Statistical Inference

Academic Year: (2019 / 2020) **Review date: 29-04-2019**

Department assigned to the subject: Statistics Department

Coordinating teacher: MOLINA PERALTA, ISABEL

Type: Compulsory ECTS Credits : 3.0

Year : 1 Semester : 1

OBJECTIVES

COMPETENCES THAT THE STUDENT WILL ACQUIRE

1 Getting and understanding concepts having the chance of being original in the development and/or application of ideas, often in the context of research.
2. Applying the obtained knowledge and ability to solve problems in new environments within wide (or multidisciplinary) contexts related with her/his area of studies.
3. Ability of integrating knowledge and facing the complexity to issue sentences from information that, being incomplete or limited, includes reflections about the social and ethic responsibilities tied to the application of her/his knowledge and sentences.
4. Ability of reporting the conclusions and knowledge, together with the reasons that sustain them, to specialized and non-specialized audiences in a clear, without ambiguity, way.
5. Ability of learning so as to continue studying in a self supervised or autonomous way.
6. Ability to apply the techniques of analysis and representation of information, so as to adapt it to real problems.
7. Ability to identify the most adequate statistical model for each real problem and knowing how to apply that model for the analysis, design and solution of the problem.
8. Ability to find, either individually or in a team, scientifically feasible solutions for complex statistical problems from the real life.
9. Ability to summarize the obtained conclusions from those analysis and present them in a clear and convincing way in a bilingual environment (Spanish and English) both in written and orally.
10. Being able to generate new ideas (creativity) and anticipate new situations, in the context of data analysis and decision making.
11. Apply social abilities for team work and for relating with others in an autonomous way.
12. Apply the advanced techniques of analysis and representation of information, so as to adapt it to real problems.
13. Apply advanced Statistical Inference knowledge to the development of analytical methods for real problems.
14. Using free software such as R and Python for the implementation of the Statistical Analyses.
15. Predicting and representing eventual associations between random phenomena, related with real problems and reflected in the collected data, by applying multivariate analysis concepts.
16. Developing and applying complex statistical models for non necessarily independent samples of random variables by applying Bayesian analysis concepts.
17. Applying the advanced Statistical foundations for the development and analysis of real problems related with the prediction of a response variable.
18. Applying non-parametric models for the interpretation and prediction of random phenomena.
19. Applying optimization techniques for the estimation of the parameters of complex sampling models.
20. Correctly identifying the corresponding type of Statistical analysis needed for specific objectives and data.
21. Applying Statistical modeling in the treatment of relevant problems appearing in the scientific world.
22. Applying models for supervised and non-supervised learning.
23. Modelling complex data with stochastic dependence.

RESULTS OF LEARNING THAT WILL BE ACQUIRED BY THE STUDENT

Knowledge acquisition of: 1) main sampling distributions; 2) methods of point estimation; 3) methods of confidence intervals and hypothesis tests; 4) multivariate distributions and properties; 5) principal component analysis; 6) multidimensional scaling; 7) factor analysis; 8) non-supervised classification

(cluster analysis); 9) linear discriminant analysis; 10) support vector machines; 11) neural networks; 12) random trees; 13) generalized linear models; 14) general additive models; 15) philosophy of Bayesian estimation; 16) informative and non-informative prior distributions; 17) generalized linear models under the Bayesian approach; 18) estimation techniques in Bayesian statistics; 19) kernel density estimators; 20) non-parametric regression methods based on smoothing; 21) use of wavelets; 22) non-parametric hypotheses tests; 23) selection of generalized linear models; 24) LASSO and ridge regression; 25) meta-methods: boosting, bagging and ensembles; 26) survival analysis; 27) multiple hypotheses testing; 28) clinical trials.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to point estimation
   - 1.1. Basic concepts
   - 1.2. Sampling distributions under normal populations
   - 1.3. The Central Limit Theorem
2. Estimation methods
   - 2.1. Moments method.
   - 2.2. Maximum likelihood method.
3. Types and properties of estimators
   - 3.1. Unbiasedness
   - 3.2. Invariance
   - 3.3. Consistency
   - 3.4. Efficiency
   - 3.5. Robust estimators
4. Confidence intervals.
   - 4.1. The method of the pivotal quantity
   - 4.2. Confidence intervals for mean, proportion and variance under normal populations
   - 4.3. Confidence intervals for large samples
   - 4.4. Bootstrap confidence intervals
5. Hypothesis testing
   - 5.1. Introduction
   - 5.2. Hypothesis testing for the mean, proportion and variance under one normal population
   - 5.3. Hypothesis testing for two normal populations
   - 5.4. Hypothesis testing for large samples
   - 5.5. Hypothesis testing by bootstrap.

LEARNING ACTIVITIES AND METHODOLOGY

LEARNING ACTIVITIES REFERRED TO SUBJECTS

AF1 Theoretical class
AF2 Practical class
AF4 Laboratory training
AF5 Tutoring
AF6 Team work
AF7 Individual work
AF8 In-person evaluation exams

Code Activity	Total Num. Hours	In-Person Num. Hours	% Student in-Person
AF1	88	88	100
AF2	40	40	100
AF4	40	40	100
AF5	36	36	100
AF6	80	0	0
AF7	304	0	0
AF8	12	12	100
TOTAL SUBJECT	600	204	34

LEARNING METHODOLOGY REFERRED TO SUBJECTS

MD1 Oral presentations of the professor with help of computing and visual media, in which the main concepts of the subject matter are developed and bibliography is given for the complementary learning of students.
MD3 Solving, either individually or in a team, real cases, problems, etc., formulated by the professor .
MD5 Elaboration, either individually or in a team, of projects and reports

ASSESSMENT SYSTEM

ASSESSMENT SYSTEM AND PROGRAM REFERRED TO SUBJECTS

SE1 Participation in class
SE2 Individual or team works carried out along the course
SE3 Final exam

System of assessment	Minimum weight (%)	Maximum weight (%)
SE1	0	20
SE2	20	100
SE3	0	60

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- D. Wackerly, W. Mendenhall and R. L. Scheaffer Mathematical Statistics with Applications, Duxbury, 2007
- G. Casella, R. L. Berger Statistical Inference, Thomson Press, 2006
- S. M. Ross Introduction to Statistics, Prentice Hall, 1989

ADDITIONAL BIBLIOGRAPHY

- B. Efron, R. J. Tibshirani An introduction to the bootstrap, Springer, 1993
- L. Gonick, W. Smith The Cartoon Guide to Statistics, William Morrow, 1993