Preparing a structural MRI target for EPI distortion correction and Creating a reorientation template

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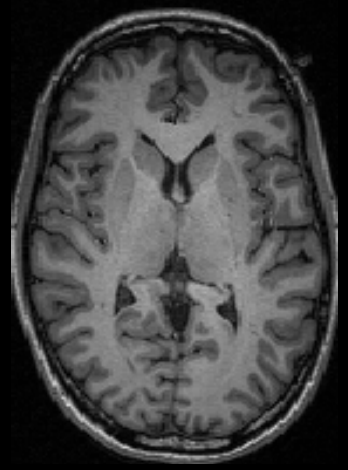
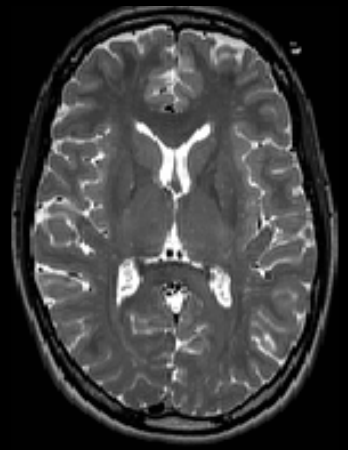
Structural MRI target for EPI correction

TORTOISE (DIFFPREP and DRBUDDI) requires good quality T2W structural images for best EPI distortion correction.

