Syllabus

Subject

Subject / Group	11017 - Information Theory / 1
Degree	Master's Degree in Physics of Complex Systems
Credits	3
Period	Second semester
Language of instruction	English

Professors

Lecturers	**Office hours for students**					
	Starting time	**Finishing time**	**Day**	**Start date**	**End date**	**Office / Building**
David Sánchez Martín david.sanchez@uib.es	14:00	15:00	Tuesday	10/09/2018	31/05/2019	Despatx 205 (IFISC)

Context

COURSE:

The science of information theory exceeds the realm of general communication and has multiple applications in physics, linguistics, ecology or psycology. This course will be divided in two broad areas. First, we will discuss the relation between information and probability in classical systems. Then, we will resort to quantum mechanics, which yields a probabilistic description of nature, and consider the fundamentals and latest developments in the field of quantum information.

PROFESSOR:

David Sánchez (PhD in Physics, 2002) is an Associate Professor at the UIB. He has published over 100 research papers and has taught different courses in quantum physics, nanostructures, mathematical methods and general physics.

Requirements

Skills

Specific

* E16, E18 .

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Generic

* TG1, TG2, TG3 .

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

1. Conditional probabilities.
   Bayes theorem. Likelihood.
2. Entropy and information
   Shannon entropy. Relative entropy. Mutual information.
3. Entropy and physics
   Maxent method. Maxwell deamon. Physical limits of computation.
4. Communications theory
   Source coding theorem. Noisy-channel coding theorem.
5. Qubits and entangled states
   Density operator. Composite systems. Entanglement.
6. Measurements
   Projective measurements. Nonideal measurements. Bell inequality.
7. Quantum computation
   Quantum gates. Deutsch's algorithm. Grover's algorithm. Physical realizations.
8. Quantum information theory
   Von Neumann entropy. Quantum mutual information. Quantum communications theory.

Teaching methodology

In-class work activities (0.75 credits, 18.75 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes		Large group (G)	Lectures.	18.75

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

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Distance education tasks (2.25 credits, 56.25 hours)

Modality	Name	Description	Hours
Individual self-study	Presentation	Discuss a relevant paper in the field of information theory.	30
Individual self-study	Homework assignments	Solve the proposed list of problems.	26.25

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Frau en elements d'avaluació

In accordance with article 33 of Academic regulations, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

Presentation

Modality	Individual self-study
Technique	Objective tests **(non-retrievable)**
Description	Discuss a relevant paper in the field of information theory.
Assessment criteria	
Final grade percentage: 50%	

Homework assignments

Modality	Individual self-study
Technique	Objective tests **(retrievable)**
Description	Solve the proposed list of problems.
Assessment criteria	
Final grade percentage: 50%	

Resources, bibliography and additional documentation

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Basic bibliography

Cover, M.T. and Thomas, J.A. Elements of information theory. Wiley, 2006.
Barnett, S.M. Quantum information. Oxford, 2009
Nielsen, M.A. and Chuang, I.L. Quantum computation and quantum information. Cambridge University Press, 2000

Other resources

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-441-information-theory-spring-2010/
http://ocw.mit.edu/courses/media-arts-and-sciences/mas-865j-quantum-information-science-spring-2006/

Date of publication: 12/06/2018