Tumor classification and prediction using robust multivariate clustering of multiparametric MRI

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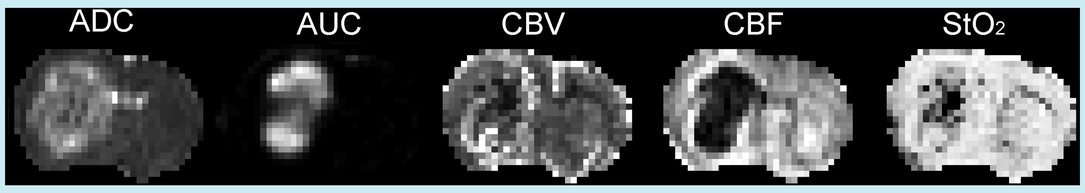
Multiparametric MRI

- Several physiological parameters can be mapped with MRI.
- How to integrate and interpret all these maps simultaneously ?
- How to use such multi-parametric information to characterize brain tumors ?

➤ **Proposed approach** : Extract and characterize voxels with similar parameter values using mutlivariate and robust clustering techniques [2].

Multiparametric data set

- 37 **rats** with 4 brain tumor models **9L**, **C6a**, **C6b**, **F98**.
- 5 physiological parameters :



➥ **ADC** : apparent diffusion constant

➥ **AUC** : vessel pemeability

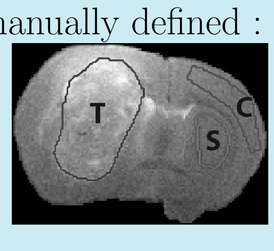
➥ **CBV** : cerebral blood volume

➥ **CBF** : cerebral blood flow

➥ **StO_2** : tissue oxygen saturation

- 3 regions of interest manually defined :

Tumor ➤

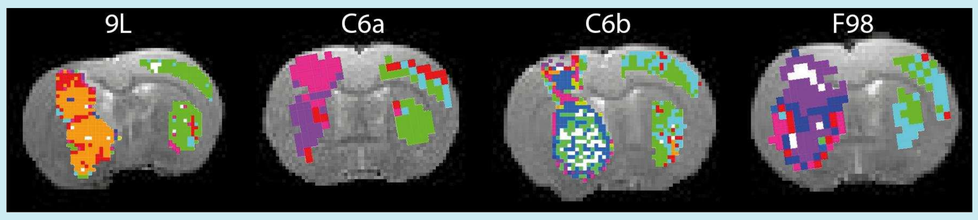


➤ **Cortex**

➤ **Striatum**

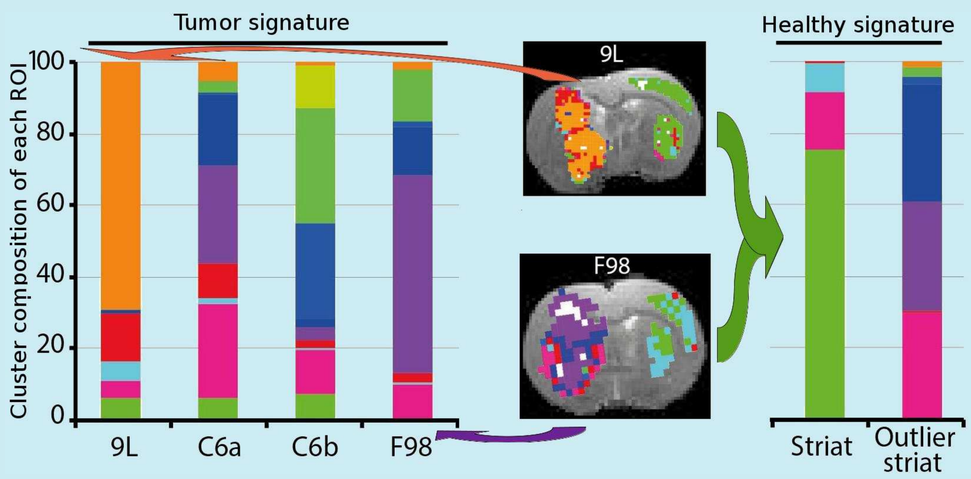
Clustering voxels into groups

- Unsupervised clustering with a mixture of generalized multivariate Student distributions
- Number of clusters automatically determined using Bayesian Information Criterion (BIC) : 10 clusters



Tumor signatures from cluster proportions in each ROI

- Outlier detection : 1 rat was discarded based on its atypical signature for its « healthy »ROI (here the striatum ROI)
- A tumor signature dictionary is built to discriminate rats according to their tumor model



Relevance of the dictionnary

Leave-one-out procedure to assess the signature predictive power :

- 84.6% of good detections in a previous study [1]
- 97.3% of good detections with the proposed Student distributions

