wellcome centre integrative neuroimaging

BIANCA

Brain Intensity AbNormality Classification Algorithm

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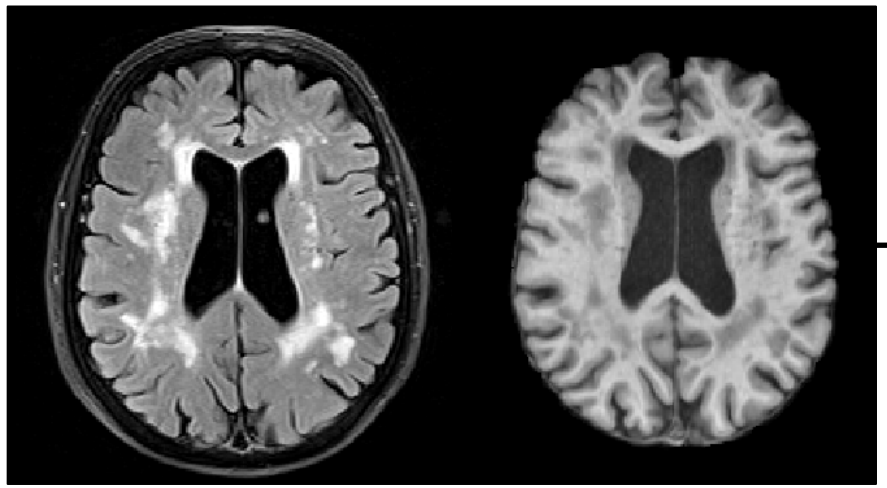
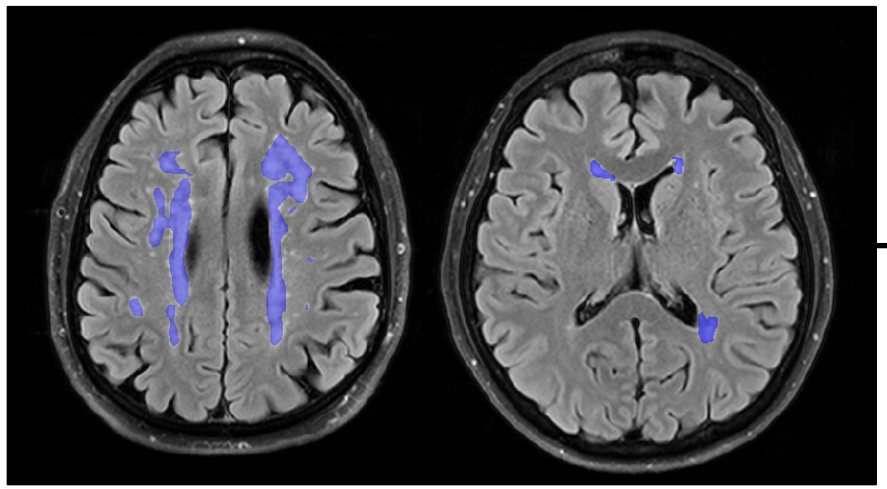
BIANCA - Overview



