

WEEK 9: ECG DATA AND NOISE ANALYSIS

- Use your recorded ECG files (data and plots) to analyze and filter noise, and make simple physiologic measurements

GOALS:

- Quantify “signal to noise ratio” of your original signal.
- Use a simple running average filter in Excel to smooth out noise.
- Run a MatLab script to perform a frequency analysis on the raw data.
- Report simple ECG parameters with clinical significance.

SIGNAL TO NOISE (S/N) RATIO

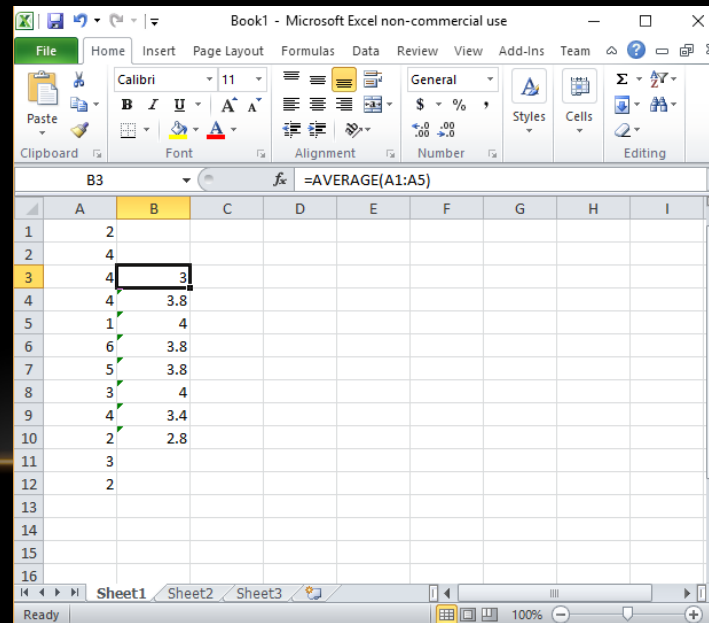
- Engineering value: defines noise amplitude relative to the signal of interest
- Divide signal amplitude by noise amplitude.
- One definition for an ECG: “signal” is the amplitude of the QRS complex; “noise” is the noise amplitude during rest (between waves).



Report this number as a S/N value (unit-less)

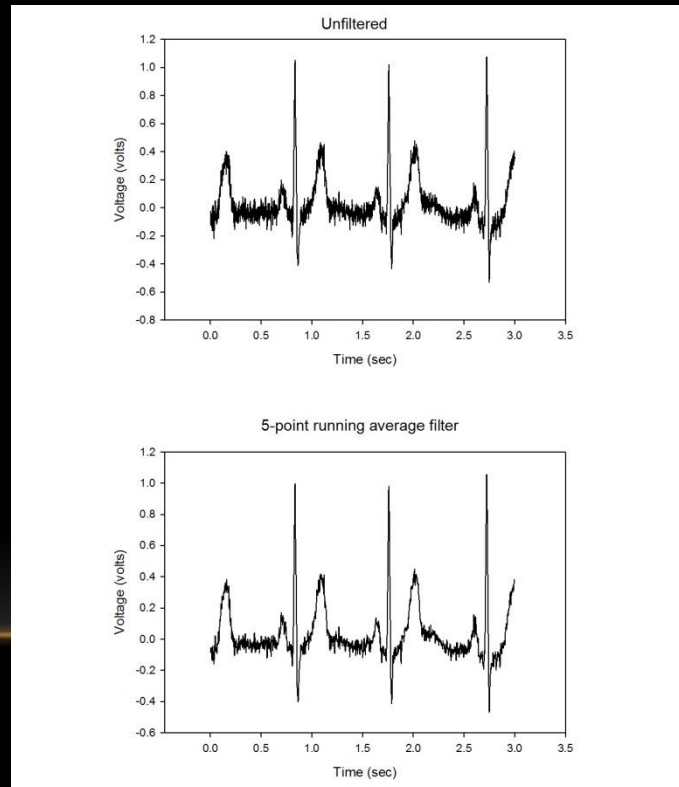
SMOOTH DATA WITH RUNNING AVERAGE

- Simple “filter” can be a running average on raw data
- Filters out random “noise”, but also can affect actual signal.
- Use Excel to filter your y-values from a saved Sigmaplot or .txt file:
 - Copy y-data (ECG voltages) into an excel file (a single column)
 - In the adjacent column, add a formula for a 5-point average
 - For example, in the screen shot below, in cell B3, the formula “=AVERAGE(A1:A5)” was entered, which averages cells A1 to A5, and puts the result in cell B3.



