MATH-444 **Multivariate statistics**

Pasche Olivier

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 knowlege 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.
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