ESE 531: Detection and Estimation Theory

Spring 2016

Instructor: Dr. Petar M. Djurić
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Office hours:
M 3:00 PM - 5:00 PM, W 3:00 PM - 5:00 PM
or by appointment

Class Meetings: Humanities 3020
W 10:00 AM - 1:00 PM

Grading: Midterm 40%, Final 60%

Textbook: Fundamentals of Statistical Signal Processing: Estimation Theory, S. M. Kay, Prentice Hall, 1993.
Fundamentals of Statistical Signal Processing: Detection Theory, S. M. Kay, Prentice Hall, 1998.

Topics:

- **Minimum variance unbiased estimation**: minimum variance criterion; existence of minimum variance unbiased estimator; generalization to vector parameters
- **Cramer-Rao lower bound**: scalar parameters; signal in white Gaussian noise; vector parameters; transformations; general Gaussian case; wide-sense stationary Gaussian processes; examples from radar, sonar, and speech processing
- **Linear models**: definition and properties; curve fitting; Fourier analysis; system identification; general linear models
- **General minimum variance unbiased estimation**: sufficient statistic; finding minimum variance unbiased estimators; complete statistics; generalizations
- **Best linear unbiased estimators**: definition; finding the BLUE; example of source localization; generalization to vector parameters
- **Maximum likelihood estimators**: definition; finding the MLE; properties; transformed parameters; vector parameters; examples
- **Bayesian estimators**: priors; posteriors; linear models; MAP estimator
- **Basics of statistical decision theory**: simple hypothesis testing; Neyman-Pearson detectors; minimum Bayes risk detectors; receiver operating characteristics; multiple hypothesis testing
- **Detection of known signals in noise**: matched filter; performance of matched filter; generalized matched filter; minimum distance detector; examples from communications, radar/sonar, and pattern recognition
- **Detection of random signals**: energy detector; estimator-correlator; canonical form of detector; performance analysis; Examples

Goal: The goal of the course is to teach students the basics of estimation and detection theory. More specifically, it is to introduce the students to classical and Bayesian estimators, estimation bounds, hypothesis testing, and a number of detectors of signals in noise. Exposing the students to applications of estimation and detection is another important goal.

Objectives: Upon completion of this course, students will be able to solve problems that involve estimation of signal parameters or detection of signals or problems where joint detection and estimation is required. The students will also be able to solve problems with practical context.