Lab 2 - EEG

- **For questions about this lab please contact the TA, Saeed Arasteh <sarasteh@sfu.ca>**
- **Two files to be uploaded on Canvas:**
  1. **Report. The report should have student's name, SFU ID, and email address**
  2. **MATLAB m-files**

Instructions

1. Download the package of the data and MATLAB codes. This package includes:
   a. EEG_IMU folder which contains IMU and EEG signals corresponding to two trials of data recording.
   b. topoplot.m which is a function that visualizes the CSP from the training data. The input arguments to this function are spatial filter weights (which you will calculate) and location of EEG electrodes which is stored in chanloc.mat. Subfunctions required for correct execution of the topoplot function are also included in the given package.
   c. A video file that shows few seconds of the data collection protocol.
2. The data was collected with the following protocol:

   The participant was instructed to perform two types of activities: writing name and bringing their hand to mouth (as normally done when eating). The EEG data was recorded with a sampling frequency of 500Hz and stored in the BioRadioData variable (8 channels). The participant was wearing a 3-axes accelerometer (IMU) recording acceleration of hand motion during each activity.

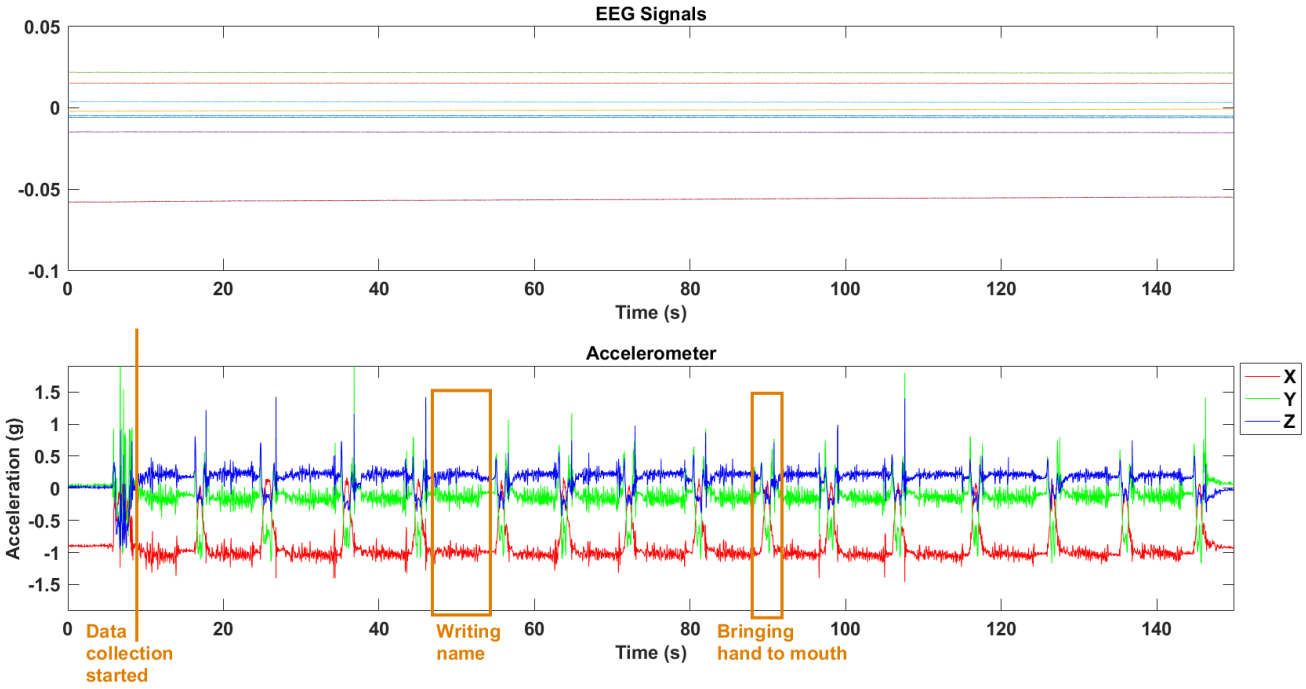

Figure 1. Sample labeling of the data

3. Plot the EEG data and the IMU data.

4. Using the IMU signals, label the EEG data for the two types of activities.
5. Filter the EEG data with a bandpass filter passing the frequency between 1 and 45 Hz.
6. For each labeled EEG event, take the first 2 seconds and discard the rest for such an event.
7. Split the data into training (75%) and validation data (25%).
8. Write your own code to implement the CSP algorithm and use it to compute the CSP weights of the EEG training dataset.
9. Take 6 CSP patterns (3 with the highest weights and 3 with the smallest weights) out of the 8 patterns generated from the training dataset.
10. Plot the topography of the 6 CSP filtered data using topoplot.m. The color represents the weight. The black dots are representing the electrodes. See Figure 2 for the map. The location and channel name are also stored in chanloc.mat (provided in the package).

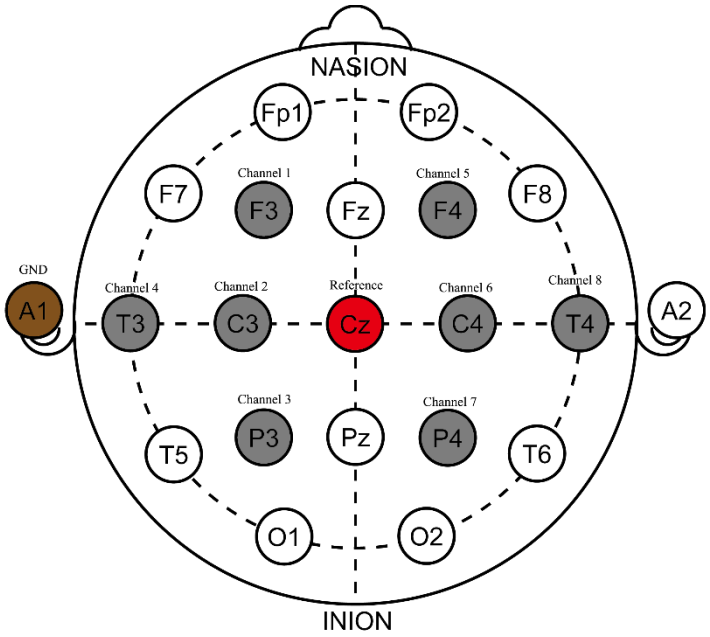

Figure 2 Locations and names for EEG location sites

11. Use the variance of the CSP filtered data as features for classification.
12. Implement an LDA. Train the linear classifier using the training dataset. Test the obtained model in the testing dataset.
13. Compare the results with the LDA built in MATLAB.
14. Classify again using the Support Vector Machine (SVM) built in MATLAB. For SVM, use a polynomial Kernel (search in the MATLAB help). Use the following different polynomial orders: 2 and 6.

Questions

1. Interpret and comment the CSP topography (examples of guiding questions: Which part of the brain is used? Why? Why do we obtain this topography? What is the difference between the two movements? Is this what you would have expected?)

2. Classification:
    a. For each of the 4 classifiers you used (i.e. your LDA, the MATLAB LDA, the SVM with the two polynomial orders), create a plot showing the correct and predicted classes for the testing dataset as a function of time.
    b. Create a table showing the average accuracy for the testing dataset for the 4 classifiers.
    c. Interpret and comment the obtained classification results.
3. Answer the following questions:
    a. which classifier provided the best accuracy? Why?
    b. Can you comment on the linearity of the separation hyperplane in the feature domain?
    c. Which classifier do you think would be best for implementation in a microcontroller?