COMPUTER ENGINEERING (LM55)

(Lecce - Università degli Studi)

Teaching ESTIMATION AND DATA ANALYSIS WITH APPLICATIONS

GenCod A004569

Owner professor DANIELA DE PALMA

Reference professors for teaching DANIELA DE PALMA, GIANFRANCO PARLANGELI

Teaching in italian ESTIMATION AND DATA ANALYSIS WITH APPLICATIONS

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SSD code ING-INF/04

Reference course COMPUTER ENGINEERING

Course type Laurea Magistrale

Credits 9.0

Teaching hours Front activity hours: 81.0

For enrolled in 2019/2020

Taught in 2020/2021

Course year 2

Language ENGLISH

Curriculum PERCORSO COMUNE

Location Lecce

Semester Second Semester

Exam type Oral

Assessment Final grade

Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

This course offers a broad overview of fundamental and emerging topics in the area of estimation theory and data analysis; furthermore, a set of applications are illustrated in the fields of robotics, multi-agent and cyber-physical systems, and social systems. It is aimed at providing principles and tools to state and solve estimation problems in technological systems, and the solution is numerically sought with the aid of a suitable software (Mathworks Matlab).

REQUIREMENTS

Sufficiency in calculus, probability theory, linear algebra.

COURSE AIMS

Learning Outcomes. After the course the student should be able to:

(Knowledge and understanding)

Describe and explain the main peculiarities (both advantages and disadvantages) of each mathematical framework for the estimation problems considered in the course.

(Applying knowledge and understanding) + (Communication) + (Making judgements)

Be aware of, describe and explain practical problems of bad data gathering and robustness issues in the framework of estimation theory.

(Applying knowledge and understanding) + (Learning skills)

For a given practical problem at hand, be able to state an estimation problem in a natural mathematical setting, either stochastic or deterministic, based on the problem assumptions.

(Applying knowledge and understanding) + (Communication) + (Making judgements)

Build a simulation framework to find a computer-aided solution of the stated mathematical problem with the use of a suitable software.

TEACHING METHODOLOGY

Frontal lessons and lectures.

ASSESSMENT TYPE	Oral exam and development of a project. The objective of the exam is to determine to what extent the student has: 1) the ability to identify and use data to formulate responses to well-defined problems, 2) problem solving abilities to seek a solution through an algorithm.
FULL SYLLABUS	Introduction. Mathematical background and connections with other courses. Set membership estimation: introduction, fundamental results and theorems. Set membership estimation: some applications. Stochastic Estimators: definitions, properties, performances and fundamental limitations. Foundations of maximum likelihood estimation. The Bayesian approach to the estimation problem. Kalman filter: discrete-time stochastic state models, (two-steps) structure, computation of the optimal gain, the alternative geometric approach. Steady–state behavior. Extended Kalman Filter. Applications of Kalman Filter. Smoothing Algorithms. Robust estimation: introduction, fundamental definitions, estimator classes and performances. Applications of the previous issues and results to various fields.
REFERENCE TEXT BOOKS	1. Yaakov Bar-Shalom, X. Rong Li, Thiagalingam Kirubarajan "Estimation with Applications to Tracking and Navigation: Theory Algorithms and Software", 2001 John Wiley & Sons, Inc. 2. D. Simon, "Optimal State Estimation: Kalman, H-infinity, and Nonlinear Approaches". John Wiley & Sons, 2006 3. Anderson, Brian D.O., and John B. Moore. "Optimal Filtering", 1979. 4. L. Ljung, "System Identification: Theory for the User". Prentice Hall PTR, Upper Saddle River, NJ, 1999. 5. Rousseeuw PJ, Leroy AM. "Robust Regression and Outlier Detection". John Wiley & Sons: Hoboken, NJ, USA, 2003. 6. Huber PJ, Ronchetti EM. "Robust Statistics" - Second Edition. Wiley: New York, 2009. 7. S. Bittanti, "Model Identification and Data Analysis". John Wiley & Sons: Hoboken, NJ, USA, 2019. 8. Milanese, M., Norton, J., Piet-Lahanier, H., Walter, E. (Eds.). (2013). "Bounding approaches to system identification". Springer Science & Business Media. 9. Zaki, Mohammed J., and Wagner Meira Jr. "Data mining and analysis: fundamental concepts and algorithms". Cambridge University Press, 2014.