Code: IGSE IMA7221 ***Signal Processing and Statistical Data Analysis***
Period: S8 **ECTS:** 5 **Language:** English

Organisation: *Face to face: 47 hours* *Homework: 47 hours* *total load: 94 h*

Objectives: Emphasize and apply the concepts studied in Probability and Statistics to fundamentals engineering problems such as spectral analysis, array processing, data science, pattern recognition, etc.

Keywords: Estimation theory, Maximum Likelihood, Bayesian Estimators, Cramér-Rao bounds, Time series analysis, ARMA processes, Markov processes, Dimension reduction, Linear Subspace Methods, Clustering, Regression, Classification.

Prerequisites:
Probability and statistics (Core courses S1), Linear Algebra

Program:
I Estimation
2.1 Estimation of deterministic parameters - Bias, variance, Cramér-Rao bounds, Maximum Likelihood estimator.
2.2 Estimation of random parameters - Condiational Mean estimator, Maximum a Posteriori estimator, Bayesian Cramér-Rao bound

II Detection

III Random signals
3.1 Temporal representations - Mean and correlation function
3.2 Main classes of random signals - Stationary signals, Theoretical white noise, Gaussian processes.
3.3 Spectral representations -Power spectral density, Filtering
3.4 Random signal models - Autoregressive processes, Moving average processes, ARMA processes.

IV Dimension Reduction
4.1 Linear Subspace Methods (Principal component analysis, Linear Discriminant Analysis)
4.2 Feature Selection

V Clustering
5.1 k-means
5.2 Hierarchical Clustering
5.3 Gaussian Mixture Models

VI Regression
6.1 Linear Regression
6.2 Multilinear Regression
6.3 Logistic regression

VII Classification
7.1. Decision Trees
7.2. Random Forests

Content:

Evaluation: Grading is as follows
Cours 24h TP 8h TD 15h Contrôle Final 3h
Mounim El Yacoubi (50%) Cours 12h TP 4h TD 7,5h
Alexandre Renaux (50%) Cours 12h TP 4h TD 7,5h

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