



# Deep Learning

## Chapter 1: Introduction to Deep Learning

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# **LECTURE OUTLINE**

**Teaching Team**

**Course Roadmap**

**Deep Learning Application**

**What is Machine Learning?**

**Deep Learning**

# **Teaching Team**

# DR. DAVID RÜGAMER

I am Researcher and Lecturer at the Chair of Statistical Learning and Data Science.

- Ph.D. in Statistics with focus on Functional Data Analysis, Gradient Boosting and Statistical Inference.
- M.Sc. in Statistics with Specialization in Theory
- B.Sc. in Statistics with a Minor in Computer Science



# **MINA REZAEI, PH.D.**

I am Researcher at the Chair of Statistical Learning and Data Science.

- Ph.D. in Computer Science with focus on Deep Representation Learning from Imbalanced/Long-tailed Data.
- M.Sc. in Artificial Intelligence with Machine Learning Application in Medical Image Diagnosis
- B.Sc. in Computer Science



# **EMILIO DORIGATTI, M.SC.**

I am Ph.D. Researcher at the Chair of Statistical Learning and Data Science.

- Double Master's degree (from the Technical University of Eindhoven and from the Royal Institute of Technology, Stockholm) in Data Science obtained through the EIT Digital Master School, as well as a minor degree in Innovation and Entrepreneurship.
- B.Sc. in Computer Science



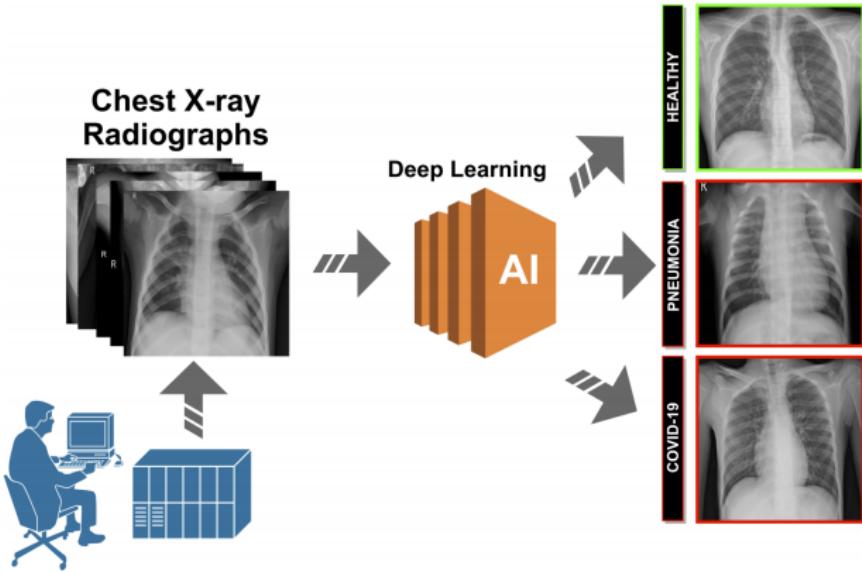
# Course Roadmap

# CONTENT TABLE

- ① Introduction, Overview, and a Brief History of Deep Learning
- ② Deep Forward Neural Network, Gradient Descent, Backprop, Hardware and Software
- ③ Regularization of NNs, Early Stopping
- ④ Dropout and Challenges in Optimization
- ⑤ Advanced Optimization
- ⑥ Activation Function and Initialization
- ⑦ Convolutional Neural Network, CNN Variants, Applications
- ⑧ Modern CNN and Overview of some applications
- ⑨ Recurrent Neural Network
- ⑩ Modern RNN and Applications
- ⑪ Deep Unsupervised Learning
- ⑫ Autoencoders, AE Regularization and Variants
- ⑬ Manifold Learning
- ⑭ Deep Generative Models, VAE, GANs

