



# Foundations of Data Analysis

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A short course at the Department of Mathematics

## Description

After successful completion of the module students are able to understand and apply the basic notions, concepts, and methods of computational linear algebra, convex optimization, differential geometry for data analysis. They master in particular the use of the singular value decomposition and random matrices for low dimensional data representations. They know fundamentals of sparse recovery problems, including compressed sensing, low rank matrix recovery, and dictionary learning algorithms. They understand the representation of data as clusters around manifolds in high dimension and they know how to use methods for constructing local charts for the data.

- 1. Representations of data as matrices:** Many data vectors form a matrix - Review of basic linear algebra - Linear dependence and concept of rank - Approximate linear dependence with varying degree of approximation: Singular value decomposition /Principal Component Analysis - Redundancy of data representations -> orthonormal bases, frames and dictionaries - Fourier basis as singular vectors of spatial shift - Fast Fourier Transform.
- 2. Linear dimension reduction:** Johnson-Lindenstrauss (JL) Lemma - Review of basic probability, random matrices - Random Matrices satisfying JL with high probability - Fast JL embeddings - Sparsity, low rank as structured signal models - Compressed sensing - Matrix completion and low rank matrix recovery - Optimization review - Dictionary Learning.
- 3. Non-linear dimension reduction:** Manifolds as data models - Review of differential geometry – ISOMAP - Diffusion maps - Importance of Nearest neighbor search, use of JL.
- 4. Outlook: Data Analysis and Machine Learning.**

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<b>Venue:</b>	Polo Scientifico e Tecnologico F. Ferrari – Room B103
<b>Date:</b>	Friday 26 <sup>th</sup> October 2018 at 14:00-18:00 Friday 30 <sup>th</sup> November 2018 at 14:00-18:00 Friday 21 <sup>th</sup> December 2018 at 14:00-18:00
<b>Language:</b>	English
<b>Credits:</b>	for students of the Dept. of Mathematics: 3CFU; for students of other Departments see information at the below link.
<b>Admission:</b>	Course open to max 30 LM students.
<b>Deadline:</b>	<b>15<sup>th</sup> October 2018</b>
<b>How to apply:</b>	<a href="https://webapps.unitn.it/Apply/it/Web/GoHome/altro/fda_2018">https://webapps.unitn.it/Apply/it/Web/GoHome/altro/fda_2018</a>
<b>Information:</b>	<a href="http://datascience.unitn.it/events/fda2018.html">http://datascience.unitn.it/events/fda2018.html</a>