



## MATH48061 - 2012/2013

### General Information

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- Title: Multivariate Statistics
- Unit code: MATH48061
- Credits: 15
- **This course unit may not be taken as well as MATH38061.**
- Prerequisites: MATH20701, MATH20802 *Statistical Methods*.
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Mr. M. Tso

## Specification

### Aims

To familiarise students with the ideas and methodology of certain multivariate methods together with their application in data analysis using the R statistical computing package.

### Brief Description of the unit

In practice most sets of data are multivariate in that they consist of observations on several different variables for each of a number of individuals or objects. Indeed, such data sets arise in many areas of science, the social sciences and medicine and techniques for their analysis form an important area of statistics. This course unit introduces a number of techniques, some of which are generalisation of univariate methods, while others are completely new (e.g. principal component analysis). The main part of the course focuses on continuous multivariate data in common with the level 3 module of the same name. The enhancement concentrates for the main part on multivariate methods for discrete data.

### Learning Outcomes

On successful completion of the course students will:

- be familiar with multivariate random vectors and their probability distributions;
- have acquired skills in dimensionality reduction techniques, inferential methods based on the multivariate Normal distribution as an underlying model and in methods of data classification;
- be aware of how the statistical package R can be used as a tool for multivariate data analysis and graphical presentation.
- have skills in analyzing discrete multivariate data.

### Future topics requiring this course unit

This course unit forms a useful background to other statistics course units.

### Syllabus

1. Introductory ideas and basic concepts - random vectors and their distribution, linear transformations (including the Mahalanobis transformation), sample statistics and their properties, overall measures of dispersion in  $p$ -space, distances in  $p$ -space, simple graphical techniques. [3]
2. Cluster Analysis - aims, hierarchical algorithms, the dendrogram. [2]
3. Principal component analysis - definition and derivation of population PC's, sample PC's, practical considerations, geometrical properties, examples. [4]
4. The Multivariate Normal (MVN) distribution - definition, properties, conditional distributions, the Wishart and Hotelling T-squared distributions, sampling distributions of the sample mean vector and covariance matrix, maximum likelihood estimation of the mean vector and covariance matrix. [4]
5. Hypothesis testing and confidence intervals (one sample procedures) - the generalized likelihood ratio test, tests on the mean vector, CI's for the components of the mean vector. [4]

6. Hypothesis testing and confidence intervals (two independent sample procedures) - tests on the difference between two mean vectors, testing equality of covariance matrices, CI's for the differences in the components of the mean vectors. [3]
7. Profile Analysis. [2]
8. Discriminant Analysis. [Guided Coursework]
9. Techniques for discrete multivariate data incl. discrete multivariate vectors, two-way contingency tables, sampling distributions, odds ratio, testing independence, correspondence analysis, higher order contingency tables, conditional independence, introduction to log-linear models . [11]

## Textbooks

- Chatfield, C. and Collins, A. J., *An Introduction to Multivariate Analysis*, Chapman & Hall 1983.
- Krzanowski, W. J., *Principles of Multivariate Analysis: A User's Perspective*, Oxford University Press 1990.
- Johnson, R. A. and Wichern, D. W., *Applied Multivariate Statistical Analysis* 3rd edition, Prentice Hall 1992.
- Bishop, Y M, Fienberg, S E, and Holland P W (2007) *Discrete Multivariate Analysis*. Springer

## Teaching and learning methods

Three lectures and one examples class each week. In addition students should expect to spend at least seven hours each week on private study for this course unit.

## Assessment

Coursework: weighting 20%

End of semester examination: three hours, weighting 80%

## Arrangements