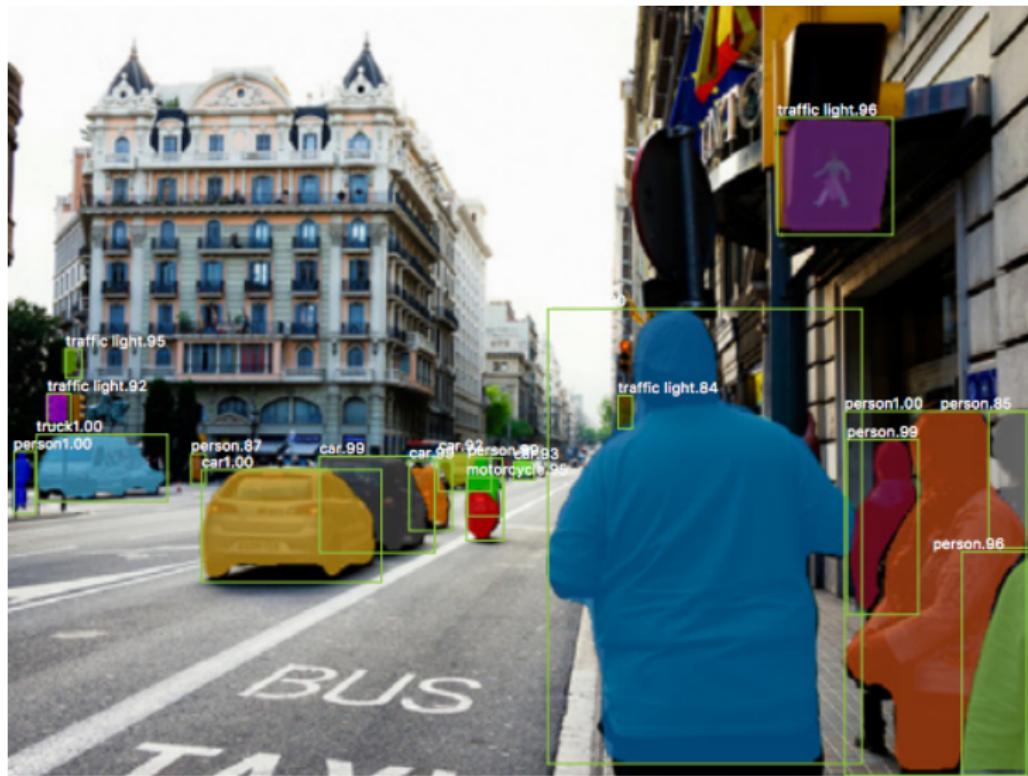
# **Deep Learning Application**

# APPLICATIONS OF DEEP LEARNING



**Impact on healthcare: Covid-19 diagnosis**  
(Source: CITIC Research Center)

# APPLICATIONS OF DEEP LEARNING



**Machine Vision** (Credit: Kaiming He)

# APPLICATIONS OF DEEP LEARNING

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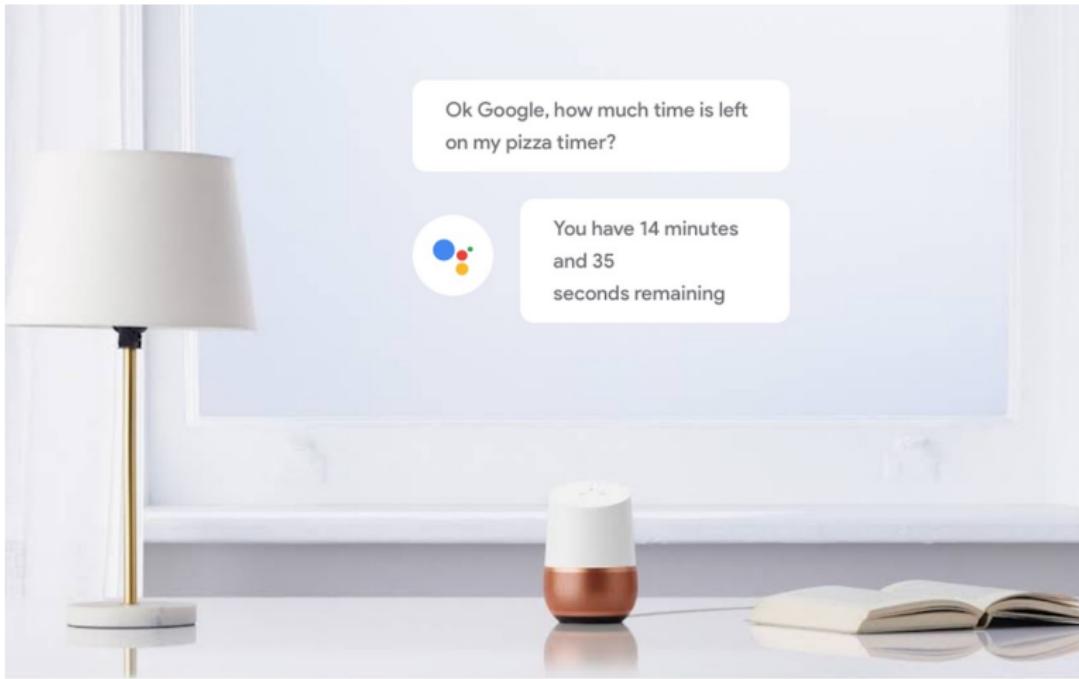
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## Machine Translation

# APPLICATIONS OF DEEP LEARNING



**Speech Recognition and Generation** (Source: Google)

# APPLICATIONS OF DEEP LEARNING



End-to-End Deep Learning for Self-Driving Cars (Source: Nvidia)

# **What is Machine Learning?**

# WHAT IS MACHINE LEARNING?

A computer program is said to **learn** from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E.

*Tom Mitchell, Carnegie Mellon University, 1998*

