

Extraction of Mesh from FreeSurfer

Lars Magnus Valnes

University of Oslo

March 4, 2016

Goals

We some goals for today :

Goals

We some goals for today :

- Basic understanding of FreeSurfer

Goals

We some goals for today :

- Basic understanding of FreeSurfer
- Know how to extract a binary surface file from FreeSurfer.

Goals

We some goals for today :

- Basic understanding of FreeSurfer
- Know how to extract a binary surface file from FreeSurfer.
- Construction of a mesh with mshr.

Introduction

Some basic things about FreeSurfer.

Introduction

Some basic things about FreeSurfer.

- FreeSurfer is a set of software tools for the study of cortical and subcortical anatomy structures.

Introduction

Some basic things about FreeSurfer.

- FreeSurfer is a set of software tools for the study of cortical and subcortical anatomy structures.
- Most of FreeSurfer is automated. Thus simple to use, but not to debug.

Introduction

Some basic things about FreeSurfer.

- FreeSurfer is a set of software tools for the study of cortical and subcortical anatomy structures.
- Most of FreeSurfer is automated. Thus simple to use, but not to debug.
- The code written in C and based on ITK (National Library of Medicine Insight Segmentation and Registration Toolkit).

Setting up FreeSurfer

Setting up FreeSurfer

- Download from [▶ here](#) and obtain license.txt [▶ here](#)

Setting up FreeSurfer

- Download from [▶ here](#) and obtain license.txt [▶ here](#)
- FreeSurfer require that we set some environment variables.

Setting up FreeSurfer

- Download from [▶ here](#) and obtain license.txt [▶ here](#)
- FreeSurfer require that we set some environment variables.
- This can be done by modifying `.bashrc` or `.tcshrc`.

Setting up FreeSurfer

- Download from [▶ here](#) and obtain license.txt [▶ here](#)
- FreeSurfer require that we set some environment variables.
- This can be done by modifying .bashrc or .tcshrc.
- Two useful environment variables to know are:

Setting up FreeSurfer

- Download from [▶ here](#) and obtain license.txt [▶ here](#)
- FreeSurfer require that we set some environment variables.
- This can be done by modifying .bashrc or .tcshrc.
- Two useful environment variables to know are:
 - \$FREESURFER_HOME
 - \$SUBJECTS_DIR

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:
`$recon-all -subjid NAME -i PATH2MRI`

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

The next step is to type :

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

The next step is to type :

```
$recon-all -subjid NAME -all
```

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

The next step is to type :

```
$recon-all -subjid NAME -all
```

The flag -all will initialize a complete FreeSurfer process.

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

The next step is to type :

```
$recon-all -subjid NAME -all
```

The flag -all will initialize a complete FreeSurfer process.

The process is stepwise and each step is described [▶ here](#).

Running FreeSurfer

The first step is to input the MRIs to FreeSurfer, this is done by typing:

```
$recon-all -subjid NAME -i PATH2MRI
```

Here NAME refers to what you want the folder in \$SUBJECT_DIR to be named, and it will store all the output related to the MRI.

PATH2MRI refers to the complete path to a nifti file or a single DICOM file in a serie.

The next step is to type :

```
$recon-all -subjid NAME -all
```

The flag -all will initialize a complete FreeSurfer process.

The process is stepwise and each step is described [▶ here](#).

For more through details, I recommend reading the relate articles found

[▶ here](#) .

Output Structure in FreeSurfer

The output will be written to folders in `$SUBJECTS_DIR/subjid`, and we can look at the folders by typing :

Output Structure in FreeSurfer

The output will be written to folders in `$SUBJECTS_DIR/subjid`, and we can look at the folders by typing :

```
$recon-all -subjid name -i path_to_dicom
```

```
$ls $SUBJECTS_DIR/name
```

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the extension `.mgz`.

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the extension `.mgz`.
- Surface files, which are 3D triangulated binary surface files.

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the the extension `.mgz`.
- Surface files, which are 3D triangulated binary surface files.
- Label are text files with vertices and corresponding values (integer or string), [▶ Label file](#)

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the extension `.mgz`.
- Surface files, which are 3D triangulated binary surface files.
- Label are text files with vertices and corresponding values (integer or string), [▶ Label file](#)
- Annotation files contains a collection of labels, and also includes a colour table

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the extension `.mgz`.
- Surface files, which are 3D triangulated binary surface files.
- Label are text files with vertices and corresponding values (integer or string), [▶ Label file](#)
- Annotation files contains a collection of labels, and also includes a colour table
- Atlas contains probabilistic information estimated to label neuroanatomy each location on a cortical surface model.

File Formats in FreeSurfer

FreeSurfer will generate many different types of files, thus we will have a short introduction to a selected few.

