

## Master M1 MAS 2020/2021

### Representation and approximation of structured data

#### Summary

After a classification of data this course presents fundamental concepts, like time and frequency representation, analysis tools (Fourier, wavelets, multiresolution, SVD, matching pursuit, ...) and then the compression and denoising of data. Different applications (signals, images and vector fields) will illustrate the properties of the different tools.

#### Contents

*Introduction and signal classification*

*Complex numbers and norms*

*Some elements of linear algebra and Hilbert analysis in finite dimensions*

*A primer on standard notations, linear applications (discrete Fourier transform in finite dimension)*

*Matrix calculus, diagonalization and SVD*

*Possible extensions to infinite dimensions (Hilbert bases)*

*Approximation, projection, decomposition, orthogonal and non orthogonal projection.*

*Application of the SVD*

*Bases and approximation by projection on subspaces generated by a sub-family of a basis.  
Example of the DCT.*

*Discrete wavelets (example Haar basis), matching pursuit.*

*Computational aspects (complexity, conditioning)*

#### Textbooks:

M. Vetterli, J. Kovacevic and V. Goyal, Foundations of Signal Processing, Cambridge University Press, 2014.

<http://fourierandwavelets.org/>

S. Mallat . *A Wavelet Tour of Signal Processing, 3rd edition, The Sparse Way.* Academic Press, 2009.

<https://wavelet-tour.github.io/>

Wiki:

<https://en.wikipedia.org/>

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#### Elevator talks (5 min, 1 A4 page, max)

- What is the FFT?
- What is the DCT
- What is the SVD?
- What is PCA?
- What is quick sort?
- What is jpeg?
- What is jpeg 2000?
- What is mpeg?
- What is mp3?
- What are pseudo-random numbers?
- What is noise and colored noise?
- What is Gaussian white noise?
- What is SNR?
- What is GAFA?
- What are neural networks?
- What are Monte-Carlo simulations?
- What is sparsity?
- What is compressed sensing?
- What is deep learning?
- What does DBSCAN?
- What are GANs?
- Top 500 supercomputers

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**Representation and approximation of structured data**

***Représentation et approximation des données structurées***

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