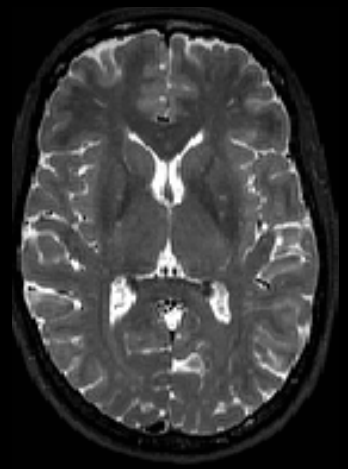
It is STRONGLY recommended that you use a T2W fat suppressed, artifact free, isotropic voxel, high resolution data.



T1W



T2W non fat suppressed



T2W fat suppressed

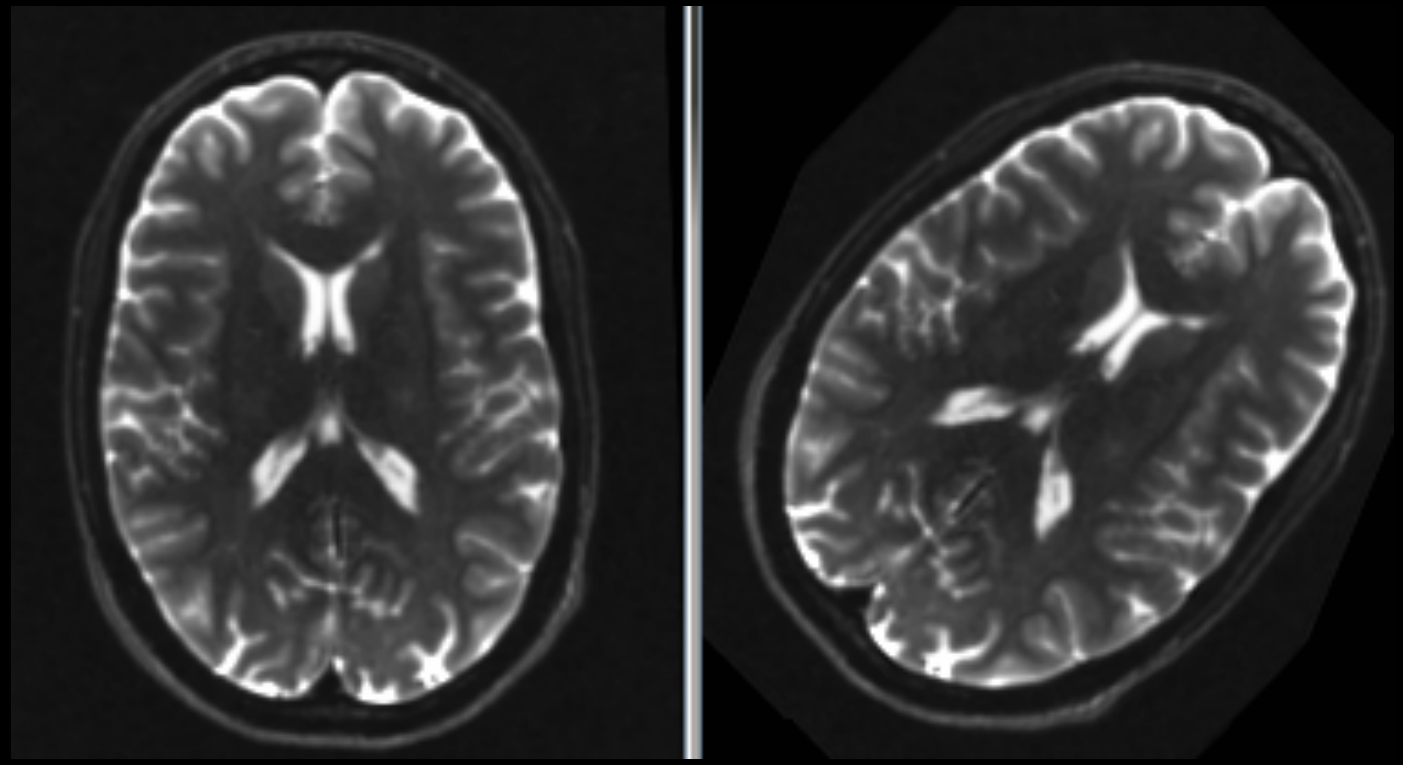
Dr. Joelle Sarlls can further guide you on good T2W acquisition protocols.

