Maestría en Ciencias de la Información y las Comunicaciones

Emphasys

NAME OF THE SUBJECT: *Herramientas Matemáticas para el Manejo de la Información.*

- Obligatory (X): Basic (X) Complementary ( )
- Elective (X): Intrinsic ( ) Extrinsic ( )

NUMBER OF ACADEMIC CREDITS: Three (3).

COURSE TYPE: THEORETICAL: ___ PRACTICAL: ___ THEORETICAL-PRACTICAL: _X_
Methodological alternatives:
Master Class (X), Seminar ( ), Seminar - Workshop ( ), Workshop (X), Practice ( ),
Tutored projects (X), Other: _____

Justification

JUSTIFICATION:

In certain investigations and even at the labor level, the adequate dealing of big volumes of data is required. Depending on the nature of the systems being observed, and the methods of observation and data acquisition, we could establish than any data set is associated with an error that must be understood and modeled, to reduce uncertainty when drawing conclusions are concerned. Additionally, the variations in the data obtained from "equal" experiments require the support of statistical estimation theory, to be compared successfully with the results of "different" experiments. In this context, a deep understanding of the techniques of estimation and statistical inference, that are associated with any research experiment, is fundamental in the academic training of master's degree students.

PREREQUISITE / PREVIOUS KNOWLEDGE: Previous knowledge of Probability and Statistics and (although it is not mandatory) it is suggested to have basic knowledge in the handling of some statistical package (like R), or mathematical package (like MATLAB); as well as the ability to program in some language (such as C, C ++, Python, etc.).

Content

GENERAL OBJECTIVE

To provide the student of the *Maestría en Ciencias de la Información y las Comunicaciones* with some of the statistical and mathematical tools for the handling of information.

SPECIFIC OBJECTIVES

1. To present some models for the handling of information.
2. To indicate which is the best methodological strategy that allows an adequate handling of information from the statistical-mathematical perspective.
3. To expose computational tools as support for the handling of information.

Academic Competencies

Context competencies: Taking into account that it is a subject of the Fundamental Core of the Master's degree program, it is expected to promote in the student the self-criticism of the knowledge that is going to be acquired and the criticism of knowledge around the academic community.

Basic competencies: It is expected that the student, through the subject, at least encourage and develop the ability to interpret statistical and mathematical methods and methodologies around the handling of information.

Labor competencies: It is expected that the student will appropriate of the basic knowledge and methodologies of handling of information to understand, analyze and address problems in their academic training and professional practice as a Master of Science in Information and Communications.

Syllabus

For the understanding of estimation and statistical inference techniques, it is suggested to study in the course three (3) main topics: Estimation Theory, hypothesis / goodness of fit tests, and the generation of random numbers. Additionally, the concepts of classical probability and random variables are presented from the beginning; while the topic of random number generation is worked on transversally and is complemented by other models that are applied in different areas of knowledge.

1. **Statistics and Probability, an introduction**
   Basic concepts of Statistics.
   Basic Concepts of Probability.
   Random variables.
   Probabilistic models.

2. **Estimation Theory**
   Parameter estimation.
   Behavioral properties.
   Maximum Likelihood Estimation.
   Confidence Intervals and Statistical hypothesis testing.
   Non parametrical and Bayesian Inference.

3. **Some Statistical Tests**
   Kolmogorov-Smirnov test.
   Chi-squared test.
   Homogeneity tests.
   Independence tests.

4. **Multivariate techniques and other tests**
   Introduction to Statistical Simulation.
   Introduction to Stochastic processes.
   Markov Chains.
   Generation of random numbers.
   Monte Carlo method.
   Resampling methods.
   Introduction to Markov Chain Monte Carlo (MCMC).

5. **Introduction to Statistical Modelling**
   The simple and multivariate linear regression model.
   Least Squares Regression Parameter Estimation.
   Introduction to Linear Generalized models.
   Other types of Linear, Dynamic and Spatial models.

