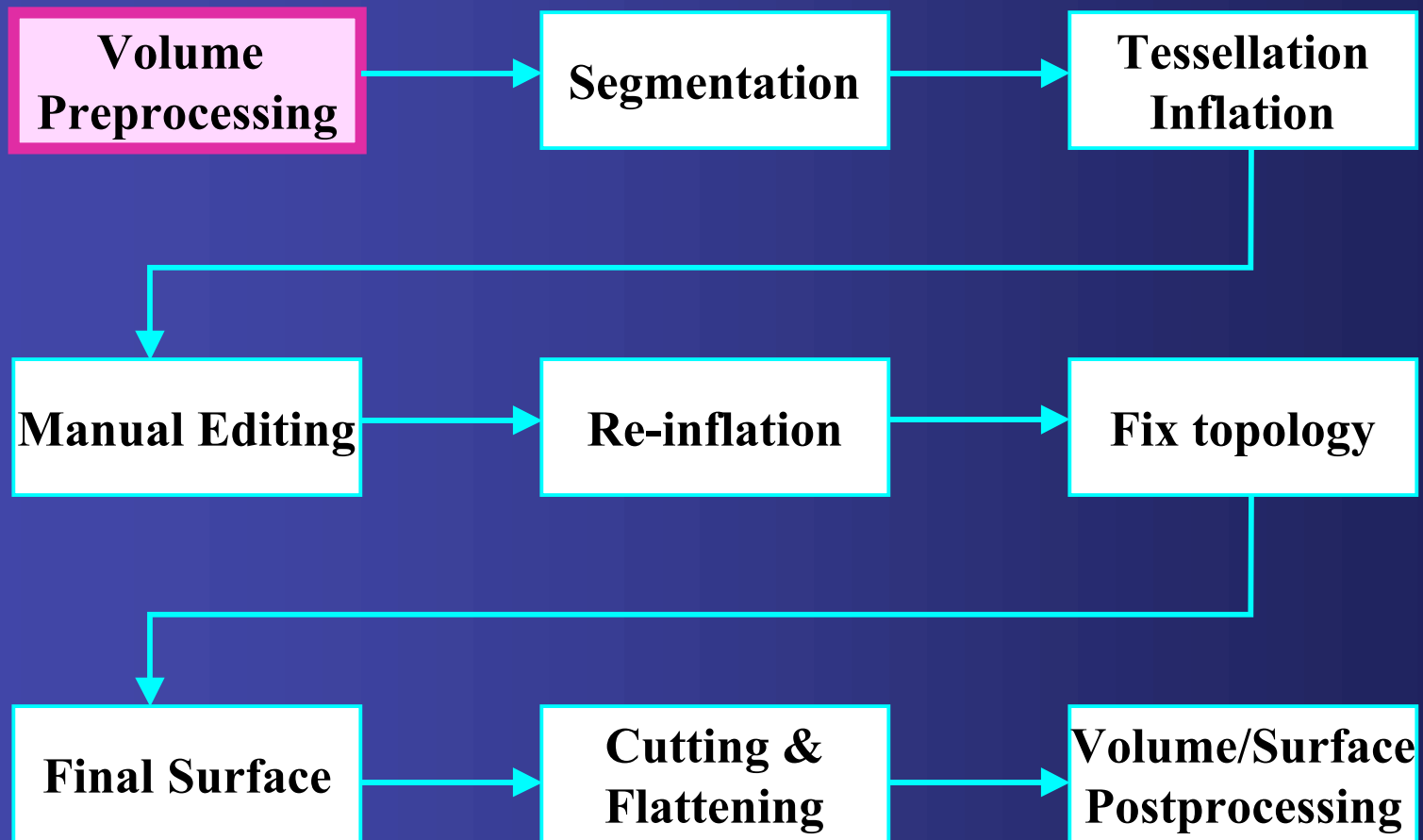


## FreeSurfer Workshop - Begin the Hands-On...





## 1) Create AFNI dataset using *to3d*

*to3d* [-options] <image\_files>

🗂️ Class Example (the long way):

```
cd lc_play
```

```
to3d -prefix mprage1 001/I.*
```

```
to3d -prefix mprage2 002/I.*
```

```
to3d -prefix mprage3 003/I.*
```

```
to3d -prefix mprage4 004/I.*
```

## Shortcut - Using the *foreach* loop

✚ **foreach** is a UNIX command that implements a loop, where the loop value (e.g., “x”) takes on values from a list (e.g., 1, 2, 3, 4).

