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 multivariate 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 permeability
  - CBV: cerebral blood volume
  - CBF: cerebral blood flow
  - StO2: 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 dictionary**
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**