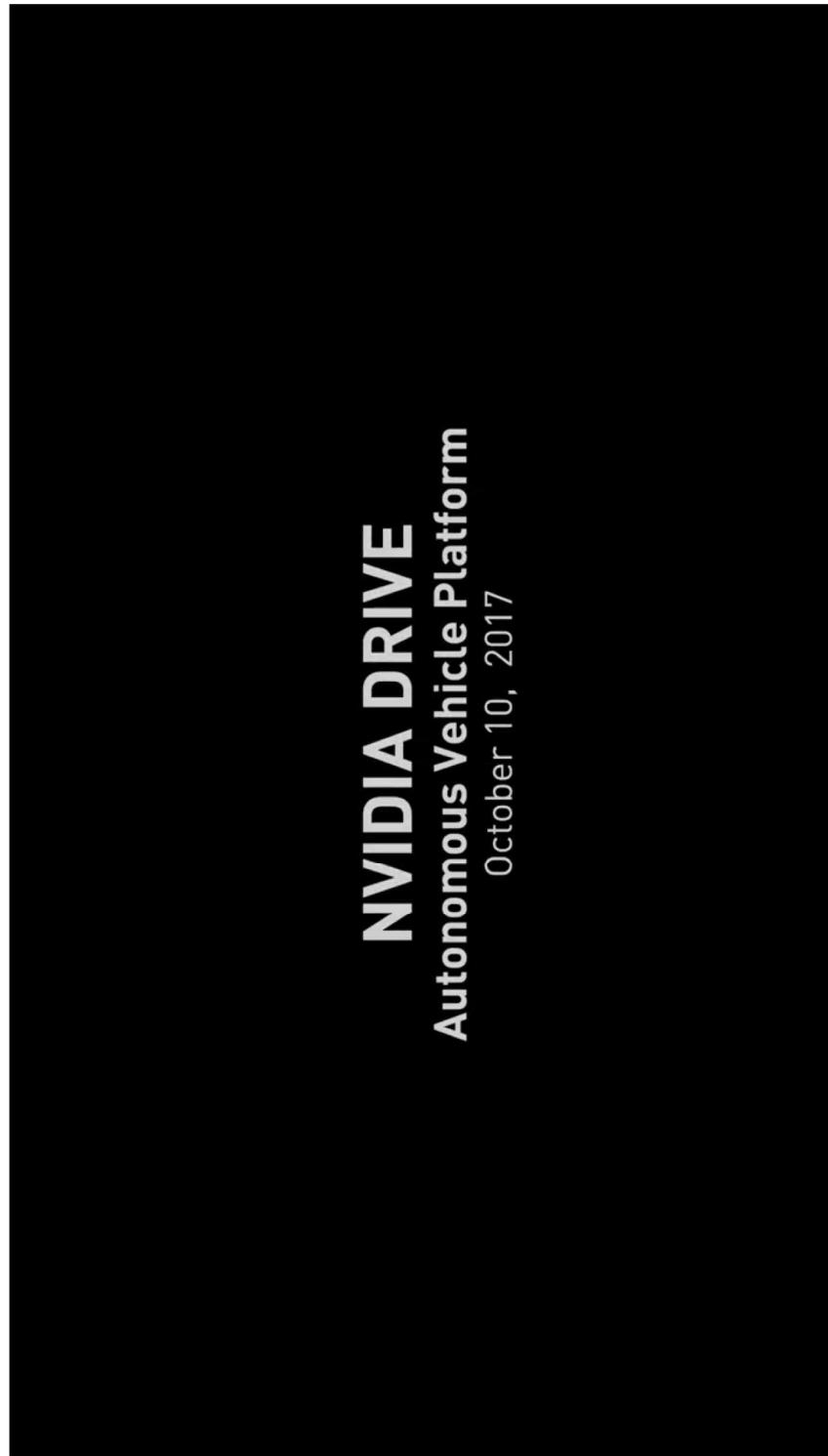
- Real-time object detection and recognition :



