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ANOMALY DETECTION IN THE MRI DATA OF NEWLY DIAGNOSED PARKINSONIAN PATIENTS

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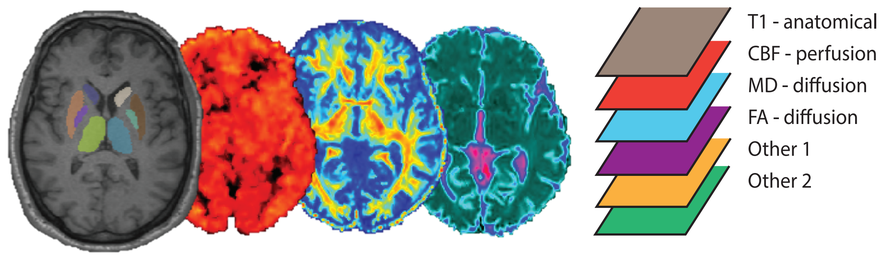
I. Abstract

The putative delay between the onset of neurodegeneration and the manifestation of clinical symptoms of Parkinson's disease drives the quest to find biomarkers present in the pre-motor stages of PD that can lead to earlier diagnosis and more tailored treatments to slow down the disease process.

In this context, our project employs Magnetic Resonance neuroimaging and unsupervised classification methods to study the interaction of several physiological and structural brain characteristics and ultimately, to draw out specific signatures in newly diagnosed Parkinson patients.

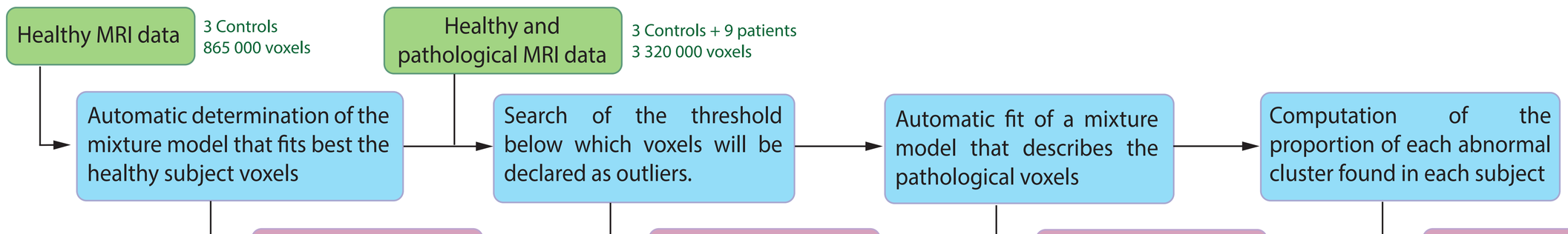
II. MRI parameters extraction

Quantitative features from different MR modalities are extracted and coregistered to an anatomical T1-weigthed scan with a subcortical structure mask [1] for each subject. These features currently come from diffusion imaging (FA, MD) and perfusion imaging (CBF).



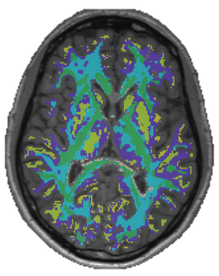
III. Signatures extraction

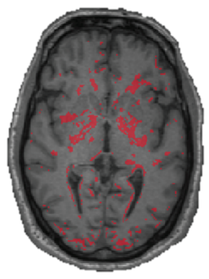
This method was previously validated by Arnaud & al. [2] to characterize different kinds of brain tumors in rats. The mixture models are built from generalized Student distributions as they provide a larger variety of distributional shapes compared to the mode standard Gaussian distributions [3].



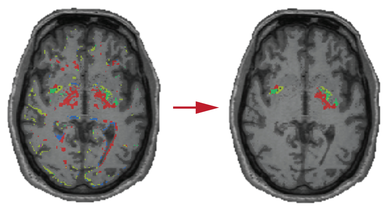
$$f_R(y) = \sum_{K=1}^{K_R} \pi_K GSD(y; \psi_K)$$

