

# Deep Learning & Applied AI

## Introduction

Emanuele Rodolà  
[rodola@di.uniroma1.it](mailto:rodola@di.uniroma1.it)



SAPIENZA  
UNIVERSITÀ DI ROMA

# Logistics

- **Lecturer:** Prof. Emanuele Rodolà
- **Assistants:** Daniele Solombrino and Giorgio Strano  
*based on material by Luca Moschella, Antonio Norelli, Marco Fumero*  
Coding sessions, project support, technicalities

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- **Office Hours:** Drop me an email!

# Repository

**Official website:** <https://erodola.github.io/DLAI-s2-2025/>

Check frequently for **news** and **material** (code, papers, ...)!

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The course is hosted on Github at the url:

<https://github.com/erodola/DLAI-s2-2025>

**Note:** The repository is your main source of information, and replaces completely the need for a mailing list. Check it often!

# Disclaimer

We are at the **sixth edition** of a popular course.

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- The course is **challenging**

A good grade at other ML courses will not guarantee success.

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- **Postpone study**

New lectures usually assume knowledge from the previous lectures.

## Recipe for success

Try to **enjoy** the course!

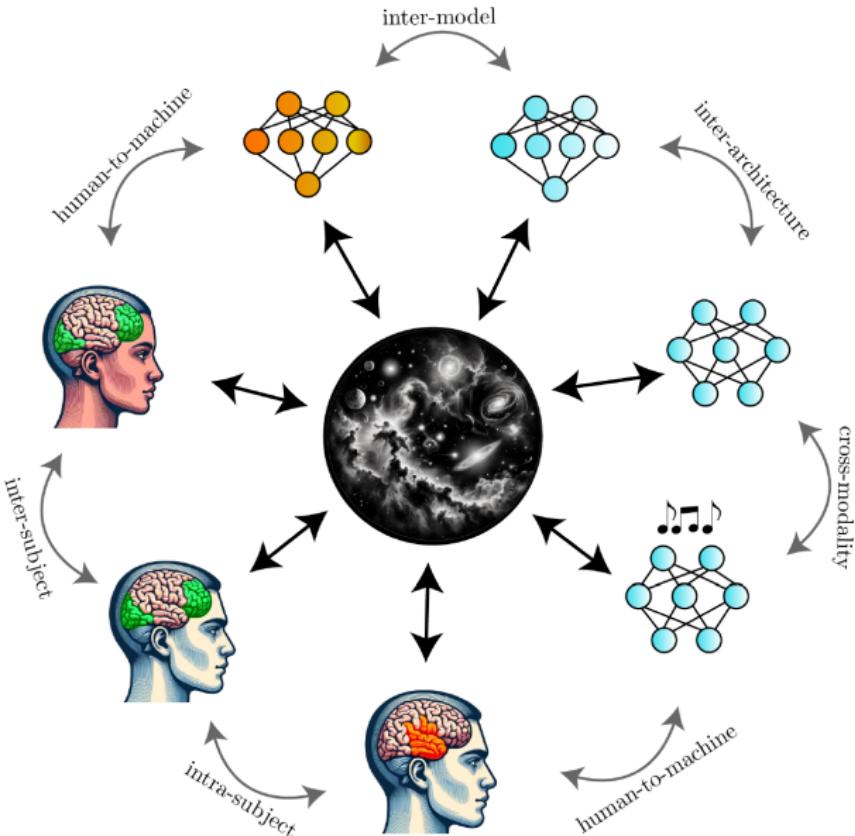
Take this as an opportunity to learn **in depth** a topic that will reshape our future.

Ask questions when in doubt.

# Who am I?

- Had research positions at U Tokyo, TU Munich, U Lugano and visiting positions at Harvard, Stanford, Ecole polytechnique, Technion among others
- Fellow of ELLIS and the Young Academy of Europe
- Research: representation learning, geometry, ML for audio
- Team: ~20 members from physics, engineering, computer science  
**GLADIA** group of Geometry, Audio, Learning and AI
- Approach us for projects / theses!





Notable Top 5% at ICLR 2023

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No official textbook.

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Pre-requisites:

- **Programming fundamentals.** We will use **Python**
- Linear algebra, calculus

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Main source: specialized conferences and journals:

**NeurIPS, ICML, ICLR, JMLR, CVPR, etc.**

The image displays two side-by-side browser windows. The left window shows a Google search results page for 'neurips'. The right window shows the homepage of the NIPS Proceedings website.

**Google Search Results (Left Window):**

- Search term: neurips
- Results: About 617,000 results (0.48 seconds)
- Top result: [nips.cc](https://nips.cc/) - NeurIPS @ Vancouver: The Thirty-fourth Annual Conference on Neural Information Processing Systems. Vancouver Convention Center ...
- Sub-links from top result:
  - Full Schedule**: Full Schedule (mobile friendly) · Multitrack Schedule ...
  - Dates**: Call for Papers · Call for Tutorials · Call for Workshops · Hotels · ...
  - NeurIPS 2019 Schedule**: NeurIPS | 2019, Thirty-third Conference on Neural ... Dates ...
  - More results from nips.cc »

**NIPS Proceedings Website (Right Window):**

- Page title: NIPS Proceedings®
- Section: Books
- Search bar: search
- Content:
  - Electronic Proceedings of the [Neural Information Processing Systems Conference](#)
  - List of proceedings:
    - [Advances in Neural Information Processing Systems 32 \(NIPS 2019\) are proceedings](#)
    - [Advances in Neural Information Processing Systems 31 \(NIPS 2018\)](#)
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**Applications:** we'll mostly illustrate things in the areas of computer vision, geometry processing, graphics, social networks, audio.