YOLO
<https://pjreddie.com/darknet/yolo>

Self-driving cars

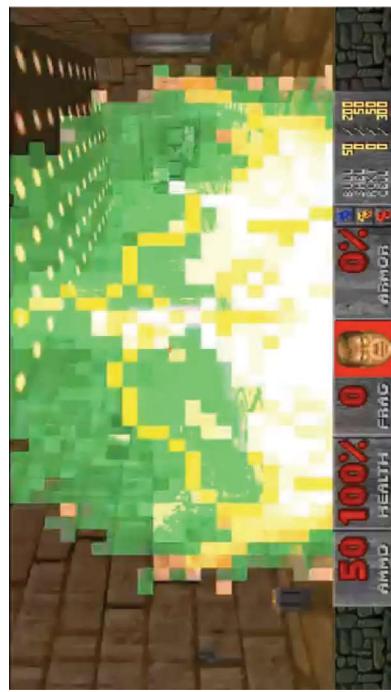
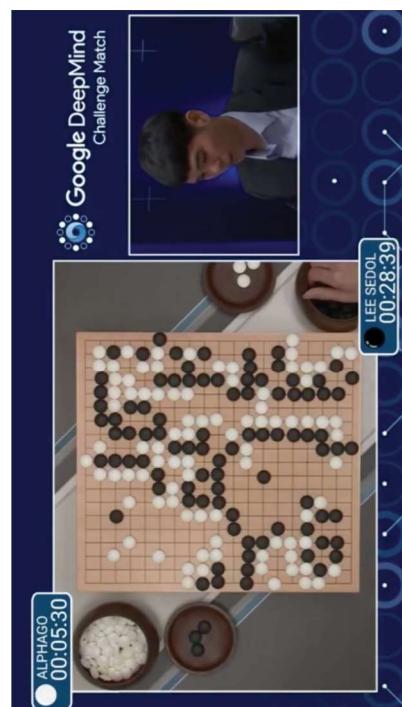
- Requires to solve several computer vision tasks simultaneously :



Autonomous cars will be the most visible AI application in the coming decade !

Strategy games

- Google DeepMind **AlphaGo** defeated the world champions at Go, March 2016, May 2017



Doom (Facebook)

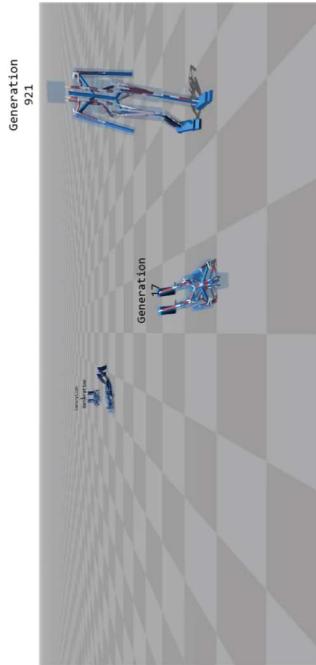
AI international competition



OpenAI Five: Dota2
The International 2018

Simulated and real-world robots

- Autonomous robots :



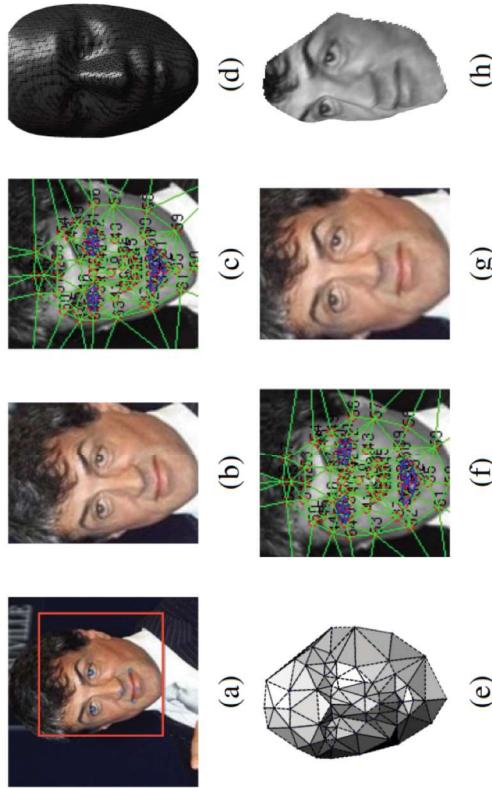
This is **not** AI-based robots (Boston Dynamics).
This is **AI**-based robots.



