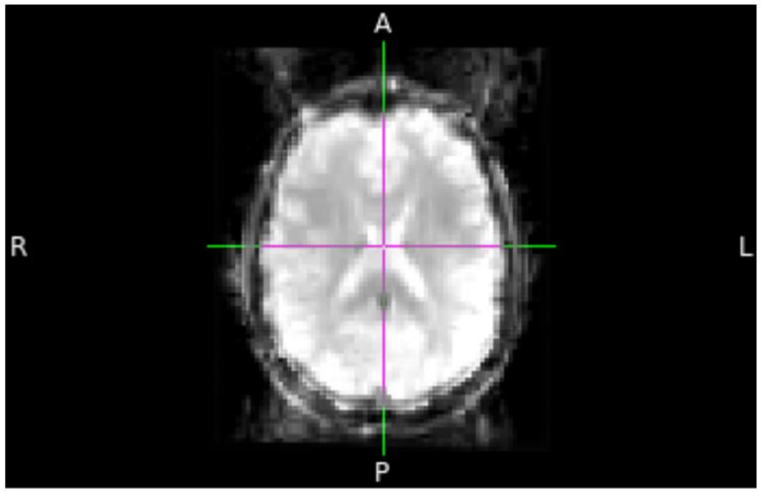
FSL pre-processing

Neuroimaging workshop session #8

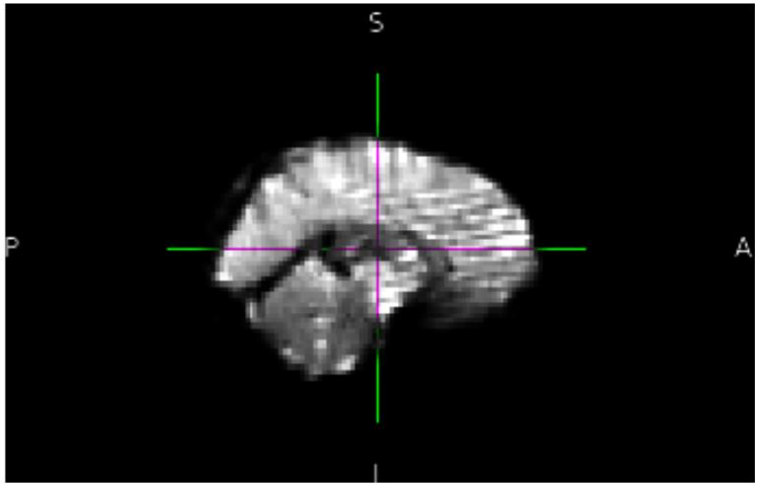
Outline

- Command line processing (bash scripting)
- Introduction to bash https://peerherholz.github.io/workshop_weizmann/prerequisites/intro_to_shell.html
- GUI: Follow this tutorial (https://andysbrainbook.readthedocs.io/en/latest/fMRI_Short_Course/fMRI_04_Preprocessing.html)
- FMRIprep https://fmriprep.org/en/stable/

