

Data Science & Machine Learning for Engineering Applications

2025-2026

6 Credits

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Course Material: researchswinger.org/teaching_datascience.html

Undergrad: PoliTO

PhD: UC London

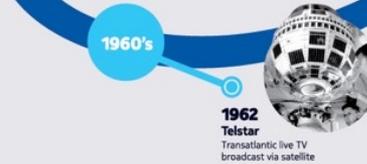
PostDoc: MIT

Yahoo! Labs

Cambridge University

Inventing the Future X Network

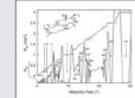
Creation of Bell Labs
 The engineering departments of the American Telephone and Telegraph Company (AT&T) and Western Electric were consolidated into Bell Telephone Laboratories. Their mission was to research and design communication technologies for the rapidly expanding telephone network and to explore fundamental areas of science that could shape the future of the industry. Over the years, many cornerstone technologies of modern society have been invented at Bell Labs and 8 Nobel Prizes have been awarded to its researchers



1995 Integrated ADSL Chip
 After co-inventing ADSL technology, follow-up innovations like vectoring continued to generate world records for high speed data transfer over copper telephone lines, fueling the Internet.



1998 Wireless MIMO Spatial Multiplexing
 Invention of wireless transmission based on multiple spatial paths



1998 Fractional Quantum Hall Effect
 Discovery of a novel collective quantum fluid state of matter



1997 Laser-Based Cooling and Trapping of Atoms
 To understand the fundamental limits of materials and matter



1995 Commercial DWDM
 Pioneering work on wavelength multiplexing in optical fibers

1980 Demonstration of DSP
 Large-scale integrated circuit for digital signal processing



1978 Commercial Cellular Network
 Invention of the cellular concept and creation of the first commercial network

1978 Cosmic Microwave Background Radiation
 Pioneering work on radio communications using the Holmdel Horn Antenna provides support for the Big Bang Theory



1977 Electronic Structure of Magnets and Glasses



1976 Fiber Optic Network
 First demonstration of 45 Mbit/s transmission

1973 UNIX and C Language
 Thompson and Ritchie's elegant design made it an immediate hit with the programming community when it was released in 1974. UNIX would later on become the Internet's foundation

1925

1930's

1940's

1950's

1970's

1960's

1980's

1990's

2010's

2000's

2014 XG-FAST

2011 LightRadio Cube
 First demonstration of building block of future small cell wireless networks



2014 XG-FAST
 First demonstration of 10 Gbps over copper telephone wires

2016 5G Massive Connectivity
 First demonstration of 1M simultaneous, ultra-low latency connections in a single cell for 5G and IoT

2015 The Future X Network: A Nokia Bell Labs Perspective
 First Nokia Bell Labs book written

2015 Optical MIMO-SDM
 Pioneering work on utilizing the spatial dimension in fiber, showing greater than 10X increase in optical network capacity

2015 GreenTouch
 International consortium delivers new technologies to improve energy efficiency in wireless networks by more than 10,000X

2014 Fluorescence Microscopy
 Ground-breaking work on sub-wavelength optical microscopy leads to super-resolution microscopy at cellular level

2009 World's first standard compliant LTE call

2009 Coherent 100G Optics
 Invention of the future of high speed optical communications with coherent processing



2006 Software Defined Routing
 Predecessor of Software Defined Networks (SDN)

2009 CCD
 Boyle and Smith's picture phone research realized the enormous potential of the Charge Coupled Device as an imaging device, leading to the invention of the digital photo, video cameras, scanners, satellite surveillance and ultra-sensitive astronomical telescopes



The Future
 Nokia Bell Labs continues to solve the great industry challenges, producing disruptive innovations for the next phase of human existence



PoliTO (part-time)

Responsible AI

Data Science & Machine Learning

What's This About?

Data Science and Machine Learning are how computers learn from data, like how your phone predicts your next text, but on a much larger scale. This course teaches you to **turn raw data into useful insights** and apply it to engineering problems.

What Will You Learn?

1. The **data science process**: collecting, cleaning, and making sense of data.
2. How to use **Python** and top **data science libraries**.
3. Key **machine learning and deep learning algorithms**.

How's It Taught?

- 1. Theory** – so you know what's actually happening.
- 2. Hands-on labs** – because real learning happens when you *do* it.
- 3. Python experiments** – you'll run code, test models, and see how ML works in action.

Why Should You Care?

By the end of this course, you'll:

1. Understand how **data science and machine learning** power real-world applications.
2. Know how to **analyze data**, build ML models, and evaluate their performance.
3. Have **practical experience** with Python and ML libraries; valuable skills in almost any field.
4. Be able to talk about AI without sounding clueless.

