Spectral Analysis and the Theory of Moments*

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Calendario: 20 ore, Martedì e Venerdì dalle 10.30 alle 12.30. Prima lezione Martedì 13 maggio. Lezioni successive: 16, 20, 23, 27, 30 maggio, 3, 6, 10, 12 giugno. Aula DEI/G (Piano 3, Dipartimento di Ingegneria dell'Informazione, Via Gradenigo 6/a)

Prerequisiti: It is expected that students have background, or taken basic courses, in linear algebra, probability, and signal and systems. The needed material in these areas will be reviewed briefly and as needed.

Tipologia di esame: The grade for the class will be based on a set of homework/project assignments (weekly), one midterm quiz (given in class) and a takehome final exam. These will be weighed as follows: Homework/projects 30%, Quiz 30%, Final 40%.

Obiettivi del corso: The goal of this class is, first, to expose the students to certain classical concepts and tools that are being used in time-series analysis, and then, to develop a modern viewpoint that aims in quantifying modeling errors, resolution, and uncertainty. Due to the centrality of time-series analysis to modern science and engineering, the subject remains always timely and an active area of research. The course will conclude with a brief overview of recent trends and research directions.

Programma del corso:

1. Rudiments of the theory of stationary random processes
   - Spectral representations and the geometry of a stochastic process
   - Optimal prediction and Toeplitz forms
   - Partial realizations, orthogonal polynomials and the trigonometric moment problem
   - Smoothing and other topics
2. Generalized moments & inverse problems
   - Positive cones & convex geometry
   - Inverse problems: entropy functionals and parametrization of solutions
   - High resolution analysis and tradeoffs
3. Statistics from data: likelihood & consistency
   - Maximum likelihood, Burg's approach, and model based alternatives
4. Distance metrics between distributions
   - Information geometry and the Fisher information metric
   - Spectral and other metrics, or, how to compare rainbows?
5. Applications
   - Snippets from model identification, sensing, radar, speech, and image processing.

References: The course will be based on recent research publications. Other reference material for the course includes:

[1] Grenander & Szego, Toeplitz Forms and their Applications, Chelsea.
[2] Stoica & Moses, Spectral Analysis of Signals, Prentice Hall.

*corso mutuato dalla Scuola di Dottorato in Ingegneria dell'Informazione