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In class, be prepared:

- Download/print the slides beforehand
- Take notes: not everything will be on the slides
- Bring your laptop: we'll do live coding sessions

## Overall objective

What will you get out of this course?  
(if you study)

- You will acquire **solid fundamental skills** for understanding, analyzing, and designing deep learning models

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- You will acquire solid fundamental skills for understanding, analyzing, and designing deep learning models
- You will be able to grasp and elaborate on more advanced topics published in the top machine learning venues
- You will get practical development expertise on applied problems



Google DeepMind

**SONY**



**amazon**

# Mathematical tools

- Linear algebra
- Calculus
- Optimization
- Discrete mathematics
- Probability & statistics
- Metric and differential geometry

This is not an easy course, but results will speak for themselves.

We will have to develop ways to **evaluate**, **visualize**, and **quantify** what we are doing. Going blind-folded and regarding learning models as black boxes will not bring us very far!

# ARTIFICIAL INTELLIGENCE

Early artificial intelligence stirs excitement.



## MACHINE LEARNING

Machine learning begins to flourish.



## DEEP LEARNING

Deep learning breakthroughs drive AI boom.



1950's

1960's

1970's

1980's

1990's

2000's

2010's

Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Image: Michael Copeland, NVIDIA

Deep learning is  
everywhere!

enses Other

question Answering

on  
on  
Image-to-Image  
e Generation

Generation

D  
on

Answering

## Models 521,547

Filter by name

 google/gemma-7b

Text Generation • Updated 3 days ago • ↓ 188 • ❤ 1.23k

 ByteDance/SDXL-Lightning

Text-to-Image • Updated 1 day ago • ↓ 2.2k • ❤ 512

 google/gemma-2b

Text Generation • Updated 3 days ago • ↓ 780 • ❤ 363

 BioMistral/BioMistral-7B

Text Generation • Updated 3 days ago • ↓ 891 • ❤ 233

 mistralai/Mixtral-8x7B-Instruct-v0.1

Text Generation • Updated 3 days ago • ↓ 1.15M • ❤ 3.01k

 stabilityai/stable-video-diffusion-img2vid-xt

Image-to-Video • Updated 9 days ago • ↓ 225k • ❤ 1.81k

 openai/whisper-large-v3

Automatic Speech Recognition • Updated 17 days ago • ↓ 921k • ❤ 1.75k

 google/gemma-7b-it

Text Generation • Updated 2 da

 stabilityai/stable-c

Text-to-Image • Updated 6 day

 google/gemma-2b-it

Text Generation • Updated 1 da

 briaai/RMBG-1.4

Image-to-Image • Updated 12 da

 CohereForAI/ayा-101

Text2Text Generation • Update

 meta-llama/Llama-2-7

Text Generation • Updated Nov

 stabilityai/stable-d

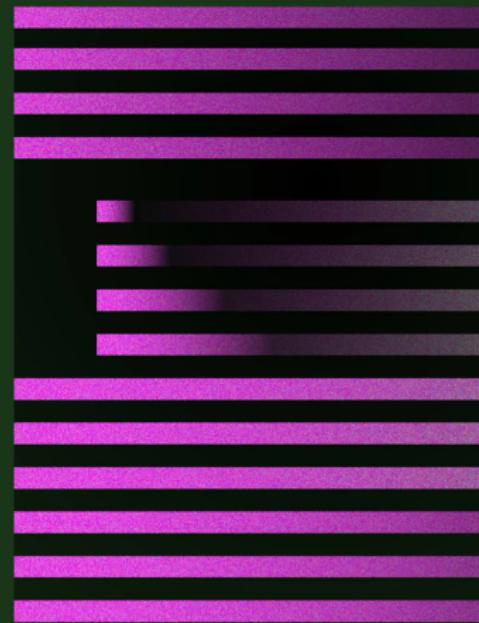
Text-to-Image • Updated Oct 30



Blog

# Introducing ChatGPT

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests.



 ✓ BOT Midjourney Bot archaeopteryx in a cartoon cel from the golden age of animation by walt disney studios drawn by walt disney 

Midjourney Bot ✓ BOT Oggi alle 08:50

archaeopteryx in a cartoon cel from the golden age of animation by walt disney studios drawn by walt disney circa 1939  
--ar 16:9 --no close up, zoom in --s 20 - Image #4 @gabagool6



 Upscale (Subtle)

 Upscale (Creative)

 Vary (Subtle)

 Vary (Strong)

 Vary (Region)

 Zoom Out 2x

 Zoom Out 1.5x

 Custom Zoom

 Make Square



Web 

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# Resurrect an ancient library from the ashes of a volcano.

## Win \$100,000. Make History.

The Vesuvius Challenge is a machine learning and computer vision competition that in 2023 cracked the riddle of the Herculaneum Papyri & awarded over \$1,000,000 in prizes.

2024's challenge is to go from reading a few passages to entire scrolls.

### 2023 Grand Prize Won

[READ THE ANNOUNCEMENT →](#)



### Read the Master Plan

[READ THE POST →](#)



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WHAT WOULD IT MEAN TO

# Understand *What Whales are Saying*

## THE ROADMAP

The CETI team collaborated to develop a scientific roadmap.

[Learn more](#)