



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                           |           |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------------------|-----------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        | 2019/20                                                                                   |           |
| Subject (*)              | Statistical Methods for Environmental Data                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |        | Code                                                                                      | 610500006 |
| Study programme          | Mestrado Universitario en Ciencias. Tecnoloxías e Xestión Ambiental (plan 2012)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                           |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                           |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Year   | Type                                                                                      | Credits   |
| Official Master's Degree | 1st four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | First  | Optional                                                                                  | 3         |
| Language                 | SpanishGalicianEnglish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |        |                                                                                           |           |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |                                                                                           |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                           |           |
| Department               | MatemáticasQuímica                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                                                                                           |           |
| Coordinador              | Jacome Pumar, Maria Amalia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | E-mail | maria.amalia.jacome@udc.es                                                                |           |
| Lecturers                | Andrade Garda, Jose Manuel<br>Estevez Perez, Maria Graciela<br>Jacome Pumar, Maria Amalia                                                                                                                                                                                                                                                                                                                                                                                                                                                                | E-mail | jose.manuel.andrade@udc.es<br>graciela.estevez.perez@udc.es<br>maria.amalia.jacome@udc.es |           |
| Web                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                                                                           |           |
| General description      | Environmental studies imply usually large amounts of experimental data, whose analysis should allow extracting the relevant information hidden behind them. This subject introduces some core advanced multivariate statistical techniques. They will allow a reduction in the dimensionality of the datasets and the discovery/description of sample groups. Commonly-available computing power simplify the treatment of large databases, which are quite frequent nowadays and, therefore, this subject is of general interest for environmentalists. |        |                                                                                           |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Coñecemento das realidades interdisciplinares da Química e do Medio Ambiente, dos temas punteiros nestas disciplinas e das perspectivas de futuro.                                                                                                                                           |
| A3   | Capacitar ao alumno para o desenvolvemento dun traballo de investigación nun campo da Química ou do Medio Ambiente, incluíndo os procesos de caracterización de materiais, o estudo das súas propiedades fisicoquímicas e biolóxicas e dos procesos que poden sufrir no medio natural.       |
| A12  | Coñecer as distintas estratexias para o tratamento estatístico de series de datos relacionadas con datos ambientais.                                                                                                                                                                         |
| B3   | Que os estudantes sexan capaces de integrar coñecementos e enfrontarse á complexidade de formular xuízos a partir dunha información que, sendo incompleta ou limitada, inclúa reflexións sobre as responsabilidades sociais e éticas vinculadas á aplicación dos seus coñecementos e suízos. |
| B5   | Que os estudantes posúan as habilidades de aprendizaxe que lles permitan continuar estudando dun modo que haberá de ser en gran medida autodirixido ou autónomo.                                                                                                                             |
| B6   | Ser capaz de analizar datos e situacións, xestionar a información dispoñible e sintetizala, todo iso a un nivel especializado.                                                                                                                                                               |
| C1   | Ser capaz de traballar en equipos, especialmente nos interdisciplinares e internacionais.                                                                                                                                                                                                    |
| C3   | Ser capaz de adaptarse a situacións novas, mostrando creatividade, iniciativa, espírito emprendedor e capacidade de liderado.                                                                                                                                                                |
| C6   | Utilizar as ferramentas básicas das tecnoloxías da información e as comunicacións (TIC) necesarias para o exercicio da súa profesión e para a aprendizaxe ao longo da súa vida.                                                                                                              |
| C9   | Valorar criticamente o coñecemento, a tecnoloxía e a información dispoñible para resolver os problemas cos que deben enfrontarse.                                                                                                                                                            |
| C10  | Asumir como profesional e cidadán a importancia da aprendizaxe ao longo da vida.                                                                                                                                                                                                             |

## Learning outcomes

| Learning outcomes                                         | Study programme competences |            |                           |
|-----------------------------------------------------------|-----------------------------|------------|---------------------------|
| Design experiments, get information and interpret results | AC3<br>AC12                 | BC3<br>BC6 | CC1<br>CC6<br>CC9<br>CC10 |



|                                                                                             |            |     |     |
|---------------------------------------------------------------------------------------------|------------|-----|-----|
| Apply critical, logical and creative thinking to solve problems as effectively as possible. | AC1<br>AC3 | BC5 | CC3 |
|---------------------------------------------------------------------------------------------|------------|-----|-----|

| Contents                      |                                                                                                                    |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Topic                         | Sub-topic                                                                                                          |
| Introduction                  | A review of the basic methods to describe a dataset, univariate and multivariate approaches.                       |
| Relationships among variables | Dependence measurements: correlation matrix, simple and multiple linear regression; multicollinearity.             |
| Multivariate analysis         | Description of multivariate datasets<br>Principal components analysis<br>Discriminant analysis<br>Cluster analysis |

