Neuroengineering 2022-2023

Exam of 1 February 2024 – Part 2

How to submit your answers.

Most or all answers can be typed in the Exam.net editor. You are required to **follow the template** provided, including the maximum length of answers, if specified.

When graphical elements are required in the answer, the latter can be written on paper and scanned **at the end of the exam**.

Keep your answers **tidy**.
Messy, hard-to-read answers may penalize your mark.

The maximum total score for Part 2 is **7**.

Problem

An experimenter performs an exploratory study to assess the scalp locations and the frequency bands in which her EEG shows a visible modulation of the mu rhythm doe to a motor imagery exercise.

Recording protocol.

The subject is instructed to monitor the cues appearing on a screen, and to imagine a continuous movement of a specific body part whenever the corresponding cue appears on the screen. The cue also included a text describing the target body part, for instance "Right hand" or "Left hand". Within the recording session, the cue stayed on the screen for 30 seconds, and each body part was shown exactly once.

Data Acquisition.

Using a sampling frequency of $200\ samples/s$, 32 monopolar EEG channels are acquired. With the subject sitting in a comfortable chair, the experimenter applies all required 34 electrodes, injects the conductive gel under each of them, and checks that all contact impedances are at most 5 kOhm.

Data segmentation

Raw data is segmented into trials, each starting when a cue appeared on the screen and ending when the cue disappeared.

Data analysis.

Spectral analysis was used to estimate the spectrum of each EEG channel in a specific condition (e.g. imagined movement of the right hand). For each EEG channel, spectra related to pairs of conditions were then compared (e.g. right vs. left hand).

Unfortunately, the experimenter did not give further details about the spectral analysis.

Results

Among others, the experimenter computed the pair of spectra shown in *Figure 1*, which are referred to the imagination of movement of the left and right hand, respectively. Vertical thin lines in the figure correspond to frequencies at which the spectrum is sampled.

Questions:

(type all answers in the exam.net editor, following the available template)

#	Question	Points
Q1	Did the experimenter apply the correct number of electrodes? Justify in max 2 lines.	1
Q2	How long is a trial (i) in seconds and (ii) in samples?	0.5
Q3	Which method would you use to estimate the EEG spectra? Justify in max 2 lines.	2
Q4	Observing the spectrum in *Figure 1*, find out what "window length" was used in the spectral estimation (in samples). Justify in max 4 lines.	2
Q5	Do you think that the EEG channel whose spectra is shown in *Figure 1* is C3 or C4? Justify in max 4 lines.	1.5
	Total points	**7**

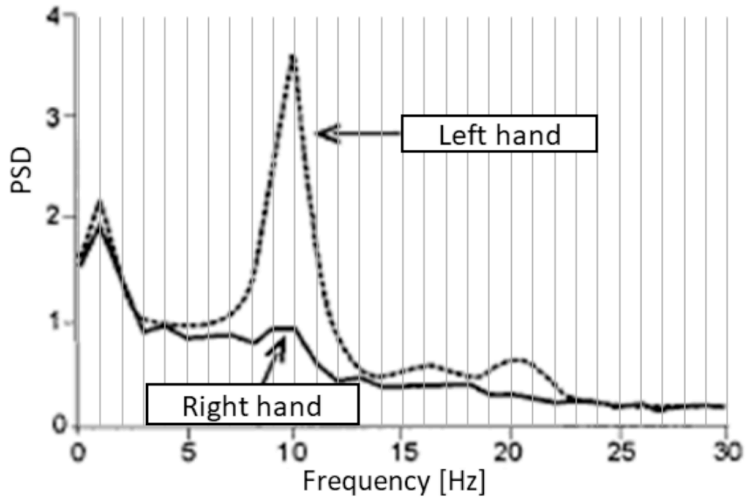

Figure 1. Power Spectral Density of one EEG channel in two conditions (left vs. right hand movement imagination). Vertical thin lines correspond to frequencies at which the spectrum is sampled

(End of the test)