Multimodal

Features

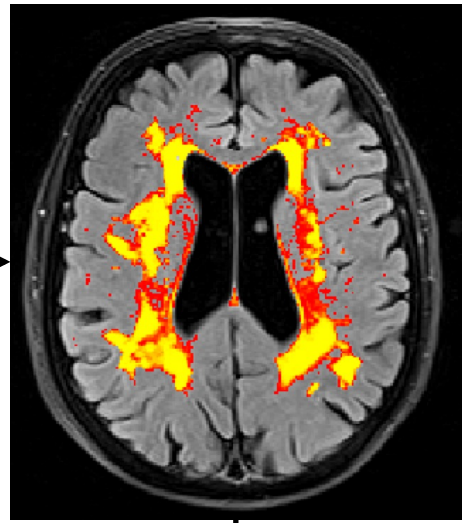
K-NN Classifier

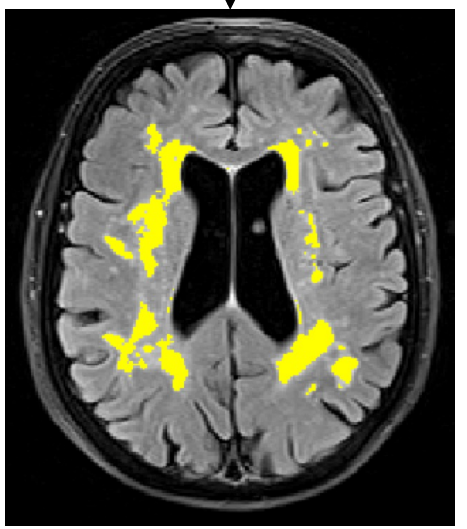


Supervised

Features
Labels

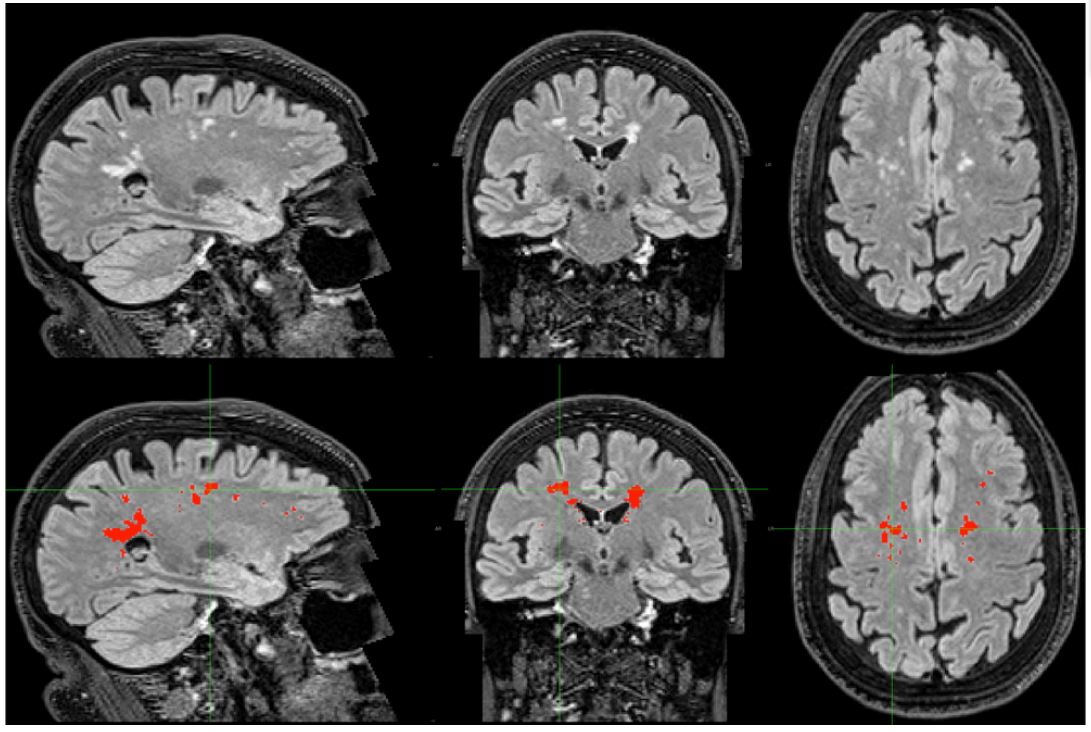
Lesion probability map





BIANCA - Overview

biobank uk
Imaging study



FSL BIANCA

Included in FSL 5.0.10

Contents
1. Introduction
   1.1. Research overview - BIANCA (Brain Intensity AbNormality Classification Algorithm)
   1.2. Referencing
2. Userguide

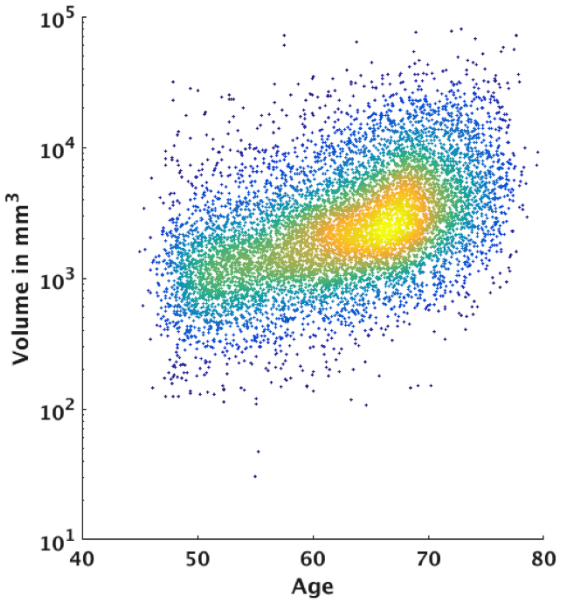
Research overview - BIANCA (Brain Intensity AbNormality Classification Algorithm)

FMRIB's tool for automated segmentation of white matter hyperintensities

BIANCA is a fully automated, supervised method for white matter hyperintensities (WMH) detection, based on the k-nearest neighbour (k-NN) algorithm. BIANCA classifies the image's voxels based on their intensity and spatial features, and the output image represents the probability per voxel of being WMH. BIANCA is very flexible in terms of MRI modalities to use and offers different options for weighting the spatial information, local spatial intensity averaging, and different options for the choice of the number and location of the training points (see user guide for details).

BETA RELEASE

BIANCA is currently considered to be in testing, meaning that you will need to inspect its output a bit more carefully to see if you are happy with it. The output will depend critically on the choice of options and the quality of the training data and manual segmentations. Further recommendations and automated tuning methods, will be supported in an upcoming release.



