ECE-497/BME-491: Applied Biomedical Signal Processing
Laptop Day #5
Due at the end of class, January 9, 2007

Today we have the following goals

- select a template from an EEG signal

- compute the autocorrelation of an EEG signal

- estimate the power spectral density of a signal

At the end of class you should turn in three plots.

1) Go to the class website and download the programs *laptop5.m*, *select_eeg_template.m*, *baf_fft.m* and the data files *eeg1-p4.dat*, *eeg1-f3.dat*, *eeg1-c3.dat*.

2) The first thing we need to do is get a template to use. The program *select_eeg_template.m* will help you do this. The only argument to this program is the name of the file you want to use. In our case, this will initially be *eeg1-p4.dat*, so you should type:

```
template = select_eeg_template('eeg1-p4.dat');
```

For this example, you should select your template to be the part of the signal from 4670 to 5810 milliseconds. If you have done this correctly, you should get a figure like Figure 1. The variable **template** will have contain the data points that make up your template. The template is the segment of the data we will be analyzing to determine if the *alpha* rhythm is present.

3) The program *laptop5.m* has three input arguments:

- the template to use (analyze). You determined this in part 2.

- the name of the data file to use, in quotes. This is the same data file used to construct the template.

- the starting index in the file. This contains the index the template starts at. Since the data is sampled at 100 Hz, in our example this will be 467.

If you type

```
laptop5(template,'eeg1-p4.dat',467);
```

you should get the plot like the top two shown in Figure 2.

4) Now you need to make some modifications to compute the autocorrelation. We will be extending the template and using data from the remainder of the signal as needed to compute the autocorrelation. We will be using the formula

$$R_{xx}(k) = \frac{1}{N} \sum_{n=0}^{n=N-1} x(n)x(n+k)$$

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However you need to be careful, since Matlab starts with indices at 1. (*Hint: Write out a few terms*). Your code should be written in terms of *Nt*.

5) In order to compute the normalized autocorrelation, we need to divide the autocorrelation by $R_{xx}(0)$. However, in Matlab that will actually be $R_{xx}(1)$. This will tell us how to scale the auto correlation to get the normalized autocorrelation.

6) If you have done everything correctly, and you uncomment the plotting commands for the *subplot(4,1,3)*, you should get at plot like the first three graphs shown in Figure 2.

7) Finally, you need to use the program *baf_fft.m* to compute the discrete-time Fourier transform of the autocorrelation (not the normalized autocorrelation). Once you have the magnitude of the spectrum (all we care about), normalize it by the maximum of the magnitude, so the maximum of the power spectrum will be 0 dB. Modify the code and uncomment the *subplot(4,1,4)* and you should get the entire plot shown in Figure 2. *Turn it your plot.*

8) Utilize file *eeg1-f3.dat*, examing data from 4.20-4.96 seconds. Go through the above steps. *Turn in your plot.*

9) Utilize file *eeg1-c3.dat*. Select a template during a period of alpha rhythm, but not during the time interval used for the first plot. Verify the presence of the alpha rhythm and *turn in your plot.*
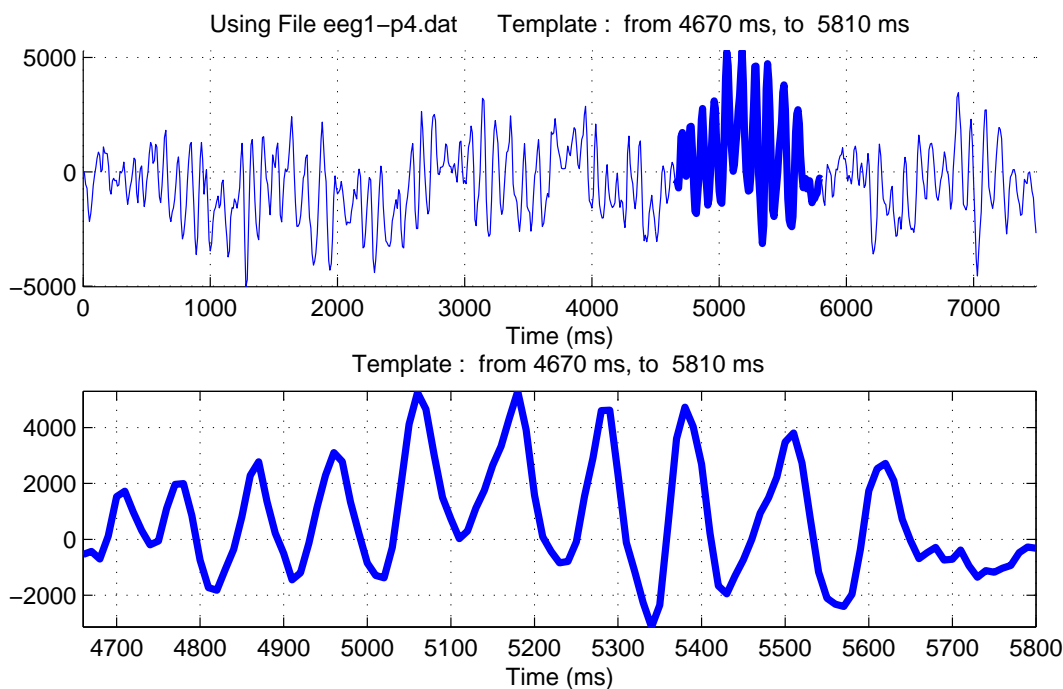
Turn in your code.