Reorientation template for DWIs and final DTI data

- Why do we need to reorient ?

T2W ACPC

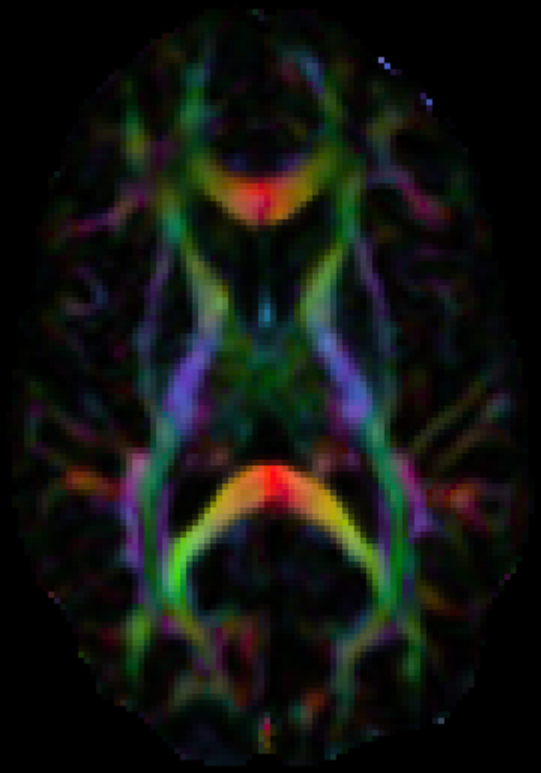
T2W non ACPC



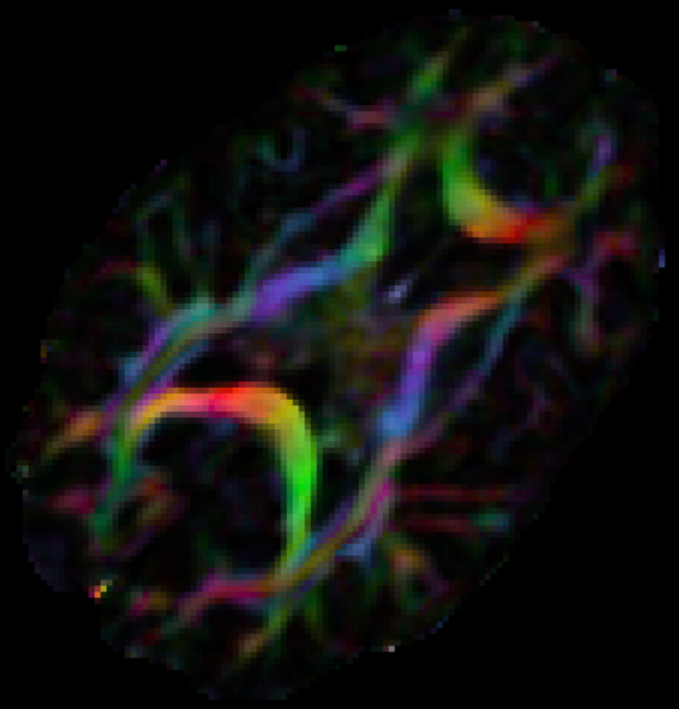
With scalar images the values at each voxel location are invariant upon rotation.

Directionally Encoded Color (DEC) maps

DEC map generated using ACPC structural



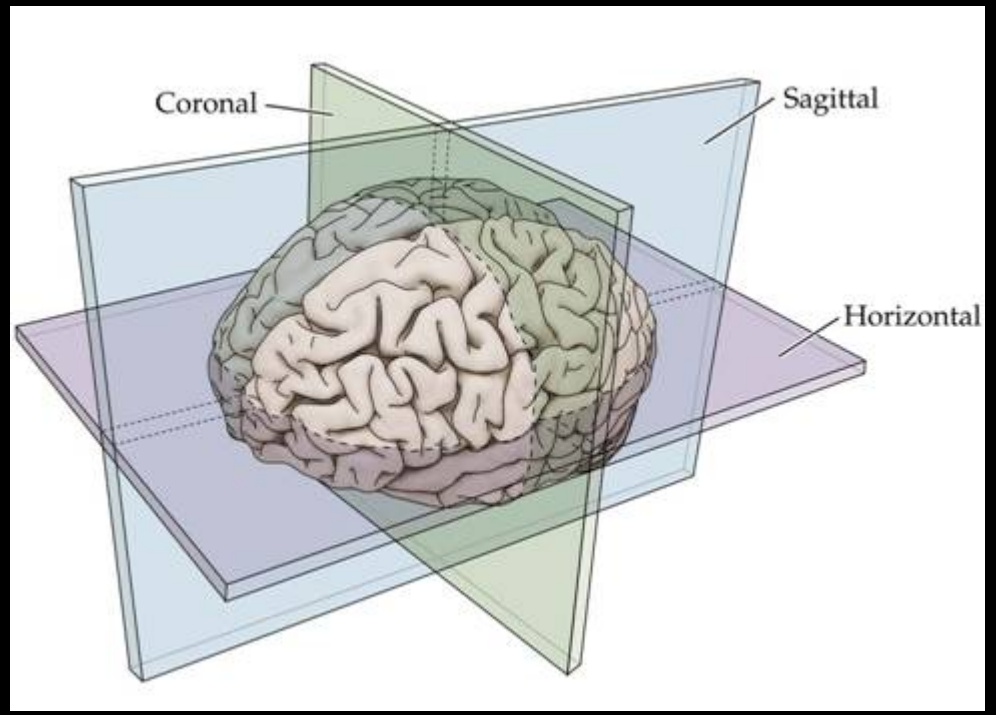
DEC map generated using non ACPC structural