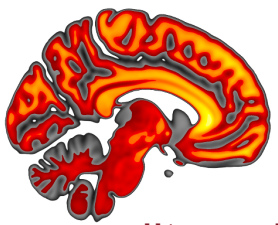
BIANCA - Usage

1. Prepare your **training dataset**
2. Prepare your **data**
3. **Usage** cases
    A. Train and test
    B. Create a training dataset
    C. Testing using existing training dataset
4. **Post-processing**

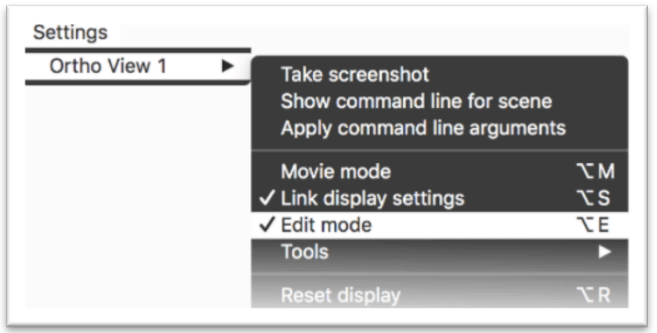
1. Prepare your training file

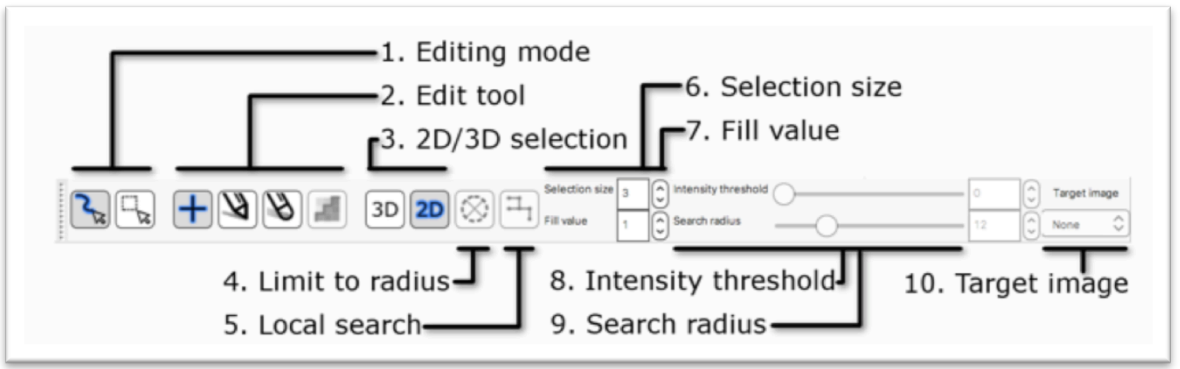
BIANCA

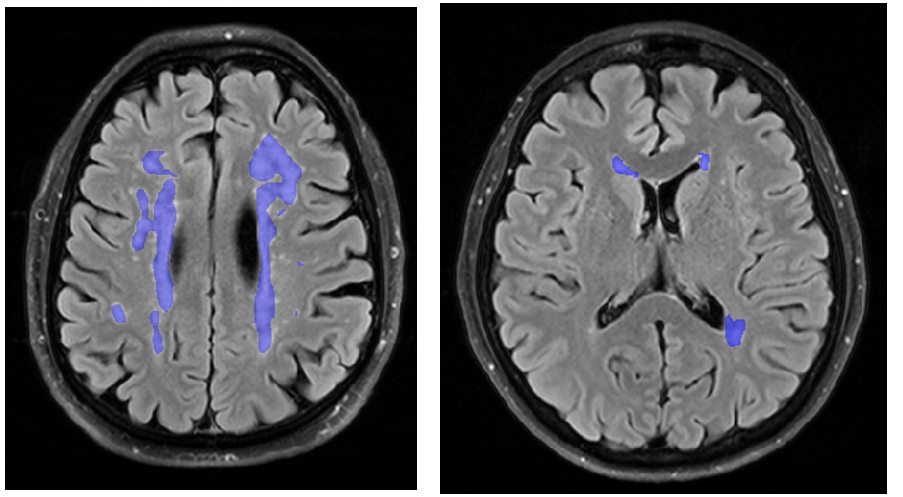
a. Manually segment lesions on 10-20 subjects (high lesion load)
b. Save manual mask as binary image (1=lesion, 0=non-lesion)