Today, we are far away from autonomous robots !

Face recognition

- Facebook face recognition system :

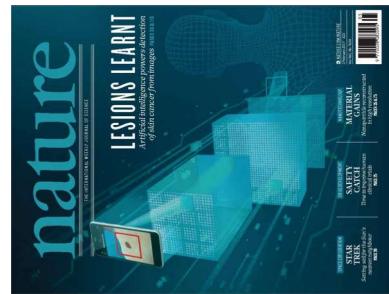
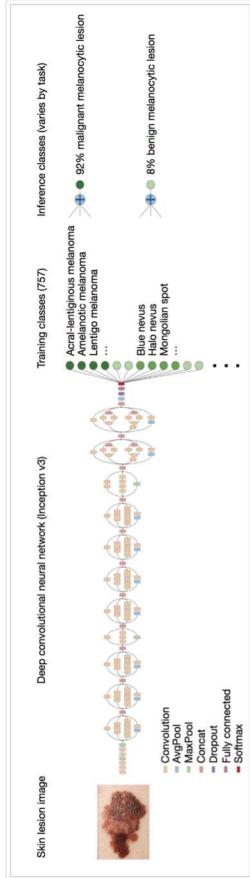


Gary Chavez added a photo you might be in.
about a minute ago ·

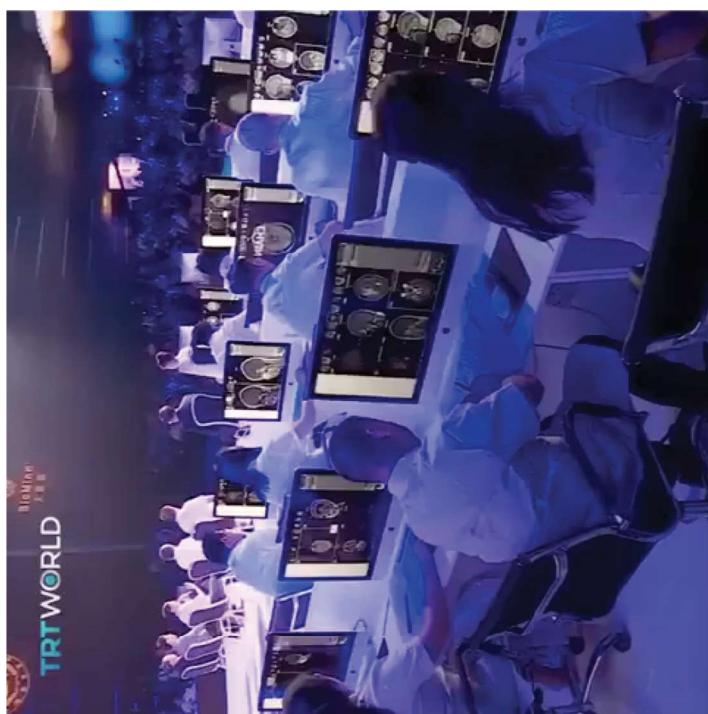


Healthcare

- Dermatology imaging : detection of skin cancer



Dataset: 129K clinical images
consisting of 2,032 different diseases
**Performance on par or slightly
better than >20 dermatologists,**
Feb 2017



Shanghai Huashan Hospital elite radiologists
vs. BioMind, an AI system, July 2018
AI made 87% prediction in 15 min.
Human doctors made 66% prediction in 30 min.

