Diffusion MRI Reconstruction

Erjun Zhang

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Brainhack School 2020 Project

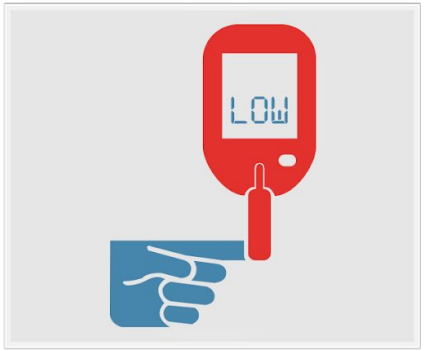
Project Background

1. dMRI: an high resolution while imaging lesions in vivo tissues
2. dMRI limitations: quality of data acquisition, quality of image reconstruction, quality of post analysis
3. dMRI reconstruction:

- Open-source tools: qMRLab
- What behind these tools?

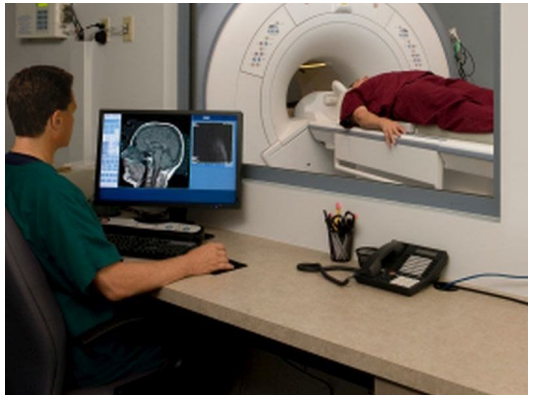
PROBLEMS!

Low blood sugar leads to brain structures changing!



Goals

1. Get preprocessed diffusion MR images from raw data
2. Reconstruct diffusion tensor images from the preprocessed data;
3. By using machine learning, try to classify two hemispherical brains from preprocessed diffusion images



Diffusion MRI: a good method to imaging this changes

Tools Used

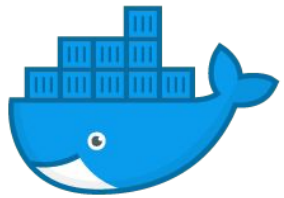
Coding:

Project organization and version control:

Visualization

GitHub

DIPY



Nipype:
Neuroimaging in Python
Pipelines and Interfaces

matplotlib

Datasets

Requirement: epi data with two opposite phase-encoding directions

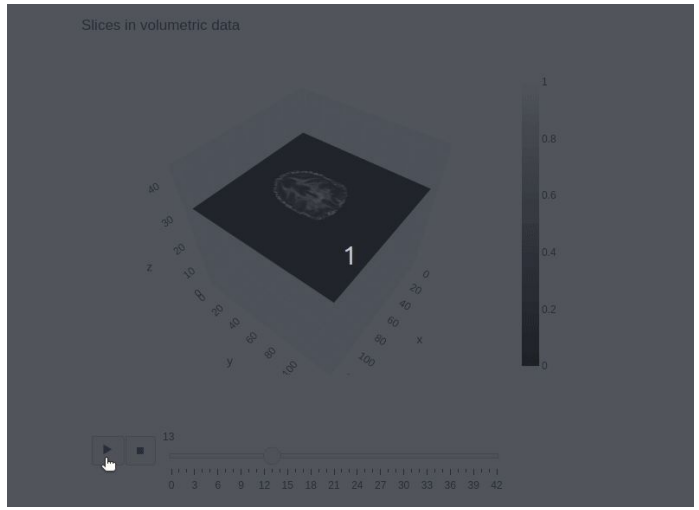
Developing Human Connectome Project

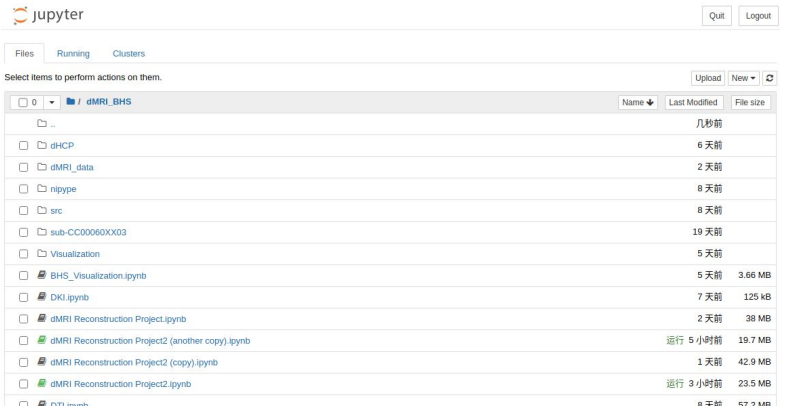
over 800 neonatal scans and over 250 fetal scans

