Signal processing basics with Matlab

1) Chose a data file and import it into Matlab.
    a. Each .mat file contains 60 seconds of neural data sampled at 30kHz. The data has been high-passed filtered.
    b. There are two vectors "time" and "wave" in each file. The "time" vector contains the time of each sample taken in seconds, while the "wave" vector contains the value of each sample taken in µVolts.

2) Determine a quantitative threshold for identifying action potentials as multiple of the variance in your signal.
    a. Calculate the variance ("noise") in the selected signal. Inspect your data to determine how what multiple of the signal variance to use as a threshold for detecting action potentials within the signal.
    b. Write code to plot the raw (time x wave) data and a line indicating the threshold used and place the plot in your written document.
    c. Write code to build a matrix of action potential waveforms and a matrix of noise data.
        i. You are building a matrix of "snippets" of data around each threshold crossing (hint: findpeaks() is a very useful function).
        ii. Action potentials are typically 1 – 2 ms in duration.
        iii. Set your threshold just low enough that you capture some "noise" along with the action potentials. Don't go too low or your matrix will be very large.

3) Sort you action potentials.
    a. Use principle components analysis (PCA) and kmeans to cluster your spikes and noise data.
        i. Removing any consistent offset in the data will help with clustering (eg, detrending or z-scoring prior to analysis might be helpful).
        ii. Inspect your clustering results and decide on the optimal number of clusters to use for kmeans.

4) Plot your PCA results.
    a. Write code to plot all the individual action potential snippets, the mean action potential, and the standard error for all neurons in the data file you choose, using a different color (e.g. red, blue, green) for each neuron. On the same figure plot the individual noise snippets, the mean noise snippet, and the standard error of all noise snippets in black.
    b. Write code to plot the first three principle components of your clustered action potential and noise data as a single 3D plot. Use the same colors for action potentials and noise as used in part 4a.
    c. Place these figures and briefly discuss the results it in the written document.

5) Repeat this process for a different data file.