Statistical Methods

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Timetable: 24 hrs. Class meets on Mondays and Wednesdays, 10:30-12:30. First lecture on Monday, April 29th 2019. The May 1st lecture will be held on Thursday May 2nd. Room: DEI/D meeting room, Dept. of Information Engineering, DEI/D Building, 1st floor.

Course requirements: familiarity with basic linear algebra and probability.

Examination and grading: Homework assignments

SSD: Information Engineering

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 quickly reviewed in order to introduce the basic notions of entropy and I-divergence. (a.k.a. relative entropy, Kullback-Leibler distance) between two probability measures.
- 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 Non-negative 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 la Csiszr Tusndy.
- Applications to stochastic processes. Introduction to HMM (Hidden Markov Models). Maximum likelihood estimation for HMM via the EM method. If time allows: derivation of the 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.