

MACHINE LEARNING APPLICATION ON FMRI DATA: BOLD AND HEAD MOTION SIGNALS

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Abstract

Resting state fMRI represents an innovative technique to understand cerebral mechanism behind brain networks interactions, but its elaboration results to be prone to noise. Head motion has become a particularly challenging problem. An interesting approach could be represented by characterizing the movements of a specific pathology. We evaluated the most important head motion in early Multiple Sclerosis patients applying Support Vector Machine. Moreover, second aim was to evaluate how well Random Forest and Support Vector Machine algorithms could support the early diagnosis of Multiple Sclerosis from these data.

BOLD signal

18 patients with early-MS (mean-age 37.42 ± 8.11 , 9 females) were recruited according to McDonald and Polman criteria [1], and matched for demographic variables with 19 healthy controls (mean-age 37.55 ± 14.76 , 10 females).

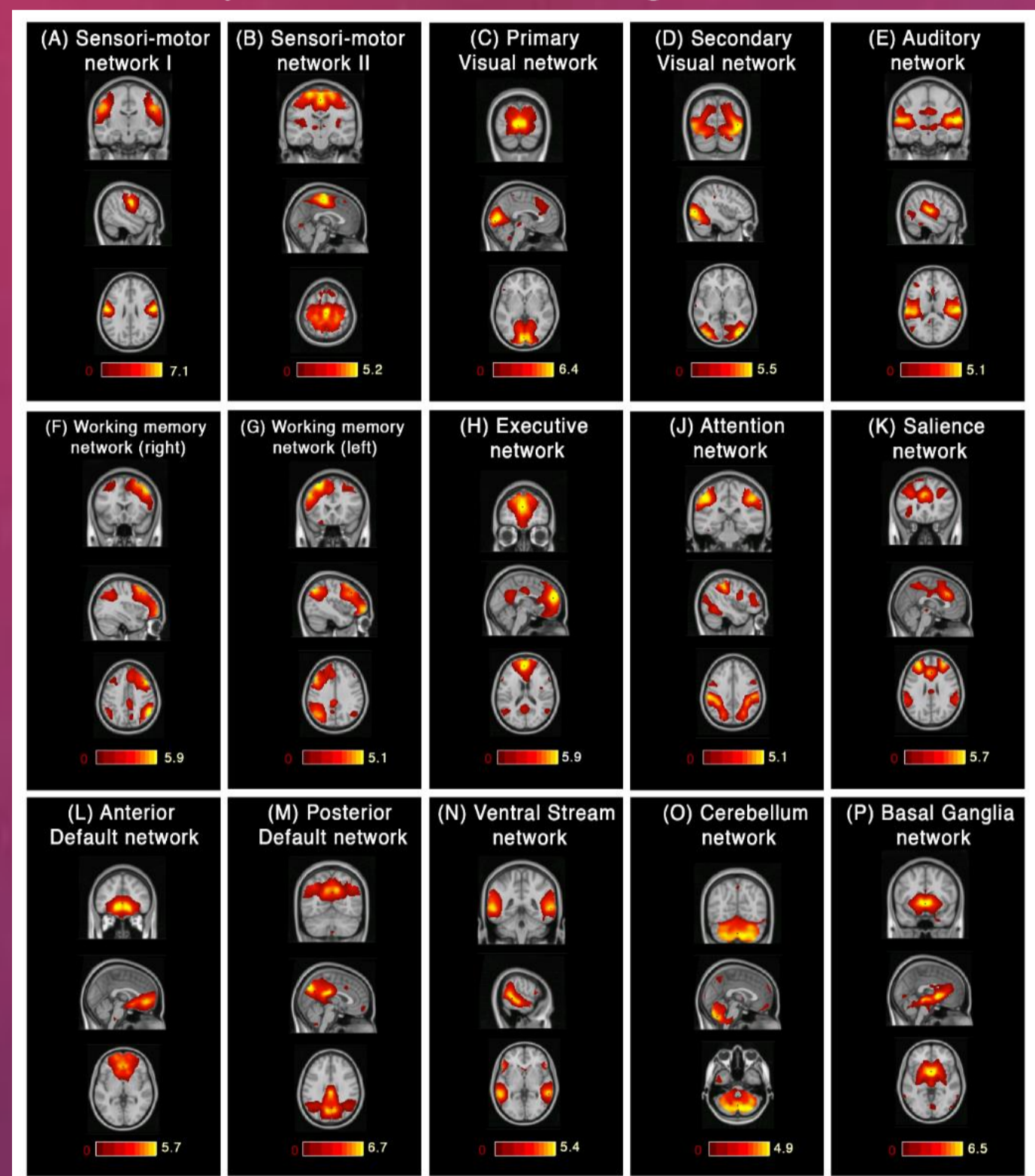


Fig. 1: The 15 networks generated by GIFT. The color bars show z-score.