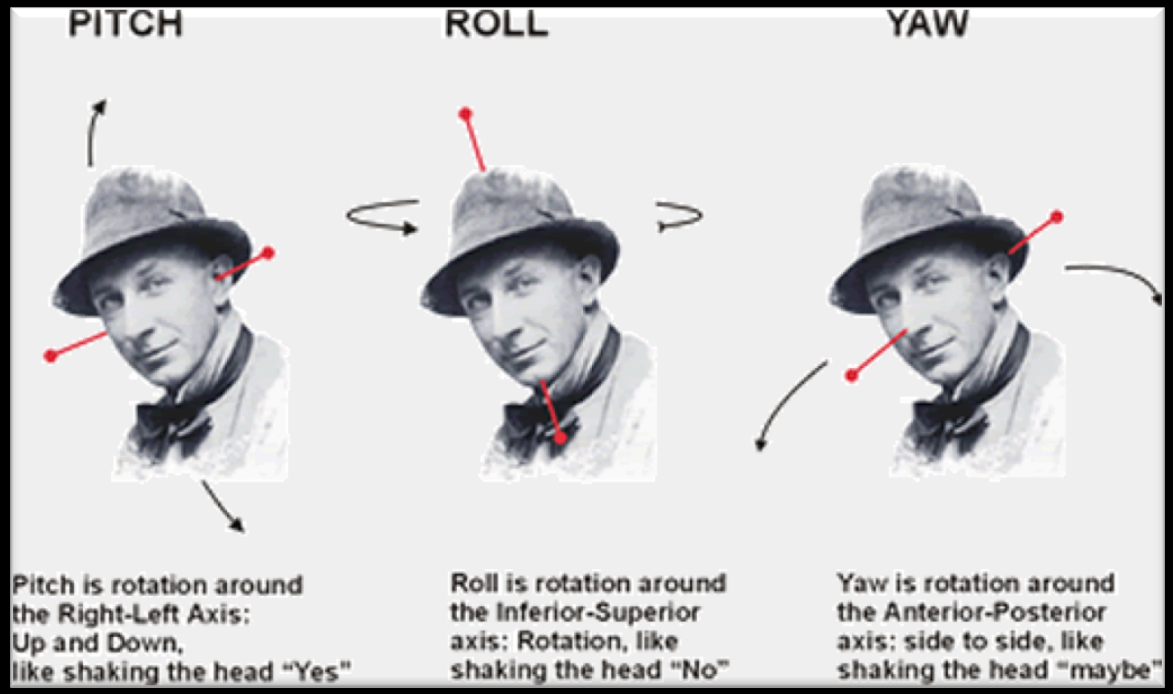


Reorientation template for DWIs and final DTI data

- What would be the ideal orientation I want to achieve?

The ideal orientation would be when the horizontal plane and the sagittal plane are orthogonal to each other.





Images courtesy Google images

A simple strategy for creating a reorientation template in DIFFPREP is to provide the structural MRI used for EPI correction properly rotated and translated to achieve the desired standardized orientation

Reorientation template for DWIs and final DTI data

Different communities may use different strategies to achieve these goals.

- Typically Radiologists prefer a so called AC-PC aligned image.
- Neuroscientists have used registration to various average brain templates.

Why AC-PC alignment?

- Anterior Commissure (AC) and Posterior Commissure (PC) are well preserved points on the same axis of the brain.
- They are usually less affected by pathology than the overall shape of the brain.

