MGT-499

Statistics and data science

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Cursus	Sem.	Type
Managmt, dur et tech	MA1	Obl.

Language of teaching	English
Credits	4
Withdrawal	Unauthorized
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	**50**

It is not allowed to withdraw from this subject after the registration deadline.

Remark

Courses given on UNIL Campus.

Summary

This class provides a hands-on introduction to statistics and data science, with a focus on causal inference, applications to sustainability issues using Python, and dissemination of scientific results to a broad audience.

Content

- Exploratory Data Analysis: Data acquisition and cleaning; Descriptive Statistics; Data Visualization; Data Ethics, Bias, and Fairness
- Causal Inference: Linear Regression; Fixed effects; Non-linear Regression; Randomized Control Trial; Regression Discontinuity Design; Difference-in-Differences; Instrumental Variables
- Applications in Python to sustainability issues

Keywords

Data Science, Statistics, Econometrics, Causal Inference, Regression, Python, Sustainability, Scientific dissemination

Learning Prerequisites

Recommended courses

- Analysis
- Algebra
- Probability and statistics
- Econometrics
- Introduction to Python

Important concepts to start the course

- Basic probability and statistics knowledge (random variable, expectation, mean, conditional and joint distribution, independence, Bayes' rule, central limit theorem)
- Basic linear algebra (matrix multiplication, system of linear equations)
- Multivariate calculus (derivative w.r.t. vector and matrix variables)
- Basic programming skills (labs will use Python, basic knowledge will help)

Learning Outcomes

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

- Describe the main pitfalls behind data analysis
- Investigate dataset, and the problems and bias behind the data
- Explore and clean datasets
- Visualize datasets
- Decide which statistical/econometrics methods to use for a given problem
- Implement these methods in Python
- Estimate model parameters from empirical observations and confidence bounds
- Test hypothesis
- Synthesize their findings to a broad audience

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Demonstrate the capacity for critical thinking
- Use a work methodology appropriate to the task.
- Access and evaluate appropriate sources of information.

Teaching methods

- Lectures
- Exercice sessions: coding lab sessions
- Group projects

Expected student activities

The students are expected to:

- attend and actively participate in lectures and lab sessions
- work on the weekly theory and coding exercises
- collaborate on group projects making use of the theory learned during lectures and code developed during lab sessions (graded)

Assessment methods

The evaluation consists of one group project. Students will have to apply the data science and econometrics techniques learned during the class to causally answer a question related to sustainability. The grade is made of 2 deliverables:

- Mid-term project (20%): Students will have to submit a short deliverable to motivate their research question, present their exploratory data analysis, and discuss the potential issues they will face in their causal analysis;
- Final report (80%): Students will have to write a short article to present their work, targeting a broad audience.

Supervision

Office hours	No
Assistants	Yes
Forum	No
Others	Slack channel

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

• [not mandatory] *Mostly Harmless Econometrics*, by Angrist, Josh and Steve Pischke (2008), Princeton University Press, EPFL library

• [not mandatory] *Python Data Science Handbook: Essential Tools for Working with Data*, by Jake VanderPlas (2016), O'REILLY, EPFL library

• [not mandatory] *Introduction to Computation and Programming Using Python, Revised And Expanded Edition*, by John V. Guttag (2013), The MIT Press, MIT Press

• [not mandatory] *A Primier on Scientific Programming with Python*, by Hans Petter Langtangen (2016), Springer, Springer Link

Ressources en bibliothèque

• Introduction to Computation and Programming Using Pytho / Guttag
• Mostly Harmless Econometrics / Angrist
• A Primer on Scientific Programming with Python / Langtangen
• Python Data Science Handbook / VanderPlas

Notes/Handbook

Slides will be made available on a Moodle page. Notebooks will be made available in a GitHub repository.

Moodle Link

• https://go.epfl.ch/MGT-499

Prerequisite for

Data Science and Machine Learning (MGT-502)