Quality, harmonization and parcellation

AIM Annual Meeting, *Pisa, February 3rd 2020*

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Outline

- Database
- The problem of PET images quality in multicenter studies
- Brain atlas: a data-driven approach

Database

We have available a naturalistic population of 885 patients from 14 EADC clinical centers. For each patient we have

- at least a late amyloid PET image. For 349 patients we also have the early PET image and a CT image
- age, sex, acquisition date, clinical center, tracer(Florbetapir, Florbetaben, Flutemetamol, PIB)
- dichotomic POS/NEG amyloid assessment

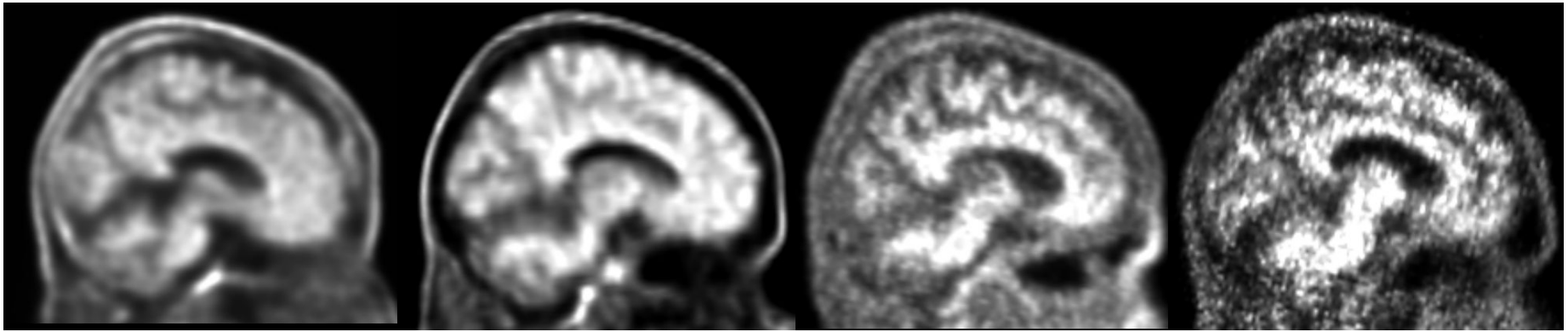
Each image have been

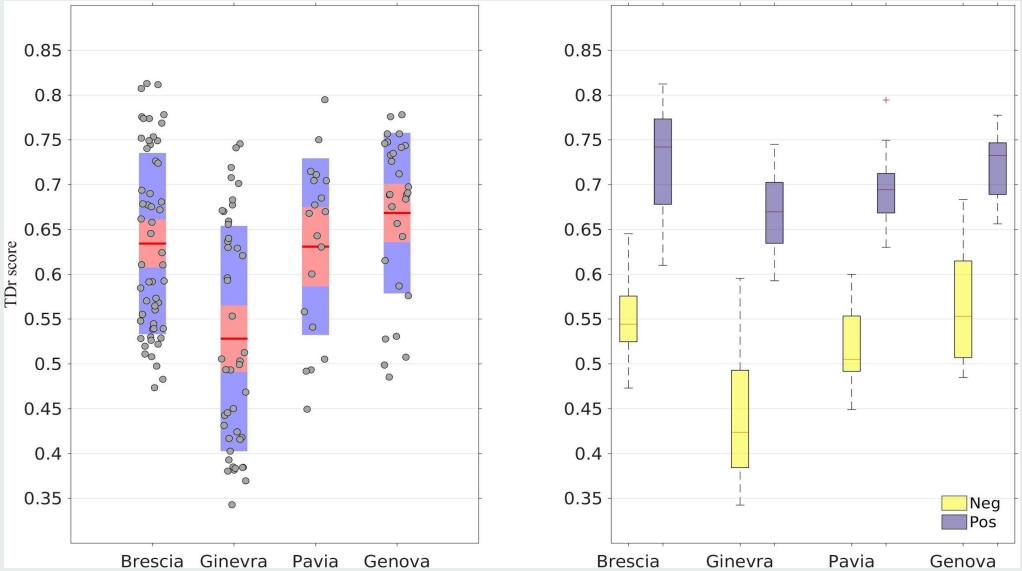
- Registered in MNI space using both an affine and a diffeomorphic transformation (ANTS Registration)
- Quantified using both three different quantification methods (ELBA, SUVr and TDr) and two different brain atlases

