**Deterministic and Stochastic Wrappers for Motor Imagery BCIs**

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**Introduction:** Electrode selection using two different wrappers approach, stochastic and deterministic, is investigated for motor imagery brain-computer interfaces (BCIs) with sets of paired combinations of four possible commands. The stochastic wrapper is proposed based on a version of a progressive wrapper that selects an electrode with a probability directly proportional to its associated success rate over a validation set (evoking the concepts of stochastic hill climbing and roulette wheel selection in genetic algorithms [1]). The motivation is to verify if the BCI could benefit from the possibility of scape from local optima on the focused stage with relative simplicity.

**Materials and Methods:** Electroencephalography **(**EEG) data of three healthy volunteers were recorded under 4 motor imagery tasks: left and right hands, feet and tongue. The acquisition procedure was approved by the Ethics Committee of UNICAMP (n. 791/2010). Sixteen electrodes were distributed on the subject scalp, mostly near to the sensorimotor regions. The interface setup included: (1) common average reference (CAR) filtering; (2) feature extraction using Welch method for the following bands: 7,5-14 Hz and 18-26 Hz; (3) channel selection via progressive, regressive and a stochastic progressive wrapper, and (4) classification based on linear discriminant analysis (LDA).

**Results:** Table 1 presents the mean accuracy (20 trials per class) for all subjects and all pairwise movement combinations.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Class | | | | | | | | | | | |
| Subject | **Wrapper** | **LH** | **RH** | **LH** | **T** | **LH** | **F** | **RH** | **T** | **RH** | **F** | **T** | **F** |
| 1 | **P** | 0.54 | 0.49 | 0.85 | 0.60 | 0.75 | 0.61 | 0.87 | 0.75 | 0.79 | 0.76 | 0.57 | 0.56 |
| **R** | 0.55 | 0.69 | 0.65 | 0.62 | 0.75 | 0.62 | 0.94 | 0.70 | 0.78 | 0.63 | 0.53 | 0.62 |
| **S** | 0.58 | 0.62 | 0.90 | 0.70 | 0.80 | 0.66 | 0.80 | 0.80 | 0.81 | 0.66 | 0.50 | 0.62 |
| 2 | **P** | 0.50 | 0.48 | 0.99 | 0.95 | 0.95 | 0.83 | 0.99 | 0.94 | 0.85 | 0.74 | 0.69 | 0.70 |
| **R** | 0.56 | 0.55 | 0.98 | 0.86 | 0.97 | 0.84 | 0.85 | 0.85 | 0.75 | 0.66 | 0.69 | 0.67 |
| **S** | 0.56 | 0.51 | 1.00 | 1.00 | 0.90 | 0.92 | 1.00 | 0.90 | 0.92 | 0.83 | 0.67 | 0.66 |
| 3 | **P** | 0.46 | 0.64 | 0.69 | 0.73 | 0.73 | 0.85 | 0.78 | 0.82 | 0.83 | 0.21 | 0.73 | 0.51 |
| **R** | 0.45 | 0.64 | 0.74 | 0.91 | 0.45 | 0.50 | 0.72 | 0.75 | 0.66 | 0.69 | 0.64 | 0.53 |
| **S** | 0.49 | 0.72 | 0.80 | 0.90 | 0.80 | 0.83 | 0.73 | 0.80 | 0.74 | 0.72 | 0.60 | 0.59 |

**Table 1 – Best results (mean accuracy) for the different tested cases – with P (progressive), R (regressive) and S (stochastic), LH (left hand), RH (right hand), T (tongue) and F (feet).**

**Discussion:** For all pairs of analyzed classes, it was found that the best discrimination is obtained for either left hand versus tongue or right hand versus tongue. The stochastic wrapper had a consistent performance in comparison with the standard wrappers, outperforming them in a number of instances.

**Conclusion:** The work provided an overview of performances for three kinds of wrappers under different pairs of motor imagery tasks. The use of hand and tongue imagination was favored and the stochastic wrapper proved itself to be a relevant option. Perhaps the addition of a greedy search mechanism thereto can lead to a performance improvement.

**References:** [1] Castro, L. N., *Foundations of Natural Computing*, CRC Press, 2006.

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