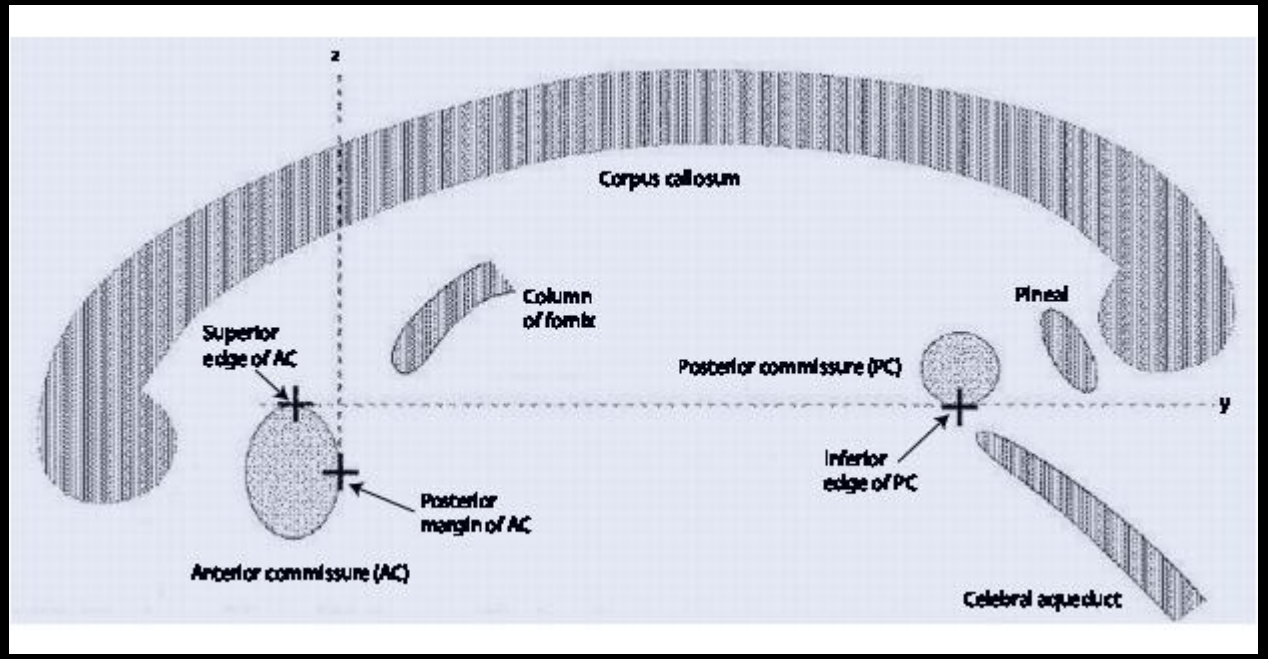
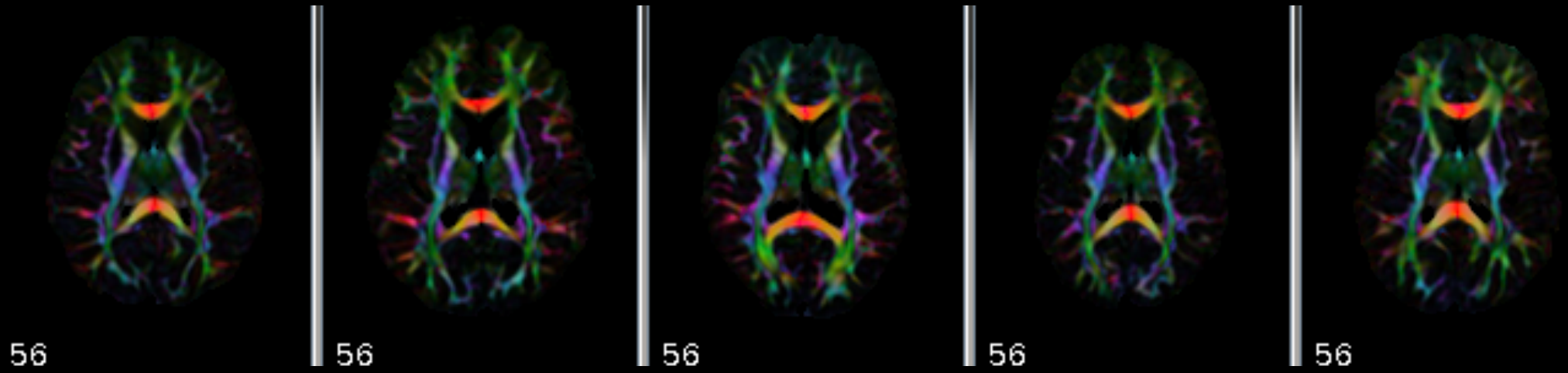


