EE4820: Biomedical Signal Processing
Power spectral density and EEG

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Due Wed. 3/23

1. Semmlow P3.23 *Compute the two spectra (normal and during meditation) and compare them using 2 methods: 1) periodogram estimate; 2) Welch's PSD estimate with 8 windows and 50% overlap*

2. Semmlow P3.33 *Be sure to try out different window lengths and show how you decided on your final window length*

3. Semmlow P3.19

4. MATLAB problem on PSD

   (a) Download the file `SleepEEGdata.mat`. These files contain 713 epochs of EEG data from 7 different channels during different stages of sleep. The channels are as follows:

      i. Ch 1 = EOGL-A2
      ii. Ch 2 = EOGR-A1
      iii. Ch 3 = EMG chin
      iv. Ch 4 = EEG C3-A2
      v. Ch 5 = EEG C4-A1
      vi. Ch 6 = EEG O1-A2
      vii. Ch 7 = EEG O2-A1

      The data was sampled at a rate of 200 Hz.

   (b) Load the data contained in `SleepEEGdata.mat`. Explore the data structure Epoch to see how the data is organized.

   (c) Plot the EEG signal from the C3-A2 channel for Epochs 16, 39, 73, and 147 all on one figure.

   (d) Are you able to detect any peak frequencies just by looking at the time domain signal?

   (e) For epoch 16, plot the power spectral density $S_X(f)$ of this recorded data vs. frequency in Hz. Use 3 different methods to compute $S_X(f)$:

      i. periodogram

    ii. Welch's modified periodogram, using a Hamming window, and window length of $L = 2^{10}$

    iii. Welch's modified periodogram, using a rectangular window, and a window length of $L = 2^{10}$

(f) How many peak frequencies would you say there are in Epoch 16? What are the peak frequencies in Hz according to the 3 different estimates? Which estimate do you trust most?

(g) How do the different methods and window lengths affect the PSD estimates?

(h) Now choose one method for computing the PSD and compute the PSD for each of the following epochs: 16, 18, 19, 33, 39, 41, 43, 44, 73, 147, 148, 634.

(i) Based on the PSD, what sleep phase would you predict each epoch to be from. Justify you ranswer.

(j) Now download `SleepEEGdataPS4_WithStages.mat`. How accurate were your sleep stage predictions?