

Description of the algorithm used for the classification of the >Albany P300< data set IIb from the BCI Competition 03

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Methodology

Processing of subtrials

Subtrials corresponding to intensifications of columns were treated separately from subtrials corresponding to intensifications of rows.

Column subtrials: Taking the channels P7,P5,P3,P4,P6,P8,Iz and all P0*,O* channels with a baseline at 150–220 ms, the interval of interest 220–550 ms was cut out and subsampled at 24 Hz by calculating jumping means in non-overlapping 10 samples windows.

Row subtrials: Taking the channels T8,T10,CP7,CP8,Iz and all P*,P0*,O* channels with a baseline at 0–150 ms, the interval of interest 240–460 ms was cut out and subsampled at 24 Hz by calculating jumping means in non-overlapping 10 samples windows.

The choice of processing parameters was based on r^2 -analysis and manual cross-validation experiments on the training data.

Classification of subtrials

A regularized linear discriminant was used for classification of the subtrial features. The regularizing parameter was estimated by cross-validation. This was done on the whole training set to get the final classifiers for the application to the unknown test data, (and it was done on several subsets of the training data to get model parameters for evaluating the leave-one-letter-out error). Different parameters were estimated for the classification of column and row subtrials.

Classification of trials (letter selection)

For selecting one letter 1 out of 6 rows and 1 out of 6 columns has to be chosen. In this stage we have for each row resp. column 15 outputs (scores) of the subtrial classifier (from the 15 repetitions). We calculate the mean of each of those 15 values and pick the row and column that got the best of those classification scores.

Results

The leave-one-letter-out procedure on the training set gave and the following output (lower case letters indicate errors):

CAT DOG FISH WATER BOWL HAT gAT GLOVE SHOES FISH RAT

The only error (letter 'G' instead of 'H' in the second occurrence of 'HAT') was so consistently classified as such that I really ask myself whether this might be a misspelling of the subject.

Applying a classifier that was trained on the whole training data set to the competition test data set gave:

FOOD MOOT HAM PIE CAKE TUNA ZYGOT 4567

Using less repetitions

The method can be used with less repetitions than $x=15$ without any changes in the algorithm. (Always the first x repetitions have been used.) This approach is very stable in this respect. Even using as little as 5 repetitions results in the same leave-one-letter-out output as for $x=15$ (see above). This is true for all numbers of repetitions from $x=5$ to 15 with the only exception being 6 where 1 additional error occurs. Using less than 5 repetitions the performance degrades:

```
rep=4: CAT DOG FISH WATER BOWL HAT ggT GLOVE SHOES FcSH RAT  
rep=3: CAT DOG FISH WATER BOWL HAT gAT GLOVE SbOES FcSH RAT  
rep=2: CsT D1G FISH WATER BOWL HyT agT hLOVE yb0kS ccSH RAT  
rep=1: CAT ezG FcSo WAT3R BiWL gms agT si0dk St0xn b15H ptT
```

The output on the test set for $x=6,8,11,12,13,14$ was the same as for $x=15$ (see above), while for $x=7,9,10$ one letter was different. For $x<6$ I got:

```
rep=5: FOOD MOOT HAM PIE CAKE TUNA ZYAUT 4567  
rep=4: FOOD MOOT HAM PIE CAKE ZUNA ZYAUT 4567  
rep=3: FOOD MOOZ HAM PIE CAKC TONA Z5AON 4567  
rep=2: FNOC MROY HAM PIC CAID TONM ZMAON F5N7  
rep=1: 410D MOOY HAM PIU CCHA B7NO 6PAON 45H
```

Some further remarks

Using letter probabilities

The spelling performance can be increased by using letter probabilities (specific for the language in which the user wants to spell). I did not implement such a thing, but I guess that the performance when using less repetitions could be enhanced by such a technique.

Neurophysiological feature

Apparently some features from the visual system are captured in the feature extraction. From my understanding this indicates that the subject directed her gaze on the letters. I am not sure whether this was intended, the description says nothing about this point. Anyway the information is in the data and can be used. A separate submission from my colleague David Tax uses the classical P300 feature. The full approach to this data set would be to combine those two kind of features but I thought for the competition it is more interesting to have two contrasting approaches.

Last remark

I looked at the test set only after I fixed the whole procedure and all parameters.