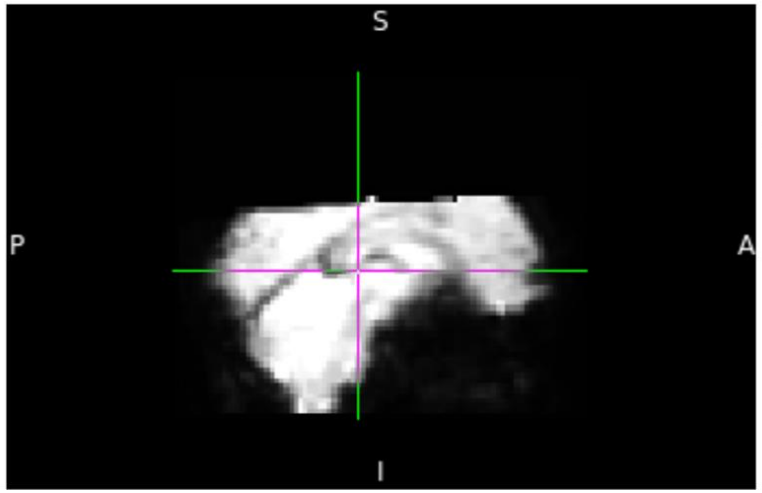
First pass



Ghost like artifact

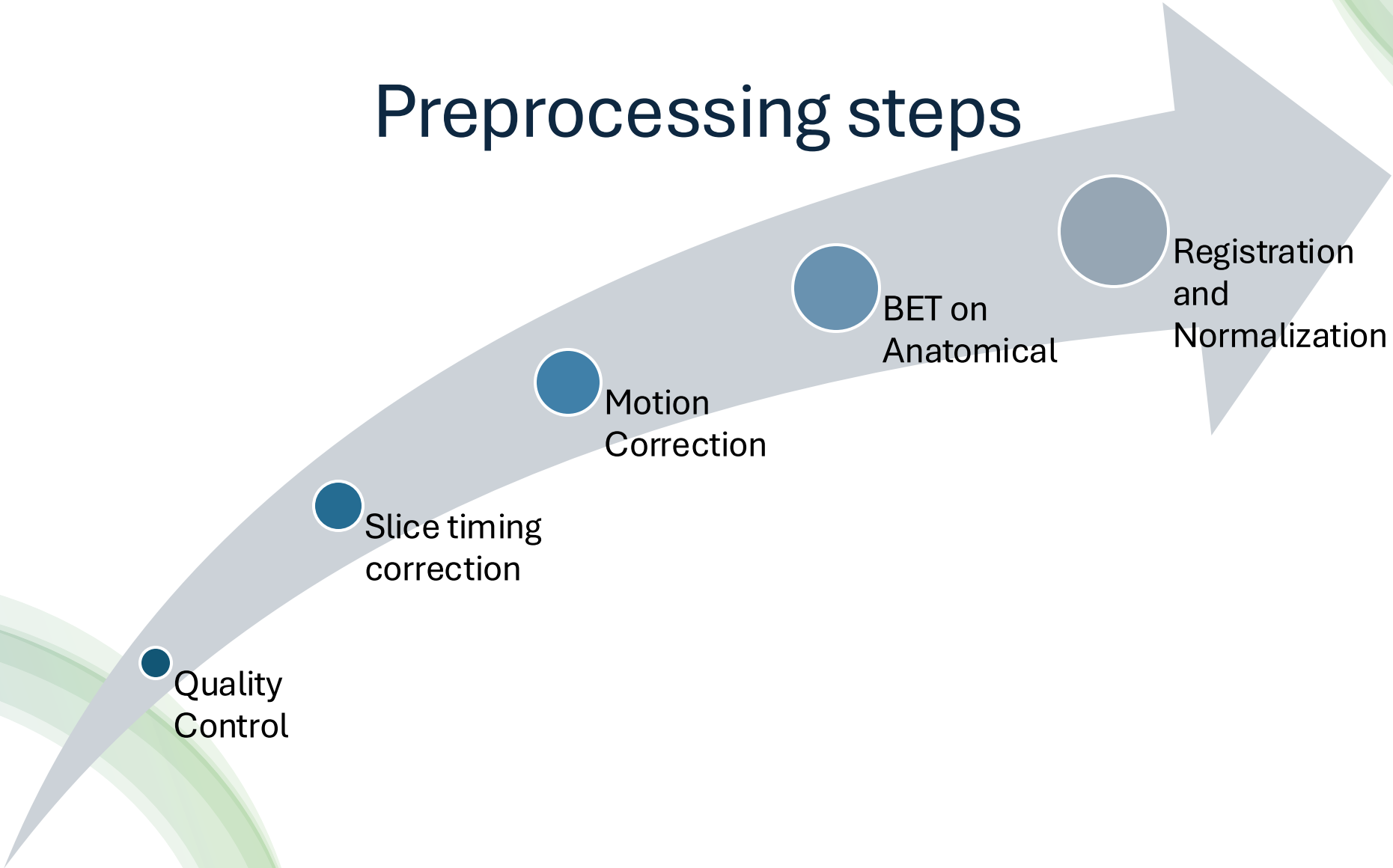


Scanner related artifact



Brain cut like errors

Preprocessing steps



Constants and variables

- Input fMRI: `sub-CC120182/ses-1/func/sub-CC120182_task-rest_bold.nii.gz`
- Input anat: `sub-CC120182/ses-1/anat/sub-CC120182_T1w.nii.gz`

