



Lectures on statistical aspects of Data Science.

## HIGH DIMENSIONAL AND FUNCTIONAL DATA ANALYSIS USING SPLINES AND MACHINE LEARNING METHODS

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30 March – 9 April, 2020

The course is made of 10 one hour lectures, 5 one hour exercises, 5 one hour computing labs. The course introduces to the modern functional data analysis that tackles the high dimensional problem through functional and regularization approach to the dimension reduction. Examples of applications for genetics data and images illustrate the methodological contents. The participants will be lead through hands-on approach to computational methods in the computer lab session (based on the individual laptops and R-system for statistical computing). The lecture is a mix of well-established methodology and novel techniques proposed in very recent developments.

The topics covered by the lectures are:

1. Introduction to multivariate, high-dimensional, and functional data.
2. Functional bases, mathematical fundamentals.
3. Mathematical functional bases vs. data oriented bases.
4. Splines and their basic properties.
5. Data analysis using splines.
6. Regularization methods and smoothing splines.

7. Elements of functional data analysis.
8. Orthogonal bases of splines -- splinets.
9. Empirically driven knots selection.
10. Functional analysis using splinets

The exercise sessions will focus on the following topics:

1. Hilbert spaces of functions, eigenvalues and eigenfunctions.
2. Mathematics of splines.
3. Connection between regularization and Bayesian methods.
4. Machine learning approach to data analysis.
5. Orthogonalization of functions.

The lab sessions (students bring their own laptops):

1. Decomposition of data with respect to a functional basis.
2. Curve fitting using splines and smoothed splines.
3. Machine learning methods for knot selection.
4. Working with the splinets.
5. Functional data analysis using splines.

The grade will be given based on the exercise assignments and the labs.