COM 523200 檢測與估計理論

(Detection and Estimation Theory)

Spring 2024

Goal and Overview:

In this course, we will introduce the basics of detection and estimation theory, which are fundamental to many problems in communications, signal processing, and systems theory. In the detection part, we will cover topics such as Neyman Pearson and Bayesian Detection, Detection of Deterministic and Random Signals, Composite Hypothesis Testing etc. In the estimation part, we will discuss topics such as Minimum Variance Unbiased Estimators, the Cramer-Rao Lower Bound, Maximum-Likelihood Estimators, Least Squares Estimator, Bayesian Estimators.

Related Topics: Stochastic Processes; Probability Theory.

Instructor: 鍾偉和 (Wei-Ho Chung)

Email: whc.sinica@gmail.com

Office Hour: Will be announced on a weekly basis.

Textbook Book:

1. S. Kay, *Fundamentals of Statistical Signal Processing Vol. II: Detection Theory*, Prentice Hall, 1998.

2. S. Kay, *Fundamentals of Statistical Signal Processing Vol. I: Estimation Theory*, Prentice Hall, 1993.

References:

1. H. V. Poor, *An Introduction to Signal Detection and Estimation*, 2nd Ed., Springer-Verlag, 1994

2. Louis L. Scharf, *Statistical Signal Processing: Detection, Estimation, and Time Series Analysis*, Addison-Wesley Pub Co, 1991.

Grades: Homework 10%; Midterm Exam 40%; Final Exam 50%

(Academic integrity is strictly enforced in this class. Any form of cheating on the homework or exams will result in FAILURE of the course. No Warnings!! This includes copied homeworks.) [If you have discussed with someone and are concerned that the solutions may be similar, then please write down their name(s).]

Important Dates:

Syllabus and Rough Schedule Topics	**Chapters**	**Approx. Date**
Introduction to Detection and Estimation Summary of PDFs	Kay-II Chap. 1,2	Week 1, 2
Statistical Decision Theory I --- Neyman-Pearson and Bayesian Approaches	Kay-II Chap. 3	Weeks 2, 3
Detection of Deterministic Signals --- Matched Filtering,	Kay-II Chap. 4	Weeks 4, 5
Detection of Random Signals --- Estimator-Correlator	Kay-II Chap. 5	Week 5, 6
Statistical Decision Theory II --- Composite Hypothesis Testing	Kay-II Chap. 6	Weeks 7, 8
Detection of Signals with Unknown Parameters	Kay-II Chap. 7,8	Week 9
Midterm		Week 10
Intro. to Minimum Variance Unbiased Estimator	Kay-I Chap. 2	Week 10
Cramer-Rao Lower Bound	Kay-I Chap. 3	Week 10, 11
Minimum Variance Unbiased Estimators --- Sufficient Statistics, Linear Models, Rao-Blackwell-Lehmann-Scheffe Theorem	Kay-I Chap. 4,5	Week 11-13
Best Linear Unbiased Estimator	Kay-I Chap. 6	Week 14
Maximum Likelihood Estimator	Kay-I Chap. 7	Week 15
Least Squares Estimator	Kay-I Chap. 8	Week 16
Bayesian Estimation --- Minimum Mean Square	Kay-I Chap. 9,10	Week 16, 17

Error Estimator

Final Exam Week 18