EE4820: Biomedical Signal Processing
Problem Set 2: Reducing Ensemble Noise

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Due Mon. 02/07

1. List at least 3 potential sources of noise in these neural recordings.
2. Describe how ensemble averaging helps as a signal processing method by filling in the blanks:

   `Ensemble averaging increases the _____ by a factor of _____.`
   `(where` n `is the number of trials or observations)`

   Then briefly outline the mathematical derivation of this statement.
3. Semmlow P2.3
4. Semmlow P2.4
5. Semmlow P2.9
6. Ensemble average MATLAB lab exercise

   - Start MATLAB.
   - Change directories to the folder in which you stored the data files (Use the *cd* command or use the drop down dialog box labeled *Current directory* at the top of the Matlab window).
     - *OR* you can add a directory to the path: *File* → *Set Path* → *Add directory.*
       Choose the folder in which the data files are saved.
       → *OK*
       → *Save*
       → *Close.*

   - Load the file by typing:

     ```
     load verg1;
     ```

   - See what data you have loaded by typing

     ```
     whos
     ```

- This data contains eye positions during a saccade; i.e., the eye was focusing on an initial target. Then the target suddenly moves, and the eye moves quickly toward the new target.
- The eye position in response to this sudden change in stimulus position is like a step response.
- Data was collected on 47 trials at a 200Hz sampling rate. Each trial was 2s long, with the recording beginning 100ms before the stimulus.

(a) Using an ensemble average, plot the average step response.

(b) Also, determine the 10-90% rise time.