

Machine Learning

Introduction

Emanuele Rodolà
rodola@di.uniroma1.it



SAPIENZA
UNIVERSITÀ DI ROMA

Logistics

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

Logistics

- **Lecturer:** Prof. Emanuele Rodolà
- **Assistants:** Dr. Adrian Minut
Coding sessions, project support, technicalities
- **When:** Mondays **10:30–12:45** and Tuesdays **8:30–10:45**

Logistics

- **Lecturer:** Prof. Emanuele Rodolà

- **Assistants:** Dr. Adrian Minut

Coding sessions, project support, technicalities

- **When:** Mondays **10:30–12:45** and Tuesdays **8:30–10:45**

- **Where:** Aula Picone

Logistics

- **Lecturer:** Prof. Emanuele Rodolà
- **Assistants:** Dr. Adrian Minut
Coding sessions, project support, technicalities
- **When:** Mondays 10:30–12:45 and Tuesdays 8:30–10:45
- **Where:** Aula Picone
- **Office Hours:** Drop me an email!

Repository

Official website: <https://erodola.github.io/ML-s2-2024/>

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

Repository

Official website: <https://erodola.github.io/ML-s2-2024/>

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

The course is hosted on Github at the url:

<https://github.com/erodola/DLAI-s2-2024>

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

Disclaimer

We are at the **first** edition of the ML course at SMIA.

- Everything will be new and fresh!
- The exam will follow the format: written test + project

Disclaimer

We are at the **first** edition of the ML course at SMIA.

- Everything will be new and fresh!
- The exam will follow the format: written test + project
- We will alternate between theoretical and lab classes

Disclaimer

We are at the **first** edition of the ML course at SMIA.

- Everything will be new and fresh!
- The exam will follow the format: written test + project
- We will alternate between theoretical and lab classes
- We will have guest lecturers on specific topics

Disclaimer

We are at the **first** edition of the ML course at SMIA.

- Everything will be new and fresh!
- The exam will follow the format: written test + project
- We will alternate between theoretical and lab classes
- We will have guest lecturers on specific topics
- Python, calculus and algebra fundamentals are a pre-requisite

Disclaimer

We are at the **first** edition of the ML course at SMIA.

- Everything will be new and fresh!
- The exam will follow the format: written test + project
- We will alternate between theoretical and lab classes
- We will have guest lecturers on specific topics
- Python, calculus and algebra fundamentals are a pre-requisite

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.

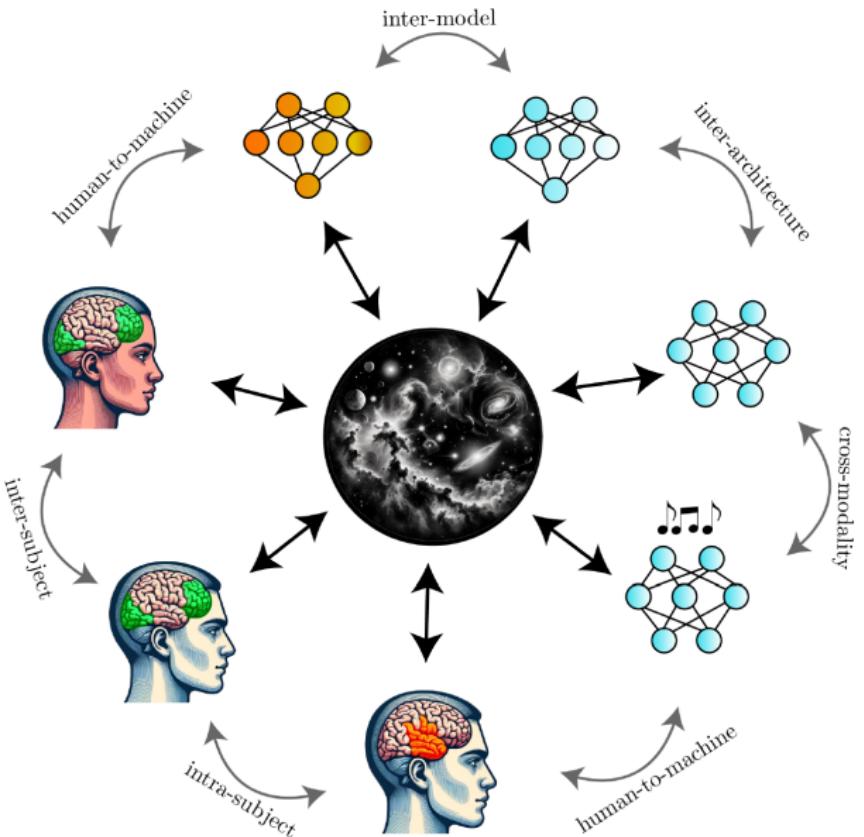
Ask questions when in doubt.

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: ~25 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.



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.