- The extension `.mgh` is volume of voxels and a compressed `.mgh` file has the extension `.mgz`.
- Surface files, which are 3D triangulated binary surface files.
- Label are text files with vertices and corresponding values (integer or string), [▶ Label file](#)
- Annotation files contains a collection of labels, and also includes a colour table
- Atlas contains probabilistic information estimated to label neuroanatomy each location on a cortical surface model.
- Template used to analyse longitudinal volumes.

Surface Files

For this presentation we will focus on surface files, and there are different types :

Surface Files

For this presentation we will focus on surface files, and there are different types :

- ?h.pial surface displays gyri and sulci, the sulci is barely visible.

Surface Files

For this presentation we will focus on surface files, and there are different types :

- ?h.pial surface displays gyri and sulci, the sulci is barely visible.
- ?h.white surface displays boundary between white and grey matter.

Surface Files

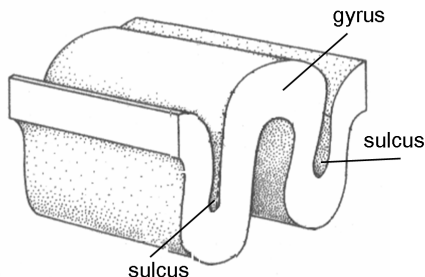
For this presentation we will focus on surface files, and there are different types :

- ?h.pial surface displays gyri and sulci, the sulci is barely visible.
- ?h.white surface displays boundary between white and grey matter.
- ?h.inflated surface shows fully the sulci.

Surface Files

For this presentation we will focus on surface files, and there are different types :

- ?h.pial surface displays gyri and sulci, the sulci is barely visible.
- ?h.white surface displays boundary between white and grey matter.
- ?h.inflated surface shows fully the sulci.



Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

- Scanner-space, often LPS (Left Posterior Superior)

Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

- Scanner-space, often LPS (Left Posterior Superior)
- Voxel coordinates, (256,256,256)

Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

- Scanner-space, often LPS (Left Posterior Superior)
- Voxel coordinates, (256,256,256)
- Scanner RAS-coordinates, stands for Right Anterior Superior

Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

- Scanner-space, often LPS (Left Posterior Superior)
- Voxel coordinates, (256,256,256)
- Scanner RAS-coordinates, stands for Right Anterior Superior
- TkReg-RAS , the coordinate system for tksurfer and surfaces.

Coordinate Systems

FreeSurfer works with multiple coordinate systems, and we will look at most of them.

- Scanner-space, often LPS (Left Posterior Superior)
- Voxel coordinates, (256,256,256)
- Scanner RAS-coordinates, stands for Right Anterior Superior
- TkReg-RAS , the coordinate system for tksurfer and surfaces.

More details are found [▶ here](#).

Freeview

Freeview is graphic user interface for FreeSurfer, and can be opened by typing :
`$ freeview.`

Freeview

Freeview is graphic user interface for FreeSurfer, and can be opened by typing :
`$ freeview.`

Freeview

Freeview is graphic user interface for FreeSurfer, and can be opened by typing :

`$ freeview.`

- We can also add flags with more specifications:

Freeview

Freeview is graphic user interface for FreeSurfer, and can be opened by typing :

\$ freeview.

- We can also add flags with more specifications:
 - -v \$SUBJECTS_DIR/bert/mri/aseg.mgz:colormap=lut:opacity=0.2
 - -f \$SUBJECTS_DIR/bert/surf/rh.white:edgecolor=blue
 - -f \$SUBJECTS_DIR/bert/surf/lh.white:annot=aparc.annot:name=pial_aparc:visible=0

Working in Freeview

When working with surface files, it can be

Working in Freeview

When working with surface files, it can be

- Overlay, load a thickness file to see the thickness of the surface.

Working in Freeview

When working with surface files, it can be

- Overlay, load a thickness file to see the thickness of the surface.
- Annotation, will display a collection of labels on a surface.

Working in Freeview

When working with surface files, it can be

- Overlay, load a thickness file to see the thickness of the surface.
- Annotation, will display a collection of labels on a surface.
- Curvature, shows the curvature of the surface.

Working in Freeview

When working with surface files, it can be

- Overlay, load a thickness file to see the thickness of the surface.
- Annotation, will display a collection of labels on a surface.
- Curvature, shows the curvature of the surface.
- Label, will highlight a specific part of the surface.

Introduction

Mesh extraction is to obtain a 3D triangulated surface file from Freesurfer and we will look at :

Introduction

Mesh extraction is to obtain a 3D triangulated surface file from Freesurfer and we will look at :

- Scripts from brainder.org.

Introduction

Mesh extraction is to obtain a 3D triangulated surface file from Freesurfer and we will look at :

- Scripts from brainder.org.
- FreeSurfer commands

Command for extraction of a 3D triangulated surface file.

If we have a 3D triangulated surface file, we can simply type :

```
$mkdir $SUBJECTS_DIR/bert/asc
```

```
$mris_convert $SUBJECTS_DIR/bert/surf/lh.pial
```

```
                $SUBJECTS_DIR/bert/asc/lh_pial.asc
```

Brainer scripts

Brainerd.org is a sharing website with application towards FreeSurfer.

