

# Deep Learning

Lecture 0: Introduction

Prof. Gilles Louppe  
[g.louppe@uliege.be](mailto:g.louppe@uliege.be)

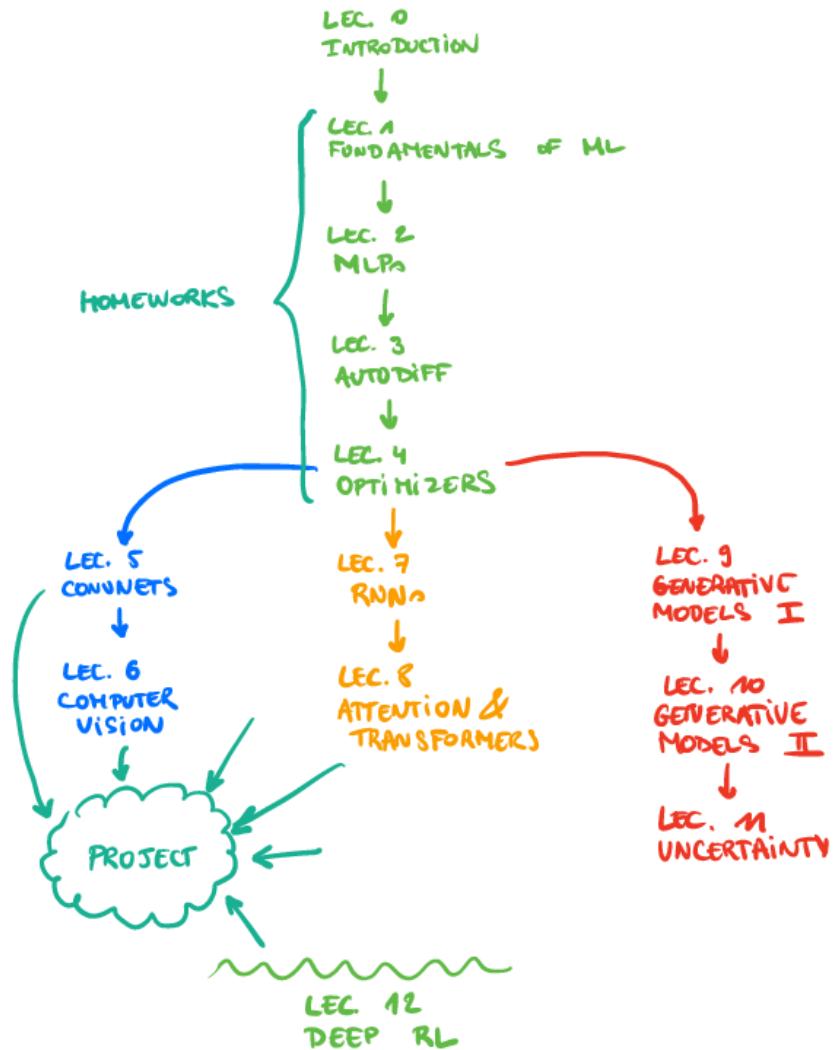


# Today

- Course outline
- Introduction to deep learning
- Fundamentals of machine learning

# Outline

- Lecture 0: Introduction
- Lecture 1: Fundamentals of machine learning
- Lecture 2: Multi-layer perceptron
- Lecture 3: Automatic differentiation
- Lecture 4: Training neural networks
- Lecture 5: Convolutional neural networks
- Lecture 6: Computer vision
- Lecture 7: Recurrent neural networks
- Lecture 8: Attention and transformer networks
- Lecture 9: Generative models (Part 1)
- Lecture 10: Generative models (Part 2)
- Lecture 11: Uncertainty
- Lecture 12: Deep reinforcement learning



## **My mission**

By the end of this course, you will have acquired a solid and detailed understanding of the field of deep learning. You will have learned how to use and architecture deep neural networks for a wide range of probabilistic inference problems, including classification, regression, detection, generation or reinforcement learning.

The techniques you will learn in this course apply to a wide variety of artificial intelligence problems, with plenty of applications in engineering and science.

# Why learning?



What do you see?



Sheepdog or mop?



Chihuahua or muffin?

