

KUL_VBG

A workflow to allow Freesurfer recon-all to run on brain images with large lesions.
VBG is a bash script tested in Mac OSX, Ubuntu 18.0 and CentOS.

Introduction

For reference we point to the paper published in Neuroimage, 2021 available here:
<https://doi.org/10.1016/j.neuroimage.2021.117731>

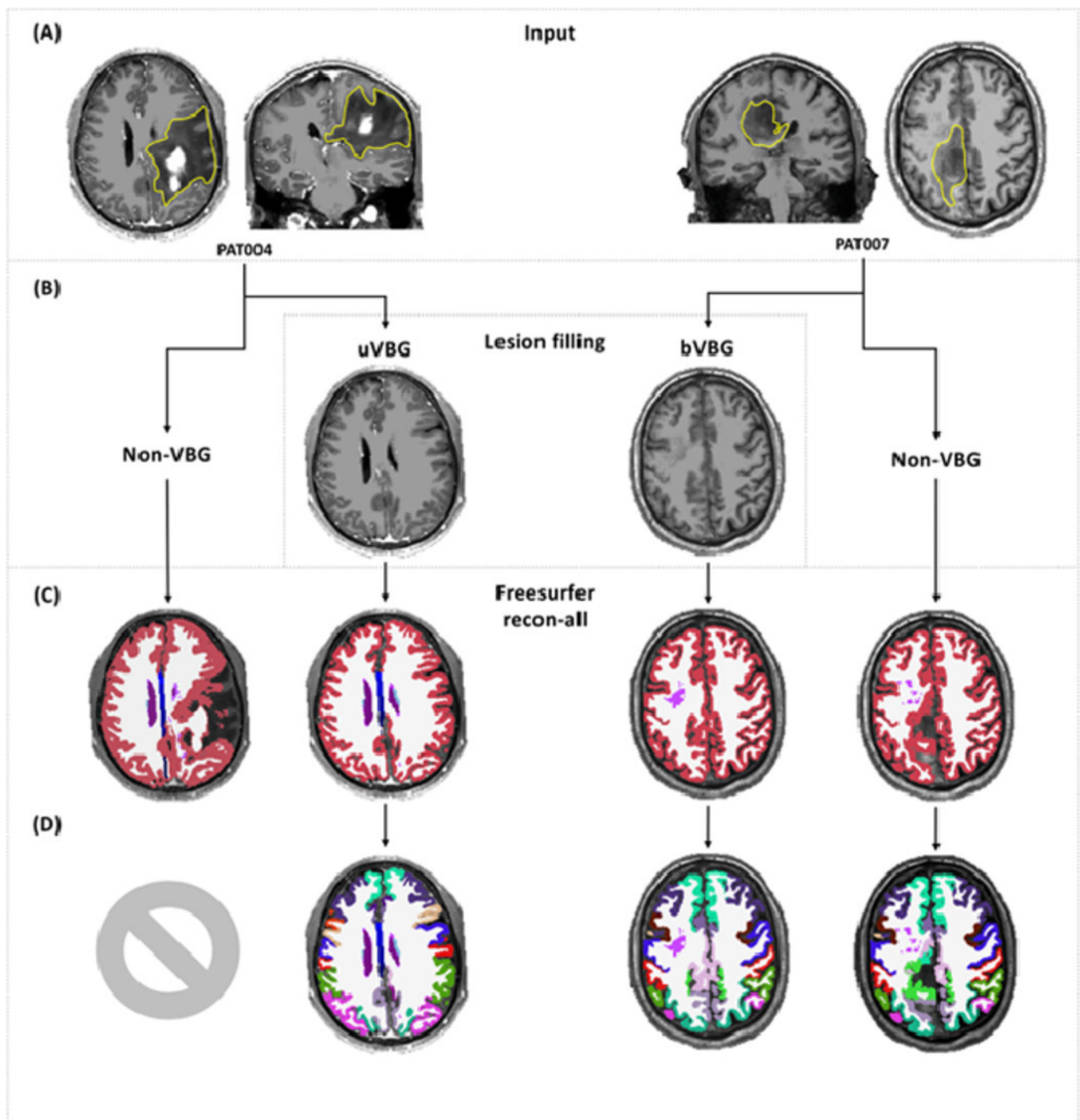
The first commit on this repository branch