How This Course Works

1. **Lectures:** You'll learn the theory
2. **Hands-on labs:** apply what you learn
3. **Real-world project**

Course Topics: What You'll Actually Learn

This course is about learning how to **make data work for you**. Here's what we'll cover:

1/ The Data Science Process

- A. How to collect, clean, and transform data (because raw data is a mess).
- B. Feature engineering – picking the right details that actually matter.

Course Topics: What You'll Actually Learn

2/ Data Science Algorithms

- A. **Classification** – Teaching machines to put things into categories.
- B. **Clustering** – Grouping things together based on similarities (like Netflix recommending “quirky indie films” when all you watch is Marvel).
- C. **Association rules** – Finding hidden patterns in data (think: “People who buy chips also buy salsa”).

Course Topics: What You'll Actually Learn

3/ Machine Learning & Deep Learning

The magic behind **automatic learning** - because why program everything manually when you can make computers do it for you?

Course Topics: What You'll Actually Learn

4/ Python & Data Science Libraries

- A. Learn **Python**, the language everyone in AI and data science swears by.
- B. Use top libraries like **scikit-learn** - so you don't have to reinvent the wheel.

Course Topics: What You'll Actually Learn

5/ Real-World Applications & Case Studies

- A. You'll design and build a complete **data science process**, applying ML & Deep Learning to real engineering problems.
- B. Basically, you'll take what you've learned and make it actually *useful*.

Grading 1/3

Scoring

Group project max 20 + written part max 12 →
→ final grade = sum (max 32). if total > 31, “30 e lode”.

Pass

group project ≥ 12 , written ≥ 7 , and total ≥ 18 .

Grading 2/3

Oral exam

May be required by the instructor; no separate score, but it can confirm or change the final grade within the scale.

Project validity & eligibility

group project counts for 1 year

Grading 3/3

Alternative track (exceptional/emergency)

If you don't do the regular group project, submit an individual/group project worth max 12 \geq **2 weeks before the exam date**; pass if that project \geq 7, written \geq 7, and total \geq 18.

Rules

- 1. Deadlines matter.** If late submissions = no points.
- 2. Points and Projects.** Only valid until **January 2027** (included).
- 3. Zero Grade Policy:** Cheating, not submitting on time, not submitting material according to instruction are all taken very seriously.

Group Project: Work Together

This is where you prove you can **apply data science and machine learning** to a real engineering problem - without breaking your group apart in the process ;)

The Assignment

1. **Teams of ~4 students** (yes, you have to work with others - welcome to real life).
2. **Design and implement a full data science process** using ML algorithms.
3. **Write a report** explaining what you did and why.

Group Project: When & How?

1. Assigned now!
2. Evaluated based on **report you submit**

Group Project: Grading (a.k.a. Why This Matters)

1. Worth **20 points**, so it's a big deal.
2. If your project score is **below 12, you fail.**

Final Thought

If you work well as a team, you'll build something impressive. If you don't... well, hopefully you made friends in the process.

The Written Exam

This is where we check class & lab material.

What's on It?

1. Typically, multiple-choice questions.
2. Covers **data preparation, classification, regression, and clustering.**
3. Includes **machine learning and deep learning for engineering applications.**

The Written Exam: Rules

1. **60-minute time limit**, so no time for daydreaming.
2. **No textbooks, notes, or electronic devices**: it's just you and your brain.
3. If you score **below 6/10, you fail**.

Final Thought

If you've been paying attention and doing the work, this will be fine. If not... well, at least it's only 60 minutes.

Course Material: researchswinger.org/teaching_datascience.html



Lecture series on **Crafting Tech** at the Department of Computer Engineering at PoliTO.



Timetable

Material
[\[live tentative timetable\]](#)



List of Project Proposals

Material
[\[projects\]](#)

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TIMETABLE

Date	Day	Instructor	TA
Feb-23	Monday	Intro+Class Project	
Feb-27	Friday		Python Basics
Mar-2	Monday		Numpy (lez.) + Inizio Esercizi
Mar-6	Friday		Conclusione Esercizi + Matplotlib (lez + es.)
Mar-9	Monday		Pandas pt. 1
Mar-13	Friday	Data Science	

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PROJECT

Class Project: Data Centres in Europe

OVERVIEW

In this project you will (1) build a Europe-wide dataset of data centre locations, (2) compile socio-economic and infrastructure variables at the NUTS3 level, and (3) train models to predict where data centres are located. The goal is to practice end-to-end data science: data collection, cleaning, standardisation, merging, modelling, evaluation, and interpretation.

KEY DATES

Milestone	Date
Project start	1 March
Mid-term Deadline (Parts 1–2)	20 April
Part 3 begins	20 April
Report Deadline	June 5th or two weeks before “Primo Appello”