FSLeyes edit mode





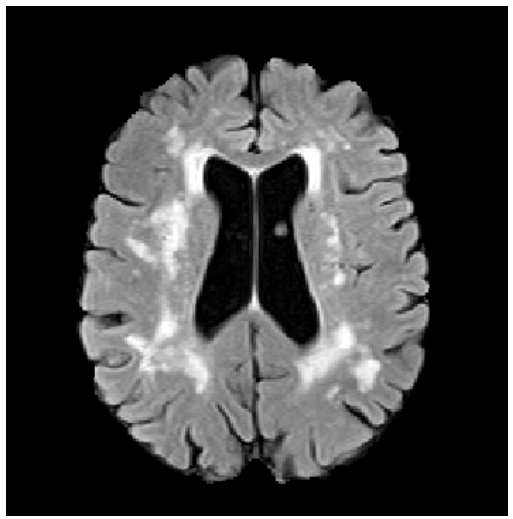


https://users.fmrib.ox.ac.uk/~paulmc/fsleyes_userdoc/editing_images.html

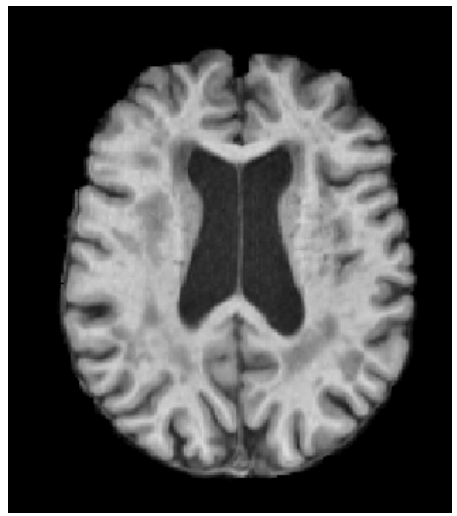
2. Prepare your data

BIANCA

a. Choose your base modality (reference for input/output)
b. For each subject, register all other modalities to your base (including manual mask, if applicable)
c. Brain-extract (at least) one modality
d. For each subject, calculate the linear registration transform from base to MNI



`FLAIR_brain`



`T1_2FLAIR`

COMING SOON:
will support non-linear registration

3. Usage case A) Train and test

BIANCA

Master file preparation

Masterfile.txt

```
sub01/FLAIR_brain.nii.gz sub01/T1_toFLAIR.nii.gz sub01/FLAIR_toMNI.mat sub01/WMHmask.nii.gz
sub02/FLAIR_brain.nii.gz sub02/T1_toFLAIR.nii.gz sub02/FLAIR_toMNI.mat sub02/WMHmask.nii.gz
sub03/FLAIR_brain.nii.gz sub03/T1_toFLAIR.nii.gz sub03/FLAIR_toMNI.mat sub03/WMHmask.nii.gz
sub04/FLAIR_brain.nii.gz sub04/T1_toFLAIR.nii.gz sub04/FLAIR_toMNI.mat sub04/WMHmask.nii.gz
sub05/FLAIR_brain.nii.gz sub05/T1_toFLAIR.nii.gz sub05/FLAIR_toMNI.mat placehold
sub06/FLAIR_brain.nii.gz sub06/T1_toFLAIR.nii.gz sub06/FLAIR_toMNI.mat placehold

...
subN/FLAIR_brain.nii.gz subN/T1_toFLAIR.nii.gz subN/FLAIR_toMNI.mat subN/placehold
```

One row per subject

All modalities registered to the base

One modality brain extracted

Registration matrix from the base to MNI

Manual masks (for training subjects. Use any “placeholder text” for others)

3. Usage case A) Train and test

BIANCA

Command line (main options)

```
sub01/FLAIR_brain.nii.gz sub01/T1_toFLAIR.nii.gz sub01/FLAIR_toMNI.mat sub01/WMHmask.nii.gz
sub02/FLAIR_brain.nii.gz sub02/T1_toFLAIR.nii.gz sub02/FLAIR_toMNI.mat sub02/WMHmask.nii.gz
sub03/FLAIR_brain.nii.gz sub01/T1_toFLAIR.nii.gz sub03/FLAIR_toMNI.mat sub03/WMHmask.nii.gz
sub04/FLAIR_brain.nii.gz sub02/T1_toFLAIR.nii.gz sub04/FLAIR_toMNI.mat sub04/WMHmask.nii.gz
sub05/FLAIR_brain.nii.gz sub01/T1_toFLAIR.nii.gz sub05/FLAIR_toMNI.mat placehold
sub06/FLAIR_brain.nii.gz sub02/T1_toFLAIR.nii.gz sub06/FLAIR_toMNI.mat placehold

...
subN/FLAIR_brain.nii.gz subN/T1_toFLAIR.nii.gz subN/FLAIR_toMNI.mat subN/placehold
```

```
bianca --singlefile=masterfile.txt --trainingnums=1,2,3,4 --querysubjectnum=5
--brainmaskfeaturenum=1 --featuresubset=1,2 --matfeaturenum=3 --labelfeaturenum=4
-o sub05_bianca_output
```

Automatic Leave-One-Out if query subject is one of the training subjects

3. Usage case B) Create a training dataset

BIANCA

Master file preparation

```
sub01/FLAIR_brain.nii.gz sub01/T1_toFLAIR.nii.gz sub01/FLAIR_toMNI.mat sub01/WMHmask.nii.gz
sub02/FLAIR_brain.nii.gz sub02/T1_toFLAIR.nii.gz sub02/FLAIR_toMNI.mat sub02/WMHmask.nii.gz
sub03/FLAIR_brain.nii.gz sub03/T1_toFLAIR.nii.gz sub03/FLAIR_toMNI.mat sub03/WMHmask.nii.gz
sub04/FLAIR_brain.nii.gz sub04/T1_toFLAIR.nii.gz sub04/FLAIR_toMNI.mat sub04/WMHmask.nii.gz
...
subN/FLAIR_brain.nii.gz subN/T1_toFLAIR.nii.gz subN/FLAIR_toMNI.mat subN/WMHmask.nii.gz
```

Command line (main options)

```
bianca --singlefile=masterfile.txt --trainingnums=1,2,3,4…N
--querysubjectnum=1 --brainmaskfeaturenum=1 --featuresubset=1,2
--matfeaturenum=3 --labelfeaturenum=4
--saveclassifierdata=MyTraining
```

