**Variants of EEG Functional Brain Connectivity Evaluation Methods for BCI Motor Imagery Classification**

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**Introduction:** Brain-computer interfaces (BCIs) not only provide alternative means for controlling assistive devices, but also allow means for a better understanding of neuronal mechanisms underlying different cognitive tasks. This work presents a BCI performance comparison between two different approaches for feature generation, based on brain functional connectivity. Connectivity was represented by an adjacency matrix (**A**), built by considering similarities between all pairs of electrodes under BCI motor imagery (MI) tasks recorded by EEG.

**Materials and Methods:** A four-command motor imagery database containing training and testing datasets for nine subjects (BCI competition IV – dataset 2a [1]) was analyzed. Functional connectivity was estimated by considering two different similarity measures between the electrodes for obtaining **A**: 1) Pearson correlation; 2) Space-Time recurrence (STr) counting. Feature extraction was performed considering classical graph metrics: degree, clustering coefficient, betweenness and eigenvector centralities. A least squares (LS) classifier was used and the classification error was obtained based on training and testing datasets as defined in [1].

**Results:** Table 1 shows the classification error for the best pair and also all classes using Pearson correlation and the space-time recurrences.

Table 1: Classification performance for the best pair of classes and for all classes considering Pearson correlation and STr similarity measures. Classes: 1: left hand; 2: right hand; 3: feet; 4: tongue; µ ± σ: mean ± standard deviation. Graph edges were defined by a correlation threshold (ρ) or by a distance threshold (ε) and counting threshold (ψ) for STr.

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|  | **Pearson Correlation (ρ = 0.78)** | **Space-Time Recurrence (**ε, ψ**) = (1.3, 0.5)** |
| **Subject** | **Best Pair (x/y) – error** | **All Classes** | **Best Pair (x/y) - error** | **All Classes** |
| S1 | (1/4) – 0.201 | 0.552 | (2/4) – 0.146 | 0.507 |
| S2 | (1/2) – 0.424 | 0.715 | (1/3) – 0.389 | 0.632 |
| S3 | (1/4) – 0.306 | 0.559 | (2/4) – 0.153 | 0.483 |
| S4 | (2/3) – 0.368 | 0.590 | (1/3) – 0.292 | 0.601 |
| S5 | (2/4) – 0.451 | 0.719 | (2/3) – 0.410 | 0.722 |
| S6 | (3/4) – 0.410 | 0.729 | (1/4) – 0.403 | 0.691 |
| S7 | (2/4) – 0.389 | 0.733 | (3/4) – 0.278 | 0.629 |
| S8 | (1/4) – 0.306 | 0.649 | (1/2) – 0.188 | 0.504 |
| S9 | (3/4) – 0.285 | 0.587 | (1/4) – 0.153 | 0.517 |
| µ ± σ | - | 0.648±0.077 | - | 0.587±0.088 |

**Discussion and Conclusion:** The results show that it is possible to use spatial recurrences between electrodes over a time window to compute similarity in order to obtain the adjacency matrix. However, it can be noted that different approaches can lead to possibly different pair of best classes for the same subject. In addition to that, the STr approach exhibited the best performance considering the mean among all subjects using all tasks (p = 0.006 – paired t-test) and can be considered a relevant alternative for measuring similarity.

**References:** [1] Blankertz B, “BCI Competition IV” [Internet]. 2008 [accessed 2017 Jan 6]. Available from: <http://www.bbci.de/competition/iv/>.

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