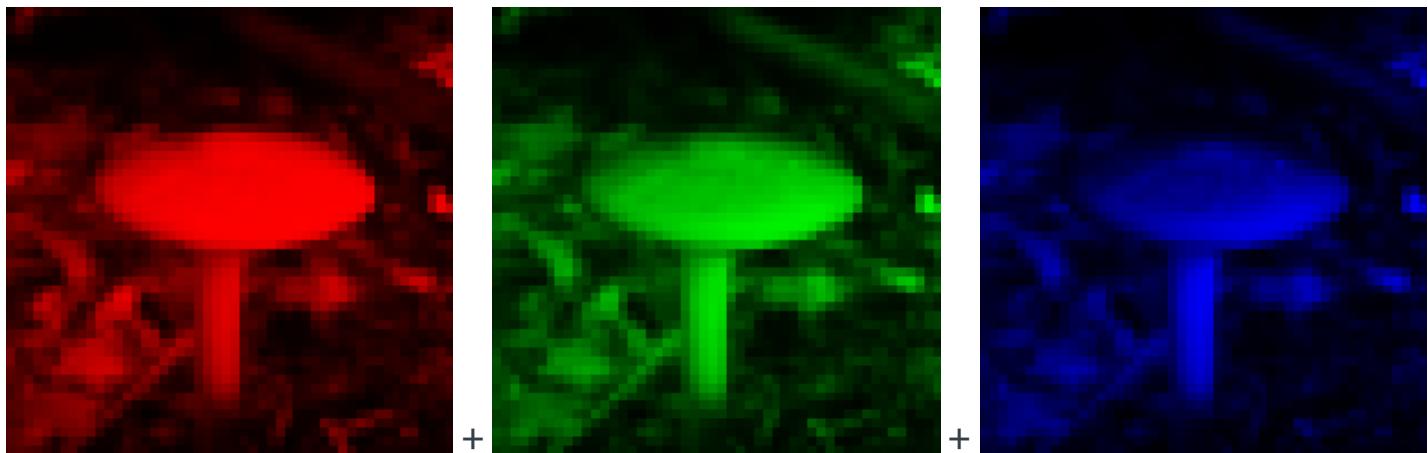
The (human) brain is so good at interpreting visual information that the **gap** between raw data and its semantic interpretation is difficult to assess intuitively:



This is a mushroom.



This is a mushroom.