Drug discovery

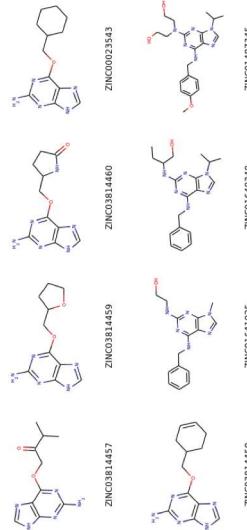
- Learn to generate molecules with special properties - personalized to patients :

nature
International journal of science

SPOTLIGHT • 30 MAY 2018

How artificial intelligence is changing drug discovery

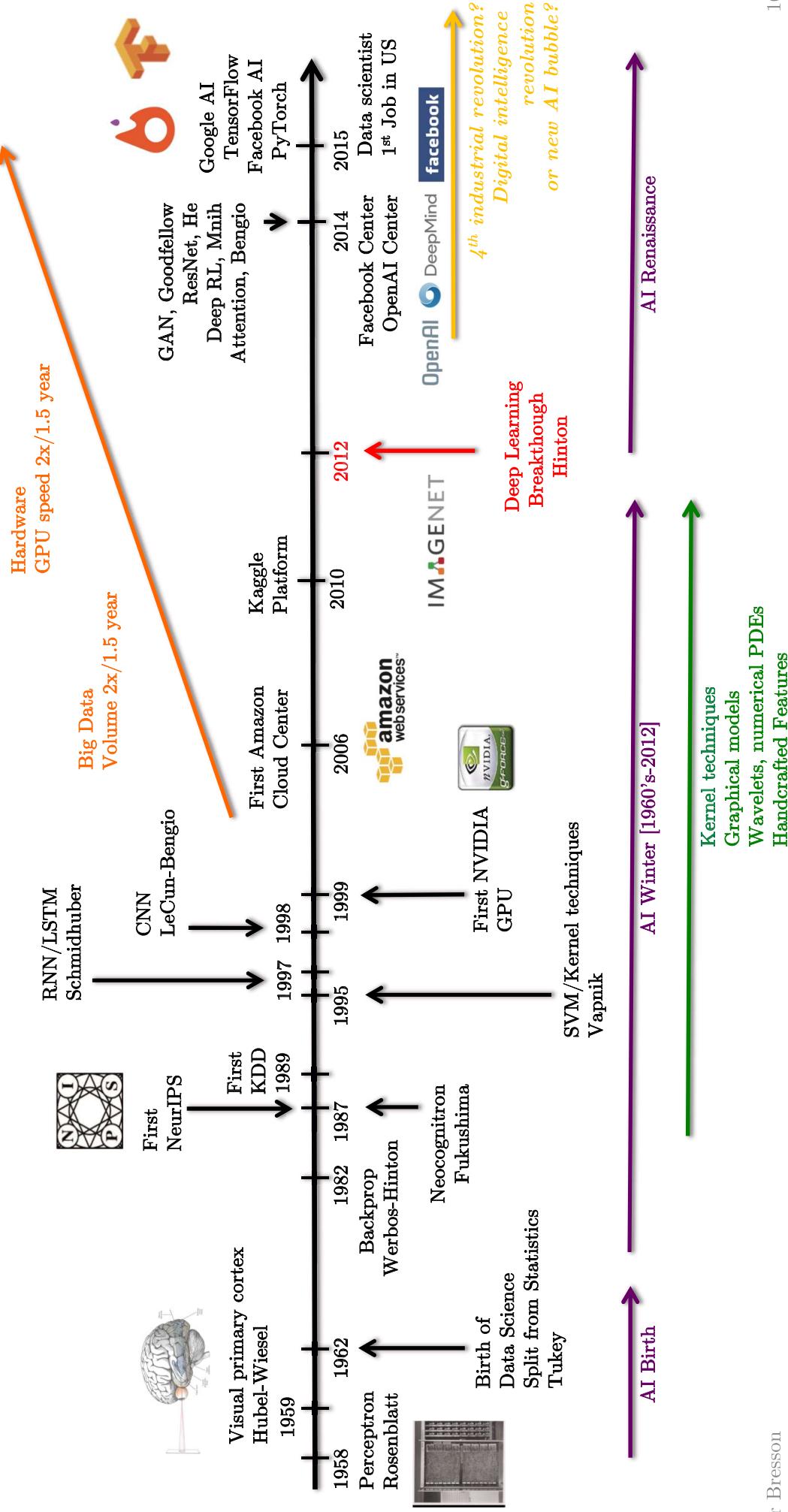
Machine learning and other technologies are expected to make the hunt for new pharmaceuticals quicker, cheaper and more effective.