to reconstruct diffusion Images

Deliverables

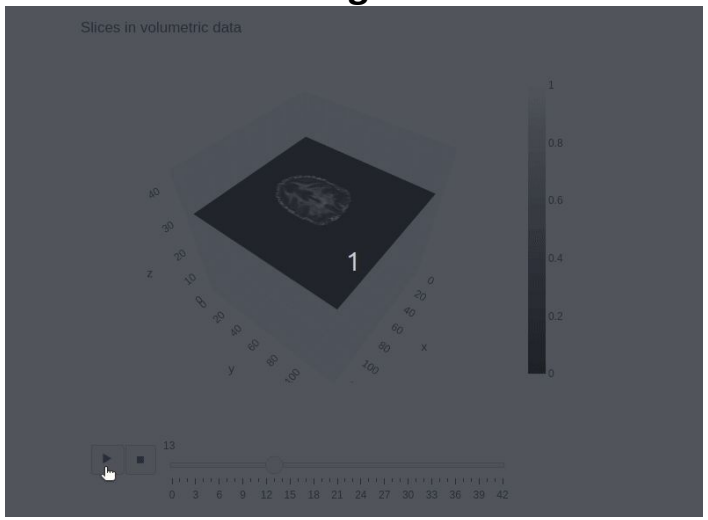
1. Data Visualization
2. Open-source dMRI reconstruction code
3. Markdown files to describe reconstruction details
4. Brain data statistics analysis example
5. Project report
6. Report google slides