+ +

This is a mushroom.

```
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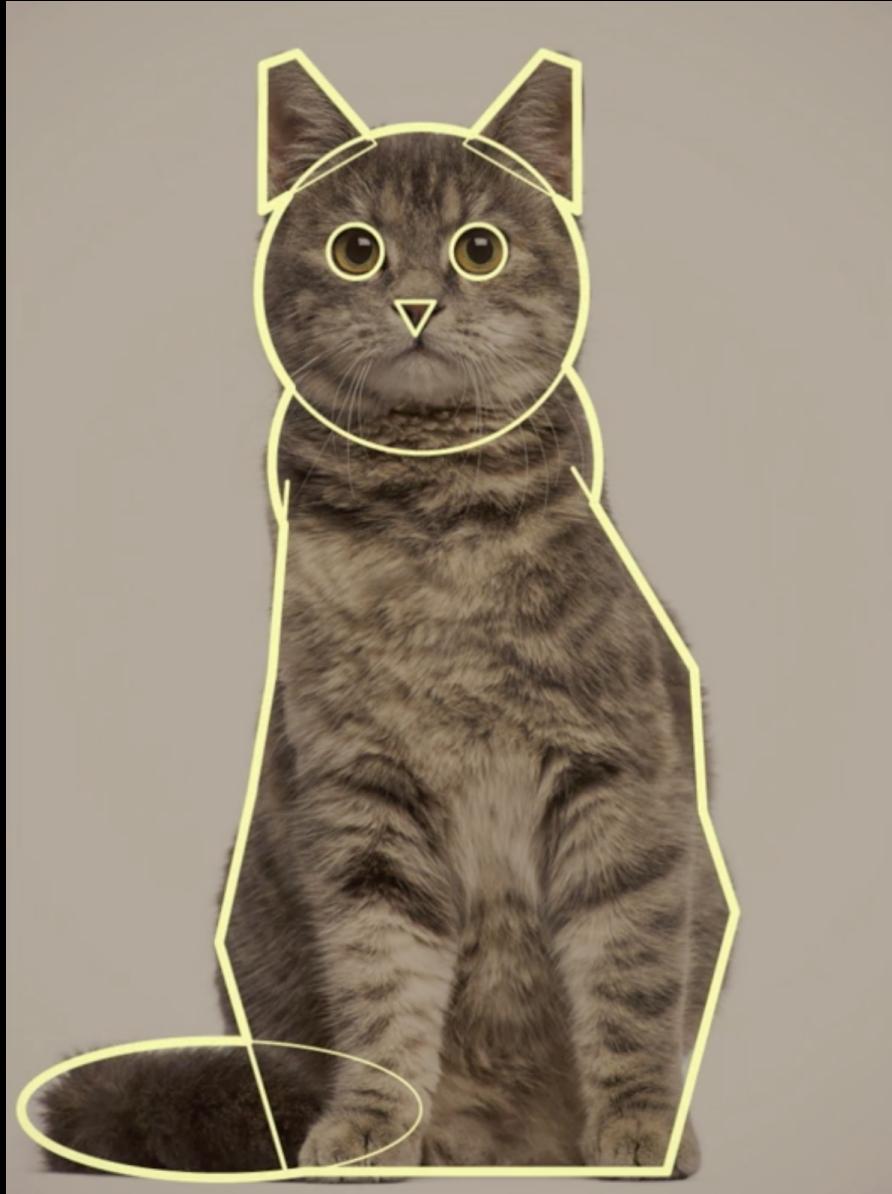
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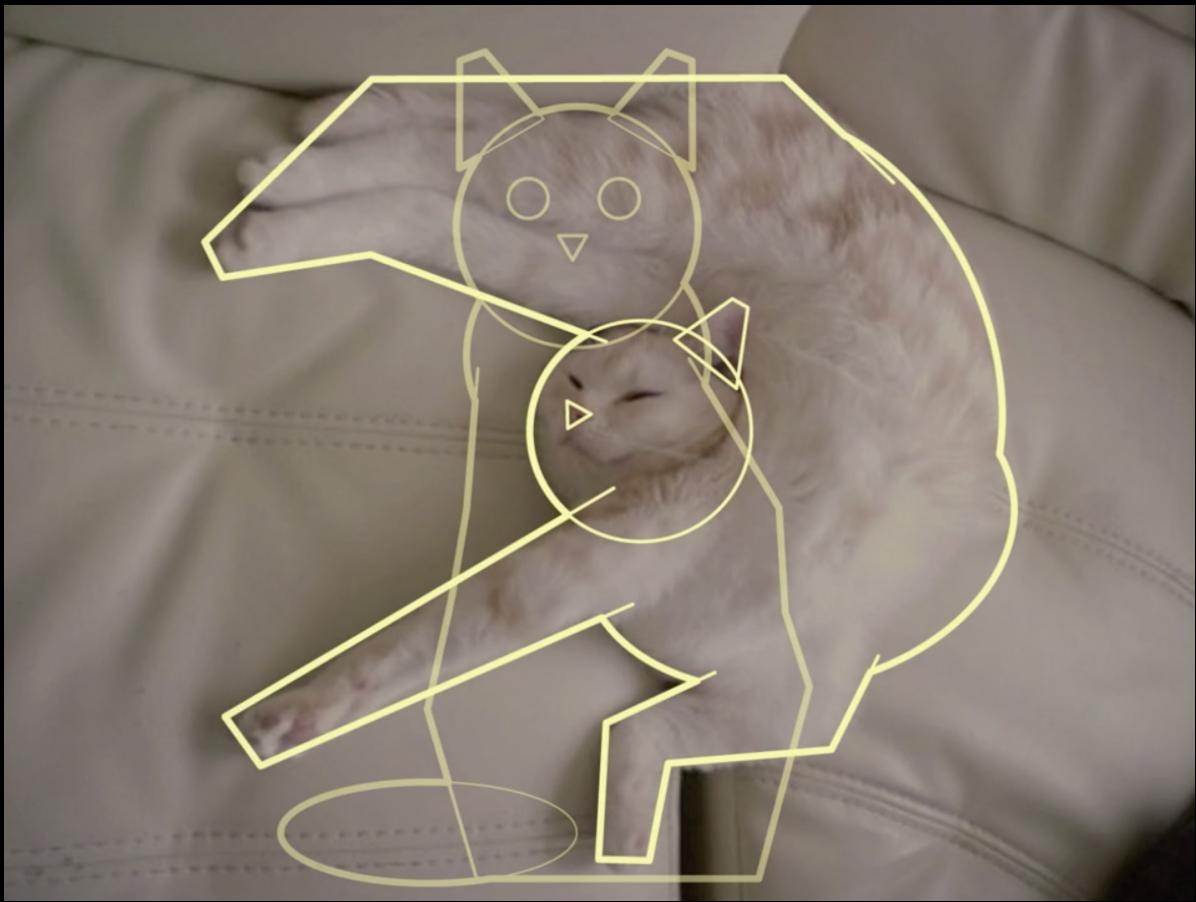
This is a mushroom.

Writing a computer program that sees?









Extracting semantic information requires models of **high complexity**, which cannot be designed by hand.

However, one can write a program that **learns** the task of extracting semantic information.



The common approach used in practice consists of:

- defining a parametric model with high capacity,
- optimizing its parameters, by "making it work" on the training data.

## **A change of paradigm**

We used to program computers. We will now train them.

# **Applications and successes**



Detectron2: A PyTorch-based modular object detection...



Copy link