Brainer scripts

Brainerd.org is a sharing website with application towards FreeSurfer.

- Generating the surfaces for subcortical structures, `aseg2srf.sh`

Brainer scripts

Brainer.org is a sharing website with application towards FreeSurfer.

- Generating the surfaces for subcortical structures, `aseg2srf.sh`
- Importing FreeSurfer cortical meshes into Blender , `srf2obj.gawk`

The Script `aseg2srf.sh`

The Script aseg2srf.sh

- Obtains the mesh from a volume of voxels.

The Script aseg2srf.sh

- Obtains the mesh from a volume of voxels.
- Can have topological defects.

The Script aseg2srf.sh

- Obtains the mesh from a volume of voxels.
- Can have topological defects.
- [▶ aseg2srf.sh](#)

Commands for Skull Surface

We can also obtain surfaces by adding optional inputs to FreeSurfer commands.

```
$mri_watershed -useSRAS -surf  
    $SUBJECT_DIR/bert/surf/outer  
    $SUBJECT_DIR/bert/mri/orig_nu.mgz  
    $SUBJECT_DIR/bert/trash/trash.mgz
```

Commands for Skull Surface

We can also obtain surfaces by adding optional inputs to FreeSurfer commands.

```
$mri_watershed -useSRAS -surf  
                $SUBJECT_DIR/bert/surf/outer  
                $SUBJECT_DIR/bert/mri/orig_nu.mgz  
                $SUBJECT_DIR/bert/trash/trash.mgz
```

This command will generate four surfaces :

- Inner skull

Commands for Skull Surface

We can also obtain surfaces by adding optional inputs to FreeSurfer commands.

```
$mri_watershed -useSRAS -surf  
                $SUBJECT_DIR/bert/surf/outer  
                $SUBJECT_DIR/bert/mri/orig_nu.mgz  
                $SUBJECT_DIR/bert/trash/trash.mgz
```

This command will generate four surfaces :

- Inner skull
- Outer skull

Commands for Skull Surface

We can also obtain surfaces by adding optional inputs to FreeSurfer commands.

```
$mri_watershed -useSRAS -surf  
                $SUBJECT_DIR/bert/surf/outer  
                $SUBJECT_DIR/bert/mri/orig_nu.mgz  
                $SUBJECT_DIR/bert/trash/trash.mgz
```

This command will generate four surfaces :

- Inner skull
- Outer skull
- Outer skin

Commands for Skull Surface

We can also obtain surfaces by adding optional inputs to FreeSurfer commands.

```
$mri_watershed -useSRAS -surf  
                $SUBJECT_DIR/bert/surf/outer  
                $SUBJECT_DIR/bert/mri/orig_nu.mgz  
                $SUBJECT_DIR/bert/trash/trash.mgz
```

This command will generate four surfaces :

- Inner skull
- Outer skull
- Outer skin
- Brain surface

Mesh Extraction

Inner and Outer Skull



Surf2Mesh

Surf2Mesh

- A set of scripts to create a mesh from a .asc file can be seen [▶ here](#).

Surf2Mesh

- A set of scripts to create a mesh from a .asc file can be seen [▶ here](#).
- Contains .asc to .off/.stl conversion, will preferably become obsolete.

Surf2Mesh

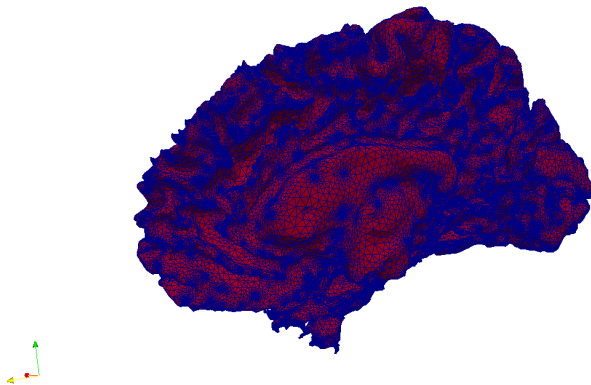
- A set of scripts to create a mesh from a .asc file can be seen [▶ here](#).
- Contains .asc to .off/.stl conversion, will preferably become obsolete.
- Also there are some scripts to simplify the mesh creation.

Surf2Mesh

- A set of scripts to create a mesh from a .asc file can be seen [▶ here](#).
- Contains .asc to .off/.stl conversion, will preferably become obsolete.
- Also there are some scripts to simplify the mesh creation.
- [▶ Extmesh_utility.py](#)

Mesh Extraction

Viewing Mesh in Paraview



Future

Future

- Python module Nibabel.

Future

- Python module Nibabel.
- Register commands.

Future

- Python module Nibabel.
- Register commands.
- Accurately marking subdomains of extracted mesh.