ECE 275A - Parameter Estimation I

Fall 2020 - Syllabus

Parameter estimation is a key task in artificial intelligence, data mining, signal processing, communications theory, machine learning, adaptive systems, stochastic control theory, and related areas. This course is focused on learning the unknown parameters defining a probability model whose purpose is to explain and capture the behavior of observed data. For the most part, but with some exceptions, we will make the classical assumption that the parameters are unknown but deterministic (non-random). The emphasis will be on the use of model discrepancy measures for parameter estimation, the use of deterministic weighted least squares techniques in the special linear Gaussian model case, and classical statistical parameter estimation techniques, including the search for a minimum variance unbiased estimator and the maximum likelihood method for estimating unknown deterministic parameters.

Summary of topics discussed:

1. Parameterized probability models (exponential class and mixture distributions) and their relationship to static and dynamic system models
2. Least squares solutions as well as their relationship to the pseudoinverse and the singular value decomposition (SVD)
3. Statistical figures of merit (bias, consistency, the Cramer-Rao lower bound, and efficiency)
4. The minimum variance unbiased estimator
5. The maximum likelihood estimator (MLE) and algorithms for computing the MLE

Time and place: Lectures are Tuesdays and Thursdays 3:30PM – 4:50PM. This course will be taught online.

Instructor:

Florian Meyer, EBU1 4402, tel. (858) 246-5016
e-mail: flmeyer@ucsd.edu

Teaching Assistant:

Mingchao Liang
e-mail: m3liang@eng.ucsd.edu

Course Website: Links to Zoom meetings, video material, handouts, and homework assignments will be posted on the Canvas website.

Prerequisites: Students are expected to know probability theory, vector (i.e., multivariate) random variables, complex variables, and linear algebra. The minimal suggested prerequisites for the course are linear algebra and basic probability (e.g., ECE 109, ECE 174), as well as Matlab programming experience.

Bibliography: This course is based on lecture notes developed by Prof. Kenneth Kreutz-Delgado. The main required references are the textbooks.

- *Fundamentals of Statistical Signal Processing. Volume 1: Estimation Theory*, Steven M. Kay, Prentice-Hall, 1993.
- *Mathematical Methods and Algorithms for Signal Processing*, Todd K. Moon and Wynn C. Stirling, Prentice-Hall, 2000.

In addition, additional book chapters and research papers will be used, which will be posted on the course website. Whenever possible, a reference to a source (text and pages) for the lecture will be given in class.

Grades: Homework 30%, Mid-Term Exam 30%, Final Exam 40%.

Homework: Homework problems will be posted approximately every 1-2 weeks on the course website and will be due one week later. It is expected that all completed problems are turned in on time. Homework is graded using an "A for effort" scheme. Individual homework problems are not corrected. Points are assigned proportionally to the percentage of work done. Because homework is not graded for correctness, students must read the solutions to determine if they performed the homework correctly or not.

Exams: The mid-term and final exams are graded in the traditional manner. Both exams are closed book and notes. Only nonprogrammable calculators can be used. All other electronic storage and communication devices are banned. Cheating will result in penalties.

Office Hours: Office hours are every Wednesday at 4 PM via Zoom.

Collaboration Policy: The goal of homework is to give you practice in mastering the course material. Consequently, you are encouraged to form study groups to discuss the course material and problem sets. However, the developed solutions you hand in should reflect your own understanding of the course material. It is not acceptable to copy a solution that somebody else has written. You must develop each problem solution by yourself without assistance.