Strategies

Pedagogical and didactic methodology:

The subject is theoretical-practical, so the development of the contents will be carried out through lectures and some practices in proposed workshops. The first part will have a motivation of the subject from examples where its relevance is highlighted. Next, theoretical

guidelines as well as the minimum mathematical basis that justify the concepts will be provided. Students will develop exercise workshops where they apply the acquired knowledge. It should be noted that students must perform readings prior the sessions.

	Hours			Teacher hours / week	Student hours / week	Total Hours Student / semester	Academic credits
Type of course	DW	CW	AW	(DW + CW)	(DW + CW +AW)	X 16 weeks	
Subject	4	0	6	4	10	160	3

Direct Presential Work (DW): classroom work in plenary session with all students.
Mediated-Cooperative Work (CW): Teacher tutoring work to small groups or individually to students.
Autonomous Work (AW): Student work without the presence of the teacher, which can be done in different instances: in work groups or individually, at home or in a library, laboratory, etc.)

Resources

PHYSICAL RESOURCES REQUIRED:

- Computer classroom with specialized software in statistics: R and MATLAB. As well as online tools for access to scientific databases, email and LaTeX compilers.

BIBLIOGRAPHY:

Bertsekas, D., & Tsitsiklis, J. (2008). *Introduction To Probability*. (A. Scientific, Ed.) (2nd ed.).
Bickel, P., Doksum, K. (2005). *Mathematical Statistics, Basic Ideas and Selected Topics*. vol 1.
Bickel, P., Doksum, K. (2018). *Mathematical Statistics, Basic Ideas and Selected Topics*. vol 2.
Gilchrist, W. (2000). *Statistical Modelling with Quantile Functions*. (C. and Hall/CRC, Ed.).
Kay, S. (1993). *Fundamentals of Statistical Processing, Volume I: Estimation Theory: Estimation Theory v. 1*. Prentice Hall.
Kay, S. (2012). *Intuitive Probability and Random Processes using MATLAB®*. Springer.
Kreyszig, E. (1979). *Introducción a la Estadística Matemática: Principios y Métodos*. Editorial LIMUSA.
McCullagh, P. and Nelder, J. (1989). *Generalized linear models* (2nd edition). Chapman and Hall, London.
Mood, A. M.,Graybill, F. A., Boes, D. C. (1974) *Introduction to the Theory of Statistics* (Third Edition), Mc Graw Hill.
Robert, C. P. and Casella, G. (2010). *Introducing Monte Carlo methods with R*. Springer, Heidelberg.

FURTHER READING:

Acuña, E. (2008). *Análisis de Regresión.* Universidad de Puerto Rico. Departamento de Matemáticas.

A. M. Law, W.D. Kelton (2000). *Simulation Modeling and Anaysis*. McGraw Hill.

Blanco, L. (2004). *Probabilidad.* Bogotá: Universidad Nacional de Colombia. Facultad de Ciencias.

Box, G. E. P., Hunter, W. G., Hunter, J.S. (1989). *Estadística para investigadores. Introducción al diseño y análisis de experimentos, análisis de datos y construcción de modelos*. Editorial Reverté.

Cepeda, E. (2008). *Notas de clase: Estadística matemática.* Bogotá: Universidad Nacional de Colombia. Facultad de Ciencias.

Díaz, L. G. (2007). *Estadística Multivariada: Inferencia y Métodos.* Bogotá: Universidad Nacional de Colombia. Facultad de Ciencias.

Díaz, L. G. y Morales, M. A. (2009), *Análisis estadístico de datos categóricos*, Bogotá: Universidad Nacional de Colombia. Facultad de Ciencias.

Gutierrez, H. P. (2003). *Análisis y Diseño de Experimentos*. McGraw Hill. México.

Haaland, P. D. (1989). *Experimental Design in Biotechnology*. Perry D Haaland. Editorial Marcel Dekker,Inc.

Hubert, J. J. (1992). *Bioassay* (Third Edition).1992.

