Spectral Analysis Tasks

Recall that if you calculate the mean of a sine wave multiplied by the data as $A(f)$ and a cosine wave multiplied by the data as $B(f)$ then the power at that frequency is given by:

$$P(f) = [A(f)]^2 + [B(f)]^2$$

and the phase, ϕ, is given by

$$tan(\phi) = \frac{A(f)}{B(f)}.$$

When calculating ϕ, be sure to add (or subtract) π, if the cosine term, $B(f)$, is negative.

1. Using the PING oscillation data, produce a spectrogram using a Gaussian filter (or another wavelet/multitaper method) so you can see the time of the frequency shift, with an initial frequency then a final frequency that differs. Compare these two frequencies with what you see in a single complete Fourier transform.

2. Load the "Noisy time trace", calculate the Fourier transform, then recreate the original time trace using only frequencies up to 50Hz.

3. Load the circadian data and select a few flies (columns). Use the Gaussian filter (or another multitaper/wavelet method) to analyze the power spectrum and identify any phase changes.

4. Load the bursting neuron data. Coarse grain it (eg take every 10^{th} data point) and look at only a small chunk of the data at a time (e.g. one minute). The reason for taking a chunk is purely for memory purposes – you may be able to use the whole set with appropriate methods/functions.

   Use a Gaussian filter or other multitaper method to extract the base frequency and the high frequency oscillation. Compare the results in different chunks of time selected from the entire trace. Note that if you select relatively stationary chunks, you can average the results of the Gaussian filter as the filter shifts through time along that chunk of data. Why is this better than just analyzing the complete chunk of data with the Fourier transform?

5. Load the "spatial noisy signal" data and use a Gaussian kernel with "conv2" to extract any spatial signal within the noise.