

# A LEARNING BY EXAMPLE APPROACH FOR MRI ANALYSIS OF HUMAN BRAIN IN THE CONTEXT OF MENTAL HEALTH

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**Objective:** This study used a learning by example approach for the analysis of human brains in the context of mental health research. Source data were transformed into several alternative representations in order to reduce the amount of data space and to find the most discriminative features in distinguishing between the two classes of examples (i.e., healthy and unhealthy). The final goal was to select the best representation which would characterize the mental health disorder taken into consideration (i.e., schizophrenia).

**Methodology:** The method was based on the learning by example approach: starting from a dataset a classifier was trained to distinguish between healthy and unhealthy classes. In the training phase the class of each sample was given to the classifier. Then, after the learning phase, the classifier was able to classify even the previously unseen examples. The classifier was based on the Support Vector Machine (SVM) which has already been demonstrated to be effective in several pattern recognition applications. In order to improve the learning phase, from the source data several feature extraction techniques were carried out, such as the histogram of gradients or wavelet coefficients. Moreover, in order to reduce the amount of data, a Principal Component Analysis (PCA) was applied to obtain a more compact data representation. The experiment was carried out in 60 patients with schizophrenia and 60 normal controls. Two MRI data were analyzed: 3D Anatomical (3DA) and Diffusion Weighted Imaging (DWI).

**Results:** Up to 82% of patients with schizophrenia were detected. The detection was even more consistent when the samples were matched for age (up to 95%) or gender (up to 87%).

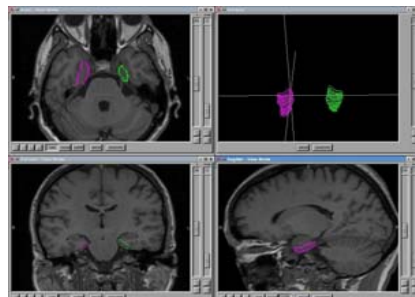
**Conclusions:** This study shows that the learning approach may be useful for human brain analysis, with high percentage of patients with schizophrenia detected. In particular, diffusion weighted imaging (DWI) data were the MRI acquisitions with better discrimination between patients and controls. This may be due to the information provided by DWI, which is related to brain tissue microstructure integrity, specifically of white matter. Also, the detection of patients with schizophrenia was even more consistent when the samples were matched for age. Indeed, there are strong evidences that white matter disruption is a key point for the pathophysiology of schizophrenia, possibly progressing with aging.

## BACKGROUND

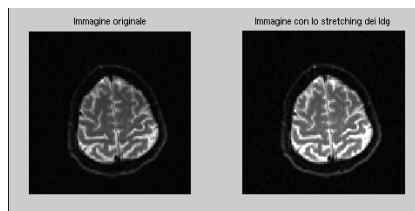
- This study used a learning by example approach for the analysis of human brains in the context of mental health research, i.e. to distinguish between healthy and unhealthy classes.
- The aim was to select the best representation which would characterize the mental health disorder taken into consideration (i.e., schizophrenia).

## METHODS

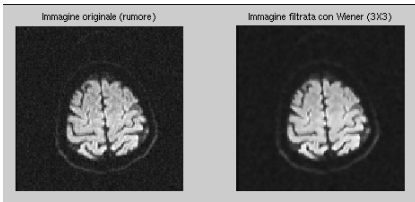
- The classifier was based on the Support Vector Machine (SVM) which has already been demonstrated to be effective in several pattern recognition applications.
- In the training phase the class of each sample was given to the classifier.
- After the learning phase, the classifier was able to classify even the previously unseen examples.
- In order to improve the learning phase, from the source data several feature extraction techniques were carried out, such as the histogram of gradients or wavelet coefficients.
- Moreover, in order to reduce the amount of data, a Principal Component Analysis (PCA) was applied to obtain a more compact data representation.
- A MRI dataset of 60 patients with schizophrenia and 60 normal controls were processed.
- Two acquisitions were analyzed: 3D Anatomical (3DA) & Diffusion Weighted Imaging (DWI).



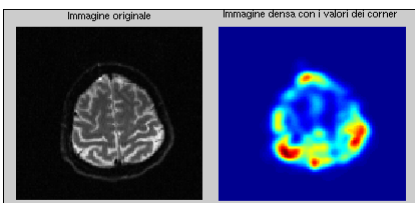
3D anatomical image



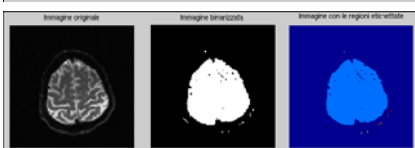
DWI image stretching



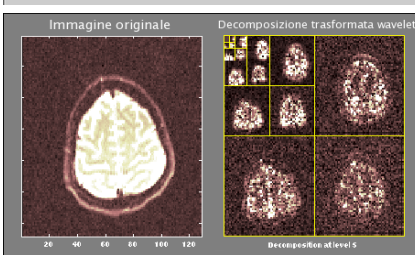
Wiener filter of DWI image



Harris DWI image



Subdivided DWI image



Wavelet DWI image

## RESULTS

- Up to 82% of patients with schizophrenia were detected with this technique.
- The detection of patients with schizophrenia was even more consistent when the samples were matched for age (up to 95%) or gender (up to 87%).

Control subjects	Patients with SCZ	Cluster	Feature	3DA	DWI	Score
60	60	All	Wavelet+PCA	No	Yes	82%
60	60	All	Histogram of image	Yes	Yes	79%
60	60	All	Histogram of grade	Yes	No	71%
20	20	Age (24-38)	Histogram of grade	No	Yes	95%
15	15	Female	Histogram of grad	No	Yes	80%
15	15	Male	Histogram of image	No	Yes	87%

## CONCLUSIONS

- This study shows that the learning approach may be useful for human brain analysis.
- The results are very promising since up to 82% of patients with schizophrenia were detected with this technique.
- In particular, diffusion weighted imaging (DWI) data were the MRI data better discriminating patients from controls.
- This may be due to the information provided by DWI, which is related to the microstructure integrity of the brain, specifically of white matter.
- Also, the detection of patients with schizophrenia was even more consistent when the samples were matched for age. Indeed, there are strong evidences that white matter disruption is a key point for the pathophysiology of schizophrenia, possibly progressing with aging.