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A brief history of DL

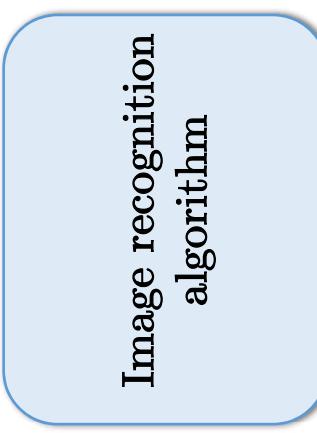


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2012: The year of DL breakthrough

- **ImageNet** challenge : International **Image Classification** Challenge
- Goal: Design the best algorithm for image recognition
(one of the most basic problems in computer vision since 50 years)



Siamese Cat

Input: An image

Output: A category

2012: The year of DL breakthrough

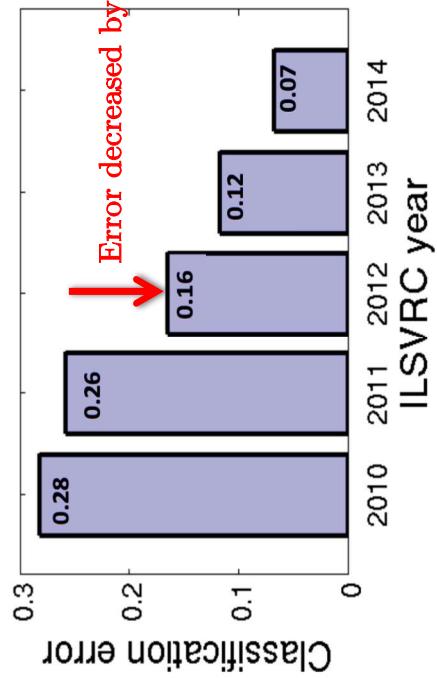
- **ImageNet challenge : International Image Classification Challenge**