"Orig_doi.org/10.1016/j.neuroimage.2021.117731" is the version used in the preprint and published article "Virtual brain grafting: Enabling whole brain parcellation in the presence of large lesions. Radwan et al., 2020 and 2021, DOIs: <https://doi.org/10.1101/2020.09.30.20204701>, and <https://doi.org/10.1016/j.neuroimage.2021.117731>

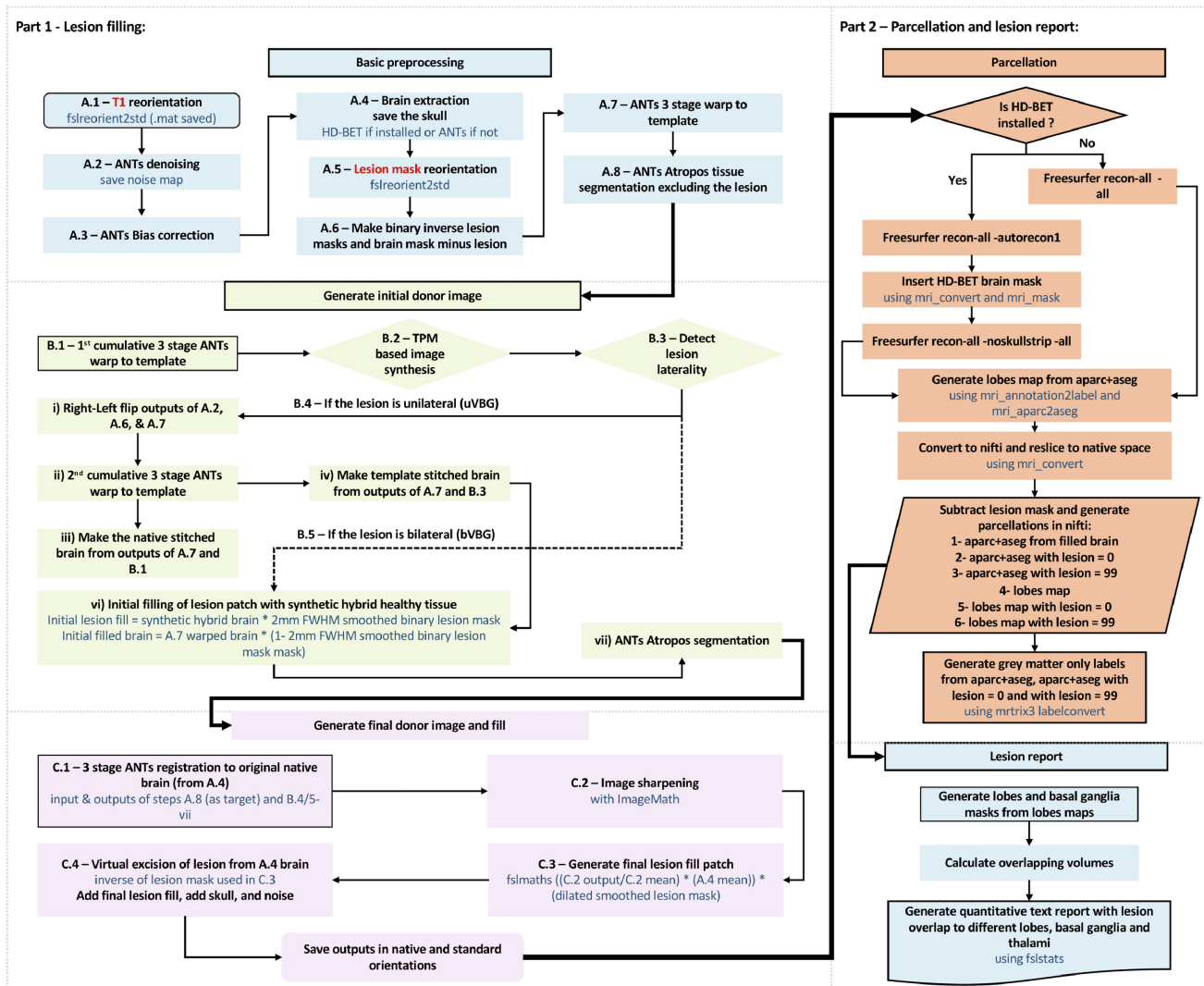
**** Further development, updates and bug fixes have been implemented on to the "master" branch of this repo, and the "dev" branch is for updates/development currently in progress.****