Dataset was composed of 37 rows (subjects) and 15 features (mean signal in the network) with R-language. The feature selection was performed with Recursive Feature Elimination (rfe) and feature weights were calculated. The most important feature was the **Sensori Motor I** in both cases.

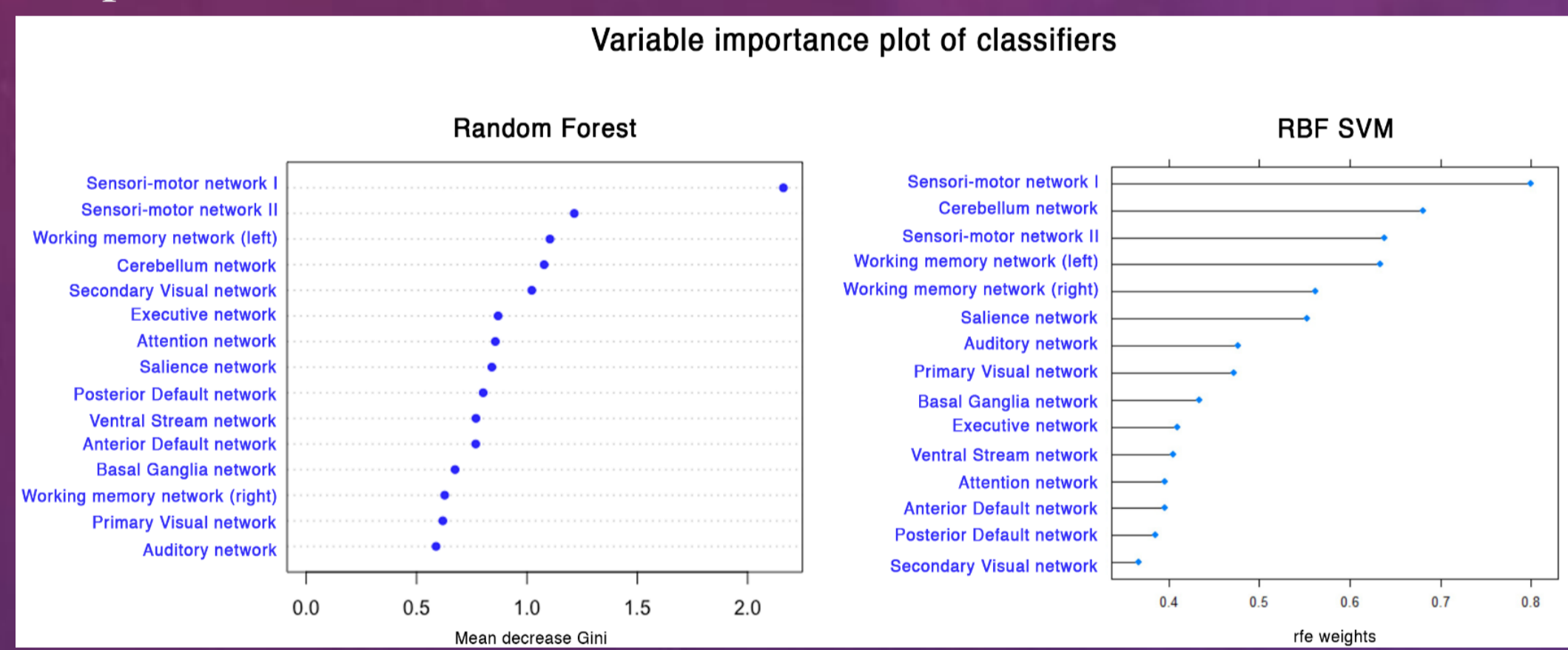


Fig. 2: Feature selection applied on RF and SVM.