The problem of PET images quality in multicenter studies

PET images acquired in different clinical centers have different quality: the use of different scanners, acquisition protocols and reconstruction algorithms has been identified as a problem that limits the use of PET in multicenter studies.

Pamplona *Brescia* *Padova* *Roma*





Tdr score: patients from different clinical centers

Problem

Images of different quality may not be comparable and systematic errors could be introduced!

Solution

A possible solution is to divide the dataset in N subsets which are homogeneous about quality

Aims

- define quality metrics *as independent as possible from the clinical evaluation*
- clustering images in N subsets according to their quality
- build a classifier to put new images in the appropriate subsets

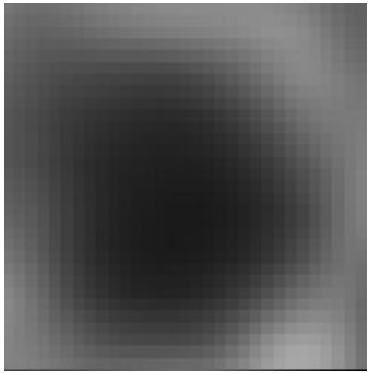
Defining quality

Metrics obtained from PET images...

- Eye analysis: Gradient analysis and no reference quality metrics (NIQE)
- Native brain counts
- Metrics based on native noise analysis: for now I used the mean noise normalized with respect to an hotspot, but I will look in depth at this issue.

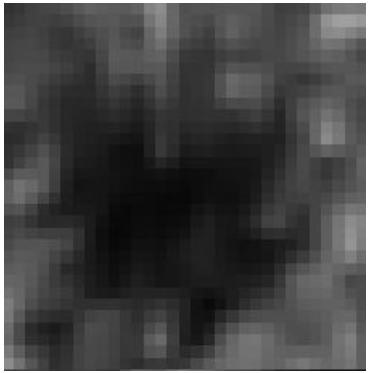
… and other parameter obtained from DICOM files, such as Radiodose, reconstruction method, matrix dimension etc...

Eye analysis...



Anversa

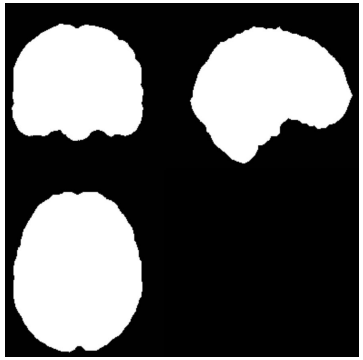
- Low NIQE value
- Few Stationary and Inflections point

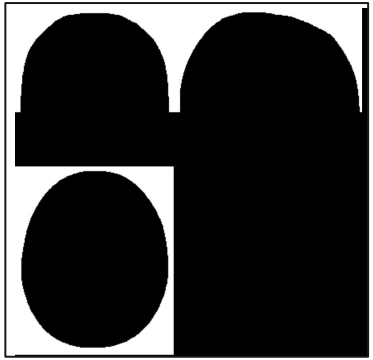


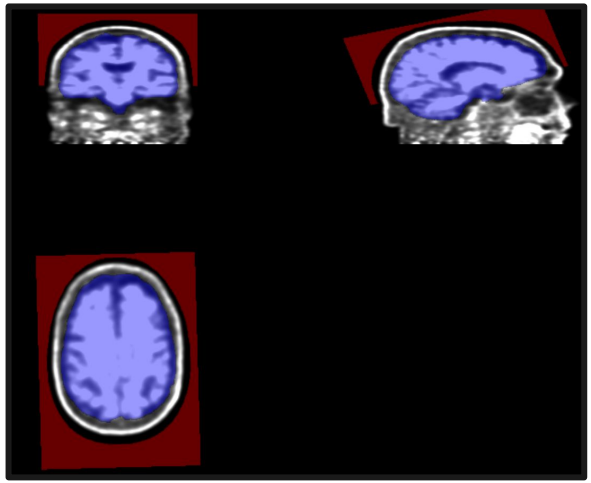
Roma

- High NIQE value
- Many Stationary and Inflections point

Noise Analysis and Brain Counts...