✚ Class Example:

```
foreach x (1 2 3 4)  
  to3d -prefix mprage{$x} 00{$x}/I.*  
end
```



\* Datasets we've created using *to3d*:

ls lc\_play/

mprage1+orig.BRIK

mprage1+orig.HEAD

mprage2+orig.BRIK

mprage2+orig.HEAD

mprage3+orig.BRIK

mprage3+orig.HEAD

mprage4+orig.BRIK

mprage4+orig.HEAD



## 2) Perform N3 Correction on each dataset with AFNI *3dUniformize*

*3dUniformize -anat <AFNI BRIK> -prefix <pname>*

🗄️ Class Example: (from within *lc\_play/* directory)

```
foreach x (1 2 3 4)
```

```
    3dUniformize -quiet -anat mprage{$x}+orig \
```

```
        -prefix mprage{$x}_n3
```

```
end
```



\* Datasets we've created using *3dUniformize*:

*lc\_play/*

mprage1\_n3+orig.BRIK

mprage1\_n3+orig.HEAD

mprage2\_n3+orig.BRIK

mprage2\_n3+orig.HEAD

mprage3\_n3+orig.BRIK

mprage3\_n3+orig.HEAD

mprage4\_n3+orig.BRIK

mprage4\_n3+orig.HEAD



### 3) Perform Volume Registration using AFNI *3dvolreg*

*3dvolreg -base <bfile> -prefix <pname> <target file>*

Base dataset:

mprage1\_n3+orig

Target datasets:

mprage2\_n3+orig

mprage3\_n3+orig

mprage4\_n3+orig

Prefix for output datasets:

mprage2\_n3vr

mprage3\_n3vr

mprage4\_n3vr



 Class Example: (from within `lc_play/` directory)

```
foreach x (2 3 4)
```

```
    3dvolreg -base mprage1_n3+orig \  
            -prefix mprage{$x}_n3vr \  
            mprage{$x}_n3+orig
```

```
end
```





\* Datasets we've created using *3dvolreg*:

ls lc\_play/

mprage2\_n3vr+orig.BRIK

mprage2\_n3vr+orig.HEAD

mprage3\_n3vr+orig.BRIK

mprage3\_n3vr+orig.HEAD

mprage4\_n3vr+orig.BRIK

mprage4\_n3vr+orig.HEAD



#### 4) Average the datasets using AFNI *3dMean*

*3dMean -prefix <pname> <datasets ...>*

🏠 Class Example: (from within *lc\_play/* directory)

```
3dMean -prefix mprage_avg \  
mprage*_n3vr+orig.BRIK mprage1_n3+orig
```



\* Datasets we've created using *3dMean*:

```
ls lc_play/
```

```
mprage_avg+orig.BRIK
```

```
mprage_avg+orig.HEAD
```

 This dataset can be viewed in AFNI.



## 5) Create FreeSurfer directory tree using *mksubjdirs*

(note: be sure to source your *.fs\_login* file first)

