VNIVERSITAT DE VALÈNCIA

Course Guide
44652 Signal analysis

COURSE DATA

Data Subject	
Code	44652
Name	Signal analysis
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
2221 - Master's Degree in Data Science	School of Engineering	1	First term

Subject-matter

Degree	Subject-matter	Character
2221 - Master's Degree in Data Science	4 - Signal analysis	Obligatory

Coordination

Name	Department
MATEO JIMENEZ, FERNANDO	242 - Electronic Engineering

SUMMARY

In this course advanced mathematical methods for data-science are introduced (especially audio, text, image and hyperspectral signals). In the first part the rudiments of information theory will be shown to adequately support the theoretical basis underlying the analysis of information when we have large amounts of data. Then, we will show how to extract temporal and frequency characteristics of a signal. To this end, we will revise the concepts of Fourier transform and wavelets. Later we will apply the aforementioned mathematical tools to extract features os signals such as audio, images and video. To implement more practically the theoretical knowledge, we will see an introduction to text processing techniques, hyperspectral data processing and streaming data.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

2221 - Master's Degree in Data Science

- Students should demonstrate self-directed learning skills for continued academic growth.
- Be able to assess the need to complete their technical, scientific, language, computer, literary, ethical, social and human education, and to organise their own learning with a high degree of autonomy.
- Ability to access and manage information in different formats for subsequent analysis in order to obtain knowledge from data.
- Ser capaces de acceder a herramientas de información (bibliográficas y de empleo) y utilizarlas apropiadamente.
- Ser capaces de asumir la responsabilidad de su propio desarrollo profesional y de su especialización en uno o más campos de estudio, aplicando los conocimientos adquiridos en la identificación de salidas profesionales y yacimientos de empleo.
- Extraer conocimiento de conjuntos de datos en diferentes formatos.
- Extraer características propias de señales N-dimensionales para ser usadas en diferentes algoritmos de análisis de datos.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

Use the techniques and algorithms to process one-dimensional signals (audio), two-dimensional (pictures) and N-dimensional (hyperspectral).
Design filters for the signal of interest from noise. Applying digital processing techniques to extract signal characteristics.
Handle suitable for signal processing (one-dimensional and images) tools.

DESCRIPTION OF CONTENTS

1. Introduction to signal analysis.

Autocorrelation and cross correlation.
Information Theory. Entropia.
Mutual Information.
Kullback-Leibler divergence.

2. Basic mathematical tools.

Fourier transform.
Gabor transform.
Generalized Transforms.
Wavelets.

3. Extracting frequency features

Spectral analysis of signals.

4. Engineering Features for audio, images and video.

Feature extraction in audio, image and video signals.

5. Hyperspectral data.

Basics concepts on analyzing data from multiple frequencies and treated as n-dimensional signals.

6. Técnicas de procesado de texto.

Basic techniques of text analysis. Frequency of words, word clouds, etc

WORKLOAD

ACTIVITY	Hours	% To be attended
Theoretical and practical classes	45,00	100
Development of individual work	10,00	0
Study and independent work	12,00	0
Readings supplementary material	2,00	0
Preparation of evaluation activities	12,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	12,00	0
Resolution of case studies	10,00	0
TOTAL	**113,00**	

TEACHING METHODOLOGY

The course will combine the theoretical and the practical part, without separating sessions devoted to theory from those devoted to practice. The lessons will be taught in a computer equipped classroom.

In the theoretical part of the classes, the teacher will introduce the concepts and methods in Signal Analysis, with examples and exercises to be solved by the students.

The practical sessions will be synchronized with the theory. In these sessions, the students will learn by solving problems, exercises and case studies, in order to acquire the skills of this course.

EVALUATION

The educational evaluation of knowledge and skills achieved by the students will be made continuously throughout the course, and will consist in the following blocks of evaluation:

1. Exercises and the class work submitted during the course: 55% of the final grade.

2. Final exam: 40% of the final grade.

3. Continuous evaluation: 5% of the final grade.

Grades earned in paragraph 1 shall be kept in the two examination sittings of the academic year in which they were made, since their evaluation is only possible in the teaching period.

REFERENCES

Basic

- Principe, J.C., (2010). Information Theoretic Learning. Ed. Springer
- Frery, A.C., Perciano, T. , (2013). Introduction to image processing using R. Ed. Springer.
- Stankovic, S., Orovic, I., Sejdic, E., (2016). Multimedia Signals and Systems, Ed. Springer.
- Gonzalez, R.C., Woods, R.E., Eddins, S.L., (2016). Image processing. http://www.imageprocessingplace.com
- Sonka, M., Hlavac, V., Boyle, R., (1993) Image processing, analysis and machine visión. Ed. Springer.
- Das, A. (2015) Guide to Signals and Patterns in Image Processing. Ed. Springer

Additional

- Venables, V.N. (2013). An Introduction to R. http://cran.r-project.org.