Course guide
270216 - IPA - Introduction to Audiovisual Processing

Last modified: 30/01/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: FERNANDO MARQUES ACOSTA

Others: Segon quadrimestre:
CARLOS HERNÁNDEZ PÉREZ - 13
FERNANDO MARQUES ACOSTA - 11, 12, 13
FRANCESC REY MICOLAU - 12

PRIOR SKILLS

The knowledge acquired in the subjects of the degree in previous semesters

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.

Generical:
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.

Basic:
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

TEACHING METHODOLOGY

The subject is based on classroom theory classes, problems and laboratory. The theory classes follow the program defined in this teaching guide. Within the lectures, the dialogue between professors and students is promoted by proposing exercises and activities to be carried out jointly based on particular aspects of the topic being dealt with. The laboratory classes exemplify the contents developed in the theory classes.

LEARNING OBJECTIVES OF THE SUBJECT

1.Know how to characterize stochastic processes
2.Understand and know how to use the most common signal transforms and their application
3.To obtain basic optimal and adaptive filtering background for audiovisual data applications

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	30,0	20.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Statistical Signal modelling

Description:
Stochastic processes: Definition. Autocorrelation. Stationarity, Ergodicity. Power spectral density. Discrete processes. Process filtering.

Estimation Theory

Description:
(1) Parameter Estimation: Concept, quality measures and types of estimators

(2) Function estimators: Autocorrelation and Power Density Espectral estimation

Optimal filter and adaptive filter

Description:
Types of filters: System identification, equalization, cancellation, prediction and interpolation. Wiener filter. Linear regression and minimum squares. Adaptive filter

Transforms

Description:
Frequency analysis: (1) Discrete Cosinus transform (DCT), (2) Short-time Fourier Transform. Interpretation as a filter bank. Window effect. Reconstruction. Spectrogram.

Statistical analysis: (1) Periodogram. Estimation principles. (2) Karhunen-Loeve Transform (KLT).

ACTIVITIES

Unit 1

Description:
Theory, exercise and laboratory classes corresponding to Unit 1

Specific objectives:
1

Related competencies :
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 39h 18m
Theory classes: 10h 18m
Practical classes: 3h 42m
Laboratory classes: 2h 18m
Self study: 23h

Unit 2

Description:
Theory, exercise and laboratory classes corresponding to Unit 2

Specific objectives:
2

Related competencies :
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 60h 54m
Theory classes: 15h 24m
Practical classes: 5h 36m
Laboratory classes: 3h 24m
Self study: 36h 30m

Unit 3

Description:
Theory, exercise and laboratory classes corresponding to Unit 3

Specific objectives:
3

Related competencies :
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CB4. That the students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 39h 18m
Theory classes: 10h 18m
Practical classes: 3h 42m
Laboratory classes: 2h 18m
Self study: 23h

GRADING SYSTEM

The final mark is obtained from the partial marks:

- Mid-term exam: M (25%)
- Final exam: F (60%)
- Laboratory assigments: L (15%)

Mark = max (0.6F+0.25P+0.15L ; 0.85F+0.15L; 0.75F+0.25P; 1.0F)

In the case of a re-evaluation exam (R), the final mark is

Mark = max(0.85R+0.15L; 1.0R)

BIBLIOGRAPHY

Basic:
- Hayes, M.H. Digital signal processing. 2nd ed. New York: McGraw Hill, 2012. ISBN 9780071635097.
- Kay, S.M. Fundamentals of statistical signal processing. Prentice-Hall, 1993-2013. ISBN 0130422681.
- Papoulis, A.; Pillai, S.U. Probability, random variables, and stochastic processes. 4th ed. McGraw-Hill, 2002. ISBN 0073660116.

Complementary:
- Manolakis, D.G.; Ingle, V.K; Kogon, S.M. Statistical and adaptive signal processing: spectral estimation, signal modeling, adaptive filtering, and array processing. Artech House, 2005. ISBN 9781580536103.
- Scharf, L.L. Statistical signal processing: detection, estimation, and time series analysis. Addison-Wesley, 1990. ISBN 0201190389.
- Marqués, F.; Rey, F. Introduction to Audiovisual Processing. Notes de classe,