Figure 1: Original signal and template for *eeg1-p4.dat* from 4.67-5.81 seconds.
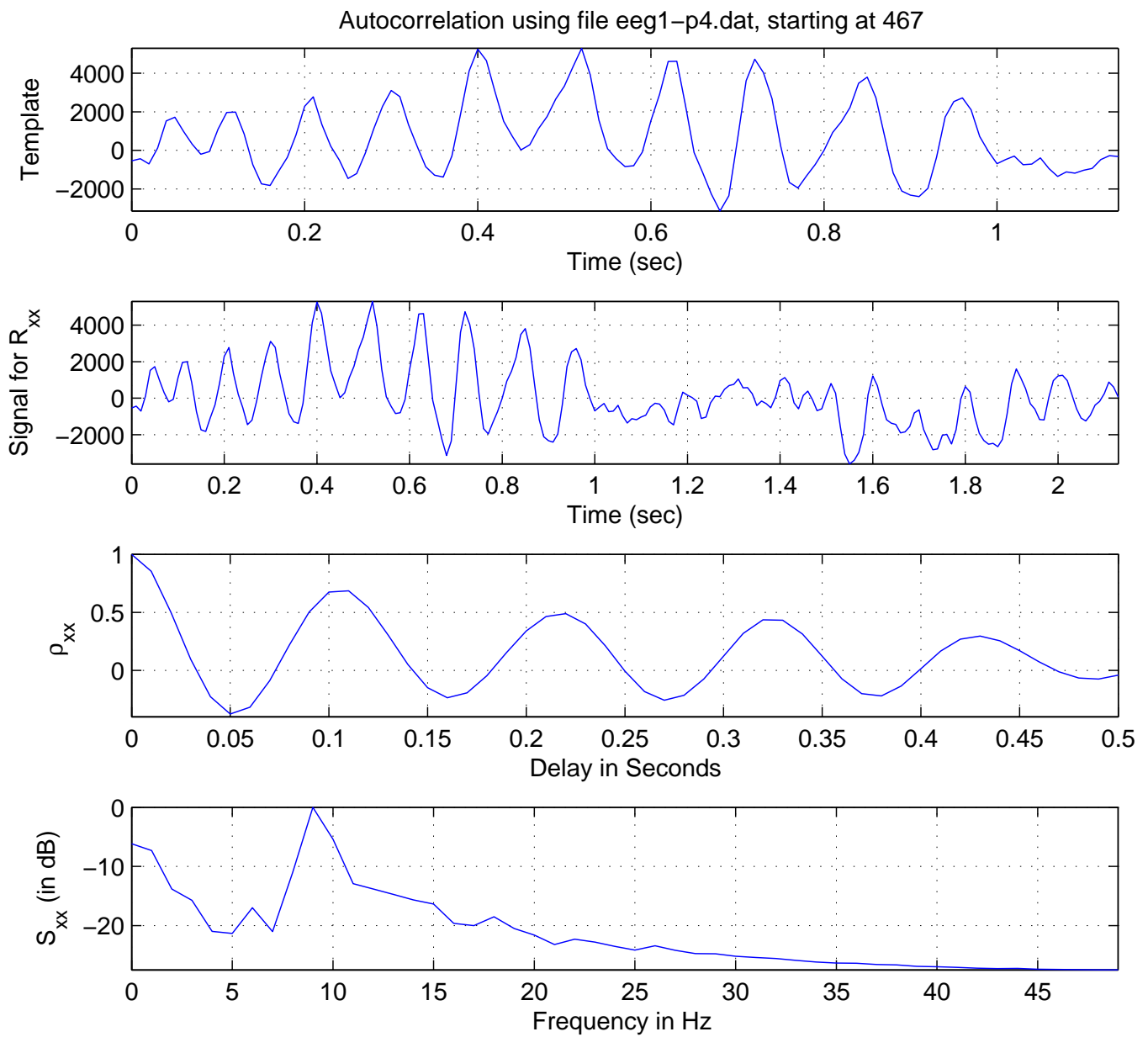
Figure 2: Original template, extended signal, autocorrelation, and power spectral density for *eeg1-p4.dat* from 4.67-5.81 seconds.