Output files:
MyTraining
MyTraining_labels

3. Usage case C) Test with existing training dataset

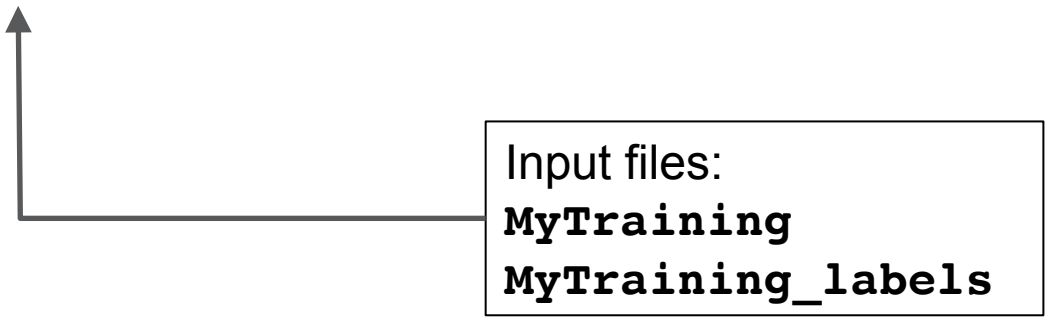
BIANCA

Master file preparation

```
subT01/FLAIR_brain.nii.gz subT01/T1_toFLAIR.nii.gz subT01/FLAIR_toMNI.mat placehold
subT02/FLAIR_brain.nii.gz subT02/T1_toFLAIR.nii.gz subT02/FLAIR_toMNI.mat placehold
subT03/FLAIR_brain.nii.gz subT03/T1_toFLAIR.nii.gz subT03/FLAIR_toMNI.mat placehold
subT04/FLAIR_brain.nii.gz subT04/T1_toFLAIR.nii.gz subT04/FLAIR_toMNI.mat placehold
...
subTN/FLAIR_brain.nii.gz subTN/T1_toFLAIR.nii.gz subTN/FLAIR_toMNI.mat placehold
```

Command line (main options)

```
bianca --singlefile=masterfile.txt --querysubjectnum=1
--brainmaskfeaturenum=1 --featuresubset=1,2 --matfeaturenum=3
--loadclassifierdata=MyTraining -o sub01_bianca_output
```



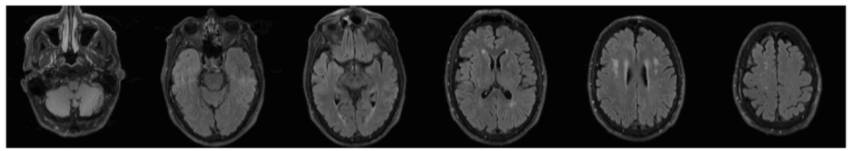
Coming soon: HTML reports

BIANCA

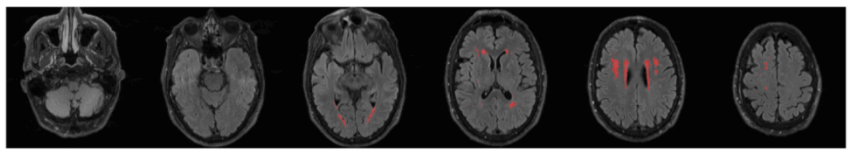
BIANCA report for subject : WH_092

/Users/ludovica/Documents/Projects/REPORT/TEST_DATA/WH_092/WH_092_biancathr09.nii.g

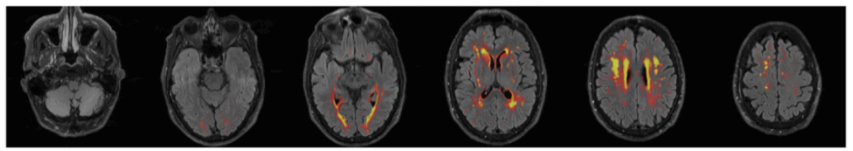
Original image



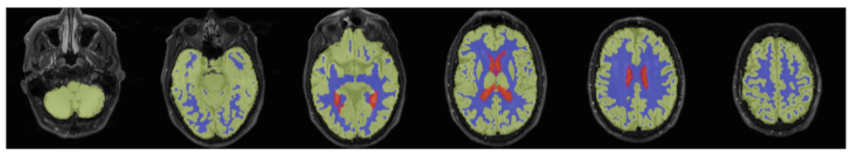
BIANCA output (thresholded)



BIANCA output (unthresholded)



