

CS-401

**Applied data analysis**

West Robert

Cursus	Sem.	Type
Civil & Environmental Engineering		Opt.
Computational Neurosciences minor	H	Opt.
Computational science and Engineering	MA1, MA3	Opt.
Computer science	MA1, MA3	Opt.
Cybersecurity	MA1, MA3	Opt.
Data Science	MA1, MA3	Obl.
Data and Internet of Things minor	H	Opt.
Data science minor	H	Opt.
Digital Humanities	MA1, MA3	Obl.
Electrical Engineering		Opt.
Electrical and Electronical Engineering	MA1, MA3	Opt.
Energy Science and Technology	MA1, MA3	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Financial engineering	MA1, MA3	Opt.
Learning Sciences		Obl.
Life Sciences Engineering	MA1, MA3	Opt.
Managmt, tech et entr.	MA1, MA3	Opt.
Neuro-X minor	H	Opt.
Neuro-X	MA1	Opt.
SC master EPFL	MA1, MA3	Opt.
UNIL - Sciences forensiques	H	Opt.

Language of teaching	English
Credits	8
Session	Winter
Semester	Fall
Exam	Written
Workload	240h
Weeks	14
<b>Hours</b>	<b>4 weekly</b>
Courses	2 weekly
Project	2 weekly
<b>Number of positions</b>	

**Summary**

This course teaches the basic techniques, methodologies, and practical skills required to draw meaningful insights from a variety of data, with the help of the most acclaimed software tools in the data science world (pandas, scikit-learn, Spark, etc.)

**Content**

Thanks to modern software tools that allow to easily process and analyze data at scale, we are now able to extract invaluable insights from the vast amount of data generated daily. As a result, both the business and scientific world are undergoing a revolution which is fueled by one of the most sought after job profiles: the data scientist.

This course covers the fundamental steps of the data science pipeline:

*Data wrangling*

- Data acquisition (scraping, crawling, parsing, etc.)
- Data manipulation, array programming, dataframes
- The many sources of data problems (and how to fix them): missing data, incorrect data, inconsistent representations
- Data quality testing with crowdsourcing

*Data interpretation*

- Statistics in practice (distribution fitting, statistical significance, etc.)
- Working with "found data" (design of observational studies, regression analysis)
- Machine learning in practice (supervised and unsupervised, feature engineering, evaluation, etc.)

- Text mining: preprocessing steps, vector space model, topic models
- Social network analysis (properties of real networks, working graph data, etc.)

#### *Data visualization*

- Introduction to different plot types (1, 2, and 3 variables), layout best practices, network and geographical data
- Visualization to diagnose data problems, scaling visualization to large datasets, visualizing uncertain data

#### *Reporting*

- Results reporting, infographics
- How to publish reproducible results

The students will learn the techniques during the ex-cathedra lectures and will be introduced, in the lab sessions, to the software tools required to complete the homework assignments and the in-class quizzes.

In parallel, the students will embark on a semester-long project, split in agile teams of 3-4 students. In the project, students propose and execute meaningful analyses of a real-world dataset, which will require creativity and the application of the tools encountered in the course. The outcome of this team effort will be a project portfolio that will be made public (and available as open source).

At the end of the semester, students will take a 3-hour final exam in a classroom with their own computer, where they will be asked to complete a data analysis pipeline (both with code and extensive comments) on a dataset they have never worked with before.

### **Keywords**

data science, data analysis, data mining, machine learning

### **Learning Prerequisites**

#### **Required courses**

The student must have passed an introduction to databases course, OR a course in probability & statistics, OR two separate courses that include programming projects. Programming skills are required (in class we will use mostly Python).

#### **Recommended courses**

- CS-423 Distributed Information Systems
- CS-433 Machine Learning

#### **Important concepts to start the course**

programming, algorithms, probability and statistics, databases

### **Learning Outcomes**

By the end of the course, the student must be able to:

- Construct a coherent understanding of the techniques and software tools required to perform the fundamental steps of the data science pipeline
- Perform data acquisition (data formats, dataset fusion, Web scrapers, REST APIs, open data, big data platforms, etc.)
- Perform data wrangling (fixing missing and incorrect data, data reconciliation, data quality assessments, etc.)
- Perform data interpretation (statistics, knowledge extraction, critical thinking, team discussions, ad-hoc visualizations, etc.)

- Perform result dissemination (reporting, visualizations, publishing reproducible results, ethical concerns, etc.)
- Construct a coherent understanding of the techniques and software tools required to perform the fundamental steps of the data science pipeline
- Perform data interpretation (statistics, correlation vs. causality, knowledge extraction, critical thinking, team discussions, ad-hoc visualizations, etc.)

### Transversal skills

- Give feedback (critique) in an appropriate fashion.
- Write a scientific or technical report.
- Evaluate one's own performance in the team, receive and respond appropriately to feedback.

### Teaching methods

- Physical in-class recitations and lab sessions
- Homework assignments
- In-class quizzes
- Course project

### Expected student activities

Students are expected to:

- Attend the lectures and lab sessions
- Complete 2-3 homework assignments
- Complete weekly in-class quizzes (held during lab sessions)
- Conduct the class project
- Engage during the class, and present their results in front of the other colleagues

### Assessment methods

- 30% continuous assessment during the semester (homework)
- 30% final exam, data analysis task on a computer (3 hours)
- 25% final project, done in groups of 4
- 15% regular online quizzes

### Resources

#### Websites

- <http://ada.epfl.ch>

#### Moodle Link

- <https://go.epfl.ch/CS-401>