- Output directory: fsl_preproc_outputs

- Repetition time

```
fslval sub-CC120182/ses-1/func/sub-CC120182_task-rest_bold.nii.gz pixdim4
```

Extract volumes of functional data

- Extract info "fslinfo"

```
fslinfo sub-CC120182/ses-1/func/sub-CC120182_task-rest_bold.nii.gz
```

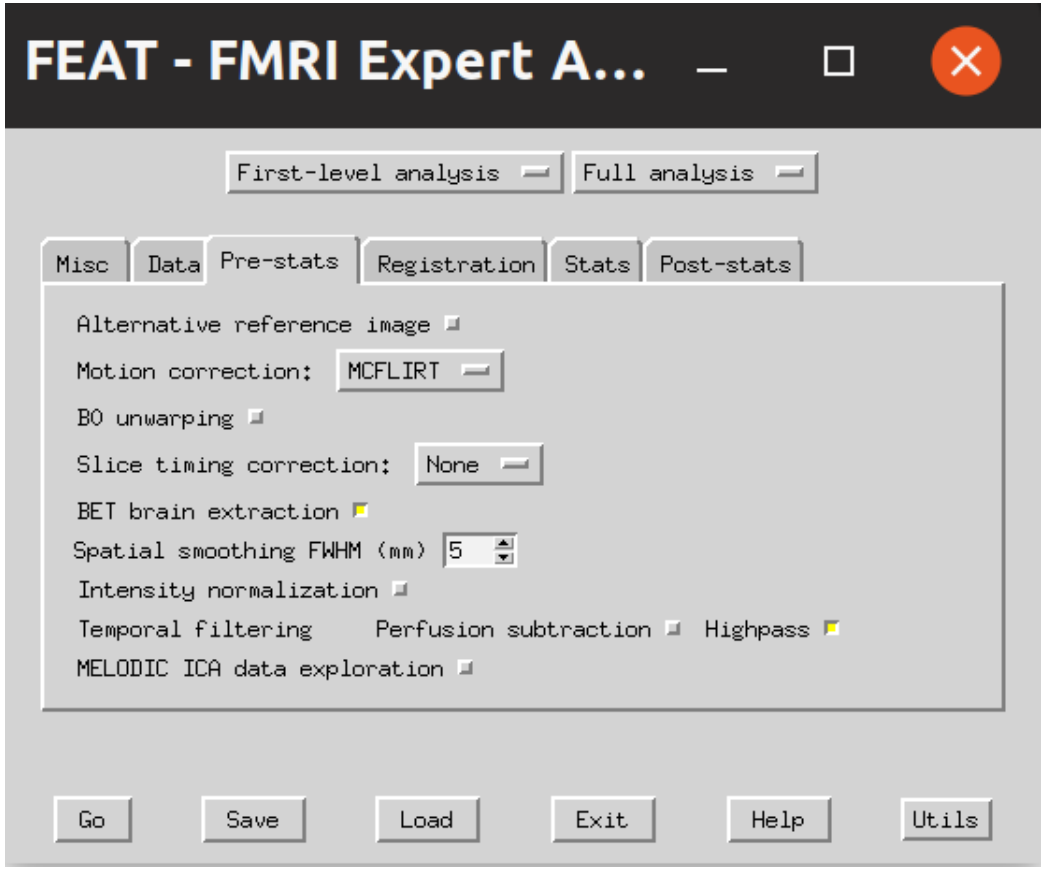
- Extract of one volume "fslroi"

