MA2500
Signal Processing and Sparsity

Professor: Gilles Chardon

Language of instruction: English – **Number of hours**: 36 – **ECTS**: 3

Prerequisites: None

Period: S8 Elective 12 March to June IN28IE5, SEP8IE5

Course Objectives

This course will introduce fundamental mathematical concepts and techniques of signal processing, alongside with more advanced sparse coding techniques. The following topics will be covered:

- Fourier Transform
- linear filters
- sampling
- denoising
- wavelets
- sparsity
- compression

A solid understanding of these techniques is essential for the analysis of signals and systems emerging in a broad range of areas, such as communications, speech and music processing, biomedical engineering, time series analysis, multimedia, image analysis and computer vision. The tools introduced in the course will be applied to audio and image processing:

- speech processing (pitch-shifting, stretching)
- sound and image compression
- denoising

On completion of the course, students should be able to

- analyze and design linear filters
- analyze and process signals using appropriate representations (Fourier, wavelets)
- apply simple signal processing techniques (filtering, denoising)

Course Contents

Deterministic signals:

- Fourier transform
- Discrete signals
- Filter analysis and synthesis
- Sampling theorem

Random signals:

- Autocovariance, power spectral density
- Wiener filter, linear prediction and application to speech processing

Time-frequency and time-scale

- Continuous wavelets and wavelet basis
- Approximation and denoising
- 2D wavelets and image processing
- Short time Fourier transform
- Audio signal processing

Course Organization

Lectures: 16.5 hr, Tutorials: 6 hr, Labwork (Matlab): 10.5 hr, Exam: 3 hr

Teaching Material and Textbooks

Foundations of signal processing, M. Vetterli, J. Kovacevic, V. Goyal

Probability, Random Variables, and Stochastic Processes, A. Papoulis

A Wavelet tour of signal processing, S. Mallat

Evaluation

- 3-hr written final exam, without documents and without computer (50%)
- Labs (50%)