NX-421: Neural signals and signal processing

MINI PROJECT 3

For this mini-project, we propose 3 variants and you will do only the one your group was assigned to. Each of the 3 variants contains tasks that you should address and integrate in your report/presentation.

Groups AA, AC, C, E, H, K, X will present on Thursday 14/12 during the exercise session.
Presentations should last **10 min + 5 min of QAs**.
The grade within the group might vary by max ¼ according to the presentation skills.

All the other groups should provide us with **a report of 3 pages max** (including images), single column, font-size 11px in Arial. Make sure to shape the structure in a paper-like format: Introduction, Methods, Results and Discussion sections + **the code** you used for solving the mini-project. Both should be uploaded on Moodle.

Report+Code are due on **Thursday 14th December at 16:00**.
Note that this is a sharp deadline, no extensions are allowed.

Everyone is encouraged to come to the presentations.

NX-421: Neural signals and signal processing

Variant 2

Groups: AC, H, B, G, L, O, W

Description

Classifiers, a subset of machine learning algorithms, enable researchers to predict an output state by analyzing input data. Specifically for amputees, these classifiers can interpret electromyography (EMG) data to predict intended actions. This is crucial in controlling robotic prosthetic arms, offering amputees the potential to regain certain functional abilities.

Dataset:

In this mini-project, you will use NinaPro Dataset 1 https://ninapro.hevs.ch/instructions/DB1.html) to investigate the **generalization of movement classification from EMG signals across different subjects**. More details could be found on the website. Briefly, the participants are tasked to replicate the movement shown on the screen. sEMG signal is recorded while the participants are performing the tasks.

Tasks

1. Visualize and preprocess the data. Split the data into training, validation, and testing sets for each subject. Why do we need the different datasets?

2. Perform sliding windows (choose a reasonable window width and sliding step) and explain your choice.

3. Extract the same set of features across 10 different subjects. Look at the typical values of those features across the same set of movements for different subjects. What do you see? Are there any regularities between the different subjects? What are some possible reasons for similarity/dissimilarity?

4. Extract the same set of features across 10 different subjects. Look at the typical values of those features across the same set of movements for different subjects. What do you see? Are there any regularities between the different subjects? What are some possible reasons for similarity/dissimilarity?

5. Perform classification (use a method of your choice) on different subjects **separately**. Perform analysis to determine the importance of the features to the classification. Compare this ranking across the different subjects. Are the features stable?

6. Train a classification model on a set of subjects and test it on a subject that does not belong to that set. Evaluate the performance. How does it compare to training on that subject and testing on the same subject directly?

7. Repeat task 5 by varying the number of subjects in the training set. Discuss how the number of subjects used in the training set could affect the classification performance.