

270209 - TEOI - Information Theory

Coordinating unit:	270 - FIB - Barcelona School of Informatics
Teaching unit:	749 - MAT - Department of Mathematics
Academic year:	2019
Degree:	BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)
ECTS credits:	6
Teaching languages:	Catalan

Prior skills

Fundamentals of probability, statistics and stochastic processes

Degree competences to which the subject contributes

Basic:

CB1. That students have demonstrated to possess and understand knowledge in an area of ??study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that imply Knowledge from the vanguard of their field of study.

CB2. That the students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and problem solving within their area of ??study.

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

Specific:

CE1. Skillfully use mathematical concepts and methods that underlie the problems of science and data engineering.

CE3. Analyze complex phenomena through probability and statistics, and propose models of these types in specific situations. Formulate and solve mathematical optimization problems.

CE7. Demonstrate knowledge and ability to apply the necessary tools for the storage, processing and access to data.

CE8. Ability to choose and employ techniques of statistical modeling and data analysis, evaluating the quality of the models, validating and interpreting them.

Generical:

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:

CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.

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.

CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.

Teaching methodology

50% of lectures in which the participation of students is stimulated, followed by 50% of practical classes based on exercises and programming of algorithms with the aim of bringing information theory to practical applications related to data science engineering.

270209 - TEOI - Information Theory

Learning objectives of the subject

1.To acquire the knowledge necessary to understand the basic principles of treatment, compression, cryptography and analysis of data based on Shannon's theory.

Study load

Total learning time: 150h	Theory classes:	30h	20.00%
	Laboratory classes:	30h	20.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

270209 - TEOI - Information Theory

Content

Discrete random variables and processes

Degree competences to which the content contributes:

Description:

Probability, ensembles of random variables, stochastic processes, Márkov processes

Measures of information

Degree competences to which the content contributes:

Description:

Information theory, entropy, joint entropy and mutual information, data processing inequality, Fano's inequality, applications

Information of data sources

Degree competences to which the content contributes:

Description:

Codes, asymptotic equipartition property, data compression, the high probability set, non-independent sources

Source coding

Degree competences to which the content contributes:

Description:

Properties of codes, unique decodability, minimum average length, Huffman codes, dictionary codes

Capacity of discrete channels

Degree competences to which the content contributes:

Description:

Joint typical sequences, channel capacity theorem, separability of source and channel coding.

Channel codes

Degree competences to which the content contributes:

Description:

Introduction to error correction codes, block codes



270209 - TEOI - Information Theory

Cryptography

Degree competences to which the content contributes:

Description:

Shannon theory of secrecy systems; main theorem; one-time pad; symmetric cryptography in practice

270209 - TEOI - Information Theory

Planning of activities

<p>Development of lecture "Discrete random variables and processes"</p>	<p>Hours: 8h Theory classes: 2h Practical classes: 2h Laboratory classes: 0h Guided activities: 0h Self study: 4h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Measures of information"</p>	<p>Hours: 16h Theory classes: 4h Practical classes: 4h Laboratory classes: 0h Guided activities: 0h Self study: 8h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Information of data sources"</p>	<p>Hours: 8h Theory classes: 2h Practical classes: 2h Laboratory classes: 0h Guided activities: 0h Self study: 4h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Source coding"</p>	<p>Hours: 16h Theory classes: 4h Practical classes: 4h Laboratory classes: 0h Guided activities: 0h Self study: 8h</p>
<p>Specific objectives: 1</p>	

270209 - TEOI - Information Theory

<p>Development of lecture "Capacity of discrete channels"</p>	<p>Hours: 8h Theory classes: 2h Practical classes: 2h Laboratory classes: 0h Guided activities: 0h Self study: 4h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Channel codes"</p>	<p>Hours: 8h Theory classes: 2h Practical classes: 2h Laboratory classes: 0h Guided activities: 0h Self study: 4h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Capacity of real channels"</p>	<p>Hours: 16h Theory classes: 4h Practical classes: 4h Laboratory classes: 0h Guided activities: 0h Self study: 8h</p>
<p>Specific objectives: 1</p>	
<p>Development of lecture "Statistical inference"</p>	<p>Hours: 16h Theory classes: 4h Practical classes: 4h Laboratory classes: 0h Guided activities: 0h Self study: 8h</p>
<p>Specific objectives: 1</p>	

270209 - TEOI - Information Theory

Development of lecture "Cryptography"	Hours: 8h Theory classes: 2h Practical classes: 2h Laboratory classes: 0h Guided activities: 0h Self study: 4h
Specific objectives: 1	

Qualification system

There will be a mid-term test of two hours duration at the 8th week and a final exam. The grade is calculated as the maximum of (final exam grade, $0.6 * \text{final exam grade} + 0.4 * \text{mid-term exam grade}$).

The re-evaluation exam, for fails who have attended lectures and final exam, will consist of one exam to be held in July and that will be considered at 100% for the final grading.

Bibliography

Basic:

Cover, T.M.; Thomas, J.A. Elements of information theory. 2nd ed. John Wiley & Sons, 2006. ISBN 978-0471241959.

Mackay, D.J.C. Information theory, inference, and learning algorithms. Cambridge University Press, 2003. ISBN 9780521642989.