# Statistical methods

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**Timetable:** Course of 24 hours. Class meets every Monday and Wednesday from 10:30 to 12:30. First lecture on Monday, April 4th, 2018. Room 318 DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

**Course requirements:** familiarity with basics linear algebra.

**Examination and grading:** homework and take-home exam.

**Aim:** The course will present a small selection of statistical techniques which are widespread in applications. The unifying power of the information theoretic point of view will be stressed.

**Course contents:**

- *Background material.* The noiseless source coding theorem will be quicklyreviewed in order to introduce the basic notions of entropy and I-divergence
- *Divergence minimization problems.* Three I-divergence minimization problems will be posed and, via examples, they will be connected with basic methods of statistical inference: ML (maximum likelihood), ME (maximum entropy), and EM (expectation-maximization).
- *Multivariate analysis methods.* The three standard multivariate methods, PCA (Principal component analysis), Factor Analysis, and CCA (Canonical Correlations analysis) will be reviewed and their connection with divergence minimization discussed. Applications of PCA to least squares (PCR principal component regression, PLS Partial least squares). Approximate matrix factorization and PCA, with a brief detour on the approximate Nonnegative Matrix Factorization (NMF) problem. The necessary linear algebra will be reviewed.
- *EM methods.* The Expectation-Maximization method will be introduced as an algorithm for the computation of the Maximum Likelihood (ML) estimator with partial observations (incomplete data) and interpreted as an alternating divergence minimization algorithm (à la Csiszár Tusnády).
- *Applications to stochastic processes.* Introduction to HMM (Hidden Markov Models). Maximum likelihood estimation for HMM via the EM method. If time allows: derivation of Burg spectral estimation method as solution of a Maximum Entropy problem.

**References:** A set of lecture notes and a complete list of references will be posted on the web site of the course.