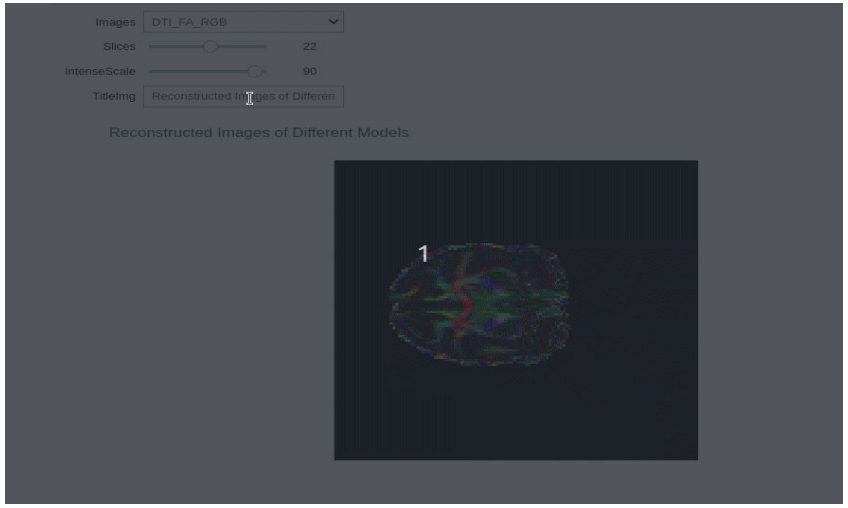


Data Visualization

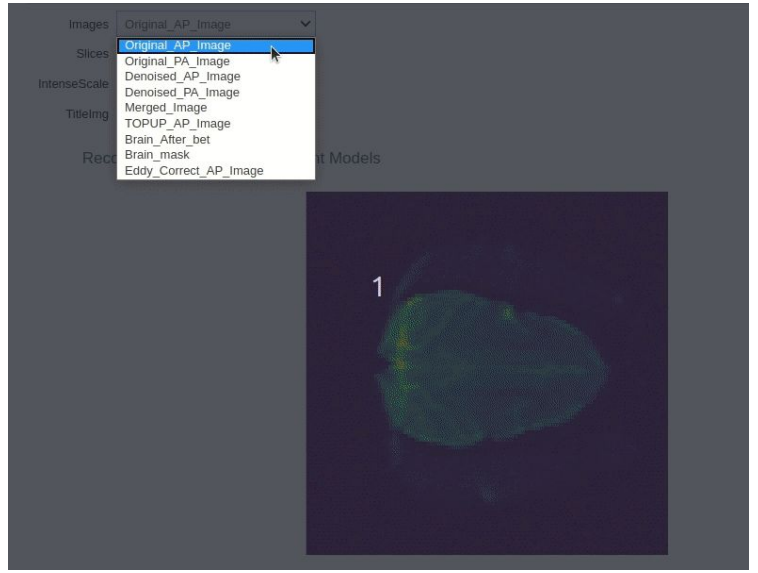
3D volume slices image



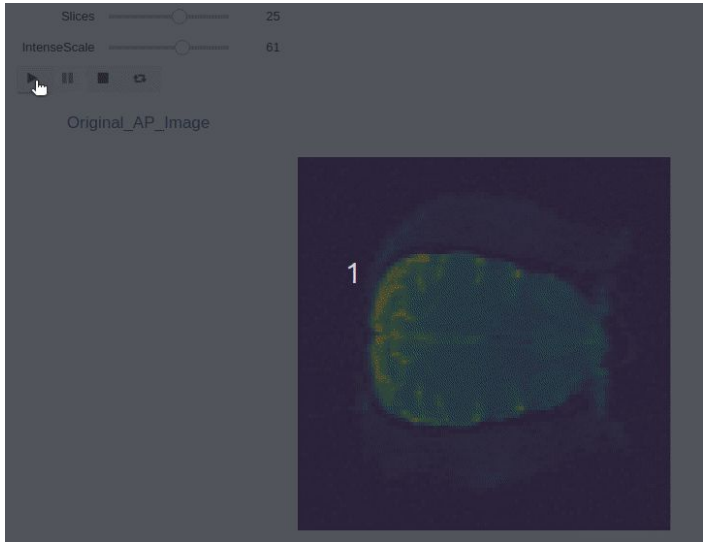
Interactive widgets use to show reconstruction results



