

## General Information

- **Schedule:**

- **Theoretical** — Wednesday, 9:00h–11.00h - Room 0.16

- **Issues and laboratory** — Wednesday, 11:30h–13.00h - Room 0.15

- **Faculty:** — Isabel Rodrigues

- **Contacts:** — irodrig@math.tecnico.ulisboa.pt;

- Phone Alameda: 218417045 or Ext.1045;

- Phone Tagus: 2142332033 or Ext. 5033

- Office: 2-N4.12

- **Website:**

- <https://fenix.tecnico.ulisboa.pt/disciplinas/MEMEG/2021-2022/1-semester>

### Classes

- **Begining:** — 29 September 2021.

### Program

#### 1. Introduction to Multivariate Analysis

- 1.1. Overview of multivariate methods and main objectives.

- 1.2. Some definitions and notation.

- 1.3. Exploratory analysis: descriptive methods and graphical multivariate data display.

#### 2. Regression Analysis

- 2.1. Multiple linear regression.

- 2.2. Least squares estimation of the parameters.

- 2.3. Properties of the estimators.

- 2.4. Tests and confidence intervals for the parameters.

- 2.5. Prediction. Model adequacy checking.
- 2.6. Categorical regressors and indicator variables.
- 2.7. Selection of variables and model building.

### **3. Design Experiments and Variance Analysis**

- 3.1. Completely randomized experiment.
- 3.2. Single-factor analysis variance, (one-way ANOVA).
- 3.3. Multiple comparisons.
- 3.4. Two-factors analysis variance, (two-way ANOVA).

### **4. Principal Components Analysis**

- 4.1. Introduction.
- 4.2. Definition and derivation of principal components.
- 4.3. Properties of principal components.
- 4.4. Geometric properties of principal components.
- 4.5. Sample principal components.
- 4.6. Question regarding the application of principal components.
- 4.7. Principal components in multiple linear regression.

### **5. Clusters Analysis**

- 5.1. Introduction.
- 5.2. Similarity measures.
- 6.3. Methods to obtain clusters.
  - 5.3.1. Graphical and visual methods.
  - 5.3.2. Hierarchical methods.
  - 5.3.3. Non hierarchical methods.

## Bibliography

### **• Recommended:**

- Johnson, R. A. and Wichern, D. W. (2002). *Applied Multivariate Statistical Analysis*. 5th edition, Prentice-Hall, Inc., New York.
- Montgomery, D.C. and Runger, G.C. (2002). *Applied Statistics and Probability for Engineers*. 3rd edition, John Wiley, New York.

- **Optional:**

- Heumann C., Michael Schomaker, M. and Shalabh, M. (2016). *Introduction to Statistics and Data Analysis* Springer.
- Latin, J., Carroll, J. D. and Green, P. E. (2003). *Analyzing Multivariate Data*. Thomson, Books/Cole, Ontario.
- Matloff, N. (2019). *Probability and Statistics for Data Science: Math + R + Data*. Chapman and Hall/CRC.
- Rencher, A. C. *Methods of Multivariate Analysis*. 2nd edition, Wiley, New York.
- Trevor C. (2005). *An Introduction to Multivariate Data Analysis*. Hodder Arnold, London.
- Sharma, S. (1996). *Applied Multivariate Techniques*. John Wiley, New York.
- Varmuza, K. and Filzmoser, P. (2009). *Introduction to Multivariate Statistical Analysis in Chemometrics* . CRC Press.
- Wonnacott, T. H. and Wonnacott, R. J. (1990). *Introductory Statistics for Business and Economics*. 4th edition, John Wiley, New York.

## Software

- R Development Core Team: <https://www.r-project.org>
- RStudio: <http://www.rstudio.com>

## Evaluation method

$$FG = 0.5 \times EG + 0.5 \times (PJ_1 + PJ_2)/2,$$

where  $FG$  is the final grade of each student,  $EG$  is the exam grade (rounded to one decimal), and  $PJ_i$ ,  $i = 1, 2$  is the grade of the  $i$ -th project (round to one decimal place).

**Minimum Grade in the Exam:** — 7.0.

### Projects:

- Performed in groups of five/six students;
- Important Dates:

|        | <b>Handed out</b> | <b>To be handed back</b> |
|--------|-------------------|--------------------------|
| $PJ_1$ | 10-November       | 4-December               |
| $PJ_2$ | 5-January         | 28-January               |

### Exams Schedule:

- 1st Exam: 3 February 2022, 8:00h-10:00h;
- 2nd Exam: 28 February 2022, 10:30h-12:30h.

## Recitation Hours

- **Room:** 2-N4.12 (office) or 2-N2.2 (Meeting Room)
- **Schedule:** Wednesday 15:45-17:30.

Students must confirm their presence in advance e.g. by email