The classifiers, trained on all the features, showed very poor accuracies on training and test sets. With only Sensori Motor I network, RF and SVM classifiers reached an accuracy of **87.5%** on test-set [2-3].

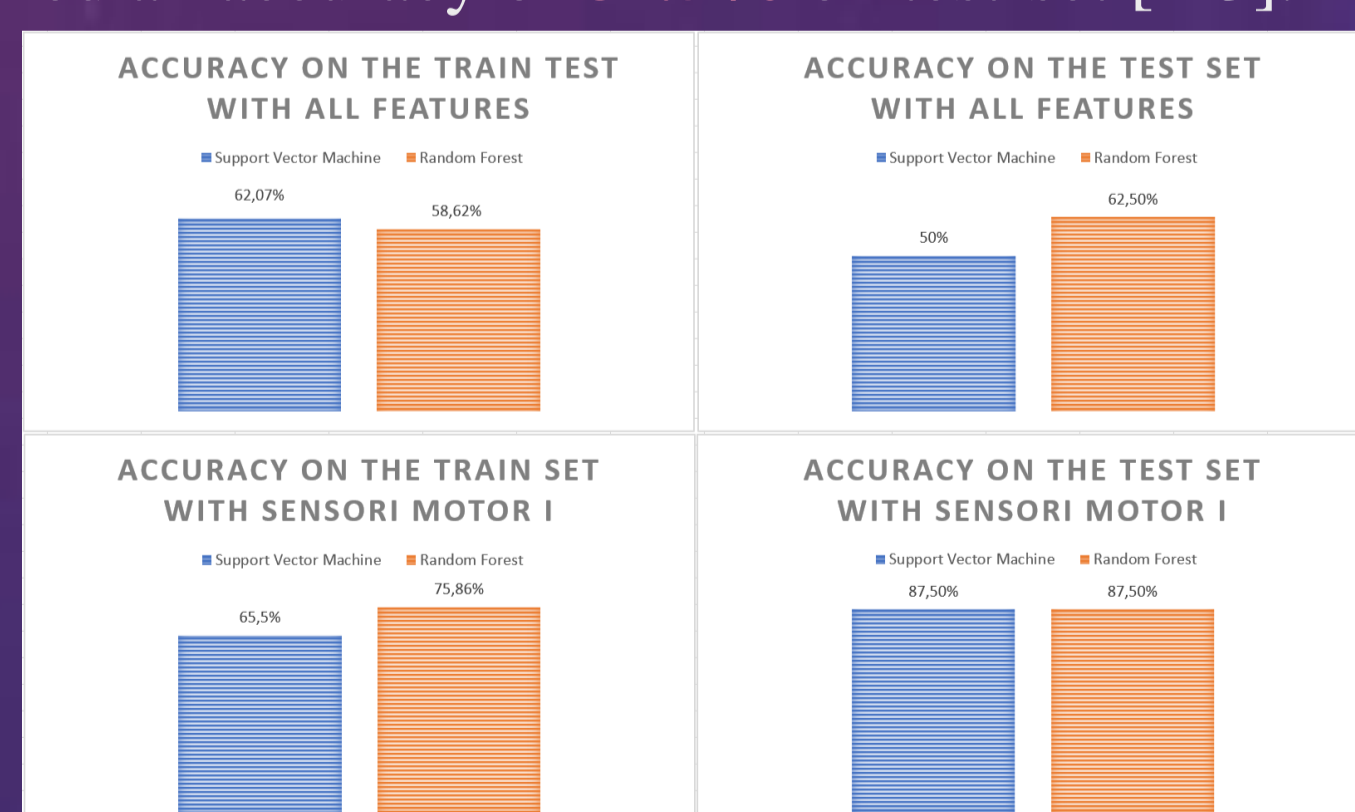


Fig. 3: Accuracies obtained with all features and with only the sensori motor I.

These findings could represent an encouraging step toward the translation to rfMRI connectivity evaluation into clinical practice.

Head motion signals

In our work, we demonstrated that motion correction algorithms allow to minimize the issues linked to head motions, but in some cases, the distortions are very remarkable and difficult to detect [4].

For the motion signal analysis, we have considered the head as a rigid body. Thus, head position is described at each timepoint by six parameters: translational displacements along X, Y, and Z axes and rotational displacements along phi (roll), theta (pitch) and psi (yaw) axes.

