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

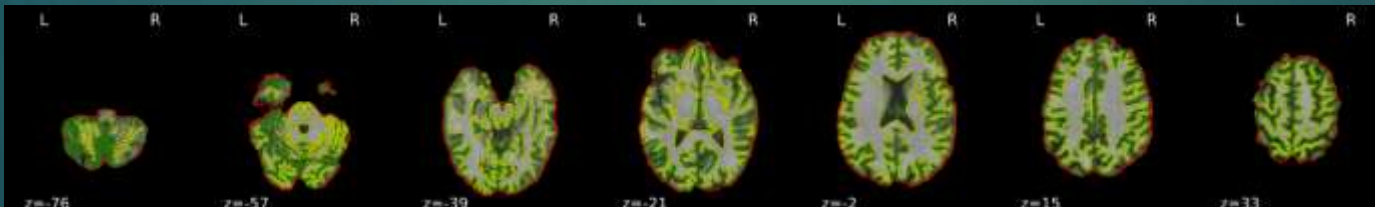▶ Transparent – "glass box" rather

than   "black box"

Details

- T1w preprocessing

- EPI preprocessing

- Transformations

T1w preprocessing

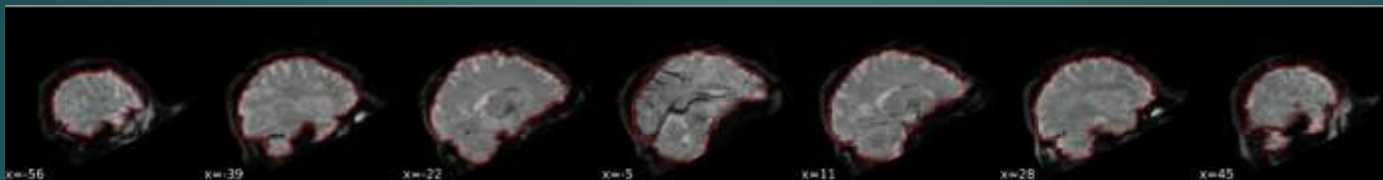▶ N4 bias field correction (ANTs)

▶ 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 displaecement

  - Global signal

  - Mean tissue signals

  - CompCor (temporal and anatomical)

EPI transformations

- Combination of:

  - Motion correction affines

  - EPI -> T1 affine

  - T1 -> MNI affine

  - T1 -> 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 native (EPI) 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

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
- Longitudinal analysis

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?

Break up sessions

- ▶ Surface analysis (FreeSurfer) – Chris M.
- ▶ Denoising (temporal and spatial) - Russ
- ▶ Custom templates and QC metrics – Oscar
- ▶ Special use cases (clinical, developmental) – Chris G.

Many thanks to the FMRIPREP team:

- Oscar Esteban
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- Chris Markiewicz
- Russ Poldrack