69301 - Biostatistics and numerical simulation of biomedical engineering

Información del Plan Docente

Academic Year	2017/18
Faculty / School	110 - Escuela de Ingeniería y Arquitectura
Degree	330 - Complementos de formación Máster/Doctorado 547 - Master's in Biomedical Engineering
ECTS	6.0
Year	---
Semester	Indeterminate
Subject Type	ENG/Complementos de Formación, Compulsory
Module	---

1.General information

1.1.Introduction

1.2.Recommendations to take this course

1.3.Context and importance of this course in the degree

1.4.Activities and key dates

2.Learning goals

2.1.Learning goals

2.2.Importance of learning goals

3.Aims of the course and competences

3.1.Aims of the course

3.2.Competences

4.Assessment (1st and 2nd call)

4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The proposed methodology aims at encouraging student continuous work. The course begins reviewing basic statistical concepts such as estimation, hypothesis testing, and *p*-values. Non-parametric tests along with tests for categoric data and survival analysis are presented too. The association between variables is analyzed by means of regression models. The course focuses on simple linear regression as well as on generalized linear models, logistic regression and survival regression models. A wide range of teaching and learning tasks are implemented, such as

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- Lectures, where the general principles -theory contents with illustrative examples- of the course are presented to the whole student group.
- Computer lab sessions, where students deal with both data analysis and modelling of real events by means of specific statistical software.

For the Numerical Methods section, the learning process provides the students with a set of numerical techniques and tools that can help them in the future to solve diverse problems based in partial deferential equations, which are essential in the Bioengineering field. Similarly to the previous section, in lectures there is a revision of the fundamental equations of the continuum mechanics to give a step ahead to the most extended numerical techniques for the solution of such type of problems. In practice sessions the students can consolidate those concepts previously seen in lectures, under the teacher's supervision.

5.2.Learning tasks

The course includes the following learning tasks:

Section 1. Biostatistics

- **A01 Lectures** (10 hours). The teacher presents the main concepts and techniques to be developed in the computer room.
- **A03 Laboratory sessions.** (20 hours). Students are enabled to use specific software for the different statistical procedures.
- **A05 Assignment.** Each student develops an individual task regarding the use of statistical procedures in biomedical data. Students can choose data-bases they are particularly interested in or, alternatively, data-bases provided by the instructor. In the latter case it will correspond to a published research article containing statistical techniques. In either case a written report is mandatory.
- **A06 Tutorials.** Personal assistance to students aiming at reviewing and discussing the topics presented in class.
- **A08 Assessment**. A set of written tests and reports that the student has to complete along the course. The grading system is described in point 4 of this guide.

Section 2. Numerical Simulation

- **A01 Lectures** (24 hours). The teacher will present the basic fundamental concepts needed for the development of the course objectives in the lecture room.
- **A03 Laboratory sessions** (6 hours). The main objective of these sessions is to learn and practice the use of specific software for the solution of differential equation problems in order to consolidate the theoretical techniques previously seen in the lectures.
- **A05 Assignments.** The student has to implement practical code in MatLab to reproduce a bioengineering problem using the learned numerical techniques.
- **A06 Tutorials.** The students can receive personal assistance by the teachers to review and/or discuss the topics presented in class.
- **A08 Assessment**. A set of written tests and reports that the student has to complete along the course. The grading system is described in point 4 of this guide.

5.3.Syllabus

The course will address the following topics:

Section 1. Biostatistics

- 1. Introduction
  - 1.1. Exploratory data analysis.
  - 1.2. Review of basic concepts on estimation, confidence intervals, hypothesis testing, goodness-of- fit tests.
- Topic 2. Parametric and non-parametric tests for one or several samples.
  - 2.1. Tests for normal distributions, ANOVA, multiple comparisons.

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  - 2.2. Non-parametric tests: One-sample sign, one-sample Wilcoxon, Mann-Whitney, Kruskal-Wallis.
- Topic 3. Regression models
  - 3.1. Simple linear regression, model building and checking, Box-Cox transformation, prediction.
  - 3.2. Generalized Linear model, covariates and factors, covariance analysis, variance decomposition, ANOVA, automatic model building.
  - 3.3. Linear model with multivarite response, MANOVA.
- Topic 4. Models for categoric data.
  - 4.1. Contingency tables
  - 4.2. Logistic regression models, log-linear models.
- Topic 5. Suvival data analysis.
  - 5.1. Measures of risk and survival. Censor data. Kaplan-Meier estimator
  - 5.2. Parametric models: Weibull.
  - 5.3. Semiparametric models: proportional hazard model.

Section 2. Numerical Methods

- Topic 1. Introduction.
- Topic 2. The basic equations of continuum mechanics.
- Topic 3. Numerical methods.
- Topic 4. Finite differences Method (FDM).
- Topic 5. Finite Element Method (FEM).
- Topic 6. Finite Volume Method (FVM).
- Topic 7. Bioengineering examples and applications.

5.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the EINA website.

5.5.Bibliography and recommended resources

BB	Chatterjee, Samprit. Regression analysis by example / Samprit Chatterjee, Ali S. Hadi . - 4th ed. Hoboken (New Jersey) : John Wiley & Sons, cop. 2006
BB	Chernick, Michael R.. Introductory biostatistics for the health sciences : modern applications including bootstrap / Michael R. Chernick, Robert H. Friis Hoboken (NJ) : John Wiley & Sons : Wiley-Interscience, cop. 2003
BB	Dupont, William D.. Statistical modeling for biomedical researchers : a simple introduction to the analysis of complex data / William D. Dupont . - 2nd ed., 3rd print. Cambridge [etc.] : Cambridge University Press, 2011
BB	Fish, Jacob. A first course in finite elements / Jacob Fish, Ted Belytschko Chichester (England) : John Wiley & Sons, 2009
BB	Larson, Stig. Partial differential equations with numerical methods / Stig Larsson, Vidar Thomée. Berlin ; Heidelberg : Springer, 2009

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BB	Lee, Elisa T. Statistical methods for survival data analysis / Elisa T. Lee ; John Wenyu Wang. Hoboken, New York : Wiley, 2013
BB	Oñate Ibañez de Navarra, Eugenio. Cálculo de estructuras por el método de elementos finitos : análisis estático lineal / Eugenio Oñate Ibañez de Navarra . - [2a. ed.] Barcelona : Centro internacional de Métodos Numéricos en Ingenieria, 1995
BB	Rosner, Bernard. Fundamentals of biostatistics / Bernard Rosner . - 7th ed. Boston : Brooks/Cole, cop. 2011
BB	González Ibáñez, David. Guía rápida de Matlab : claves para la certificación / David González Ibáñez . Zaragoza : Prensas de la Universidad de Zaragoza , 2016