Master's Department of Engineering Sciences

Name of the unit: Information theory

Lecturer: Nicolas OBIN (nicolas.obin@sorbonne-universite.fr)
Course code: UM4EET10-TI
Student workload: 10h of lectures, 12h of tutorial sessions, 6h of lab sessions@
Credits: 3 ECTS

Specialization tracks:	- **E3A** :	☒ CIMES	☒ Syscom	☒ IPS
	- **AR** :	☐ ROBOT	☒ SI	☐ MeDH
	- **MECA** :	☐ MS2	☐ MF2A	☐ CompMech
		☐ ACOU	☐ EE	☐ EE APP

Semester offered: ☒ S1 ☐ S2 ☐ S3 ☐ S4
Language of instruction: ☒ French ☐ English
Targeted audience: ☒ Engineering Sciences students ☐ Other (specify):
Localization : ☒ PMC Campus ☐ Other (specify):

Course Overview

This course introduces students to the fundamentals of information theory. Starting with the definition of key concepts and mathematical definitions of quantitative information measurement, the course presents all the elements of an information processing chain: source coding and entropy compression, channel coding, linear and convolutional block error-correcting codes, symmetric and asymmetric encryption.
Keywords: Information measurement, coding, transmission, encryption, Shannon entropy, mutual information

Prerequisites

Students should have previously acquired the following prerequisites to follow this course:

- Mathematics 1: Linear algebra, vector and matrix calculus
- Mathematics 2: Random signal processing, random variables, probabilities, mathematical expectation
- Computer science: Programming (using Matlab), algorithms

Intended Learning Outcomes

By the end of this course, students will be able to:

1. Calculate information metrics
2. Encode a source with a fixed-size code
3. Encoding a source with variable-length code and average coding length
4. Calculate the source coding limits
5. Calculate the capacity of a transmission channel
6. Calculate the transmission limits of a source on a transmission channel
7. Implement error correction upon receiving a noisy source
8. Apply encryption and decryption to a source

Indicative Teaching Sequence and Methods

Week	C/TD/TP*	Content	Preparation	Learn. outc.
S1	C1 / TD1	Quantitative measurement of information and source coding theorem		1, 2
S2	C2 / TD2	Source coding, Huffman algorithm, channel capacity		3, 4, 5, 6
S3	C3 / TD3	Corrective codes: linear block codes		7
S4	TD4	Preparation for practical work	Exam1 (1h30) the same week	1-7
S5	C4 / TD5	Correction codes: convolutional codes		7
S6	C5 / TD6	Information encryption: Symmetric algorithms, asymmetric algorithms		8
S7	TP1	Simulation of a complete information processing chain in Simulink		1-8
S8	TP2	Simulation of a complete information processing chain in Simulink		1-8

* C/TD/TP respectively corresponds to lectures, tutorials and lab sessions.

Sequence of the unit:
The unit is divided into three successive sequences:
- Sequence 1: information measurement, source coding, and channel capacity (C1/2, TD1/2/3, and CC1)
- Sequence 2: error correction codes and encryption (C3/4/5, TD4/5/6, and CC2)
- Sequence 3: practical work

Indicative Assessment of Intended Learning Outcomes (1st session)

Week	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
S4	Individual	In-person	Written	1-6	30 %
S7-8	Individual	In-person	Practical	1-8	30 %
S9	Collective	In-person	Written	7-8	40 %

2nde session of exam

Session	Individ./group	In-person/remote	Type of exam	Evaluated outcomes	Scale %
2	Individual	In-person	Written	1-8	70 %
1	Individual	In-person	Practical	1-8	30 %

Bibliographic references

- C. Shannon, W. Weaver. Théorie Mathématique de la Communication, 1948
- O. Rioul. Théorie de l'information et du codage, Lavoisier, 2007.

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