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Syllabus

The topics do not necessarily appear in chronological order, and will only be **partially covered**, as time permits.

- Overview of the parameter estimation problem

- Estimation in parametric families:

    - Minimum variance unbiased estimation
    - Fisher information and the Cramer-Rao lower bound
    - Linear models: Linear regression and best linear unbiased estimation
    - Sufficient statistics: The Neyman–Fisher factorization Theorem; the Rao–Blackwell and Lehmann–Scheffe Theorems; exponential families
    - Maximum likelihood estimation and its asymptotic properties
    - Maximum spacing estimation
    - The least squares approach

- Bayesian estimation:

    - MMSE estimation
    - Maximum A-Posteriori (MAP) estimation and conjugate priors
    - Linear MMSE estimation, Wiener filtering

- Algorithms:

    - Sequential estimation
    - Expectation–Maximization and Alternating–Minimization

- Detection theory:

    - The Bayesian approach
    - The Neyman–Pearson Approach
    - Composite hypothesis testing

- Advanced topics:

    - Regularization techniques and sparse models
    - Robust estimation
    - Minimax estimators

Online Material

The course website operates on Moodle. Material will be regularly posted throughout the semester. Announcements posted on the course website are binding.

Homework

Homework submission is not required. However, students are highly encouraged to individually solve the homework and go over the official solutions.

Quizzes

Two non-obligatory quizzes will be given. Both quizzes will be based on minor variations of homework exercises, and designed to be very easy for students who all the exercises and thoroughly read through the official solutions. The passing threshold for each quiz is 70.

Exam

Any written material is allowed. Calculators and any other electronic devices cannot be used.

Final Grade

Let S be the final exam score. The final course grade G will be determined as follows:

- Passing both quizzes (with *any* passing scores): $G = 19 + 0.81 \cdot S$.

- Passing only one quiz (with score Q): $G = \max\{S, \, 0.1 \cdot Q + 0.9 \cdot S\}$.

- Failing both quizzes: $G = S$.

- Being unable to take a quiz for <u>whatever reason</u> will be counted as not passing the quiz.

- Please note that your final grade can never be lower than your final exam score.

Literature

[1] S. M. Kay. Fundamentals of Statistical Signal Processing Estimation Theory, Prentice Hall Signal Processing Series, 1993.

[2] S. M. Kay. Fundamentals of Statistical Signal Processing Detection Theory, Prentice Hall Signal Processing Series, 1993.

[3] H.L. Van-Trees, Detection, Estimation and Modulation Theory - Part I, Wiley, 1968 (reprint, 2007).

[4] A. Gelman, J. B. Carlin, H. L. Stern, D. B. Dunson, A. Vehtari, D. B. Rubin, Bayesian Data Analysis, CRC Press Texts in Statistical Science, 3rd edition, 2014.