Mini-Project: MUSIC & Co.

Goals of the Mini-Project

Each mini-project proposes to examine in deep one of the statistical signal and data processing tools seen in class.

The goals of the mini project are:

- Implement one (or more) of the tools seen in class;
- Explore more advanced / specific tools related to the tools seen in class, via scientific literature and numerical implementation;
- Present the tools to the class with a demo and a performance comparison.

Such goals are achieved via specific tasks:

- Work as a team (everyone must contribute and be aware of every detail of the accomplished work);
- Implement the assigned tool seen in class (Python or Matlab);
- Test it on simulated and real data (real data will be provided);
- Submit a report on the test of the tool on simulated and real data (**Assignment #1**);
- Explore other advanced tools, not presented in class, outperforming the assigned tool (start from the suggested literature, and pursue the research of information on additional papers & books);
- Submit a report on the advanced tools (**Assignment #2**);
- Implement the new tools (Python or Matlab);
- Prepare a demo (on simulated and real data) comparing the tools;
- Prepare about 5 slides to present to your colleagues the tools, their comparison, a demo, and your conclusions.
- Submit the demo (with instructions), the presentation, and a short report (min 6 pages, max 10 page) on the mini-project (**Assignment #3**);

You will be evaluated on these tasks, on the quality of problem solutions, on the quality of your implementation, on the quality of the presented demo & results.

Description of the Mini-Project

We have presented MUSIC as a parametric line spectra estimation methods that takes into account the noise component of the signal. While theoretically elegant and attractive, MUSIC has in practice some limitations.

Other methods are available, such as ESPRIT and the iterative sparse asymptotic minimum variance (SAMV) algorithm. Following the general tasks of a mini project, implement and compare these methods.

References:

- S.M. Kay and S.L. Marple. Spectrum analysis - a modern perspective. *Proceedings of the IEEE*, 69(11):1380-1419, 1981.
- J.G. Proakis and D.G. Manolakis. *Digital Signal Processing Principles Algorithms and Applications*. Prentice Hall, 1996.
- P. Stoica and R. Moses. *Spectral Analysis of Signals*. Prentice-Hall, 1997.
- A. Paulraj, B. Ottersten, R. Roy, A. Swindlehurst, G. Xu and T. Kailath. *Subspace Methods for Directions-of-Arrival Estimation*. Handbook of Statistics, Vol. 10, K. Bose and C. R. Rao, eds., Elsevier, 1993.