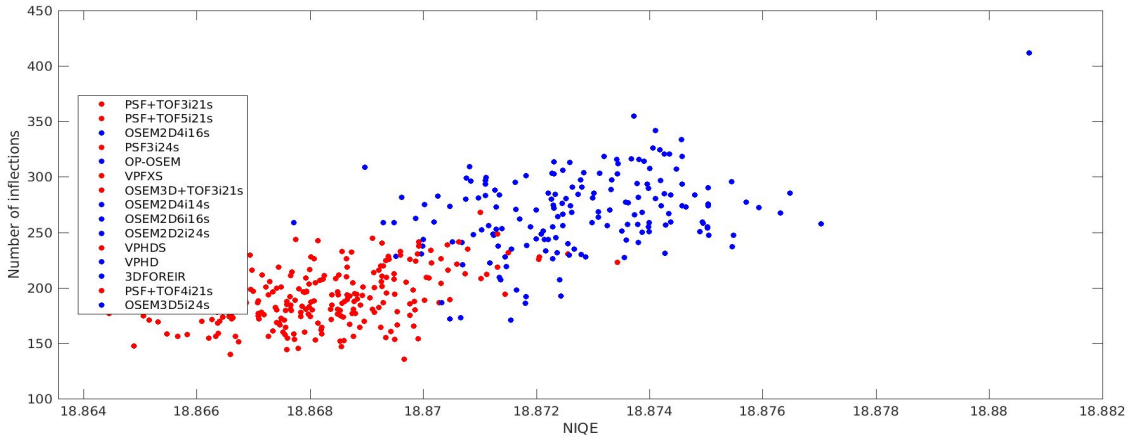


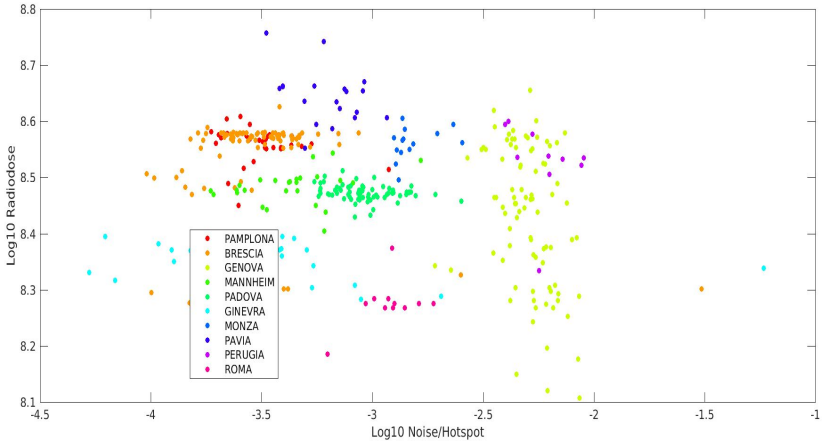
A very important question...

How can we know if the metrics we choose are good estimators of PET image quality?

As far as I know, there is no exact answer to this question. Rather, there are some control check that the subsets division have to pass

- the division must be in agreement with visual assessment
- the division must be in agreement with reconstruction method
- Last, but not the least, it is reasonable to assume that images acquired in the same centers are similar about quality. Then, images from the same center, have to be classified in the same subset.