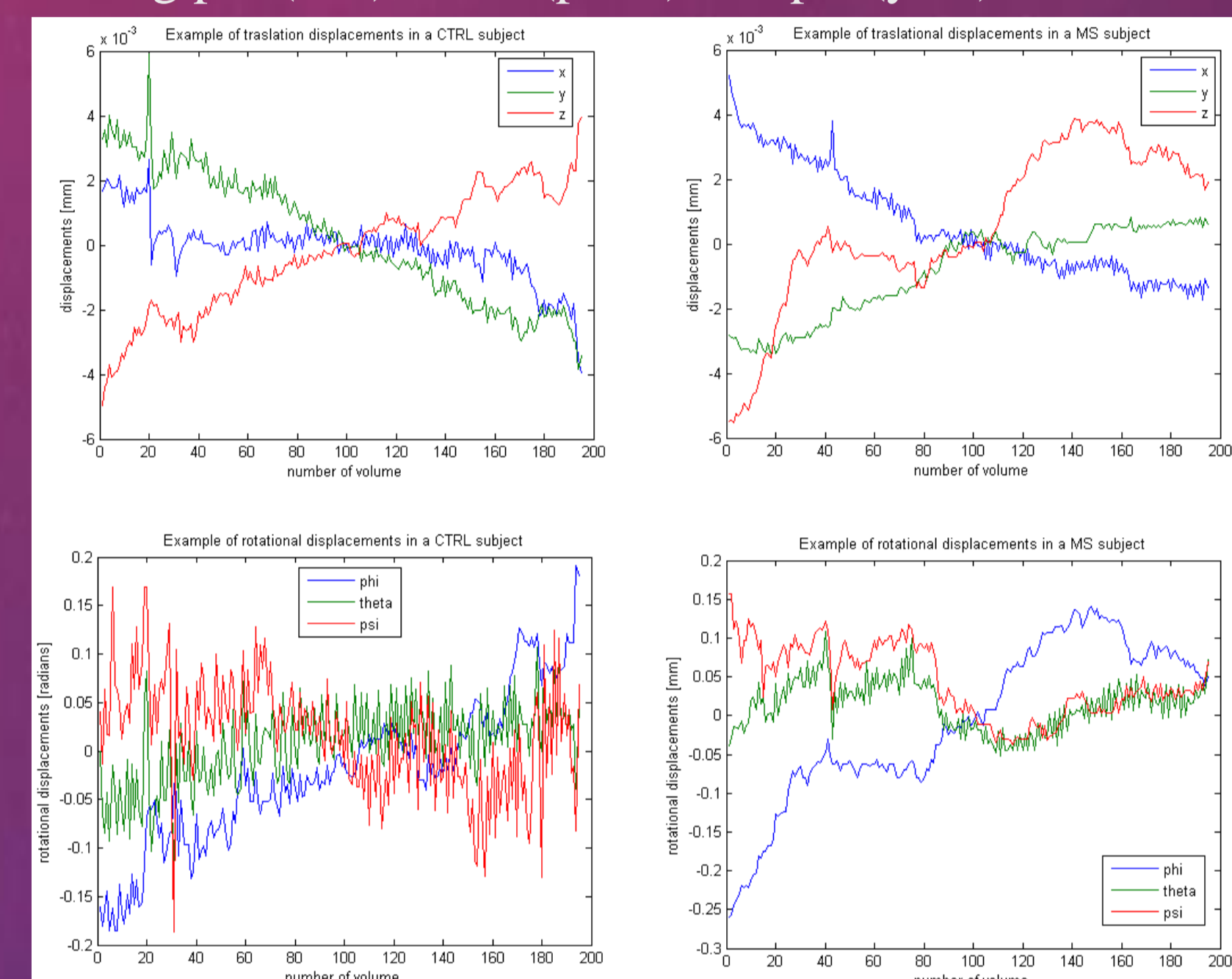


Fig. 4: Movements signals in a CTRL subject and in a MS subject.

SVM algorithms was trained using the mean values of the motion parameters previously calculated. The accuracy calculated with leave one out algorithm was about 72.97%. Rfe showed the most important movement as the rotation on the **Psi** axis (with a weight of 0.73).