Posing the problem and solution

An image to explain the problem: Freesurfer will not parcellate these brains



The graphical solution of the VBG workflow is shown here:



Using VBG

Updated Dependencies:

- ANTs v2.3.1 and ANTsX scripts
- FSL v6.0
- MRtrix3 v3.0.2-64-g3eadb340
- HD-BET
- Freesurfer v6.0

** Check (https://github.com/treanus/KUL_Linux_Installation.git) for help with setting up your environment with different neuroimaging packages.

Inputs:

Obligatory:

- Input to -p flag (participant name in BIDS convention, without the leading sub-).
- A nifti format T1 WI of a subject (input to -a flag)
- Binary lesion mask (lesion = 1, background = 0) integer nifti format (input to -l flag)
- Indicate lesion mask space (input to -z flag) N.B. the specified lesion mask must have the same dimensions and transform as the input T1 WI.

Optional:

- 1- Specify location of intermediate processing and output folders (-m and -o flags)
- 2- Specify number of parallel workers used (input to -n flag)
- 3- Specify type of filling (default = uVBG, to activate bVBG use the -t flag)
- 4- Specify age group of participant (default = adult, to activate pediatric friendly mode specify the -P flag)
- 5- To run Freesurfer recon-all after the lesion filling is finished, specify the -F flag.
- 6- Verbose mode = -v

Examples:

```
- Using the unilateral VBG approach and HD-BET for brain extraction, input
data is in BIDS format with only 1 session
KUL_VBG.sh -p pat001 -b -n 6 -l /fullpath/lesion_T1w.nii.gz -z T1 -o
/fullpath/output -B 1

- Using the bilateral VBG approach and HD-BET for brain extraction, input data
is not in BIDS, FreeSurfer is also called at the end
KUL_VBG.sh -p pat001 -a /fullpath/sub-PT_T1w.nii.gz -n 6 -l
/fullpath/lesion_T1w.nii.gz -z T1 -o /fullpath/output -t -B 1 -F
```

Purpose:

```
The purpose of this workflow is to generate a lesion filled image, with
healthy looking synthetic tissue in place of the lesion
Essentially excising the lesion and grafting over the brain tissue defect in
the MR image space
```

Required arguments:

```
-p: BIDS participant name (anonymised name of the subject without the "sub-"
prefix)
-b: if data is in BIDS, KUL_VBG automatically finds it, output and processing
dirs are set to ./BIDS/derivatives/output_VBG
-l: full path and file name to lesion mask file per session
-z: space of the lesion mask used (only T1 supported in this version)
-a: Input precontrast T1WIs
```

Optional arguments:

```
-s: session (of the participant)
-t: Use the VBG template to derive the fill patch (if used, template tissue
is used alongside native tissue to create the donor brain)
-E: Treat as an extra-axial lesion (skip VBG bulk, fill lesion patch with 0s,
```

run FS and subsequent steps)

-B: specify brain extraction method (1 = HD-BET, 2 = ANTs-BET), if not set ANTs-BET will be used by default

-F: Run Freesurfer recon-all, generate aparc+aseg + lesion and lesion report

-P: In case of pediatric patients - use pediatric template (NKI_under_10 in MNI)

-m: full path to intermediate output dir

-o: full path to output dir (if not set reverts to default output ./VBG_out/output_VBG)

-n: number of cpu for parallelisation (default is 6)

-v: show output from mrtix commands

-h: prints help menu

Notes:

- You can use -b and the script will find your BIDS files automatically

- If your data is not in BIDS, then use -a without -b

- This version is for validation only.

- In case of trouble with HD-BET see lines 1124 - 1200)

- cook_template_4VBG requires two brains with unilateral lesions on opposing sides

- it is meant to facilitate the grafting process and minimize intensity differences

- You need a high resolution T1 WI and a lesion mask in the same space for VBG to run

- If you end up with an empty image, it is possible you have a mismatch between the T1 and lesion mask