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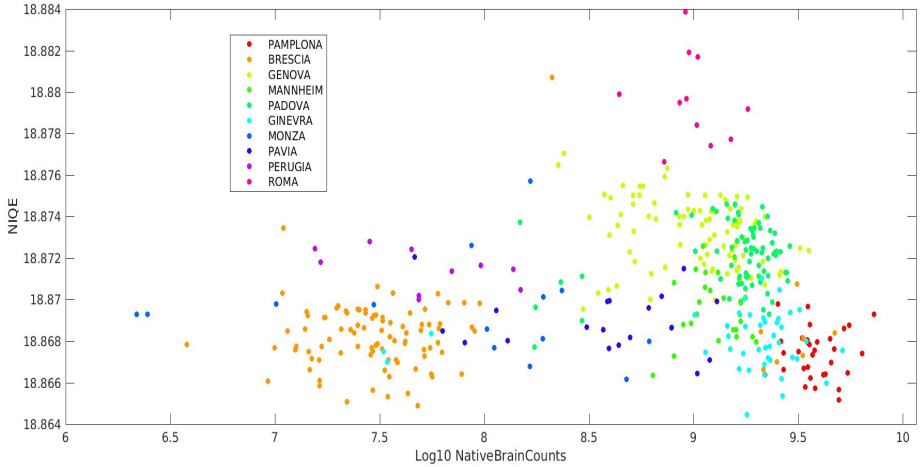
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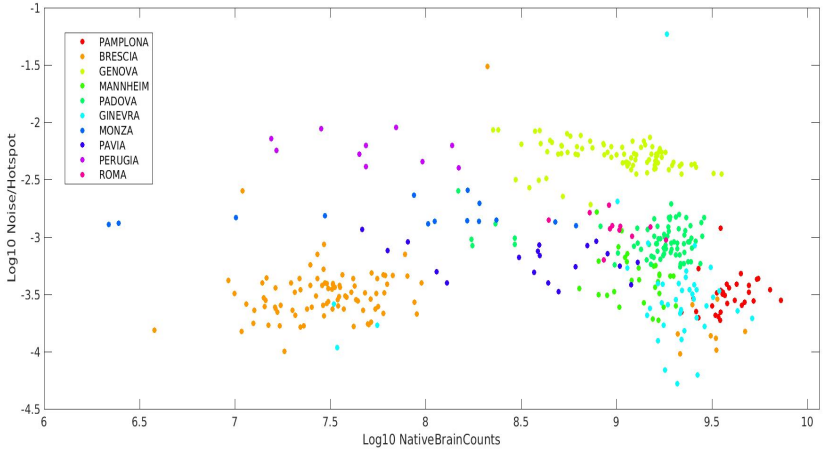
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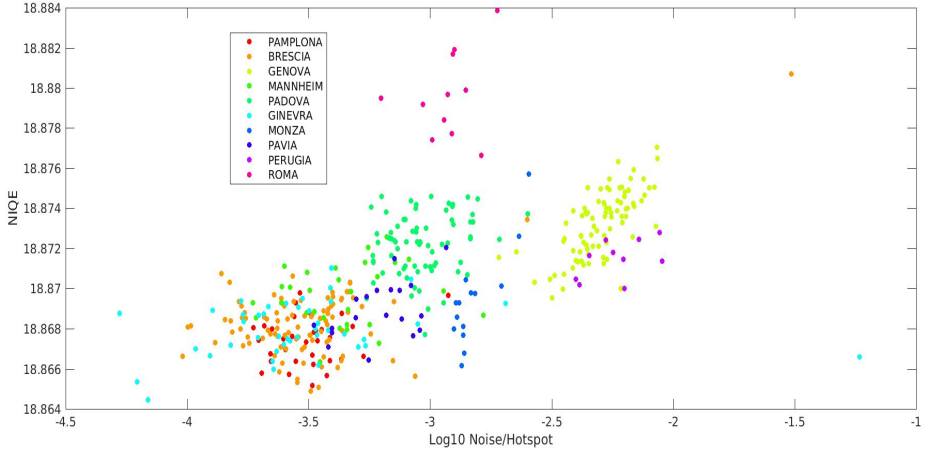
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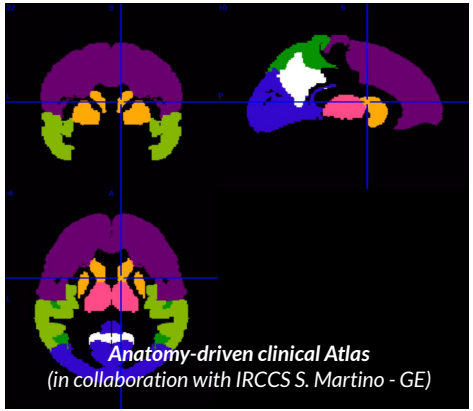
Brain atlas: a data driven approach