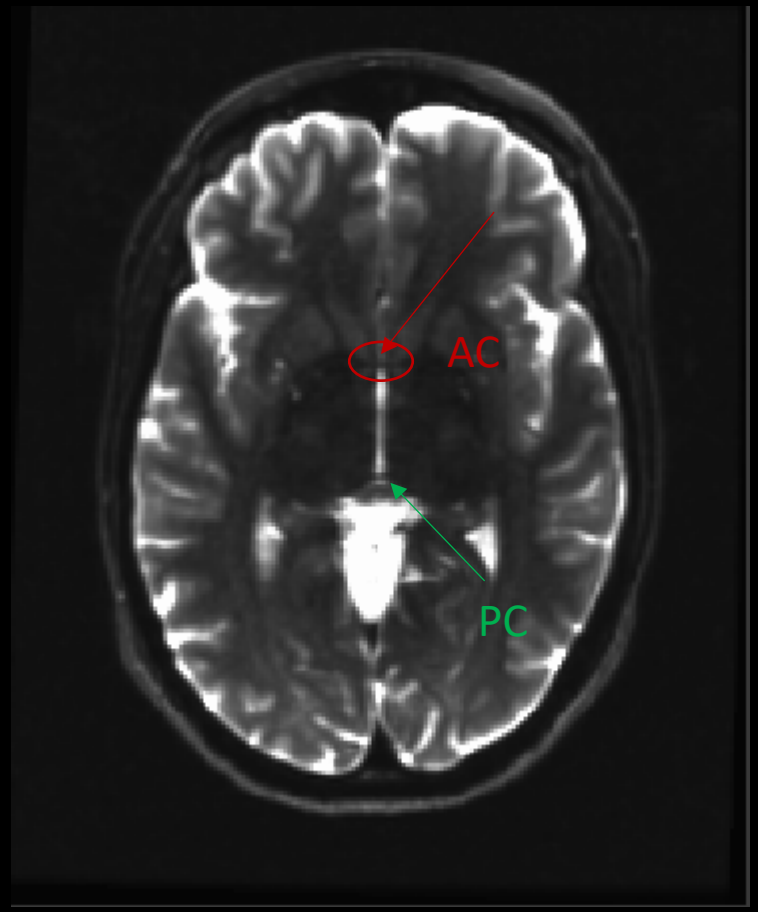
*image courtesy of MIPAV acpc alignment manual

