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NEUROENGINEERING 2020-2021 - PROJECT WORKSHOP #3

TITLE: P300 Speller.

Context

Individuals living with debilitating conditions, caused by brain or spinal cord injuries, amyotrophic lateral sclerosis or other diseases, are no longer able to voluntary control muscles movement. For these individuals, assistive technologies are required to allow, or ease, communication and mobility. One example of assistive technologies are Brain-Computer Interfaces (BCI). BCI are based on monitoring the activity of the brain, typically through the electroencephalographic (EEG) signal. P300 BCI are based on the detection of the P300 event related potential (ERP). A P300 ERP is elicited when an auditory, visual, or somatosensory stimulus, which is significant for the subject, is presented to him/her infrequently and interlarded with insignificant stimuli. The P300 response is visible in the EEG trace as a positive peak at about 300 ms after the stimulus onset. The typical setup for a P300 BCI requires the presentation, to the subject, of a matrix of flashing letters and numbers. A P300 response will be elicited when the row, or the column, containing the letter the subject is focusing on flashes. Referring to Fig.1, consider that the subject is focusing on letter **R**. When the row or the column containing such letter flash, a P300 is elicited and visible in the EEG trace (green trace on the left of the figure). While when all the other rows and columns flash, no P300 is elicited (red trace on the left of the figure). By detecting and identifying the P300 responses, it is possible to determine which letter or number the subject was focusing on. Since detection of a P300 response is challenging, multiple repetitions of the same stimuli are presented to the subject and the EEG signals are averaged.

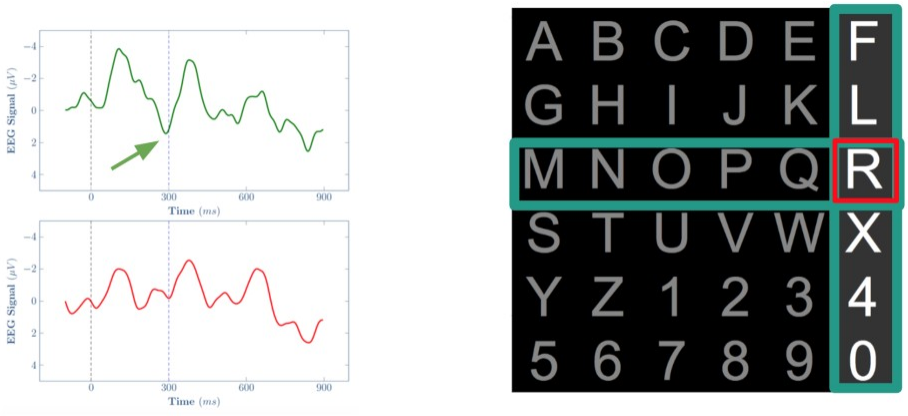

Figure 1: Upper-left: P300 wave in the EEG signal. Lower-left: No-P300 wave in the EEG signal. Right: setup for P300 Speller.

Aim of the work

The aims of this project workshop are:

1. Analyze the provided P300 speller datasets
2. Extract EEG epochs from EEG signals and filter them
3. Develop a neural network able to classify EEG epochs in two classes (P300 – NO P300)
4. Predict the letters spelled by the subjects during the test

Development will be carried out using cloud computing by Google Colab (https://colab.research.google.com). Colab, exploiting Google Drive as the main data repository, supports TensorFlow and many other Python libraries devoted to machine and deep learning.