DEGREE CURRICULUM

MATHEMATICAL AND STATISTICAL MODELING OF BIOLOGICAL PROCESSES (BIOMODELS)

Coordination: VILAPRIÑO TERRE, ESTER

Academic year 2020-21

MATHEMATICAL AND STATISTICAL MODELING OF B... 2020-21

Subject's general information

<table>
<tr><td>Subject name</td><td>MATHEMATICAL AND STATISTICAL MODELING OF BIOLOGICAL PROCESSES (BIOMODELS)</td></tr>
<tr><td>Code</td><td>101531</td></tr>
<tr><td>Semester</td><td>2D SEMESTER - DEGREE - JUN/SET</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biomedical Sciences</td><td>3</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><td>PRAULA</td><td>TEORIA</td></tr>
<tr><th>Number of credits</th><td>3</td><td>3</td></tr>
<tr><th>Number of groups</th><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>VILAPRIÑO TERRE, ESTER</td></tr>
<tr><td>Department</td><td>BASIC MEDICAL SCIENCES</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>At Class 60 hours.
At Home 90 hours</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Distribution of credits</td><td>50% Theory
50% Seminars</td></tr>
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MATHEMATICAL AND STATISTICAL MODELING OF B... 2020-21

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
GOMEZ ARBONES, XAVIER	xavier.gomez@udl.cat	1	
MARTÍNEZ ALONSO, MONTSERRAT	montserrat.martinez@udl.cat	1	
SORRIBAS TELLO, ALBERT	albert.sorribas@udl.cat	3	
VILAPRIÑO TERRE, ESTER	ester.vilaprinyo@udl.cat	1	

Subject's extra information

- 10 sessions of 2 hours of master classes
- 13 sessions of 3 hours of computer seminars

Learning objectives

Motivation: Biomedical research, like any scientific discipline, is based on the evidence provided by the observations of the results obtained in observational or experimental studies, designed in an appropriate manner. The complexity of many of the problems under study makes it necessary to have methods of analysis that go beyond the basic methods studied in a first biostatistics course.

Objectives: To deepen in the concept of statistical model and in the knowledge of the models that allow to support the most common experimental and observational designs in biomedical research. We will focus especially on the models that allow us to analyze situations where different factors may be influencing the results, discussing the different techniques that can help us with a reasoned interpretation of the most relevant factors in each case.

Competences

- To unnderstand and to apply statistical modeling techniques.
- To manage quantitative data from different sources.
- To critically interprete results of any scientific work.

Subject contents

1. **The concept of model in statistics**: Overview based on design. Introduction to the linear model. Importance of multivariate models.
2. **Linear regression model:** approach, estimation, interpretation.
3. **Experimental design**: examples and methods of analysis (ANOVA).
4. **Non linear models:** characterization of bacterial strain growth, enzymatic kinetics, etc.

5. **Logistic regression model**: Factors that may influence the likelihood of suffering from a disease
6. **Neural networks**: Machine learning and medical diagnosis
7. **Unsupervised classification methods**: exploring the evolution of proteins
8. **Principal component analysis (PCA)**: Dimension reduction to better visualize the data
9. **Supervised classification methods**: Discriminant analysis and Support vector machine (SVM)
10. **Survival analysis**: Assess which factors favor the late onset of a health problem.

Methodology

Working method: Analysis of results corresponding to real or simulated work, discussion of objectives and critical analysis of the design. Introduction of statistical and mathematical models and learning of computer tools in order to adjust the models to the available data. Deepening in the criteria to validate models and discuss their implications with respect to the objectives of each study. Critical reading of articles and interpretation of the models used and their suitability for design.

Other aspects: Critically analyze the literature and know how to interpret the results of biomedical research. Transversal skills in the use of information technology and cooperative group work. Data visualization.

Development plan

The first part of the subject will review and deepen the criteria of scientific evidence, the research methodology, the basis of inference and descriptive and bivariate statistics. It will also contribute to critically analyze the literature and know how to interpret the results of biomedical research.

The second part will deal with the modeling of biological processes and will provide tools for multivariate analysis. It will analyze how to achieve the treatment of data of different nature. We will apply multivariate techniques both with descriptive objectives and to quantify the relationships between different variables and sample classification procedures (eg, clusters, main components, evolution and decision trees, etc.).

Evaluation

• 40% Test type test to assess the degree of understanding of the concepts and methods explained during the course.

• 25% Final work of data analysis. Assessment of the ability to apply the knowledge acquired in the analysis of a specific problem.

• 25% Critical analysis of articles and Tasks (written works)

• 10% Participation in the discussion of examples and demonstration of the acquisition of the concepts explained.

• Compulsory attendance at 80% of classes.

Changes in the development and evaluation of the course will be indicated in the resources section of the virtual campus depending on the conditions imposed by the SARS-COV-2 pandemic.

Bibliography

- An Introduction to R. W. N. Venables, D. M. Smith and the R Core Team. https://cran.r-

project.org/doc/manuals/r-release/R-intro.pdf

- An Introduction to Machine Learning with R. Laurent Gatto
  https://lgatto.github.io/IntroMachineLearningWithR/
- Introduction to Machine Learning with R: Rigorous Mathematical Analysis. Scott V. Burger