| Planning                                                                                                                        |                              |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                 | Ordinary class hours | Student's personal work hours | Total hours |
| Problem solving                                                                                                                 | A1 A3 A12 B3 C3 C1<br>C6 C10 | 5                    | 15                            | 20          |
| Collaborative learning                                                                                                          | A3 A12                       | 0                    | 6                             | 6           |
| Guest lecture / keynote speech                                                                                                  | A12 B5 B6 C6 C9<br>C10       | 16                   | 32                            | 48          |
| Personalized attention                                                                                                          |                              | 1                    | 0                             | 1           |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                              |                      |                               |             |

| Methodologies                  |                                                                                                                                                                                      |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                                          |
| Problem solving                | After finishing the theoretical classes, practical exercises will be reviewed in the classroom, and might be proposed as autonomous work.                                            |
| Collaborative learning         | Collaborative learning groups work, consisting on applying the concepts to a real dataset dealing with environmental issues. This training example may be reviewed in the classroom. |
| Guest lecture / keynote speech | Theoretical lessons will be devoted to teach the basic concepts involved in the selected data treatment techniques, along with practical examples of each of them.                   |

| Personalized attention |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Problem solving        | Students will be required to develop a study on a particular dataset. They will apply the different techniques learnt in this subject, along with a critical discussion of the results and addressing several predefined questions. They will be monitored by the teachers so that they can solve their doubts with both "face-to-face" and online advice sessions.<br><br>Tutorships will take place at the office of the teachers for solving doubts, correcting mistakes, suggesting proper approaches to deal with the proposed problems and reviewing initial versions of the works. Online advice sessions will be by means of e-mail, virtual platform, and similar.<br><br>Part-time students may also perform these works and provide them to the teachers for their assessment. Part-time students can also receive personalized assistance using both in-person and online approaches. |

| Assessment    |              |             |               |
|---------------|--------------|-------------|---------------|
| Methodologies | Competencies | Description | Qualification |



|                                |                           |                                                                                                                                                      |    |
|--------------------------------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Guest lecture / keynote speech | A12 B5 B6 C6 C9 C10       | Attendance to the theoretical classes and participation there will be scored positively.                                                             | 5  |
| Problem solving                | A1 A3 A12 B3 C3 C1 C6 C10 | Participation in the class, in particular, to address the resolution of the exercises will be scored positively.                                     | 5  |
| Collaborative learning         | A3 A12                    | Students will analyze a dataset and they will present their findings in a written report. The study may be individual or forming small working teams | 90 |

## Assessment comments

Attendance to the guest lectures and active participation will be scored positively (up to 10% of the final overall score of the subject). Attendance should not be lower than 80% of the total hours of the subject (but for clearly justified reasons). The remaining 90% of the overall score will be obtained by performing a written report on a practical case-study. This task may be supervised by the teachers so that main doubts are solved. Scoring of the reports will consider: formal aspects, clarity in the written explanations, sound defence/argument of the explanations and, when required, the performance on the oral presentation. All activities (problem solving, working team essays) posed by the teachers must be addressed by the students, otherwise the subject will not be passed. The overall final score will be a weighted sum of the scores obtained in the different parts. For part-time students and/or with academic exemption, 100% of the overall score will be obtained by performing a written report on a practical case-study and they are not required to defend their works in class. To obtain a NR (No Grade Reported), the student must not participate in the collaborative learning activities.

## Sources of information

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | Jobson, J.D. (1992). Applied Multivariate Analysis. Vol. II: Categorical and Multivariate Methods. Springer Texts in Statistics, Springer-Verlag: NewYork.Miller, J.N. & Miller, J.C. (2002) Estadística y Quimiometría para Química Analítica. Edit. PrenticeHall. Mongay Fernández, C. (2005) Quimiometría. Servicio Publicaciones Universidad de Valencia.Morrison, D.F. (1990) Multivariate statistical method. 3rd Edition. McGraw-Hill Series in Probability and Statistics.Peña, D. (2002). Análisis de Datos Multivariantes. McGraw-Hill.Pérez López, C. (2004) Técnicas de análisis multivariante de datos. Aplicaciones con SPSS. Pearson Prentice Hall, Madrid.Pérez López, C. (2005) Métodos Estadísticos Avanzados con SPSS. Thomson, Madrid.Ramis Ramos, G. (2001) Quimiometría. Síntesis, Madrid. |
| <b>Complementary</b> | Millard, S.P. & Neerchal, N.J. (2001) <i>Environmental Statistics with S-Plus</i> . Springer. CRC Press LLC<br>Millard, S.P. & Neerchal, N.J. (2001) Environmental Statistics with S-Plus. Springer. CRC Press LLC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Recommendations

Subjects that it is recommended to have taken before

Subjects that are recommended to be taken simultaneously

Subjects that continue the syllabus

## Other comments

Active participation in the classes is recommended. It is also important to combine the notes taken by the students with the books and reports suggested by the teachers. Tutorships are available for the students, specially for those whose basic skills in statistics may be faulty. It is recommended to review the notes of the subject daily.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.