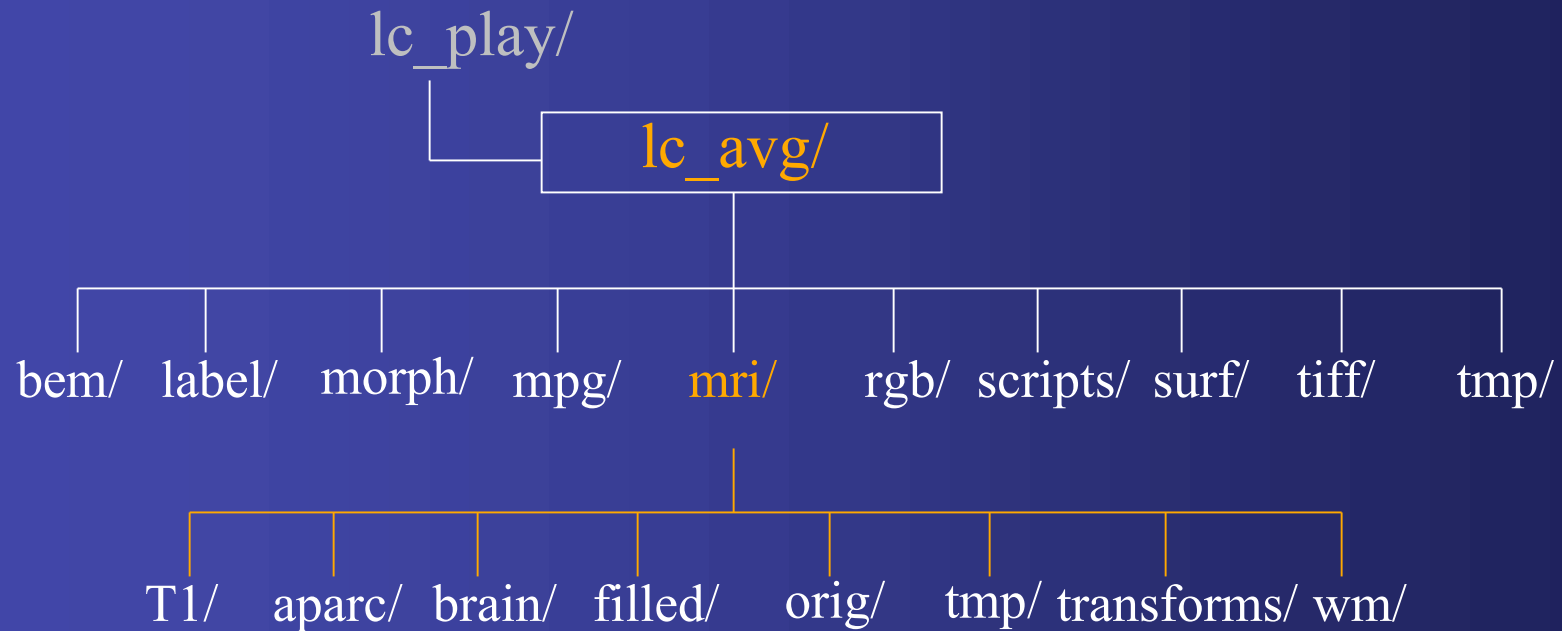
```
mksubjdirs <subject_name>
```

🗄️ Class Example: (from within *lc\_play/* directory)

```
mksubjdirs lc_avg
```



Result from `mksubjdirs lc_avg`:





