Fall 2017
EE 189
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EE189: Systems and Signals - Fast Track

Final Project
Due: Sunday, December 3rd, 2017 - 23:59

Project Description:
During this class, we have learned a number of techniques to try to identify whether a noisy signal is periodic and what is its period. For some cases, we were given some statistics about the noise or the noise structure while, in others our estimation had to be blind to the underlying noise statistics. For the final part of this project, we want to estimate the period of ECG heart signals. In particular, think of the following scenario:

You have a huge amount of recorded ECG signals and you would like to analyze their heart rates (period) in order to determine particular patterns and correlations to diseases. Given this huge data set, your algorithm need to run as fast as possible (in terms of smallest order complexity), while allowing an error of at most 20% of the observed period from the ECG.

We ask you, for your final project, to come up with your own low-complexity (heuristic engineering) solution to identify the period on such real ECG signals. You do not need to have any theoretical proofs for the approach you follow, but be able to logically defend the choices you made.

Project Logistics:
• The project will be done in groups in 2. Please send an email to the TAs to inform them of your teams as soon as possible and before the end of the day Wednesday **November 22nd 2017**.
• For this project, you will need to prepare 3-4 slides (at most 5-6 mins) and submit a short report (of max size 2 pages) where you describe your algorithm, what your choices are and what is the complexity of your algorithm.
• Please submit the slides and report through CCLE by **December 3rd, 23:59**, so that we upload them on a common computer for presentation in the class.
• We will post a schedule of order of presentation with exact times.

Some Useful complexity information:
If in your algorithm you would like to use the Discrete Fourier transform, you can use the `fft` command in MATLAB. The `fft` algorithm on a signal of length N has a complexity of $O(N \log N)$. If you would like to use the Sparse Fast Fourier Transform SFFT algorithm instead, then for an input signal of length N and sparsity parameter k, the complexity is $O(k \log(N/k) \log(N))$. Then

use the `SFFT(x,k)` function provided in the Project files.

Description of Project Files:
In your project directory, you will find a sub-directory called `TestSignals` which contains a collection of signals that you can use to test your algorithms and implementations. Below is a detailed description of the content of this sub-directory.

- `SFFT`: An implementation of the SFFT algorithm.
- `Signals/RealSignals`: A sub-directory containing real signals
  - `RealSignals.mat`: Contains a collection of real ECG signals.
- `Signals/Noisy`: A sub-directory containing signals that contain added noise
  - `HighNoise/`: contains noisy signals with high level of noise
    - `PeriodicCompleteFewHighNoise.mat`: Contains a collection of noisy periodic signals with few complete cycles and high noise level.
    - `PeriodicCompleteManyHighNoise.mat`: Contains a collection of noisy periodic signals with many complete cycles and high noise level.
    - `PeriodicInCompleteFewHighNoise.mat`: Contains a collection of noisy periodic signals with few incomplete cycles and high noise level.
    - `PeriodicInCompleteManyHighNoise.mat`: Contains a collection of noisy periodic signals with many incomplete cycles and high noise level.
  - `LowNoise/`: contains noisy signals with low level of noise
    - `PeriodicCompleteFewLowNoise.mat`: Contains a collection of noisy periodic signals with few complete cycles and low noise level.
    - `PeriodicCompleteManyLowNoise.mat`: Contains a collection of noisy periodic signals with many complete cycles and low noise level.
    - `PeriodicInCompleteFewLowNoise.mat`: Contains a collection of noisy periodic signals with few incomplete cycles and low noise level.
    - `PeriodicInCompleteManyLowNoise.mat`: Contains a collection of noisy periodic signals with many incomplete cycles and low noise level.