Masks



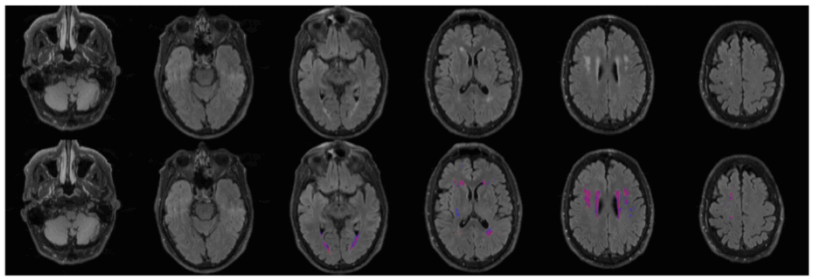
Measures

Metric	Absolute value (mm^3)	Normalised (% of brain volume)
Total lesion volume (mm^3)	13937.532	0.889
Total lesion count	154	-
Average lesion volume (mm^3)	90.503	0.006
Stdev lesion volume (mm^3)	373.783	0.024
Min lesion volume (mm^3)	0.554	0.0
Max lesion volume (mm^3)	2513.498	0.16

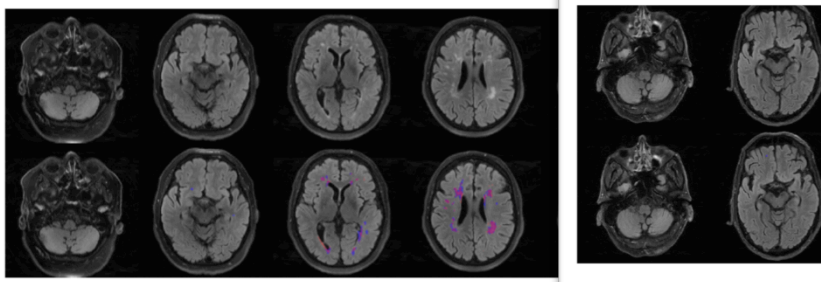
BIANCA training report

TRAINING SUBJECTS FILE:
/Users/ludovica/Documents/Projects/REPORT/training_list.txt

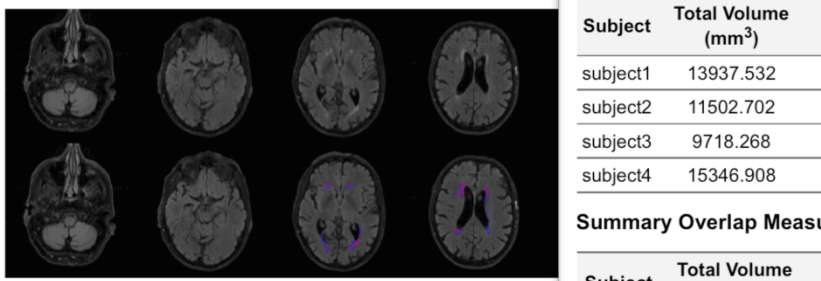
subject1: BIANCA vs Ground truth



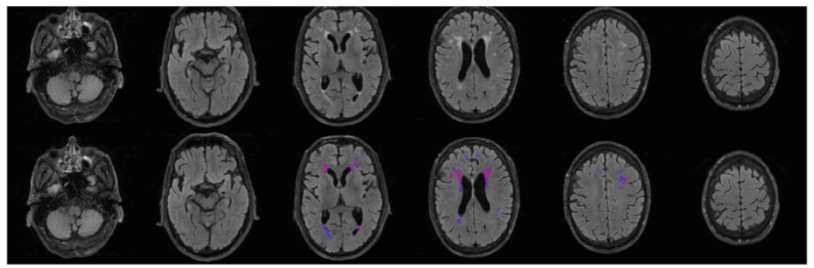
subject2: BIANCA vs Ground truth



subject3: BIANCA vs Ground truth



subject4: BIANCA vs Ground truth



Overlap measures

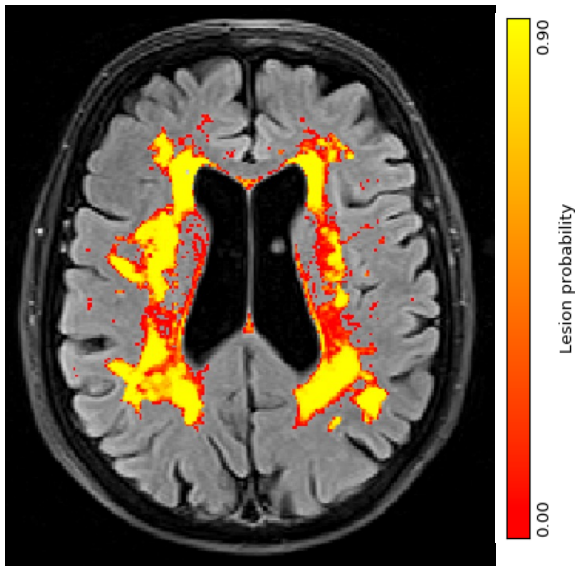
Subject	Total Volume (mm^3)	Ground truth (GT) volume (mm^3)	Diff. volume (BIANCA - GT) (mm^3)	Dice index
subject1	13937.532	16486.486	-15821.468	0.777756
subject2	11502.702	17478.7	-20047.298	0.696347
subject3	9718.268	19207.18	-24951.732	0.634567
subject4	15346.908	24271.294	-28464.092	0.739782