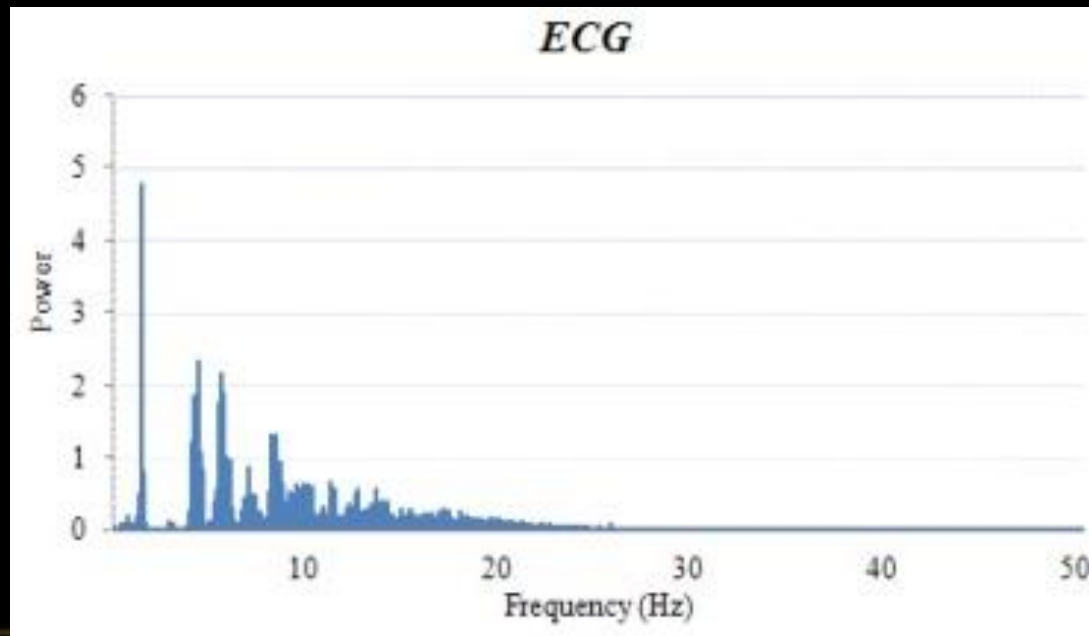
SMOOTH DATA WITH RUNNING AVERAGE

- You can “fill” the formula for the rest of the B-column cells by pulling down the “fill” corner of the cell highlight (bottom right corner, small box)
- For an example like this, only fill/use B cells from B3 to B(N-2), or 2 cells from the top and bottom of the Y data
- Copy your filtered data back into SigmaPlot as a new Y column, and plot it. Compare filtered to unfiltered plots:



