

27019 - Mathematical Statistics

Syllabus Information

Academic year: 2023/24

Subject: 27019 - Mathematical Statistics

Faculty / School: 100 - Facultad de Ciencias

Degree: 453 - Degree in Mathematics

ECTS: 7.5

Year: 3

Semester: Second semester

Subject type: Compulsory

Module:

1. General information

This is a compulsory and fundamental course within the Mathematics degree, aimed at teaching the principles and basic techniques of statistical inference. It requires prior knowledge of descriptive statistics, probability calculus, and mathematical analysis (calculus in one and multiple variables).

The approaches and objectives of this module are aligned with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda; the learning activities could contribute to some extent to the achievement of the goals 4 (quality education), 5 (gender equality), 8 (decent work and economic growth), and 10 (reducing inequality).

2. Learning results

- Understand the concepts of population, sample, and statistical model, as well as the objectives and principles of statistical inference.
- Understand the concept of statistic and the basic properties of common statistics, under random sampling, particularly for statistics associated with normal, exponential, and other populations.
- Get familiar with different methods of point estimation: maximum likelihood estimation (MLE), method of moments (MME), and Bayesian estimation, and the key properties for assessing their quality: unbiasedness, sufficiency, consistency, and efficiency. Understand the asymptotic properties of MLE.
- Understand the concept of confidence interval and be able to use common methods for its construction.
- Be able to formulate a parametric hypothesis testing problem and evaluate the quality of a test. Understand the Neyman-Pearson paradigm for constructing a hypothesis test. Be able to construct a likelihood ratio test.
- Be able to formulate and solve parametric tests for comparing two populations. Know the basic nonparametric tests for assessing the independence or association of two variables, as well as the goodness of fit of a statistical model.

3. Syllabus

1. Introduction to statistical inference. Population and random samples. Statistics. Sampling from the normal distribution. Order statistics. Convergence concepts and limit theorems.
2. Point estimation. Desirable properties of an estimator. Methods of finding and evaluating estimators. Large sample properties for maximum likelihood estimators. Interval estimation.
3. Hypothesis testing. The Neyman-Pearson approach. The duality of confidence intervals and hypothesis tests. Likelihood ratio tests. Tests for normality, goodness of fit and independence. Comparing two samples.

4. Academic activities

Master classes: 45 hours.

Problem solving: 10 hours.

Computer classes: 20 hours.

Project: 12 hours.

Study: 93 hours.

Assessment tests: 7.5 hours.

5. Assessment system

Assessment is split into two parts, corresponding to theory/problems and computer classes. Once the marks for theory/problems (CT) and computer classes (CP) are obtained, the final mark will be $CF = 0.7 \times CT + 0.3 \times CP$

The student will pass the module if CF is greater than or equal to 5.0, provided that both CT and CP are 2.5 or higher.

CT and CP marks are computed as follows:

- First call (June).

Both for CT and for CP, students may take two mid-term exams. The first exams correspond to topic 1 and the second exams correspond to topics 2 and 3. The first exams will be held at the end of that topic. The second exams will be held at the official date of the June exam. The CT and/or CP marks will be obtained as

$$CT = 0.3 \times CT1 + 0.7 \times CT2$$

$$CP = 0.4 \times CP1 + 0.6 \times CP2$$

In order to obtain the CP score from CP1 and CP2, it is necessary to attend at least 80% of the computer lab classes. Alternatively, students may take a unique final exam for getting either CT, CP or both at the official date of the June exam.

- Second call (July)

In the second call, students will take a unique final exam for getting CT and CP at the official date of the July exam.

Additionally, students will have the opportunity to carry out a task consisting of a statistical analysis proposed by the teachers. This activity will be graded on a scale of 0 to 0.5 points. Students in the English group, furthermore, will have the option to present their work to the class, and the presentation will be graded on a scale of 0 to 0.5 points. These activities are optional, and the grade will be added to the score obtained in the exams.