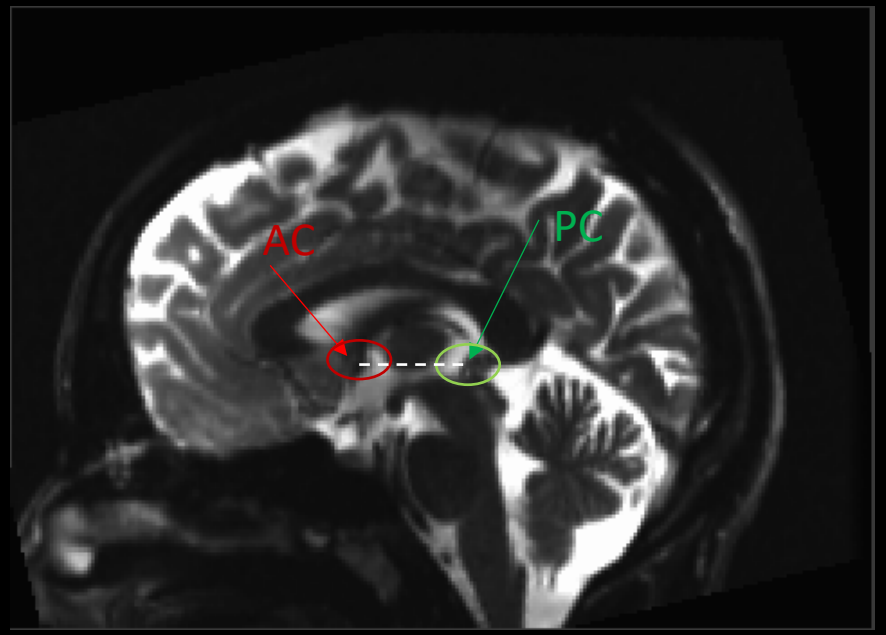
DEC maps in AC-PC orientation



Subject1 Subject2 Subject3 Subject4 Subject5

Identifying ACPC points on a T2W structural image





Present method within the TORTOISE group: MIPAV AC-PC alignment

- Semi automatic method with automatic midsagittal alignment but need to manually identify 5 prescribed landmarks on the structural image to AC-PC align the data.
- Needs accurate identification of the points and can result in inter rater variability.
- Labor intensive !

For instructions on performing AC-PC alignment using MIPAV, please visit the following page: https://mipav.cit.nih.gov/pubwiki/index.php/Select_Algorithms_and_Brain_Tools_for_Talairach_Transform

Template based alignment

Images will be registered to a template but just with a rigid body transformation.

AFNI-FATCAT Axialization (fat_proc_axialize_anat) tool with additional landmark placement

- Aligns images to a reference template of same contrast.
- The image is registered using an affine transformation to the template but only applies the rigid and rotation component to the image, not warping the images to the template.
- Good mid sagittal alignment of data
- Morphologically faithful images in the space of the template.
- Currently it is not designed to identify AC-PC points and thus the resulting images are AXIALISED and not AC-PC aligned, although it will bring you closer to that solution provided the data to be aligned matches the reference template.

https://afni.nimh.nih.gov/pub/dist/doc/htmldoc/tutorials/fatcat_prep/Prepreprocessing.html#axialize-the-anatomical

Requirements to run

fat_proc_axialize_anat:

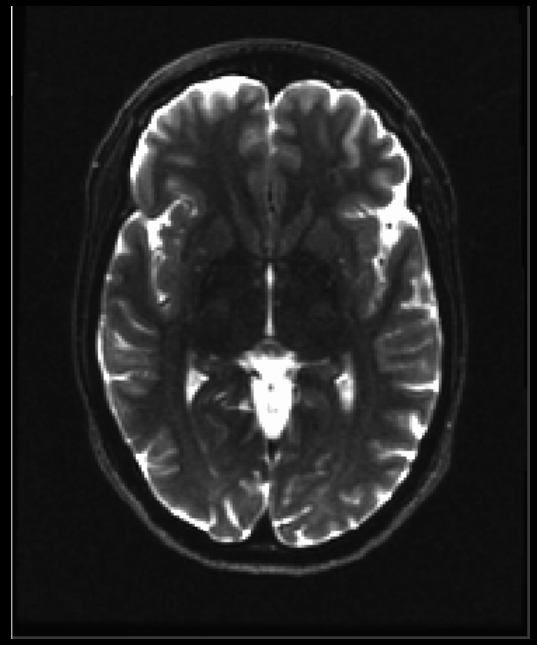
1) AFNI needs to be installed
2) A good reference template that matches your study population in contrast