Object detection, pose estimation, segmentation (2019)



Google DeepMind's Deep Q-learning playing...



Later bekijk...



Delen



Reinforcement learning (Mnih et al, 2014)



## AlphaStar Agent Visualisation



Later bekijk...

Delen



Strategy games (Deepmind, 2016-2018)



NVIDIA Autonomous Car



Watch later



Share



Autonomous cars (NVIDIA, 2016)



Full Self-Driving



Watch later



Share



Autopilot (Tesla, 2019)



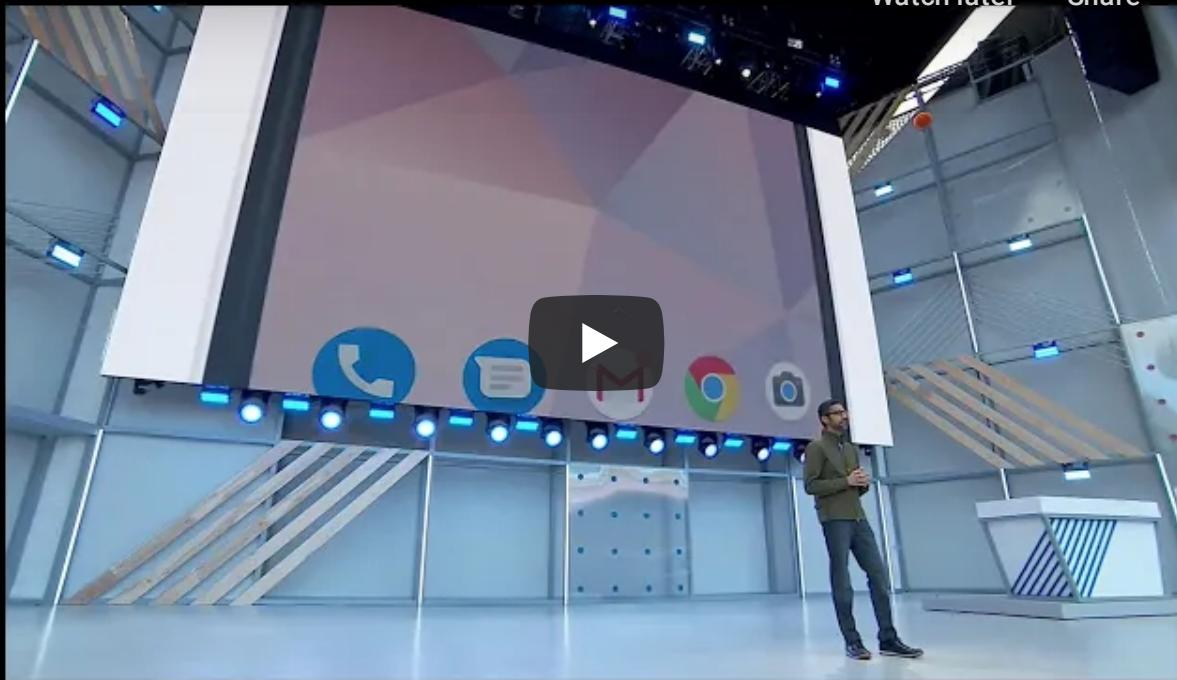
Google Assistant will soon be able to call res...



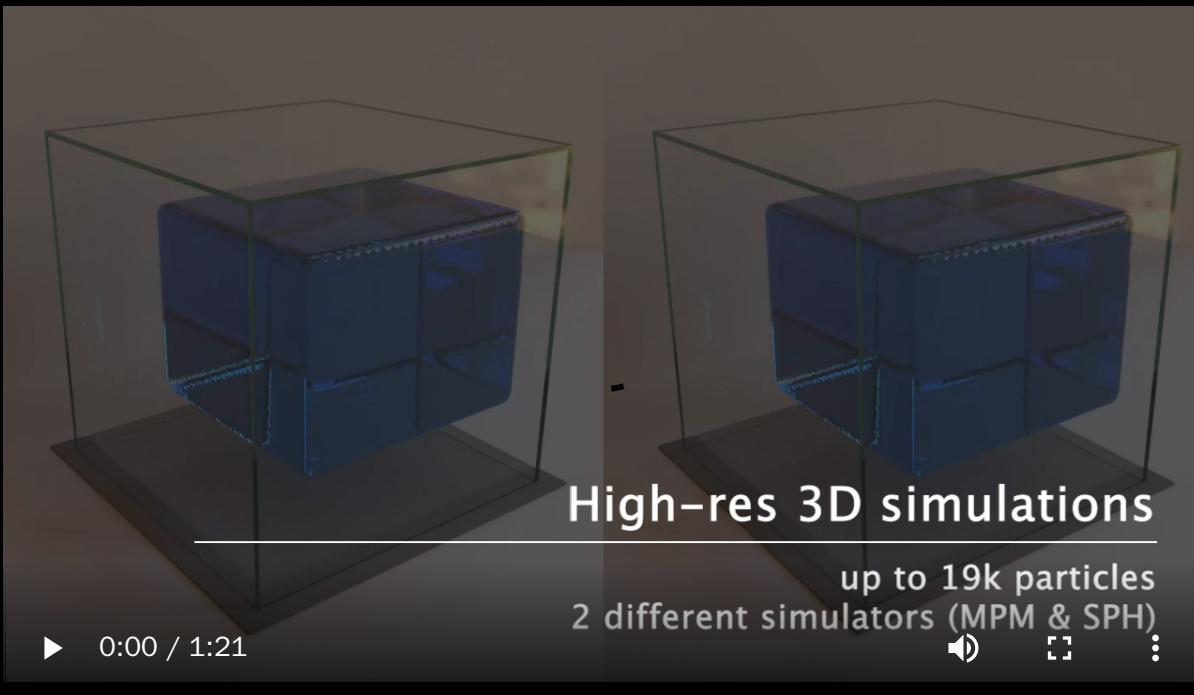
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Speech synthesis and question answering (Google, 2018)



Physics simulation (Sanchez-Gonzalez et al, 2020)



Artistic style transfer for videos



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Sintel movie, III



Artistic style transfer (Ruder et al, 2016)

