1. **Introductory lecture**

   The MUSIC algorithm:


   General textbooks:

   H. van Trees, Detection, estimation and modulation theory, Wiley. Especially volumes 1 and 4.


   P. Stoica and R. Moses, Spectral analysis of signals, Prentice-Hall

2. **Asymptotic analysis of estimators and detectors**

   Basic theory:

   L. Ljung, System Identification: Theory for the user.

   T. Söderström and P. Stoica, System Identification.

   Sections 6.5-6.6 of S. Kay, Fundamentals of Statistical Signal Processing, Part II: Detection Theory.

   Applications:


   Suggested structure and material to cover in the presentation:

   Present the basic methodology for asymptotic analysis of estimators. Prove that uniform convergence of the cost function onto a limiting cost function implies consistency (Stoica & Söderström textbook, exercise 7.15). Then give at least a heuristic derivation of the asymptotic covariance matrix. Exemplify with the applications source localization, and array processing. Finally, give a brief overview of asymptotic performance of detectors: recap what we know from the basic course (van Trees) and give the basic formulas for asymptotic performance of the GLRT.
3. **Conditional and unconditional maximum likelihood**


4. **MUSIC, Maximum Likelihood and CRB**


5. **Cramer-Rao bounds**

   The purpose of this lecture is to learn some techniques for finding CRBs. Three techniques will be covered:

   1) Constrained CRBs. Reading:


   2) Projector methods for finding neat proofs of CRBs. Reading:


   3) Concentrated CRBs (we will not discuss all proofs in detail):


   Also read this paper, but we will not discuss it in the lecture:


6. **Model order selection**

   The recommendation for this presentation is to recapitulate the Laplace approximation of the posterior log-likelihood that we did in the basic detection & estimation course (pages 60-64 here: http://www.commsys.isy.liu.se/DetEst2010/slides2010.pdf) Then from there, more on to more specific techniques.

   Reading:

7. **Covariance matching techniques**

Focus on this paper:


Further reading:


8. **Basic spectral estimation - 1**

Introduction: Definitions of PSD, the spectral estimation problem, broad classification of spectral estimation methods

Nonparametric methods: windowed periodograms and their analysis

**TBD**

9. **Basic spectral estimation - 2**

Introduction to parametric methods. Parametric methods for rational spectra

**TBD**

10. **Basic spectral estimation - 3**

Parametric methods for line spectra?
Data dependent filters (Capon, ...)?

**TBD**