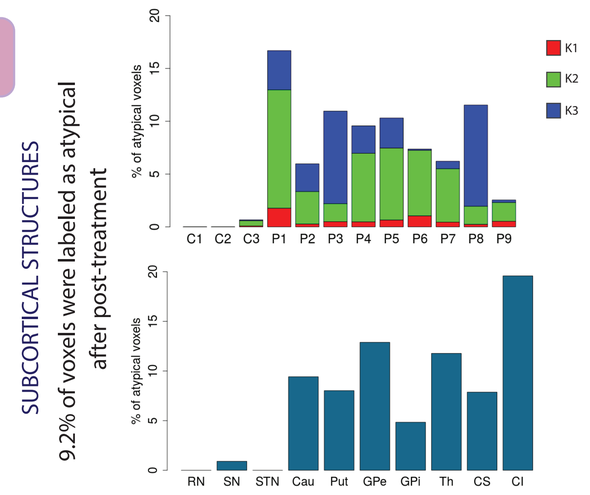
Reference model built from K GSD (Generalized Student Distributions)

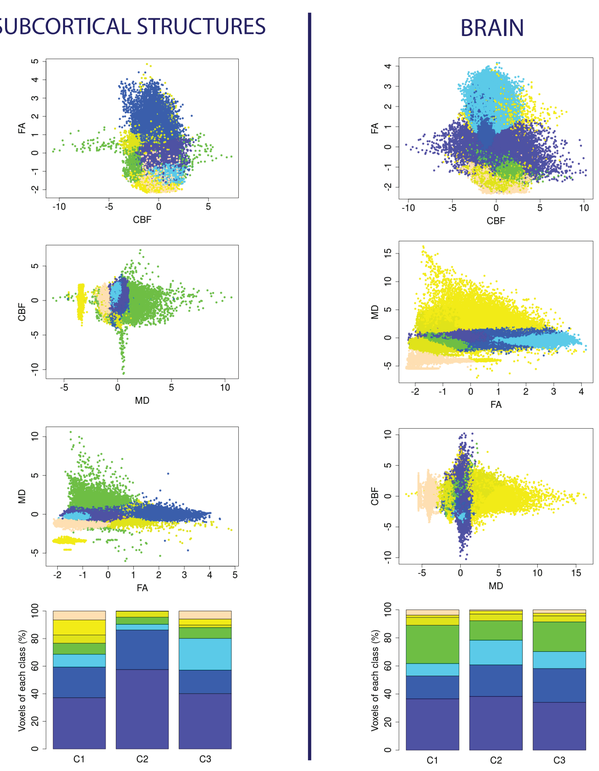




FPR α =5%







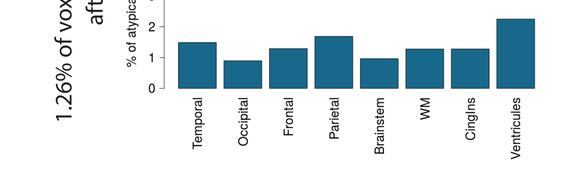
Classification of all healthy voxels in the subcortical structures [K=7](left) and the brain [K=6] (right) following their respective reference model. In the first 3 rows the different 2D views of the voxels distribution with respect to features CBF, FA and MD. The barplot on the last row contains the proportions of each K class.

IV. Conclusions

Our method allows the classification of brain tissues in healthy subjects, as well as the identification of atypical and thus potentially pathological tissues in the brain of newly diagnosed Parkinsonian patients.

Further work must be done to provide a physio pathological explanation to the signatures found based on their clusters location and characteristics.

In addition, we will include more patients and other MR modalities to our study to have a more complete picture of the changes undergone by the Parkinsonian brain.



The repartition of each K class from the Atypical Model in the atypical voxels of each subject defines their individual signature. Above appears the population signatures (top) and the localisation of the detected atypical voxels in a set of relevant regions for the subcortical structures (top) and the brain (bottom).

References :

[1] Xiao, Y. & al. (2015). "Multi-contrast unbiased MRI atlas of a Parkinson's disease population". International Journal of Computer Assisted Radiology and Surgery.

[2] Arnaud, A. & al. (2017). "Fully Automatic Lesion Localization and Characterization: Application to Brain Tumors Using Multiparametric MRI Data". IEEE Transactions on Medical Imaging.

[3] Forbes, F. & Wraith, D. (2014). "A new family of multivariate heavy-tailed distributions with variable marginal amounts of tailweights: Application to robust clustering." Statistics and Computing.

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