Project 2 • Fall 2019 • PROF. BOYLAND

Due in hard copy form at the start on class on Friday, November 1. Each answer must include Matlab code (if used), any plots required and the answer to all questions. All figures must have titles with both axes labeled.

Given a real data set $x_1, \ldots, x_N$ (using matlab indexing and notation) with N even, let $\hat{x} = \text{fft}(x)$. The periodogram is the plot of the frequency versus P where

$$\begin{aligned} P(1) &= \frac{1}{N^2}|\hat{x}_1|^2 \\ P(j) &= \frac{2}{N^2}|\hat{x}_j|^2 \text{ for } j = 2, \ldots, N/2 \\ P(\frac{N}{2}+1) &= \frac{1}{N^2}|\hat{x}_{\frac{N}{2}+1}|^2 \end{aligned}$$

The frequency is the list $[0 : \frac{N}{2}]/TT$ where TT is the total time, namely, $TT = N/Fs$ where Fs is the number of samples per unit time.

(a) Write a matlab function called "myper" that given a real data set and sample rate produces the periodogram plot.

(b) Let

$$g(t) = 0.8\sin(2\pi 60t) + 2.3\sin(2\pi 25t).$$

Create a data set by sampling g at 800 points at the rate of 200 samples per unit time and plot the periodogram and make sure you get the spikes at the correct frequencies.

(c) Load the gong sample file in matlab with the command `load gong.mat`. This puts two variable in your workspace, namely, `y` containing the data and `Fs` the sample rate. Produce the periodogram plot for the data. What are approximately the two most dominant frequencies?

(d) Repeat part (c) for the file `handel.mat`. Note that in this case the length of N is not even so you have to cut back the data to get even length.

(e) If you want to, you can listen to a sound using `sound(y, Fs)`; this works on most but not all systems.