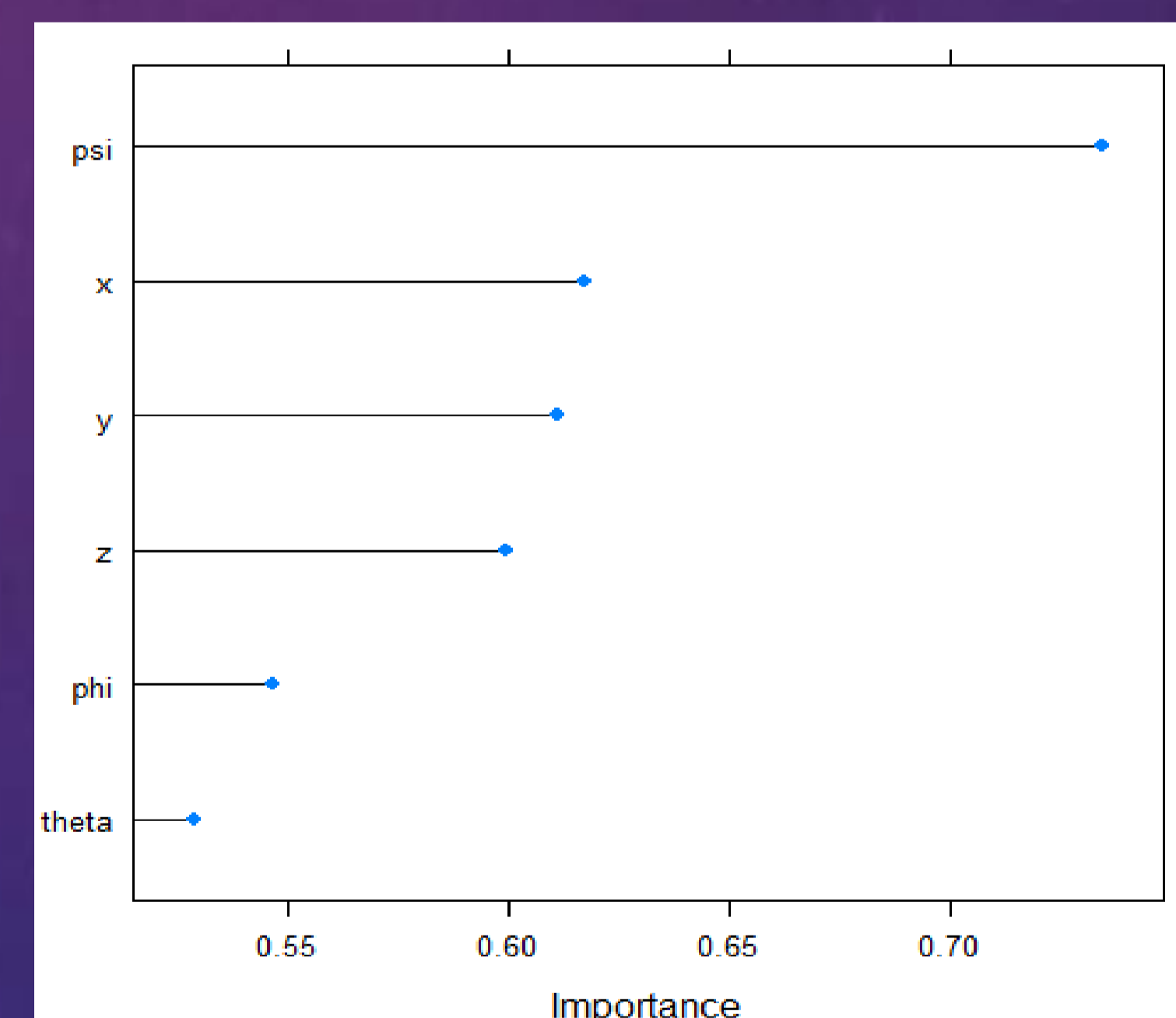


Fig. 5: Feature selection applied on the SVM.

Results of paired t-test and the examination of the means showed that the major movements in all timepoint was own the psi rotation. It suggests that psi rotation could be linked with the early MS pathology. A better control of this parameter could decrease the risk of signal distortion and its uncorrected interpretation.

Possible strategies could include particular filter to remove this noise by the signals or another solution could be the use of particular cushions or bite bars to inhibit the movement though psi axes in the patients [5].

References

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