Steady state visual evoked potential (SSVEP) classification

Exercise 4.1: Generate an artificial SSVEP signals

The goal is to construct artificial SSVEP signals by superposition of sine waves and noise. Make use of the following specifications:

- Length of each signal: 100 seconds
- Sampling Rate of each signal: 256 Hz
- Class 1 signal:
    - Frequency/Amplitude of sine: 8 Hz / 1
    - Frequency/Amplitude of sine first harmonic: 16 Hz / 0.5
- Class 2 signal:
    - Frequency/Amplitude of sine 2: 13 Hz / 1
    - Frequency/Amplitude of sine 2 first harmonic: 26 Hz / 0.5
- Noise: (Matlab `randn`)
    - Noise STD: 3

> Task:
> - Calculate 2 signals (`class1` and `class2`) by summing sine signals and the noise.
> - Make a plot of the signals. For the plot use a one second window of each of the two signals. What is the SNR of our signals for the main component?

Exercise 4.2: Extract feature from artificial SSVEP signals

The goal for this exercise is to extract features and create training and test data sets for classification. Generate the signal using the following procedure:

- Divide your artificial SSVEP signals into non-overlapping segments with a length of one second. Note: You should get 100 signal segments per class.
- Apply a DFT to each of the windows (use your own implementation from unit 3. Alternatively use the Matlab function `fft`).
- Extract the 4 relevant frequency amplitudes (8, 13, 16, 26 Hz) from each Fourier transformed segments. These 4 amplitudes are the features for classification.
- Use half of `class1` and half of `class2` data to form the training set (features `X_train`, class labels `Y_train`). Use the remaining halves of these data for your test set (features `X_test`, classlabels `Y_test`).

> Task:
> - Create the matrices `X_train` (size 100x4; 2 classes 50 trials each), `Y_train` (size 100x1), `X_test` (size 100x4; 2 classes 50 trials each) and `Y_test` (size 100x1)

Exercise 3: Artificial SSVEP classification with LDA at different SNRs

In this exercise we want to classify the test data (`X_test`) with an LDA classifier trained on the training data (`X_train`). You can either use your LDA implementation (unit 2) or the code provided.

Task:

- Which accuracy do you achieve?
- Vary the SNR (change STD for the `randn` function). What are your accuracies achieved for STD = [3, 4, 5, 6, 7, 8, 9]? Make a plot with the accuracy and SNR over the STD.

Exercise 4: Classification of patient SSVEP data

The goal for this exercise is to classify SSVEP data recorded from a patient (files `X.m` and `Y.m`). The data was prepared as follows:

- Application on an fft to 1-second EEG segments (from second 4 to 5 of each trial).
- Selection of the most important frequencies.

The prepared data are built up as described below:

- X: (160 trials x 6 frequencies)
  - 6 frequency bins (8,13,16,24,26,39 Hz)
  - Stimulation for class 1: 8 Hz (harmonics: 16 and 24 Hz)
  - Stimulation for class 2: 13 Hz (harmonics: 26 and 39 Hz)
- Y: (160 trials x 1 class label)

Task:

- Calculate a 10-times 10-fold cross-validation to estimate the classification accuracy. Again, you can either use your own LDA implementation or that I provided to you.

Pre-submission via TeachCenter at the end of the unit; final submission 19.05.2019