

MATH-444

Multivariate statistics

Panaretos Victor

| Cursus | Sem. | Type |
|-----------------------|----------|------|
| Financial engineering | MA2, MA4 | Opt. |
| Ing.-math | MA2, MA4 | Opt. |
| Mathématicien | MA2 | Opt. |
| Minor in statistics | E | Opt. |
| Statistics | MA2, MA4 | Obl. |

| | |
|----------------------------|-----------------|
| Language of teaching | English |
| Credits | 5 |
| Session | Summer |
| Semester | Spring |
| Exam | Written |
| Workload | 150h |
| Weeks | 14 |
| Hours | 4 weekly |
| Courses | 2 weekly |
| Exercises | 2 weekly |
| Number of positions | |

Summary

Multivariate statistics focusses on inferring the joint distributional properties of several random variables, seen as random vectors, with a main emphasis on uncovering their underlying dependence structure. This course offers a broad introduction to its concepts, methods & theory

Content

- Review of central linear algebra concepts.
- Random vectors and random matrices.
- Product moments, covariance and precision matrices.
- The multivariate Gaussian and elliptical distributions.
- Gaussian data matrices and their sampling theory.
- Limit theorems and concentration of measure.
- Likelihood theory for Gaussian vectors.
- Hypothesis tests for means and (partial) correlations.
- Dimension reduction and low rank approximation.
- Principal Component Analysis and Canonical Correlation Analysis.
- Perturbation/asymptotic theory for empirical covariance spectra.
- Markov properties and joint density factorizations.
- Gaussian graphical models and their likelihood inference.

Learning Prerequisites**Required courses**

A solid introduction to probability (e.g. MATH-230) and statistics (e.g. MATH-240). Basic knowledge of linear models (e.g. MATH-341) is useful but not necessary.

Learning Outcomes

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

- Manipulate the multivariate normal distribution and some of its extensions.
- Expound the main concepts in coupling and copulas
- Expound and apply the main dependence measures.
- Apply a canonical correlation analysis to some concrete cases.

- Apply a principal component analysis to some concrete cases.
- Perform basic multivariate hypothesis tests.
- Demonstrate a basic understanding of linear discriminant analysis.
- Demonstrate a basic understanding of graphical models theory.
- Demonstrate his/her understanding of the main mathematical concepts/proofs of the course.
- Justify the use of a method for a particular data set and objective

Teaching methods

Lecture ex cathedra using slides as well as the blackboard.

Assessment methods

Written examination (midterm and final exam).

Dans le cas de l'art. 3 al. 5 du Règlement de section, l'enseignant décide de la forme de l'examen qu'il communique aux étudiants concernés.

Supervision

| | |
|---------------|-----|
| Office hours | No |
| Assistant.e.s | Yes |
| Forum | Yes |

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

- Theodore W. Anderson: Multivariate Analysis, Wiley

Ressources en bibliothèque

- [Find the references at the Library](#)

Notes/Handbook

The slides will be available on Moodle.

Moodle Link

- <https://go.epfl.ch/MATH-444>