Statistical methods

Prof. Lorenzo Finesso[1]

[1] *Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni, IEIIT-CNR, Padova*
Email: lorenzo.finesso@unipd.it

Timetable: 24 hrs (two lectures of two hours each per week). Class meets every Monday and Wednesday from 14:30 to 16:30, starting on Monday, April 18-th, 2016. Meeting Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basics of probability, basics of linear algebra.

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

Aim: The course will present a small selection of linear 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 quickly reviewed in order to introduce the basic notions of entropy of a probability measure and I-divergence (a.k.a. relative entropy, Kullback-Leibler distance) between two probability measures.

Divergence minimization problems. Three 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.

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. Derivation of Burg spectral estimation method as solution of a Maximum Entropy problem. Introduction to HMM (Hidden Markov Models). Maximum likelihood estimation for HMM via the EM method.

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