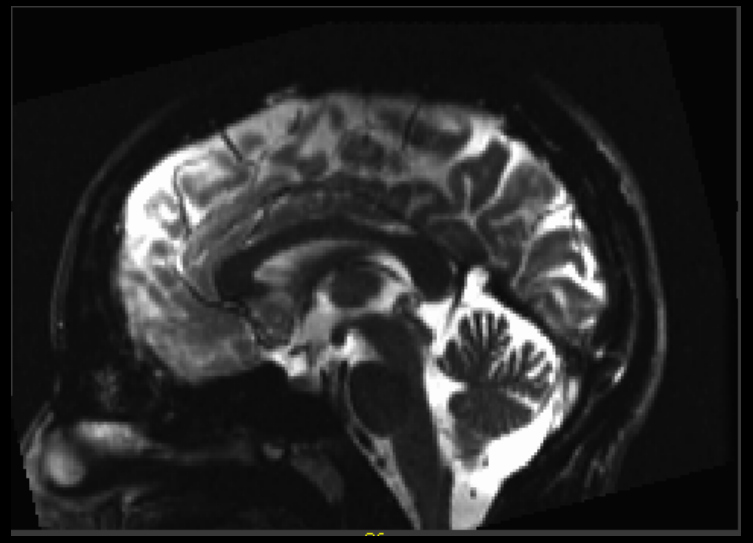
Things to remember

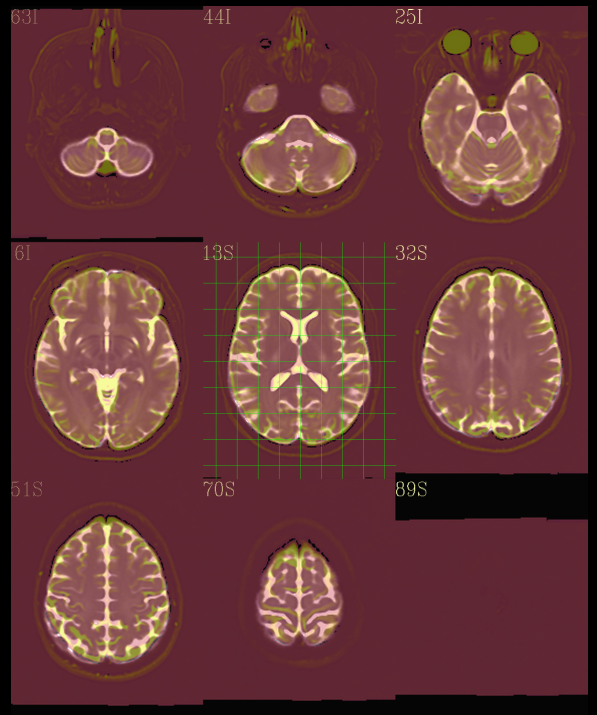
1) Specific patient group may be problematic due to the brain size differences and can cause the output to not be completely axialized.
2) Default parameters may work in general but may need to be adjusted depending on data

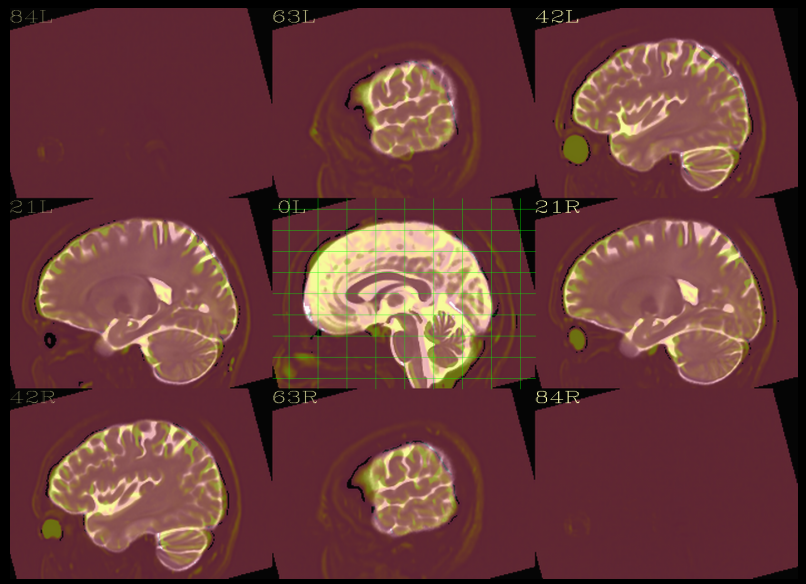
Useful Features

1) Working directory with outputs at various stages of alignment are output for debugging.
2) outputs screenshots (png files) of axial, coronal and sagittal slices output for quick visual check.









Auto ACPC tool

- Automatic identification of AC-PC points
- Mainly works on T1W data

http://www.nitrc.org/projects/art/

Remember!

Please be consistent with type of method you choose in standardizing your structural data, within a study.