Information Theory

Academic Year: (2019 / 2020) **Review date: 10/05/2019 17:31:34**

Department assigned to the subject:

Coordinating teacher: KOCH , TOBIAS MIRCO

Type: Electives ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Students should have a solid basis in probability and calculus, as well as pleasure with mathematics. Having taken a course on Digital Communications / Communication Theory is also helpful.

OBJECTIVES

This course teaches the fundamentals of Information Theory, including the basic source coding and channel coding theorems. Students will acquire a profound understanding of:
- the concepts of data compression/transmission in digital communication systems.
- the fundamental limits of source codes and error correcting codes.
- information-theoretic quantities, such as entropy, Kullback-Leibler divergence, and mutual information.
- mathematical tools/concepts commonly used in Information Theory, such as Jensen's inequality, Fano's inequality, and the Asymptotic Equipartition Property (AEP).

DESCRIPTION OF CONTENTS: PROGRAMME

This course teaches the fundamentals of Information Theory, which concerns data compression and transmission in digital communication systems. The topics covered in this course are as follows:

1) Fundamental quantities and concepts in Information Theory: entropy, Kullback-Leibler divergence, mutual information, Jensen's inequality, Fano's inequality, Asymptotic Equipartition Property (AEP), method of types.
2) Data compression: uniquely decodable and instantaneous source codes, Kraft's inequality, analysis of the optimal codeword length, Huffman codes, almost lossless source coding.
3) Data transmission: description of the information-theoretic communication system, channel capacity, Kuhn-Tucker conditions, the channel coding theorem, the joint source-channel coding theorem.
4) Data transmission over the Gaussian channel: differential entropy, entropy-maximizing property of Gaussian random variables, the channel capacity of the Gaussian channel.

LEARNING ACTIVITIES AND METHODOLOGY

Lectures:
The basic concepts will be mainly taught at the blackboard. We will follow closely the book "Elements of Information Theory" by Cover & Thomas (see Basic Bibliography).

Exercises:
In order to deepen the understanding of the taught material, every two weeks students have to hand in the solutions to a set of problems. These solutions will be graded from 1 to 10, the average grade over the whole semester will constitute the grade of the continuous assessment.

Both lectures and exercises will be held in English.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

Continuous assessment:
Every two weeks, each student has to hand in the solutions to a set of problems. These solutions will be graded from 1 to 10, the average grade over the whole semester will constitute the grade of the continuous assessment.

End-of-term-examination:
At the end of the semester, there will be an oral exam of 30 minutes duration, where each student is tested on the material taught in this course.

Convocatoria extraordinaria:
There will be an oral exam of 30 minutes duration, where each student is tested on the material taught in this course.

BASIC BIBLIOGRAPHY

- Thomas M. Cover and Joy A. Thomas Elements of Information Theory, Second Edition, 2006

ADDITIONAL BIBLIOGRAPHY

- Abbas El Gamal and Young-Han Kim Network Information Theory, First Edition, 2011

- Imre Csiszár and János Körner Information Theory: Coding Theorems for Discrete Memoryless Systems, Second Edition, 2011

- Robert G. Gallager Information Theory and Reliable Communication, First Edition, 1968