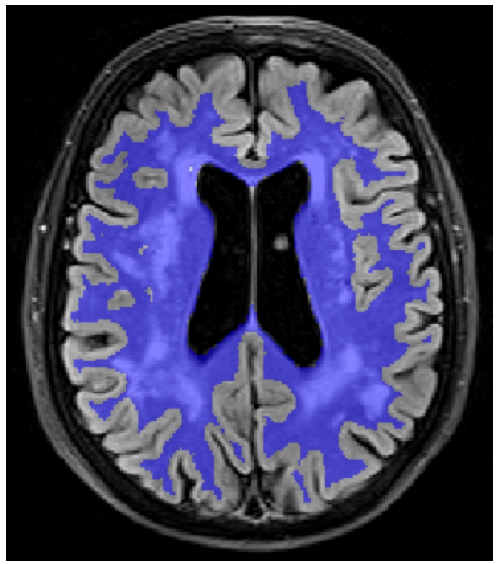
Summary Overlap Measures

Subject	Total Volume (mm^3)	Ground truth (GT) volume (mm^3)	Diff. volume (BIANCA - GT) (mm^3)	Dice index
Average	12626.3525	19360.915	-22321.1475	0.712113

4 Post-processing

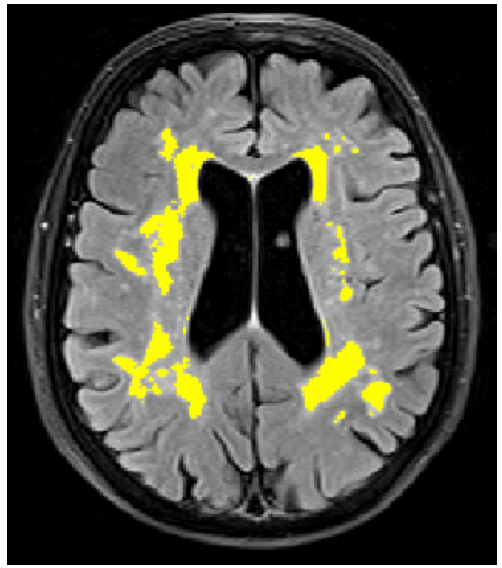
BIANCA





Masking

`make_bianca_mask`

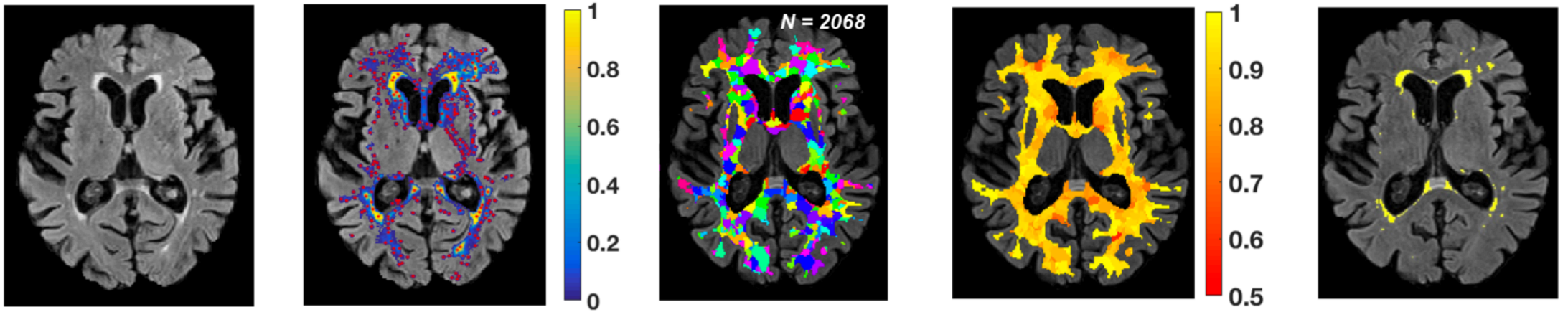


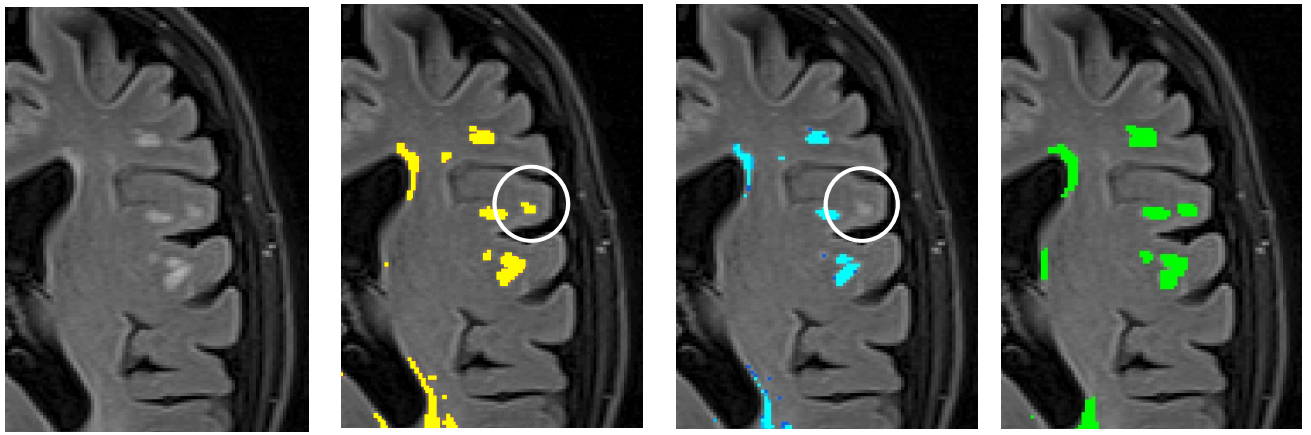
Thresholding

- How to decide the best threshold?
- Is one threshold enough?