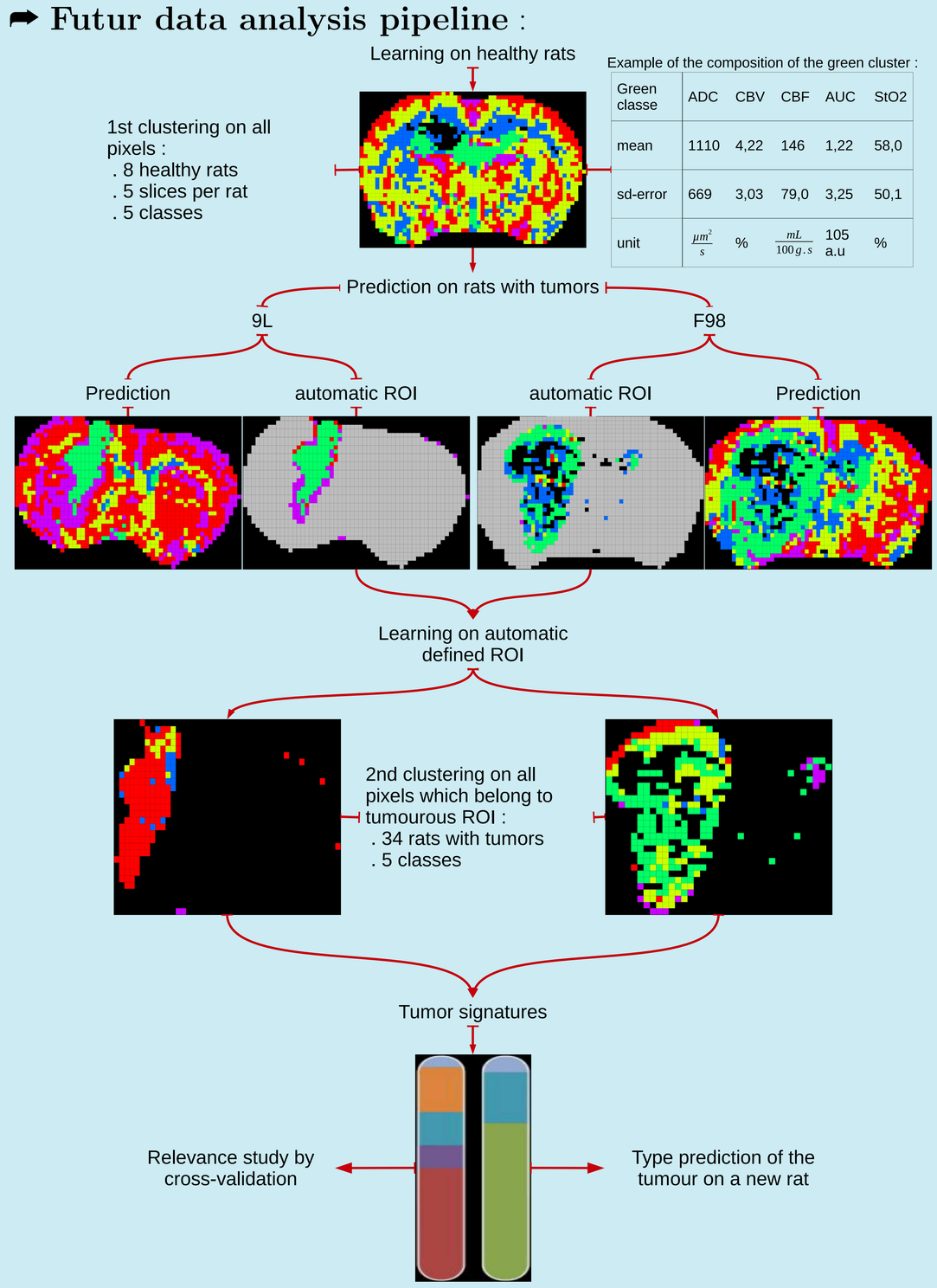
Conclusion

Mixtures of generalized Student distributions allow to improve data quality control by allowing automatic outlier detection and to identify discriminative tumor signatures with improved predictive power.

Future work : whole brain analysis

- Clustering using whole brain slices (vs manually selected ROI)
- Automatic determination of ROIs as atypical regions
- Markov modelling to account for voxels spatial dependencies
- Sensitivity analysis to identify discriminative parameters

➦ **Futur data analysis pipeline** :



Main references

1. N. Coquery, O. Francois, B. Lemasson, C. Debacker, R. Farion, C. Rmy, E. Barbier. *Microvascular MRI and unsupervised clustering yields histology-resembling images in two rat models of glioma.* Journal of Cerebral Blood Flow & Metabolism, 2014 Aug ; 34(8) :1354-62.
2. F. Forbes and D. Wraith. *A new family of multivariate heavy-tailed distributions with variable marginal amounts of tailweights : Application to robust clustering.* Statistics and Computing, 2014 Nov ; 24(6) :971-984.