T

# A Style-Based Generator Architecture for Ge...



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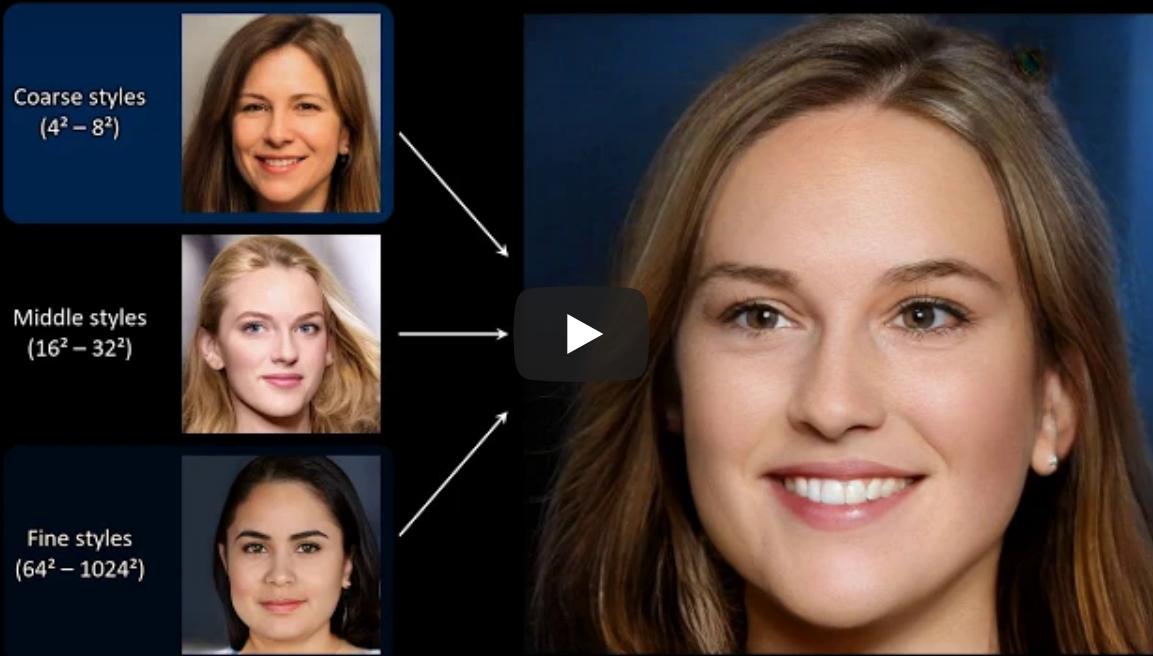


Image generation (Karras et al, 2018)



GTC Japan 2017 Part 9: AI Creates Original ...



Later bekijk...



Delen



Music composition (NVIDIA, 2017)



Behind the Scenes: Dali Lives



Watch later



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Dali Lives (2019)

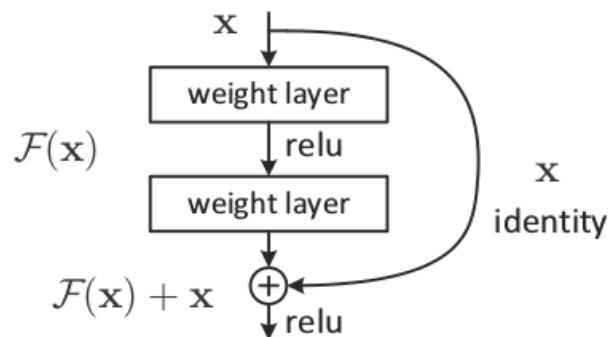


*"ACM named **Yoshua Bengio**, **Geoffrey Hinton**, and **Yann LeCun** recipients of the **2018 ACM A.M. Turing Award** for conceptual and engineering breakthroughs that have made deep neural networks a critical component of computing."*



# Why does it work now?

Algorithms (old and new)



More data



Software



Faster compute engines



## Building on the shoulders of giants

Five decades of research in machine learning provided

- a taxonomy of ML concepts (classification, generative models, clustering, kernels, linear embeddings, etc.),
- a sound statistical formalization (Bayesian estimation, PAC),
- a clear picture of fundamental issues (bias/variance dilemma, VC dimension, generalization bounds, etc.),
- a good understanding of optimization issues,
- efficient large-scale algorithms.

## Deep learning

From a practical perspective, deep learning

- lessens the need for a deep mathematical grasp,
- makes the design of large learning architectures a system/software development task,
- allows to leverage modern hardware (clusters of GPUs),
- does not plateau when using more data,
- makes large trained networks a commodity.

The end.

# References

- LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *nature*, 521(7553), 436-444.