# WHAT IS MACHINE LEARNING?

All machine learning algorithms consist of three key components:

- **Hypothesis space:**

- This is basically the search space of the algorithm.
- It is the predefined set of functions from which the algorithm picks a function/model that is the best fit to the data.

- **Risk:**

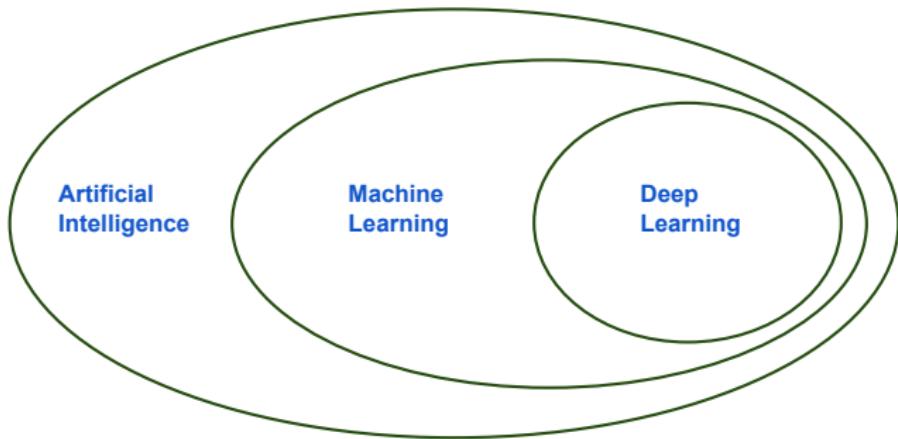
- A metric by which to evaluate models in the hypothesis space.
- The model returned by the algorithm must perform well on *unseen* data.

- **Optimizer:**

- A method/algorith to find the “right” model.

# **Deep Learning**

# DEEP LEARNING



- (Deep) neural networks are fundamentally a special kind of hypothesis space (*very*) loosely inspired by the organisation of neurons in biological brains.
- This lecture is about the nature of this hypothesis space.
- Some (important!) added tricks related to optimization will be covered in later lectures.