Slice timing correction

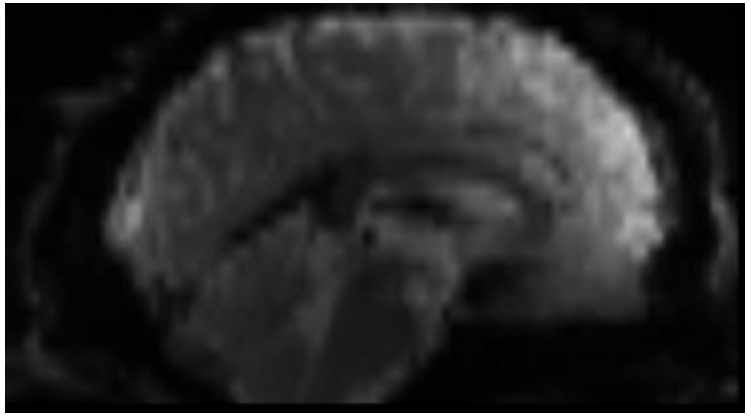
https://andysbrainbook.readthedocs.io/en/latest/fMRI_Short_Course/Preprocessing/Slice_Timing_Correction.html

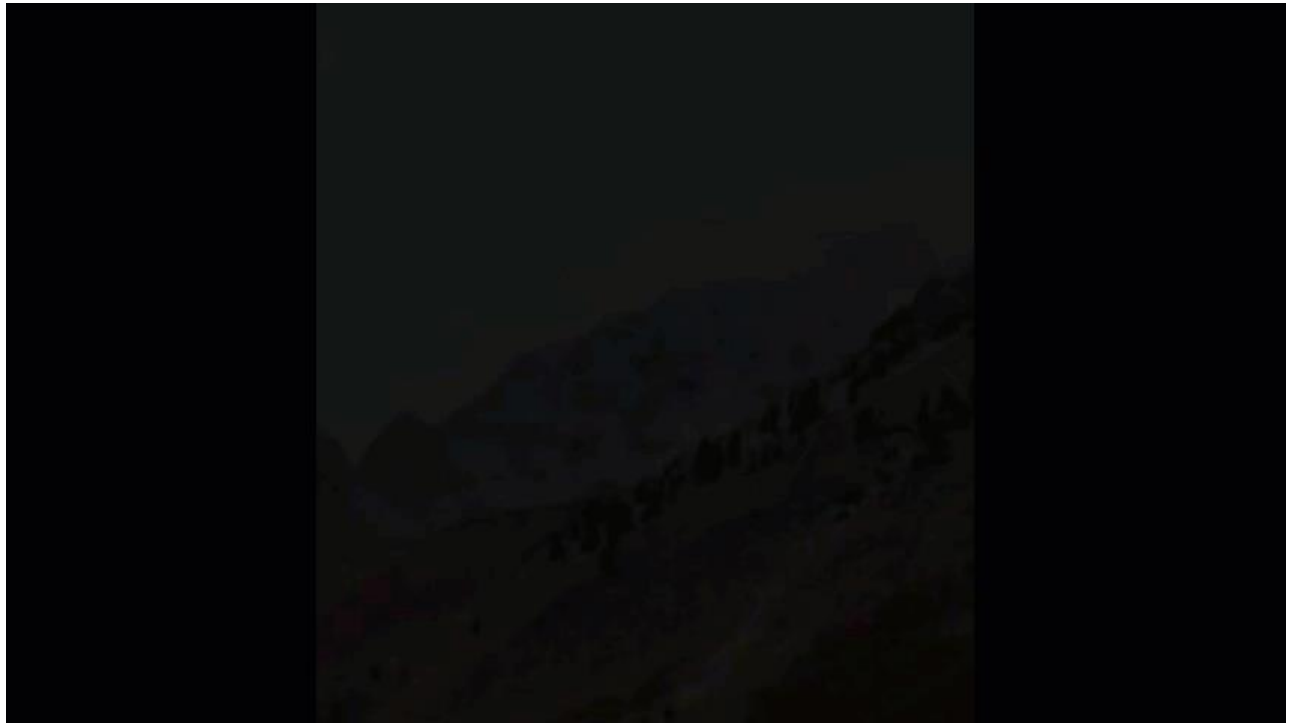
Slice timing correction in FSL

slicetimer -i input_image.nii.gz -o output_func_data_st –r TR --odd



Motion in fMRI





https://andysbrainbook.readthedocs.io/en/latest/fMRI_Short_Course/Preprocessing/Motion_Correction.html