ImageNet dataset

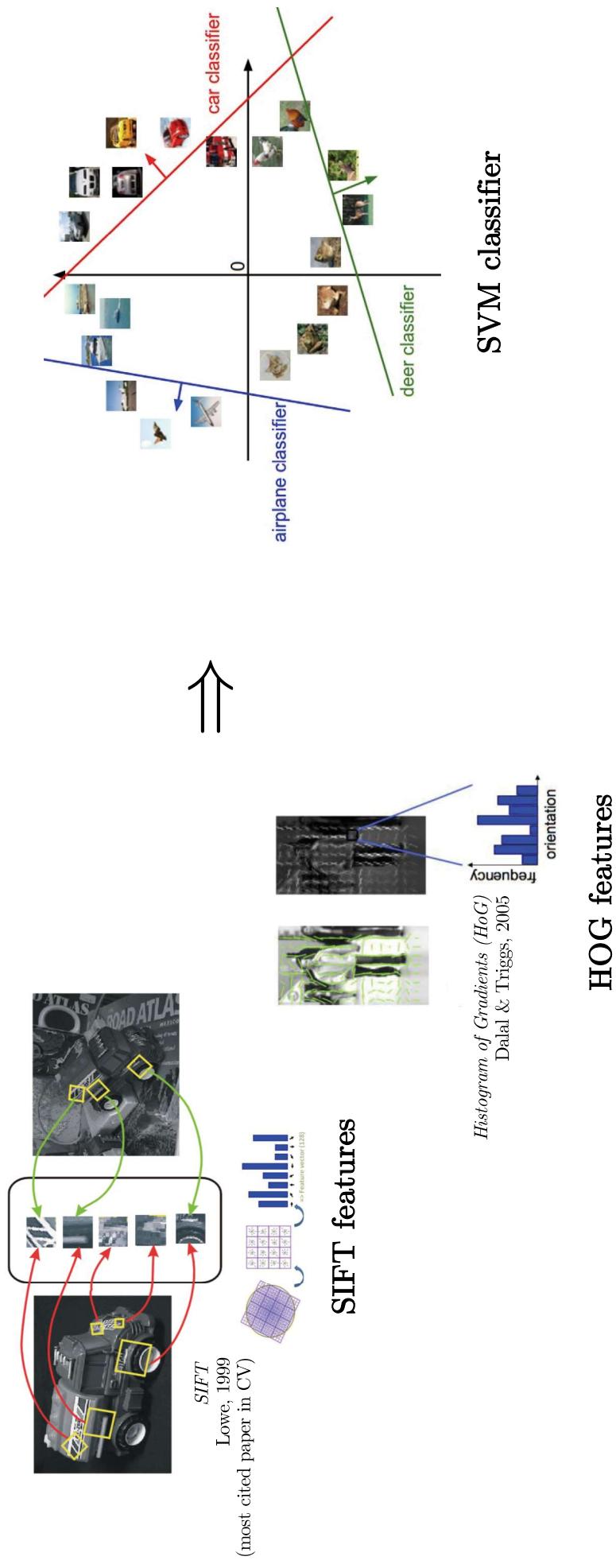
2012: The year of DL breakthrough

- **ImageNet challenge :**
 - Training set: 1.2 million labelled images (given to the teams)
 - **Test set:** 0.2 million labelled images (kept by the organizers)
 - Each team use the training set to **train** their algorithm, then they **submit** it to the organizers.
 - The organizers evaluate each algorithm on the test set.
- Observe the plot between 2011 and 2012 :
Change of paradigm : From 50 years of **hand-crafted** visual features to **learned** visual features from massive amount of data.



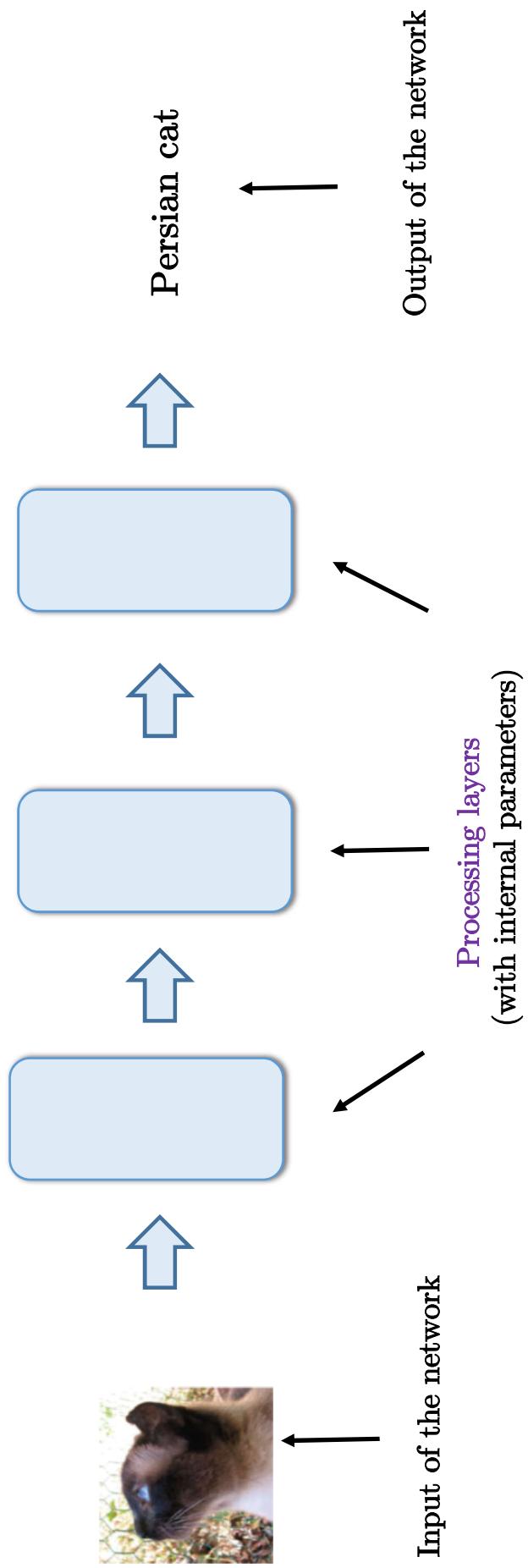
Before 2012

- Paradigm: Handcraft data features and feed them to a classifier.