Kenett, R. y Zacks, S. (2000). *Estadística industrial moderna. Diseño y control de la calidad y la confiabilidad*. Internacional Thompson editores.

Kuel, R. O. (2001). *Diseño de experimentos*. Editorial Thomson Learning.Segunda edición. México.

Levine, D. M., Krehbiel, T. C. y Berenson, M. L. (2006). *Estadística para administración*, Prentice Hall.

Mayorga, J. H. (2004). *Inferencia Estadística.* Bogotá: Universidad Nacional de Colombia. Facultad de Ciencias.

Meeker, W. Q. y Escobar, L. A., (1998). Statistical Methods for Reliability Data. Jhon Wiley & Sons, Inc.

Milton J. S. (1994). *Estadística para Biología y Ciencias de la Salud*. 2ª Edición. Editorial Interamericana Mc Graw Hill.

Montgomery, D. C. (2002). *Introducción al Análisis de Regresión Lineal*. Compañía Editorial Continental.

Novales, A. (1997*). Estadística y Econometría.* Mc Graw Hill.

Peña, D. (1986). *Estadística: modelos y métodos, Vol. 1.* Alianza Editorial.

Peña, D. (1986). *Estadística: modelos y métodos, Vol. 2.* Alianza Editorial.

Peña, D. (2001). *Fundamentos de Estadística.* Alianza Editorial.

Peña, D. (2002). *Análisis de Datos Multivariantes.* Mc Graw Hill.

Petersen, R. G. (1985). *Design and Analysis of Experiments*. Editorial Marcel Dekker, Inc. 1985.

Soto, O. F. (2002). *Notas de clase: Fundamentos Conceptuales de Estadística.* Bogotá: Universidad Nacional De Colombia. Facultad de Ciencias.

Wackerly, D., Mendehall, W. y Scheaffer, R. L. (2002). *Estadística Matemática con Aplicaciones,* Grupo Editorial Iberoamérica.

Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2017). *Probability and Statistics for Engineers and Scientists* (9th ed.). Pearson.

BIBLIOGRAPHIC RESOURCES:

- IEEE Database
- SPRINGER Database
- ELSEVIER Database

ONLINE RESOURCES:

http://www.sgapeio.es/INFORMEST/VICongreso/taller/applets/biomates/vari/vari.htm
http://alomax.free.fr/projects/expdesign/
http://web.warwick.ac.uk/statsdept/user2011/TalkSlides/Invited/Gromping-Design_of_Experiments.pdf
http://halweb.uc3m.es/esp/Personal/personas/mcasas/esp/disenio/disenio.html

Course Schedule

Week/subject	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Probability and Statistics.																
2. Estimation Theory.																
3. Some statistical tests.																
4. Multivariate tecniques and other tests.																
5. Introduction to Statistical modelling.																

Evaluation

The evaluation of the course will be discussed in the first session and the professor will choose the methodology, type of evaluation and percentages for each assignment. Below, two evaluation schemes are suggested:

	ACTIVITIES	WEEKS	PERCENTAGES
FIRST ASSIGNMENT	First Homework (three integrants per group). Deliverables: Working Paper and Oral presentation.	6	20%
SECOND ASSIGNMENT	Second Homework (three integrants per group). Deliverables: Working Paper and Oral presentation.	10	20%
THIRD ASSIGNMENT	Third Homework (three integrants per group). Deliverables: Working Paper and Oral presentation.	14	20%
FOURTH ASSIGNMENT	Fourth Homework (three integrants per group). Deliverables: Working Paper and Oral presentation.	16	20%
FIFTH ASSIGNMENT	Permanent work (individual). Tasks and exercises in class.	ALL	20%

	ACTIVITIES	DATES	PERCENTAGES
FIRST ASSIGNMENT	First Homework		15%
SECOND ASSIGNMENT	Second Homework		15%
THIRD ASSIGNMENT	Midterm		20%
FOURTH ASSIGNMENT	Third Homework		20%
FIFTH ASSIGNMENT	Final Exam.		30%