Clinical brain atlas: suitable to relate amyloid load in certain ROIs to POS/NEG assessment.

Why is it important to have a data-driven atlas?

- Comparison between anatomical-and data-driven atlas. Are we missing something? ROI carrying information OTHER than the negative/positive dichotomy
- Data-driven atlas to study amyloid patterns
- Clinical importance: about 30% of cognitively unimpaired elderly has abnormal Amyloid biomarkers. Different symptoms could be related to specific amyloid load network and data driven atlas will be useful to investigate this issue



...Versus...

DATA-driven atlas

Aims:

- Build an overall data-driven brain atlas, as well as atlases for patients with low, medium, and high amyloid load
- Investigate amyloid load pattern and amyloid network

Methods and my preliminary work

Two possible way:

- **hierarchical clustering**: clustering in one shot is computationally too expensive. I am looking for a smart solution to avoid this problem.
- **not hierarchical clustering** such as k-medoids

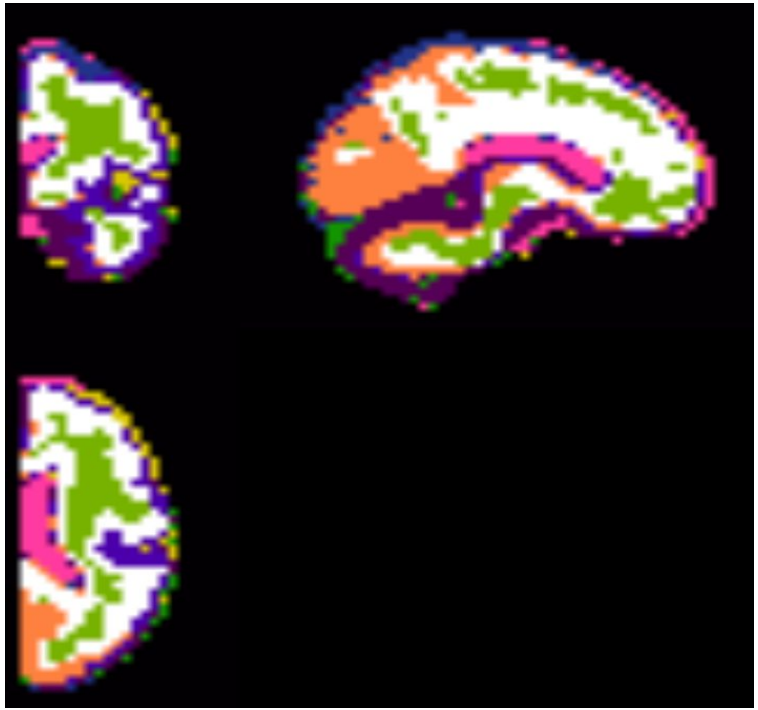
Which kind of distance is suitable to obtain a data-driven atlas?

- Correlation
- Distance between voxel distributions

My preliminary results

I have obtained a preliminary data driven atlas:

- I have used good quality images only (about 400 of 885)
- For the sake of simplicity I have reduced the brain volume of 4 times
- I have used distance between distribution (the first 10 central moment) as a metric
- I have chosen 10 cluster
- the atlas is *anatomically agnostic*



THANK YOU FOR YOUR ATTENTION!!!