Mini-Project: Periodogram & 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

The periodogram was presented as a very simple yet not accurate method for estimating the power spectral density. The main reason of its lack of accuracy is related to its variance which remain asymptotically constant, *i.e.*, as the number of samples increases.

Several modified periodograms are avalaible: Blackman-Tukey, Bartlett, and Welch. As well executing the general tasks of a mini-project, implement and compare these methods on different type of spectra: Line spectra, smooth spectra, with and without noise.

References:

- S.M. Kay and S.L. Marlpe. 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.
- "Smoothed Periodogram Method".