Warning: A [blog post](#) does not (always) count as a reliable reference, since it's not peer-reviewed.



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.

Warning: A blog post does not (always) count as a reliable reference, since it's not peer-reviewed.



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 NeurIPS website and related links.

Results (617,000 results):

- [NeurIPS](#) - 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

NIPS Proceedings website showing a list of conference 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](#)
- [Advances in Neural Information Processing Systems 26: NIPS 2013](#)
- [Advances in Neural Information Processing Systems 25: NIPS 2012](#)
- [Advances in Neural Information Processing Systems 24: NIPS 2011](#)
- [Advances in Neural Information Processing Systems 23: NIPS 2010](#)
- [Advances in Neural Information Processing Systems 22: NIPS 2009](#)
- [Advances in Neural Information Processing Systems 21: NIPS 2008](#)
- [Advances in Neural Information Processing Systems 20: NIPS 2007](#)
- [Advances in Neural Information Processing Systems 19: NIPS 2006](#)
- [Advances in Neural Information Processing Systems 18: NIPS 2005](#)

Pre-requisites and reading material

Main source: specialized conferences and journals:

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

A screenshot of a Google search results page for the query "neurips". The results are as follows:

- 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](#)

A screenshot of the NIPS Proceedings website. The header reads "NIPS Proceedings® Books". Below the header, there is a search bar and a list of proceedings volumes:

- [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](#)
- [Advances in Neural Information Processing Systems 26: NIPS 2013](#)
- [Advances in Neural Information Processing Systems 25: NIPS 2012](#)
- [Advances in Neural Information Processing Systems 24: NIPS 2011](#)
- [Advances in Neural Information Processing Systems 23: NIPS 2010](#)
- [Advances in Neural Information Processing Systems 22: NIPS 2009](#)
- [Advances in Neural Information Processing Systems 21: NIPS 2008](#)
- [Advances in Neural Information Processing Systems 20: NIPS 2007](#)
- [Advances in Neural Information Processing Systems 19: NIPS 2006](#)
- [Advances in Neural Information Processing Systems 18: NIPS 2005](#)

Applications: we'll mostly illustrate things in the areas of computer vision, geometry processing, graphics, social networks, audio.

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

- ② **Project** with report (fixed template)

When: Within each exam session

The project can be selected from a pool, or can be proposed.

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

- ② Project with report (fixed template)

When: Within each exam session

The project can be selected from a pool, or can be proposed.

- ③ Written exam

When: June TBD / July TBD / September TBD

Some past exams are on the course webpage.

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

- ② Project with report (fixed template)

When: Within each exam session

The project can be selected from a pool, or can be proposed.

- ③ Written exam

When: June TBD / July TBD / September TBD

Some past exams are on the course webpage.

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

- ② Project with report (fixed template)

When: Within each exam session

The project can be selected from a pool, or can be proposed.

- ③ Written exam

When: June TBD / July TBD / September TBD

Some past exams are on the course webpage.

- ④ Optional: oral exam, contributing ± 3 points to the final grade

Grading

- ① Midterm self-evaluation (*not graded*)

When: first half of April

- ② Project with report (fixed template)

When: Within each exam session

The project can be selected from a pool, or can be proposed.

- ③ Written exam

When: June TBD / July TBD / September TBD

Some past exams are on the course webpage.

- ④ Optional: oral exam, contributing ± 3 points to the final grade

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

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
- You will be able to grasp and elaborate on more advanced topics published in the top machine learning venues

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
- 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

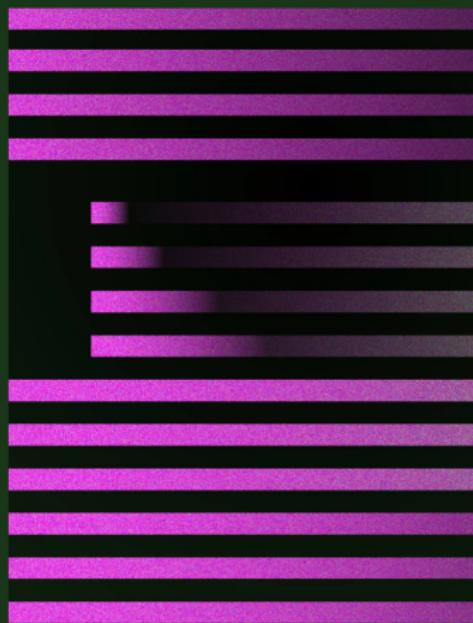
Machine learning is
everywhere!



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

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

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 →](#)

[ABOUT](#)[GET INVOLVED](#)[DOMINICA](#)[NEWS & RESEARCH ▾](#)[DONATE](#)

WHAT WOULD IT MEAN TO

Understand *What Whales are Saying*

THE ROADMAP

The CETI team collaborated to develop a scientific roadmap.

[Learn more](#)