

Machine Learning

Introduction

Emanuele Rodolà
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- **Lecturer:** Prof. Emanuele Rodolà
- **Assistants:** Dr. Daniele Solombrino
Coding sessions, project support, technicalities

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

Repository

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

Note: Webpage and repository are your main source of information, and replace completely the need for a mailing list. Check them often!

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We will cover all the mathematical background required for the course.

Recipe for success

Try to **enjoy** the course!

Take this as an opportunity to learn in depth.

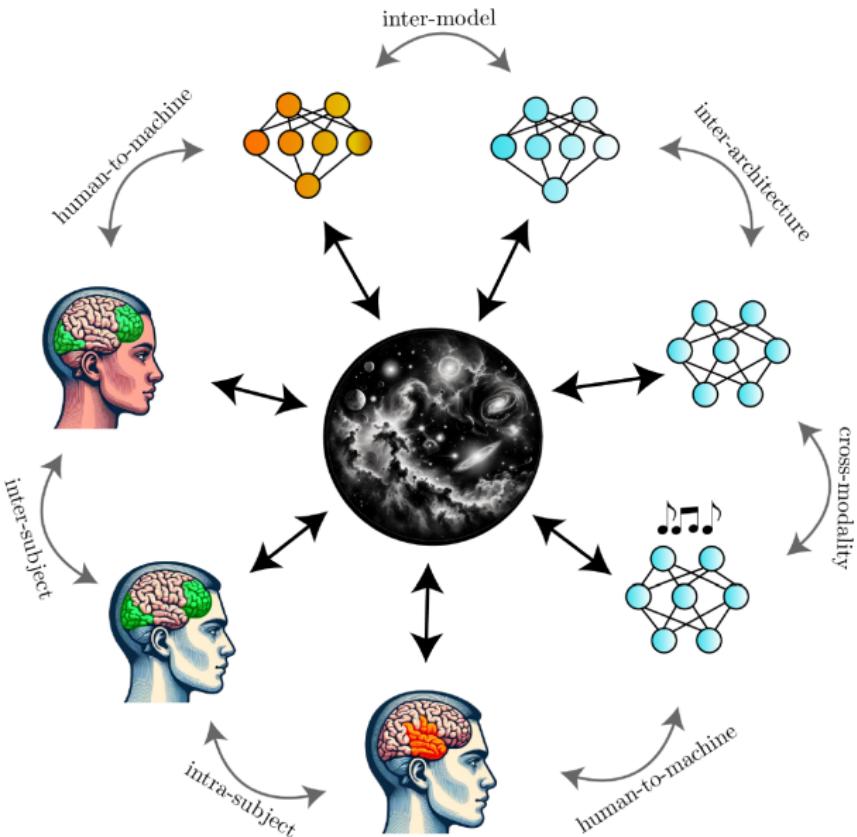
Ask questions when in doubt.

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!



European Research Council
Established by the European Commission



Notable Top 5% at ICLR 2023

Pre-requisites and reading material

No official textbook.

Specific references will be given throughout the course in the form of book chapters and scientific articles.



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Pre-requisites:

- **Programming fundamentals.** We will use [Python](#)
- Linear algebra, calculus

Pre-requisites and reading material

Main source: specialized conferences and journals:

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

Google search results for "neurips" showing the official NeurIPS website and schedule information.

Results (617,000 results):

- NeurIPS**
NeurIPS Website... NeurIPS @ Vancouver: The Thirty-fourth Annual Conference on Neural Information Processing Systems. Vancouver Convention Center...
 - Full Schedule**
Full Schedule (mobile friendly) Multitrack Schedule ...
 - Dates**
Call for Papers - Call for Music - Call for Workshops - Hotels - ...
 - NeurIPS 2019 Schedule**
NeurIPS | 2019, Thirty-third Conference on Neural... Dates ... More results from nips.cc x
- 2019**
Dates - NeurIPS 2019 Schedule - Posters - Call for Papers - Press
- NIPS Proceedings**
Electronic Proceedings of Neural Information Processing Systems ...
- NeurIPS Foundation**
The Neural Information Processing Systems Foundation is a non...
 - The Conference: Neural Information is a machine learning computational ...

NIPS Proceedings Books

Electronic Proceedings of the [Neural Information Processing Systems Conference](#)

- [Advances in Neural Information Processing Systems 32 \(NIPS 2019\) pre-proceedings](#)
- [Advances in Neural Information Processing Systems 31 \(NIPS 2018\)](#)
- [Advances in Neural Information Processing Systems 30 \(NIPS 2017\)](#)
- [Advances in Neural Information Processing Systems 29 \(NIPS 2016\)](#)
- [Advances in Neural Information Processing Systems 28 \(NIPS 2015\)](#)
- [Advances in Neural Information Processing Systems 27 \(NIPS 2014\)](#)
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A screenshot of a Google search results page for the query "neurips". The results include links to the NeurIPS website, the 2019 schedule, and the NIPS Proceedings. The NeurIPS logo is visible on the right.

Google Search results for "neurips":

- [neurips](#)
- [Full Schedule](#)
- [2019](#)
- [NIPS Proceedings](#)
- [NeurIPS Foundation](#)

A screenshot of the NIPS Proceedings website. It features a navigation bar with "Books" and a search bar. Below the header, there is a list of proceedings from 2019 down to 2005.

NIPS Proceedings Books

Electronic Proceedings of the Neural Information Processing Systems Conference

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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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When: first half of April

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±3 points on top of the project's grade.

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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 machine learning models

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- 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



Meta

amazon

Mathematical tools

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

Not an easy path, 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

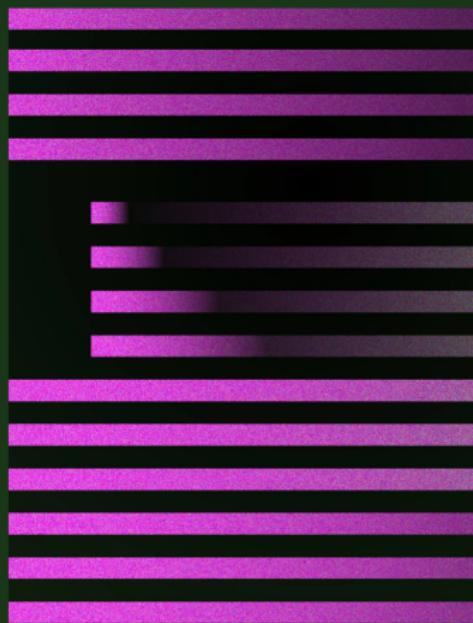
Machine learning is
everywhere!



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.





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](#)