Coming soon: LOCally Adaptive Thresholds Estimation (LOCATE)

BIANCA





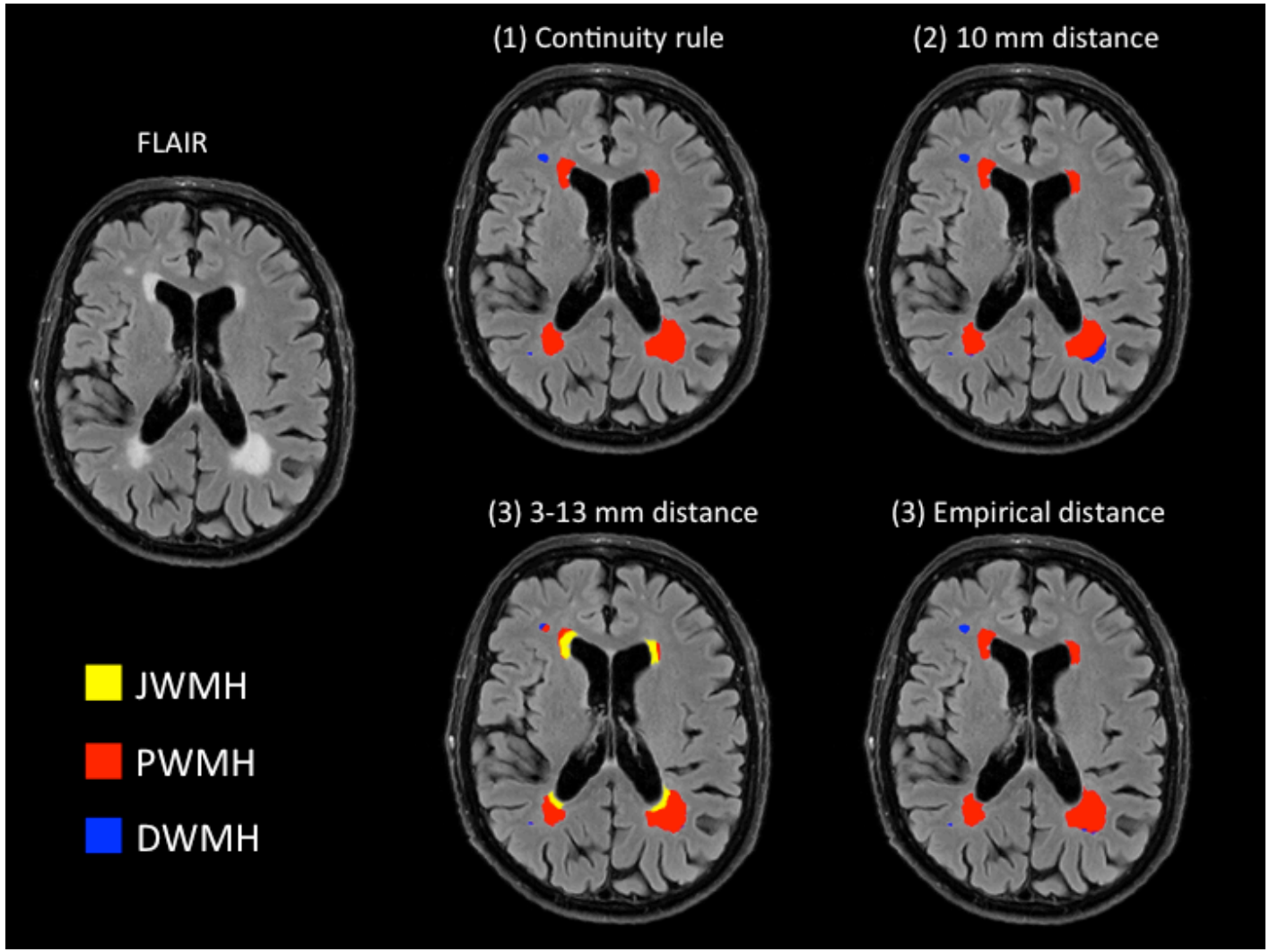
LOCATE FIXED THR Manual

Sundaresan et al., in prep.

Poster n. 2587

Coming soon: WMH sub-classification

BIANCA



Griffanti et al., 2017
Neuroimage

Thank you

BIANCA

University of Oxford
Prof. Mark Jenkinson
Vaanathi Sundaresan
WIN-FMRIB Analysis Group

Poster n. 2587

USER GUIDE
https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/BIANCA

SUPPORT
https://fsl.fmrib.ox.ac.uk/fsl/fslwiki/Support

@ludogriffanti

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