# Individual latent state scoring based on Hyperplane Navigation


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## Introduction

A large number of fMRI studies concentrates on identifying neural modules responding to specific stimuli or task execution. The most popular approach to address this issue is the general linear model (GLM) which provides intuitive interpretations of results. In addition, pattern recognition methods founded on statistical learning have been shown to be useful in extracting multivariate information from fMRI data (Mitchel et al., 2004).

In this study, we demonstrate how approaches based on discriminant hyperplanes (e.g., linear discriminant analysis) can be informative in extracting multivariate differences on activity patterns between two groups of subjects, and how these methods can be used to quantify the latent state of each individual within the group. The main motivation of this study is the clinical application of fMRI, which has become a crucial issue in this field. We illustrate the usefulness of this method using an fMRI dataset of a motor experiment and two groups: younger and older people. The aim of this study is to estimate the subjects age in a multivariate fashion, from the activation maps of fingertap executions. Since the ages of subjects are actually known, they can be used to evaluate the method reliability.

## Methods

The classification approach applied in this study is a regularized version of Fisher Linear Discriminant Analysis (LDA), the Maximum uncertainty Linear Discriminant Analysis (MLDA) (Thomaz et al., 2004).

The fMRI volumes of 35 healthy subjects (18 males, 17 females, ages from 18 to 64 years old, age average=39.34 years) were acquired in a 1.5 T GE scanner, 150 volumes, 33 mT/m gradient., 24 slices, slice thickness=5.5 mm (0.5 gap), matrix of 64 x 64 pixels, FOV=24 x 24 mm, flip angle=70 degrees, TR=2.0 s, TE=40 ms. This study was approved by the local ethical committee (CAPPESQ-HC-FMUSP number 507/03) and is in accordance with the Helsinki Declaration. The subjects executed left and/or right hand fingertapping sequences, in an ABC block design paradigm.

## Results

The leave-one-subject-out classification rates for right hand was 82.2% and 74% for left hand 74%. The brain regions identified as containing the most discriminative information between the younger and older groups (1% highest absolute values) are depicted in Figure 1. The Pearson correlation coefficient between the leave-one-subject-out state projections and the true subjects' age for right and left hand were 0.656 (p-value<0.0001) and 0.495 (p-value=0.002), respectively. The scatter plots between predicted and observed ages are shown in Figure 2.

## Conclusion

The areas identified were mostly on motor cortex, which are expected, since vascular parameters depending on age are known to influence BOLD responses. In addition, both correlation and scatter plots suggest an acceptable agreement between the predicted and observed ages. In this case, the subjects age were previously known and were the goldstandard for evaluating the proposal. Nevertheless, in many clinical applications (e.g.: medicated vs non medicated, patient vs controls) this group score is unkown.

The results evidence that the proposed approach is useful both to identify the neural modules containing discriminative information between groups, and to define a continuous score for the latent state of individuals for which the observed profile allows only a categorical labeling.

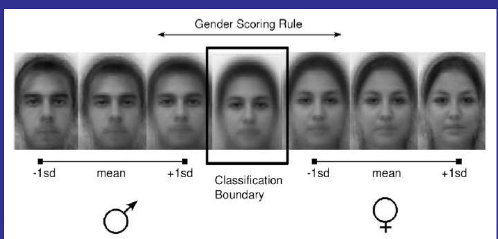


Fig. 1 – Illustrative example of hyperplane navigation in human faces. The navigation is through gender direction.

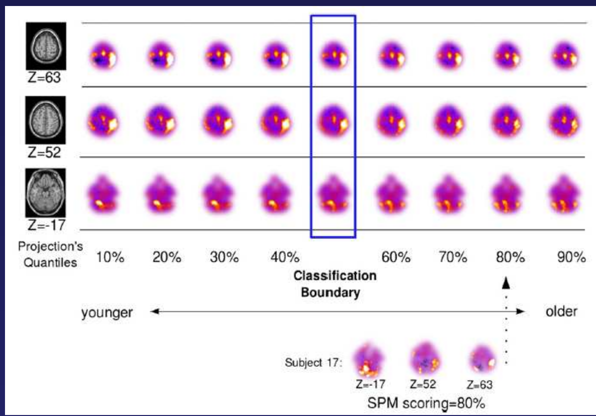


Fig. 2 – Hyperplane navigation in right-hand fingertapping SPMs.

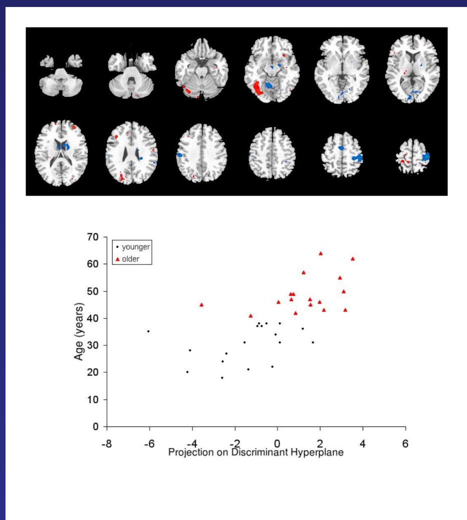


Fig. 3 – 1% most relevant voxels for navigation and latent scoring for right-hand fingertapping.

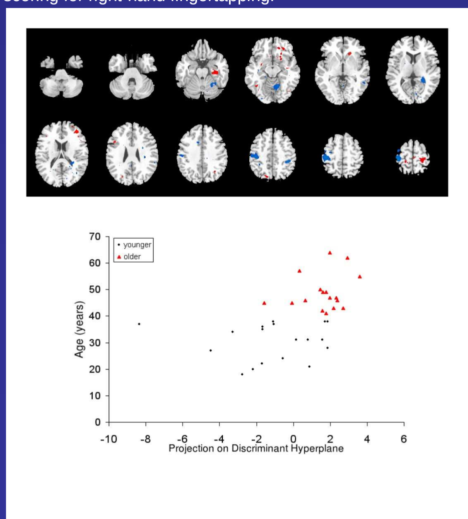


Fig. 4 – 1% most relevant voxels for navigation and latent scoring for left-hand fingertapping.

## References


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