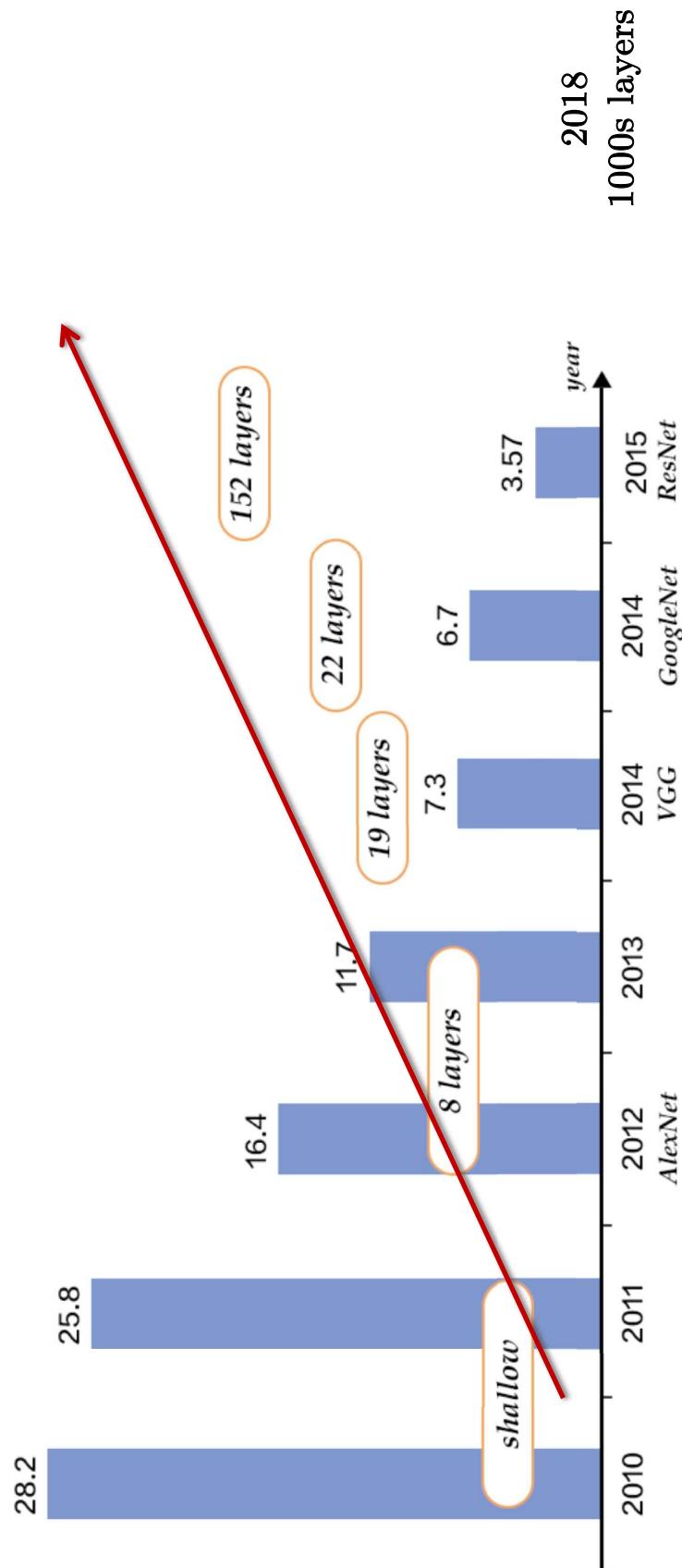
After 2012

- New paradigm: Learn data features and classifier **together**, a.k.a. **end-to-end** systems.
- **Neural networks** are the first class of models that can train end-to-end systems with large learning capacity by using multiple layers.



The deeper the better

- Deep Learning = Neural networks with many layers
- The deeper the more learning capacity :



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