Motion correction in FSL

```
mcflirt -in output_func_data_st -out output_func_data_mcf –plots –refvol 0
```

Plotting motion parameters

```
fsl_tsplot -i output_func_data_mcf.par -t "MCFLIRT rotation radians" -u 1 –start=1 –finish=3 –a x,y,z –w 640 –h 144 –o rot.png
```

BET on functional image

fslmaths output_func_data_mcf –Tmean mean_func

bet2 mean_func mask –f 0.35 -n –m

fslmaths output_func_data_mcf –mas mask_mask output_func_data_bet

fslmaths output_func_data_bet –Tmean mean_func

BET on structural image

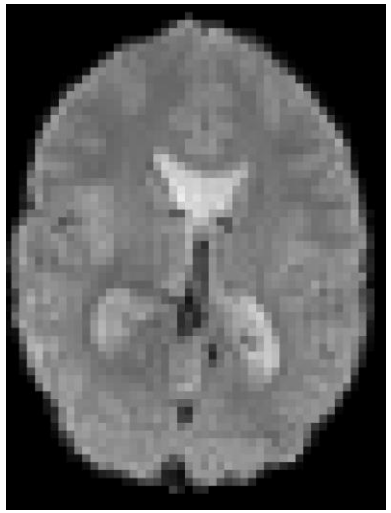
```
fslreorient2std
bet input_structural structural_brain –B –f 0.35
```

Segment BET image into 3 classes

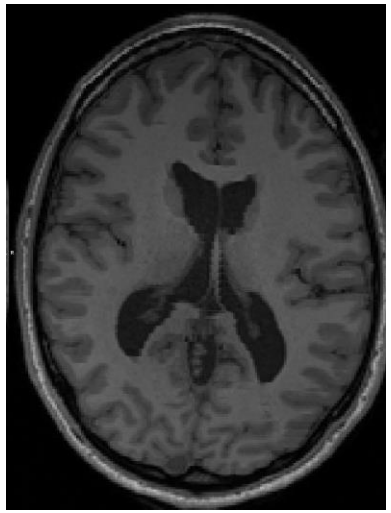
```
fast –t 1 –n 3 –B –g –o structural_brain structural_brain
```

