

PH.D. COURSE SCHEDULE, SPRING 2022
Department of Statistics, Uppsala University

Course Advanced Multivariate Statistics (15 ECTS)

Teacher Rauf Ahmad: *rauf.ahmad@statistik.uu.se*

Tatjana Pavlenko: *tatjana.pavlenko@statistik.uu.se*

Recommended books The course will mainly follow Mardia, KV, JT Kent, JM Bibby (1979; Reprint 2003). *Multivariate analysis*, Academic Press, London. Occasionally, some extensions will be discussed for which the following books are useful: Hastie, T, R Tibshirani, J Friedman (2017, corrected 2nd ed.). *Elements of statistical learning.*, Springer, and Hastie, T, R Tibshirani, M Wainright (2016). *Statistical learning with sparsity: The LASSO and generalizations*, CRC.

Structure Lectures and exercises

Assessment Hand-in exercises to be submitted

Pre-requisites Basic multivariate statistics (at the level of, e.g., Johnson & Wichern); Additionally, Linear algebra; Statistical inference and Univariate linear model theory

Course plan Following chapters from Mardia et al. will be covered (with intermittent additions from other books):

Tatjana Pavlenko: Chapters 1-6

Rauf Ahmad: Chapters 8, 10-13

All lectures are 3-hour duration, including one or two short breaks.

Chapter-wise detailed contents are as following (to be extended as and when needed):

Chap 1: Introduction; Multivariate problems and techniques.

Chap 2: Basic properties of random vectors; Population moments and Mahalanobis space; Characteristic functions; Some multivariate generalizations of univariate distributions; Families of distributions; Limit theorems.

Chap 3: Multivariate normal distribution theory; Characterization and properties; Random matrices and the Wishart distribution; statistics based on the Wishart distribution; Hotelling's T^2 distribution; Mahalanobis distance; Other statistics related to the multivariate normal distribution.

Chap 4: Theory of point estimation; Likelihood and sufficiency; Bayesian inference.

Chap 5: Hypothesis testing; One- and multi-sample hypotheses; Simultaneous confidence intervals.

Chap 6: Multivariate regression analysis; Maximum likelihood and Least squares estimation; Linear methods for regression; High-dimensional regression modeling; Sparse multivariate methods (Lasso-based and other regularization techniques for linear models).

Chap 8: Introduction, PC transformation and properties; PC spaces and optimality; Sample PCA; Statistical inference; No. of PCs; PC regression; Extensions and recent developments.

Chap 10: Introduction, mathematical development and properties; Tests of independence and zero correlation; Inference; Other measures and extensions.

Chap 11: Introduction; Problem of misclassification; Two-class classifiers; Fisher's idea of classification; Multi-class case; Logistic classifier; Inference; Value of classification; Extensions and recent additions.

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SCHEDULE: ADVANCED MULTIVARIATE STATISTICS, SPRING 2022

Date	Time	Room	Contents
Thursday, February 17	13:15-16:00	B115	Lecture 1: Chapters 1-2
Thursday, February 24	13:15-16:00	B115	Lecture 2: Chapters 3-4
Thursday, March 03	13:15-16:00	H425	Lecture 3: Chapters 5
Thursday, March 10	13:15-16:00	B115	Lecture 4: Chapters 6
Tuesday, March 15	14:15-17:00	B115	Lecture 5: Chapter 8
Monday, March 21	09:15-12:00	B115	Lecture 6: Chapter 10
Wednesday, March 30	14:15-17:00	B115	Lecture 7: Chapter 11
Monday, April 04	09:15-12:00	B115	Lecture 8: Chapters 11-13