FOURIER FREQUENCY ANALYSIS

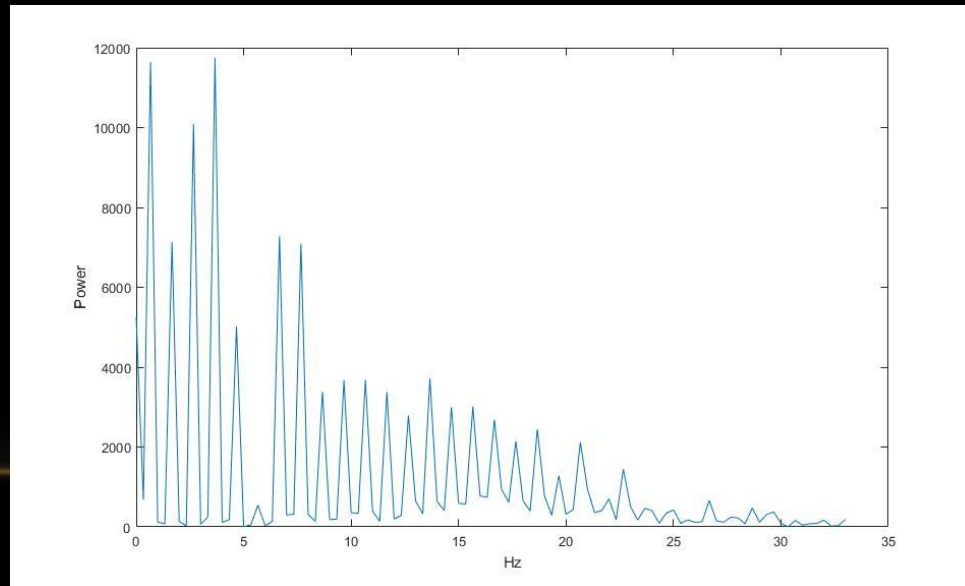
- A Fourier Spectral or Frequency signal analysis will show relative frequency content of the signal. Analysis is done with a Fast-Fourier Transform (FFT)
- ECG will have the “base” frequency (heart rate), plus other higher frequencies in the signal. May also contain lower “drift” frequencies.
- Analysis can be used to help with various filter and data analysis routines.



ECG power spectrum: FFT shows largest frequency component at the heart rate (~ 2 Hz), with many other higher frequency components, but only to about 20 Hz.

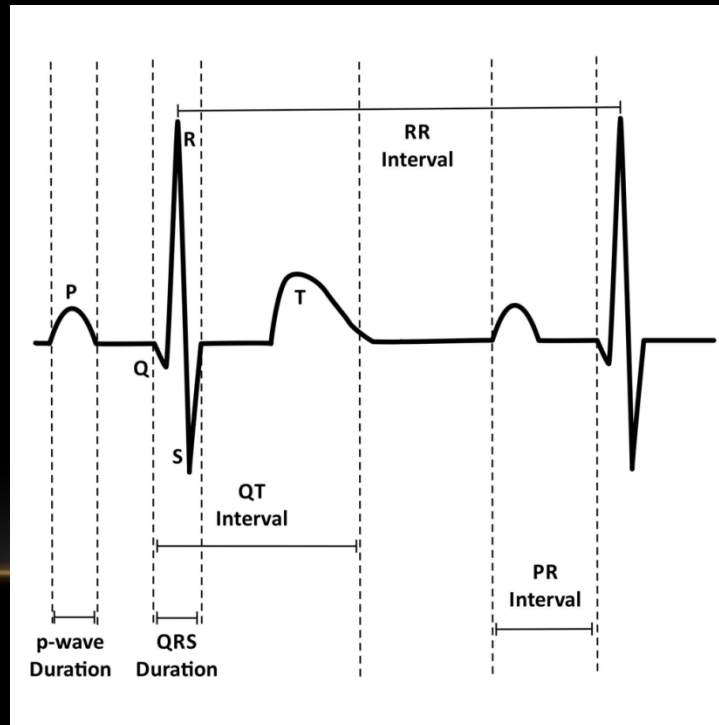
FOURIER FREQUENCY ANALYSIS

- Use Matlab to run a Fourier analysis on your raw (unfiltered) ECG voltage data. Use the x-y *.txt files (renamed from Labview output, with header removed).
- Matlab can be run in an interactive mode, to read in the data file, compute the Fourier spectrum, then create a power spectrum plot that can be saved.
- Instructions for running Matlab for this purpose are on the class website for this week (sample output below).



CLINICAL ECG PARAMETERS

- ECG measurements correspond to physiologic function; measure from Sigmaplot graph
- R-R interval: time between beats, inverse of heart rate
- QRS duration: Time for electrical activation (depolarization) of the ventricles
- Q-T interval: Total time of electrical depolarization and repolarization of the ventricles
- P-R interval: Time for electrical activation to travel from atria to ventricles



WEEK 9 TOPICS FOR FINAL REPORT

- Signal to noise (S/N) ratio: definition, numerical value
- Show results for a running average filter on the data (graphs)
- Results (plot) of the Fourier frequency analysis; interpretation
- Clinical ECG parameters: heart rate, QRS duration, P-R interval, Q-T interval: values (from your ECG) and physiologic interpretation.