Registration – input images

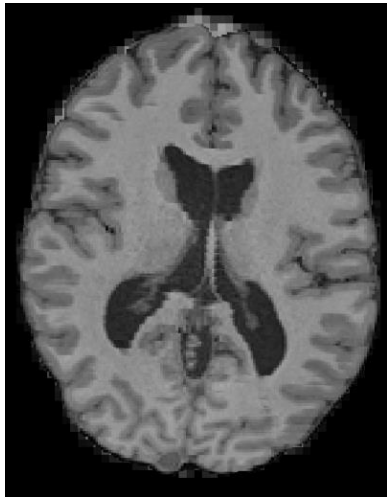
Subject images



Mean functional

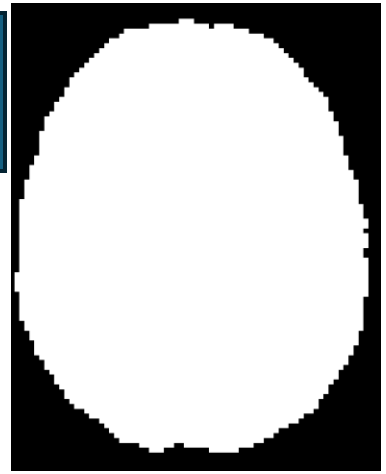


Structural



Structural brain

Standard templates

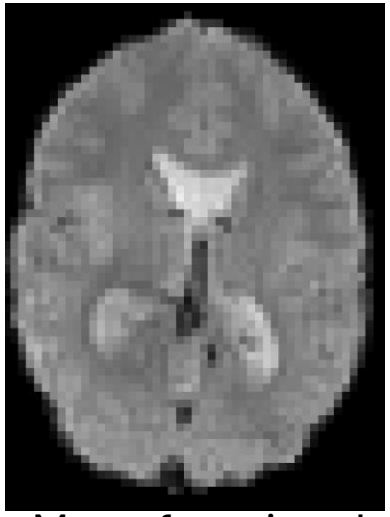


Registration methodology

https://andysbrainbook.readthedocs.io/en/latest/fMRI_Short_Course/Preprocessing/Registration_Normalization.html

Registration – linear schematic

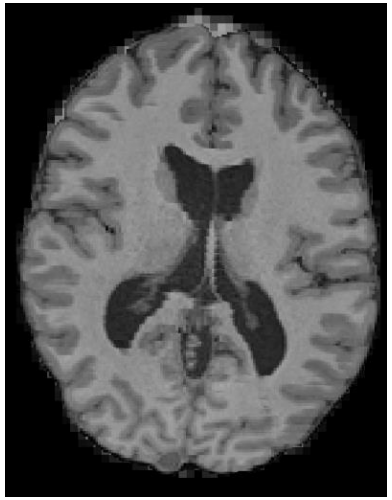
Mean functional to high resolution



Mean functional

Structural brain

High resolution to standard



Structural brain

Standard template

Registration – linear

Mean functional to high resolution subject brain

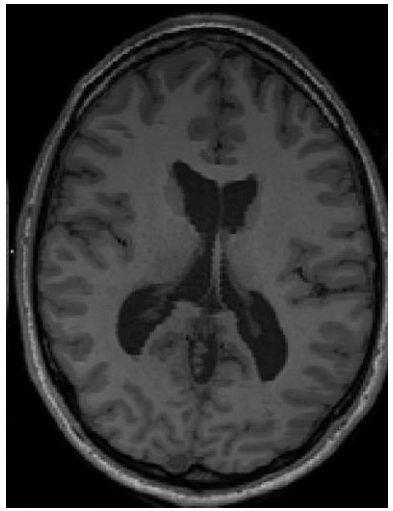
```
flirt -ref structural_brain.nii.gz -in mean_func.nii.gz -out meanfunc2highres -omat meanfunc2highres.mat -cost corratio -dof 6 -searchrx -90 90 -searchry -90 90 -searchrz -90 90 -interp trilinear
```

High resolution subject brain to standard

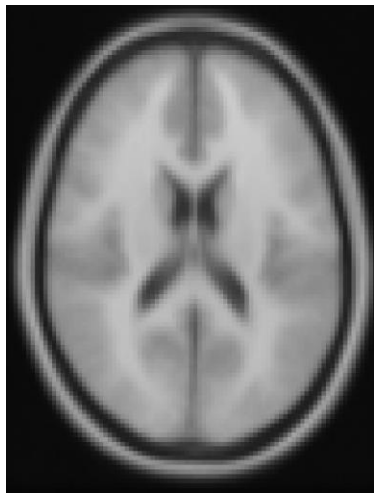
```
flirt -ref /usr/local/fsl/data/standard/MNI152_T1_2mm_brain -in structural_brain_restore.nii.gz -out highres2standard -omat highres2standard.mat -cost corratio -dof 12 -searchrx -90 90 -searchry -90 90 -searchrz -90 90 -interp trilinear
```

