Infant Cortical Surface Parcellation based on Spherical U-Net

Version 0.8

This is the manual for using Spherical U-Net architecture [1] for infant cortical surface parcellation.

1. Where to download

The package can be freely downloaded at: https://www.nitrc.org/projects/infantsurfparc.

It is freely available to the public for the purpose of academic research. Note the ownership, copyright and all rights are retained by the University of North Carolina at Chapel Hill.

The package includes the codes for data preparation and inference of the parcellation map from a cortical surface.

2. How to use it

Our codes can be used to parcellate the infant cortical surface into 36 regions based on FreeSurfer Desikan protocol [2], without performing spherical registration. Specifically, it can be divided into the following steps.

2.1 Prerequisites

- Linux
- NVIDIA GPU
- CUDA CuDNN
- Python dependencies
  - pytorch (0.4.1+)
  - torchvision (0.2.1+)
  - tensorboardx (1.6+)
  - pyvista (0.22.4+)

You can use *conda* to easily create an environment for the experiment using following command:

```
conda create -n sunet python=3.6
conda install pytorch torchvision cudatoolkit=10.0 -c pytorch
conda install -c conda-forge pyvista
```

Activate the newly created conda environment via:

```
conda activate sunet
```

2.2 Data preparation

The input file is a cortical inner surface of one hemisphere in vtk format, which has been resampled as either 40,962 or 163,842 vertices. Note that the input cortical surface should be reconstructed after AC-PC alignment. Two features, i.e., mean curvature and average convexity, are required for the parcellation, denoted as "`curv`" and "`sulc`" field attributes in the vtk file, respectively. For resampling and feature computing, FreeSurfer [2] can be used. To be consistent with the trained model, gyral crests should have negative curvature values, while sulcal bottoms have positive curvature values.

2.3 Usage

You can easily obtain the output parcellation maps on your surfaces via the following commands.

To predict a single surface' parcellation map:

```
python predict.py -hemi left -l 7 -i input.vtk -o output.vtk
```

To predict the parcellation maps of multiple surfaces in the same folder:

```
python predict.py -hemi left -l 7 -in_folder INPUT_FOLDER -out_folder OUT_FOLDER
```

You can also view the help information of the whole usage of this command by running

```
python predict.py -h
Usage: predict.py [-h] [--hemisphere {left, right}] [--level {7,8}]
                  [--input INPUT] [--in_folder INPUT_FOLDER] [--output OUTPUT] [--out_folder OUT_FOLDER]

Predict the parcellation maps with 36 regions from the input surfaces

optional arguments:
  -h, --help            show this help message and exit
  --hemisphere {left, right}, -hemi {left, right}
                        specify the hemisphere for parcellation, left or right. (default: left)
  --level {7,8}, -l {7,8}
                        specify the level of the surfaces. Generally, the level 7 spherical surface has 40,962 vertices, the level 8 has 163,842 vertices. (default: 7)
  --input INPUT, -i INPUT
                        the filename of input surface (default: None)
  --in_folder INPUT_FOLDER, -in_folder INPUT_FOLDER
                        the folder path of input files. Will parcellate all the files ending with .vtk in this folder. Accept input or in_folder. (default: None)
  --output OUTPUT, -o OUTPUT
                        the filename of the ouput surface. (default: [input].parc.vtk)
  --out_folder OUT_FOLDER, -out_folder OUT_FOLDER
                        the folder path of the ouput surfaces. Accept output or out_folder. (default: [in_folder])
```

Troubleshoot notes:

1. The code requires `input` or `in_folder` option, not both, for a single surface or all surfaces in the folder, respectively.
2. The input data should be ending with `.vtk`.

2.4 Examples

You can test the codes using the example surfaces we provided in the `surfaces` folder. Simply run:

```
python predict.py -hemi left -l 7 -i surfaces/left_hemisphere/40962/test1.lh.40k.vtk
```

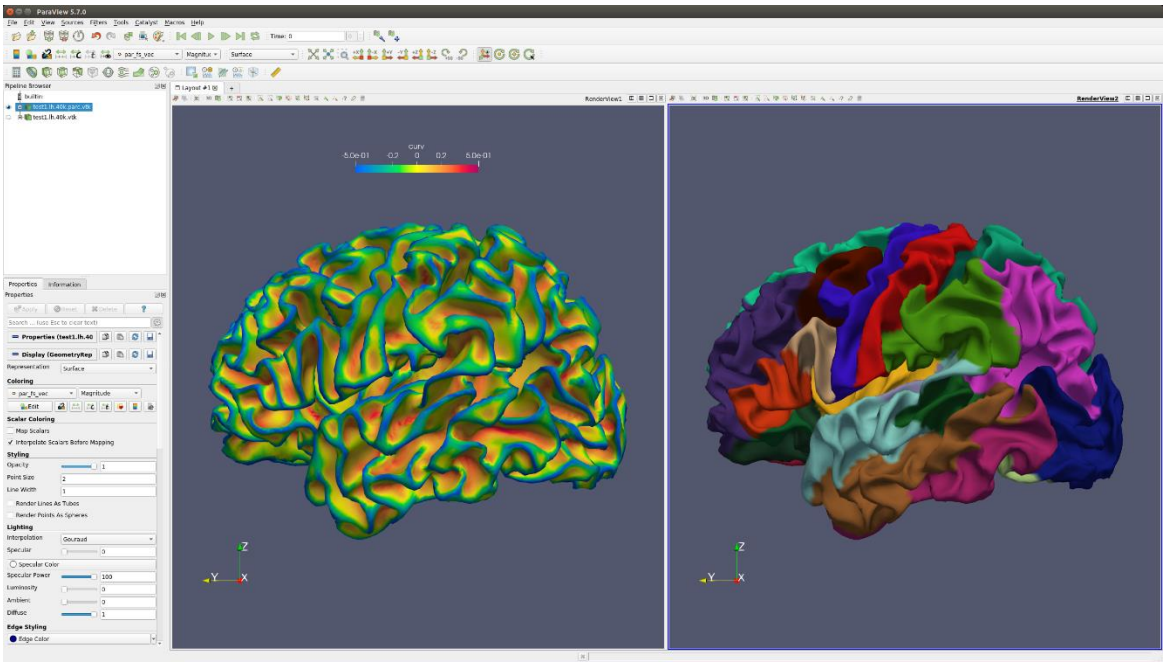
You will get the corresponding output surface in the same folder with name `test1.lh.40k.parc.vtk`

Or, run the command for all the 3 surfaces in the same folder:

```
python predict.py -hemi left -l 7 -in_folder surfaces/left_hemisphere/40962
```

2.5 Visualization

You can use ParaView software (https://www.paraview.org) to visualize the parcellated surface in VTK format. An example of the input curvature map and output parcellation map are shown below.



3. Cite

If you use this tool for your research, please cite the following paper:

F. Zhao *et al.*, "Spherical u-net on cortical surfaces: Methods and applications," in *International Conference on Information Processing in Medical Imaging*, 2019, pp. 855-866.

4. Contact

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5. References

[1] F. Zhao *et al.*, "Spherical u-net on cortical surfaces: Methods and applications," in *International Conference on Information Processing in Medical Imaging*, 2019, pp. 855-866.

[2] B. Fischl, "Freesurfer," *Neuroimage,* vol. 62, no. 2, pp. 774-781, 2012.