



FMRIPREP

ROBUST.EASY.TRANSPARENT



What is it?

fMRI data preprocessing tool



Preprocessing?

denoising and normalization

What it is not

- ▶ GLM
- ▶ DCM
- ▶ connectivity
- ▶ dynamics
- ▶ etc.

Principles

- ▶ Easy to install and use
- ▶ Robust – works on any* data
- ▶ Transparent – “glass box”
rather than “black box”

Details

- ▶ T1w preprocessing
- ▶ EPI preprocessing
- ▶ Transformations

T1w preprocessing

- ▶ N4 bias field correction (ANTs)
- ▶ Skull stripping (ANTs)



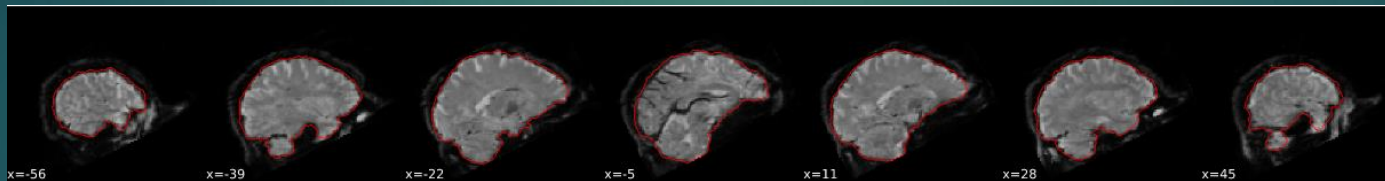
- ▶ 3 class tissue segmentation (FSL FAST)



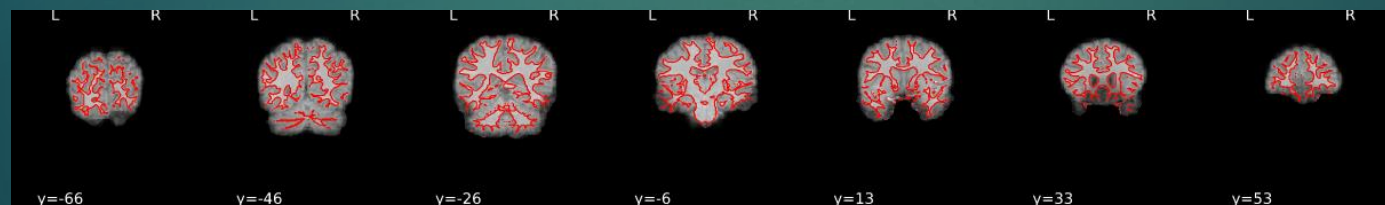
- ▶ Robust MNI coregistration (ANTs)

EPI preprocessing

- ▶ Motion correction (FSL MCFLIRT)
- ▶ Skull stripping (nilearn)



- ▶ Coregistration to T1 (FSL FLIRT with BBR)



EPI preprocessing

- ▶ Confounds estimation (nipype)
 - ▶ DVARS
 - ▶ Framewise displacement
 - ▶ Global signal
 - ▶ Mean tissue signals
 - ▶ CompCor (temporal and anatomical)

EPI transformations

- ▶ Combination of:
 - ▶ Motion correction affines
 - ▶ EPI \rightarrow T1 affine
 - ▶ T1 \rightarrow MNI affine
 - ▶ T1 \rightarrow MNI warp field
- ▶ Single interpolation step
- ▶ No upsampling (keeping original voxel size)

Input

A BIDS formatted dataset

<http://bids.neuroimaging.io>

Outputs

- ▶ T1w
 - ▶ Bias corrected volume
 - ▶ Brain mask
 - ▶ Tissue segmentation (+probability maps)
 - ▶ Affine and warp to MNI (both ways)

Outputs

- ▶ EPI
 - ▶ Motion corrected images
 - ▶ Brain mask
 - ▶ Affine T1w
 - ▶ Tabular text file with all noise confounds
- ▶ All volumes in MNI and T1w space

fmriprep/

README.txt

sub-01/

anat/

sub-01_T1w_preproc.nii.gz

sub-01_T1w_brainmask.nii.gz

sub-01_T1w_class-CSF_probtissue.nii.gz

sub-01_T1w_class-GM_probtissue.nii.gz

sub-01_T1w_class-WM_probtissue.nii.gz

sub-01_T1w_target-MNI152NLin2009cAsym_affine.txt

sub-01_T1w_target-MNI152NLin2009cAsym_warp.nii.gz

func/

sub-01_task-nback_bold_brainmask.nii.gz

sub-01_task-nback_bold_preproc.nii.gz

sub-01_task-nback_bold_confounds.tsv

sub-01_task-nback_bold_space-MNI152NLin2009cAsym_brainmask.nii.gz

sub-01_task-nback_bold_space-MNI152NLin2009cAsym_preproc.nii.gz

sub-02/

sub-03/

sub-04/

GlobalSignal	WhiteMatter	FramewiseDisplacement	tCompCor0
-0.2581	2.0061	1.1279	0.0653
0.2227	1.3199	1.1339	0.0452
-5.1468	1.4347	1.14117	0.0672
0.2979	-2.9292	1.1296	0.1186
0.2315	0.1759	0.2456	0.0781

REPORTS

Installation

- ▶ For single user machines (laptops desktops): Docker
 - ▶ Works on Mac, Windows and Linux
- ▶ For multi user compute clusters (Sherlock): Singularity
- ▶ Both options provide all of the required dependencies

Docker

► Install: <https://docs.docker.com/engine/installation/>

► Run:

```
docker run --rm \
-v $HOME/ds005:/data:ro \
-v $HOME/ds005_preprocessed:/out \
poldracklab/fmriprep:latest /data /out participant
-w /out/work/
```

Singularity

- ▶ Already installed on Sherlock
- ▶ Use our image or convert one from Docker
- ▶ Run:

```
fmriprep.img /data /out participant  
-w /out/work/
```

- ▶ All data (and output folder) needs to be on \$SCRATCH or \$PI_SCRATCH or \$HOME

Command line options

- ▶ `--participant_label` – process only one participant (great for parallelization)
- ▶ `--work-dir` – folder where all intermediate results will be stored
- ▶ `--skip-native` – don't output EPI images in MNI space
- ▶ `--nthreads` – limit number of threads used
- ▶ `--mem_mb` – limit amount of memory used
 - ▶ (useful for big multiband datasets)
- ▶ `--no-skull-strip-ants` – use AFNI instead of ANTs for skullstripping
- ▶ `--no-freesurfer` – don't do surface reconstruction

User support

- ▶ Questions:
 - ▶ <https://neurostars.org>
- ▶ Bug reports and feature requests:
 - ▶ <https://github.com/poldracklab/fmriprep/issues>
- ▶ Contributors guide:
 - ▶ <http://fmriprep.readthedocs.io/en/latest/contributors.html>

Upcoming features

- ▶ Fieldmaps
 - ▶ TOPUP, spiral, and double TE difference
- ▶ Surface reconstruction using FreeSurfer
 - ▶ Surfaces and timecourses mapped to the surface
- ▶ Longitudinal analysis
- ▶ ICA Aroma
- ▶ Slice time correction

Discussion

General questions

- ▶ What setup do you use to analyze data?
 - ▶ Single user laptop/desktop?
 - ▶ Cluster (i.e. Sherlock)?
 - ▶ Cloud?
- ▶ What new features would you like?

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- ▶ Oscar Esteban
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- ▶ Chris Markiewicz
- ▶ Russ Poldrack