Registration – nonlinear schematic

High resolution to standard



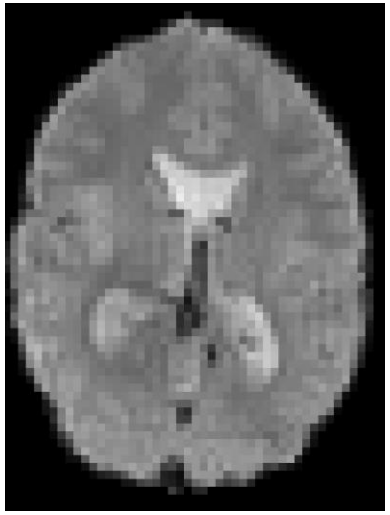
Structural



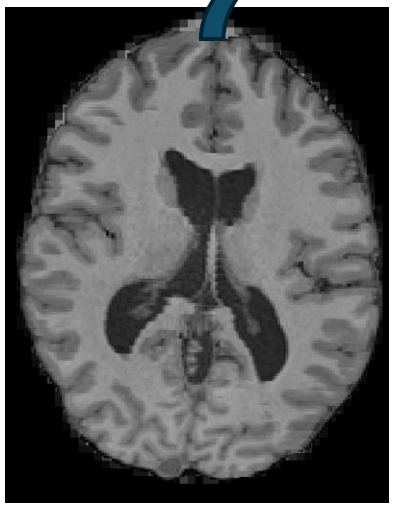
Standard

Warp output

Apply transformations to mean functional



Mean functional



Structural brain

Mean functional

Registration non-linear

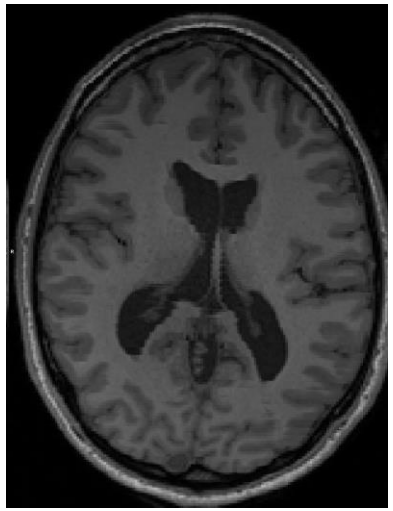
High resolution subject brain to standard

```
fnirt --in=structural.nii.gz --aff=highres2standard.mat --
cout=highres2standard_warp --iout=highres2standard_fnirt --
jout=highres2standard_jac --config=T1_2_MNI152_2mm --
ref=/usr/local/fsl/data/standard/MNI152_T1_2mm --
refmask=/usr/local/fsl/data/standard/MNI152_T1_2mm_brain_mask --
warpres=10,10,10
```

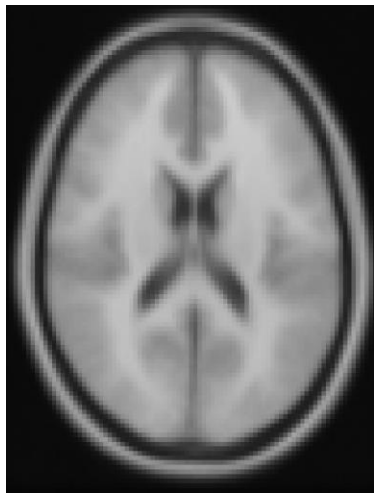
```
applywarp --ref=/usr/local/fsl/data/standard/MNI152_T1_2mm_brain --
in=mean_func.nii.gz --out=meanfunc2standard_w --
warp=highres2standard_warp --premat=meanfunc2highres.mat
```

Registration – nonlinear schematic

High resolution to standard



Structural



Standard

Apply transformations to high resolution anatomical

Structural

Registration non-linear

Apply transformation to high resolution subject brain

```
applywarp --ref=/usr/local/fsl/data/standard/MNI152_T1_2mm_brain --
in=structural_brain --out=highres2standard_w --warp=highres2standard_warp
```

Final step in registration

```
applywarp --ref=/usr/local/fsl/data/standard/MNI152_T1_2mm --
in=filtered_functional_data --warp=highres2standard_warp.nii.gz --
out=registered_functional --premat=meanfunc2highres.mat --interp=trilinear
```

Steps not covered here

- Frame Displacement Estimation
- Confounds Extraction
- Bandpass filtering