Interactive widgets use to show preprocessed results 1



Interactive widgets use to show preprocessed results 2



Skills learnt

Developing Human Connectome Project

python™

DIPY

matplotlib

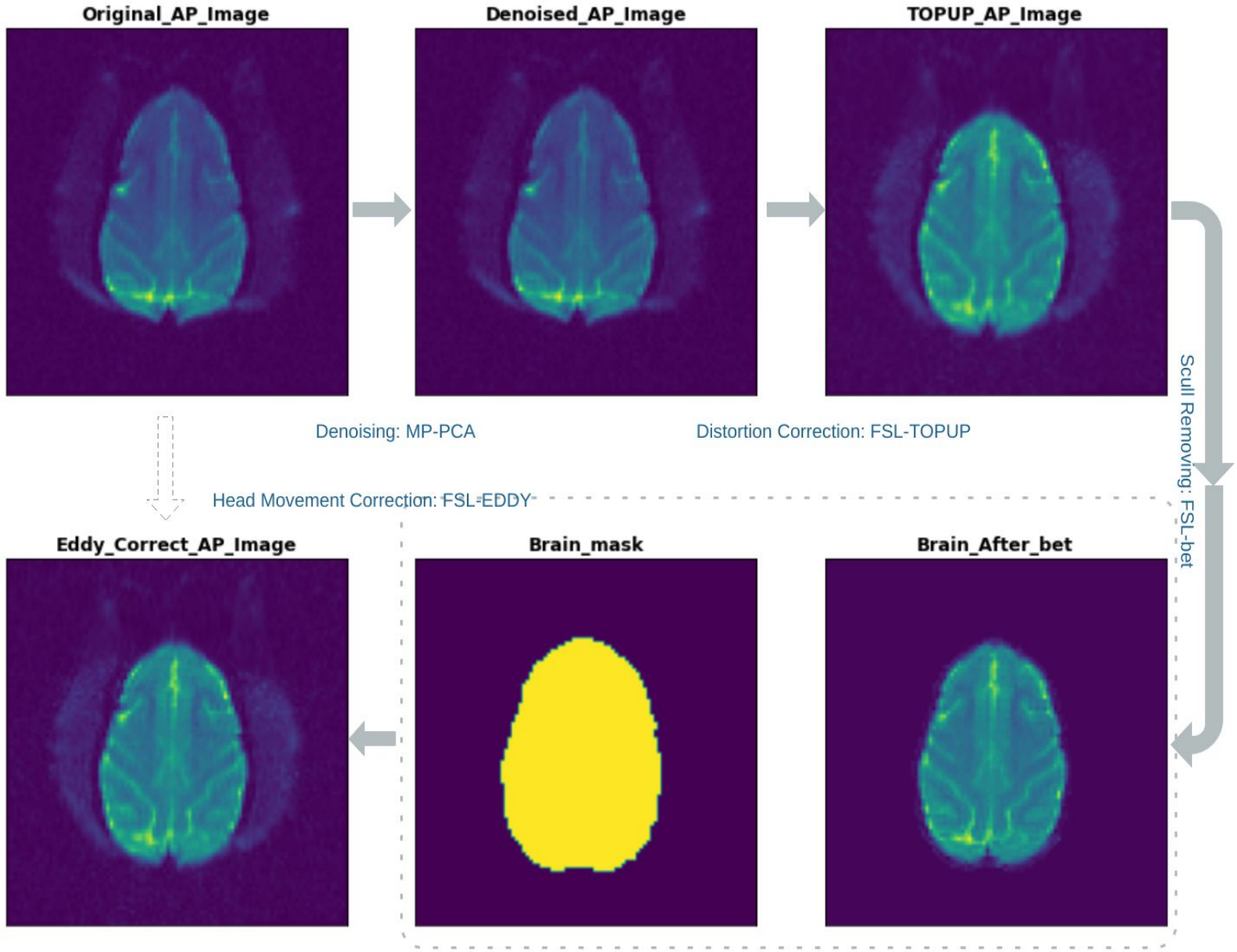
plotly

GitHub

docker

jupyter

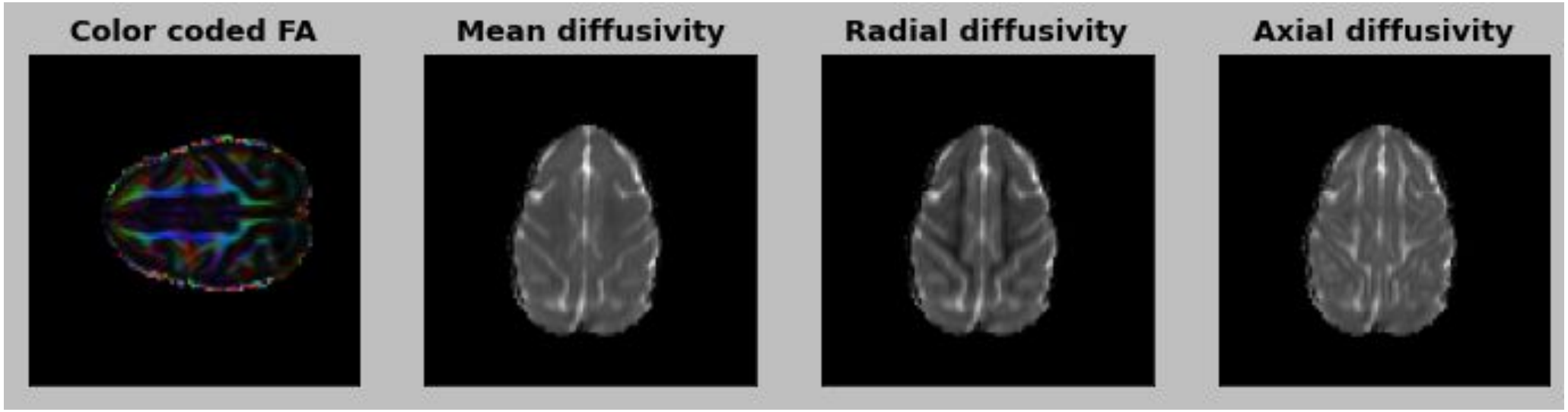
Results 1



Methods:

1. Load diffusion weighted image data and set data
2. Denoise data by using MP-PCA method of DIPY;
3. Correct distortion by using FSL TOPUP;
4. 4. Extract brain and create brain mask by using FST bet;
5. Correct head movement artifacts by using FSL EDDY;
6. Extract maps from 4D data and show results.

Results 2



Methods:

1. DIPY was used to fit tensor model;
2. Different maps were saved;
3. Colored diffusion map was coded and saved;
4. Show maps

Results 3

Methods:

1. 80 Slices of brain images (40 left hemisphere slice and 40 right hemisphere) were extracted and transfered to brain parts classification;
2. Left hemisphere brain image and right hemisphere brain iamge were taged with 0 and 1 specifically;
3. Slice number was treated as one of features used for classification;
4. Diffusino strength of each slice hemisphere was calculated as the second feature of classification;
5. Total effictive voxel of eahc slice hemisphere was calculated as the third feature for classification;
6. Dataset was splitted into train dataset (70%) and test dataset (30%);
7. Use KNN to classify

Left and right hemispheres classification

	precision	recall	f1-score	support
0.0	0.91	0.91	0.91	11
5.0	0.92	0.92	0.92	13
accuracy			0.92	24
macro avg	0.92	0.92	0.92	24
weighted avg	0.92	0.92	0.92	24

What To Do Next

- Combine different processing methods into this project
- Look deep into DTI model fitting
- Try to replace it by a new model created by myself

Thanks