COM-514

Mathematical foundations of signal processing

Cursus	Sem.	Type
Communication systems minor	H	Opt.
Computational science and Engineering	MA1, MA3	Opt.
Computer and Communication Sciences		Opt.
Computer science	MA1, MA3	Opt.
Cybersecurity	MA1, MA3	Opt.
Data Science	MA1, MA3	Opt.
Minor in Imaging	H	Opt.
Robotics, Control and Intelligent Systems		Opt.
SC master EPFL	MA1, MA3	Opt.
Statistics	MA1, MA3	Opt.
Systems Engineering minor	H	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
Hours	**5 weekly**
Lecture	3 weekly
Exercises	2 weekly
Number of positions	

Remark

cours pas donné en 2023-24

Summary

A theoretical and computational framework for signal sampling and approximation is presented from an intuitive geometric point of view. This lecture covers both mathematical and practical aspects of modern signal processing, with hands-on projects, applications and algorithmic aspects.

Content

From Euclid to Hilbert (1/2): Hilbert Spaces and Linear Operators (Vector spaces, Hilbert/Banach spaces; adjoint and inverse operators; projection operators)
From Euclid to Hilbert (2/2): Hilbert Representation Theory (Riesz bases; Gramian; basis expansions; approximations & projections; matrix representations)
Application (1/2): Sampling and Interpolation (Fourier transforms and Fourier series; sampling & interpolation of sequences and functions; Shannon sampling theorem revisited; bandlimited approximation)
Application (2/2): Computerized Tomography (line integrals and projections, Radon transform, Fourier projection/slice theorem, filtered backprojection algorithm).
Regularized Inverse Problems (1/2): Theory (Discrete and functional inverse problems; Tikhonov regularisation; sparse recovery; convex optimisation; representer theorems; Bayesian interpretation)
Regularized Inverse Problems (2/2): Algorithms (Proximal algorithms; gradient de- scent; primal-dual splitting; computational aspects; numerical experiments and examples)

Learning Prerequisites

Important concepts to start the course

Good knowledge of linear algebra concepts. Basics of Fourier analysis and signal processing. Basic knowledge of Python and its scientific packages (Numpy, Scipy).

Supervision

Office hours	No
Assistants	Yes

Resources

Moodle Link

- https://go.epfl.ch/COM-514