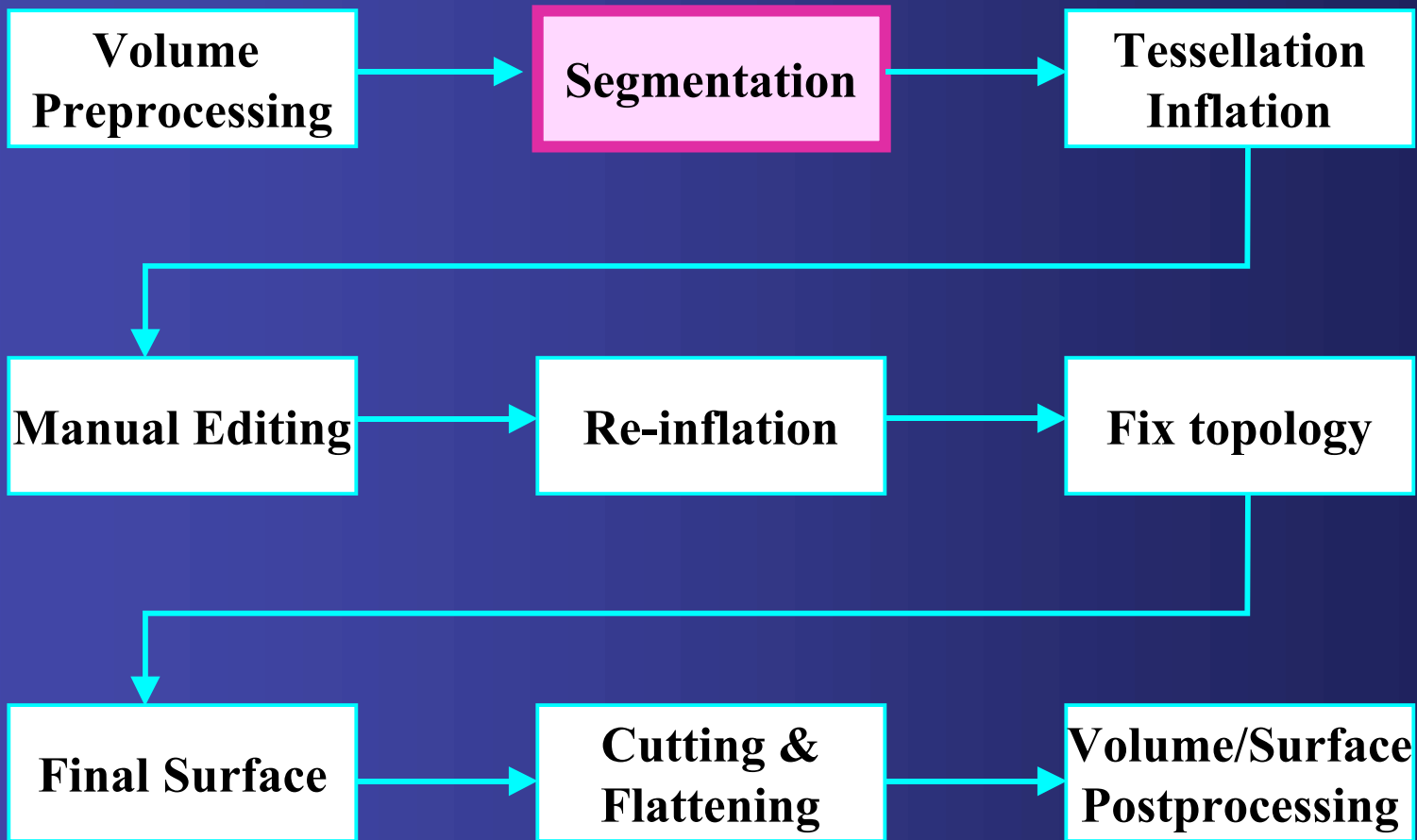
## 6) Convert volume dataset into *COR* format:

(i.e., 256 coronal slices, 256 x 256 in-plane, 1mm<sup>3</sup> voxel resolution)

```
mri_convert <volume_dataset>
```

📁 Class Example: (from within *lc\_play/* directory)

```
mri_convert mprage_avg+orig.BRIK lc_avg/mri/orig
```



## HOW TO RUN FREESURFER:

TYPE `csurf` ON THE COMMAND LINE!

If you like, go to the Freesurfer GUI, select PREFERENCES --> VIEW LOGS to see “stuff” spewing onto the screen.





## Process Volume using FreeSurfer's program, *segment\_subject*

*segment\_subject* <subject\_name>

🗑️ Class Example: (from FreeSurfer GUI):

Subject Tools → Process Volume

(do this for BOTH hemispheres)

🗑️ Class Example: (from Command Line):

`cd ../../..` takes you up to `lc_play/`

`segment_subject lc_avg`

or... `recon-all -stage1 -stage2 -nomotioncor -subjid lc_avg`



## Result of 'Process Volume':

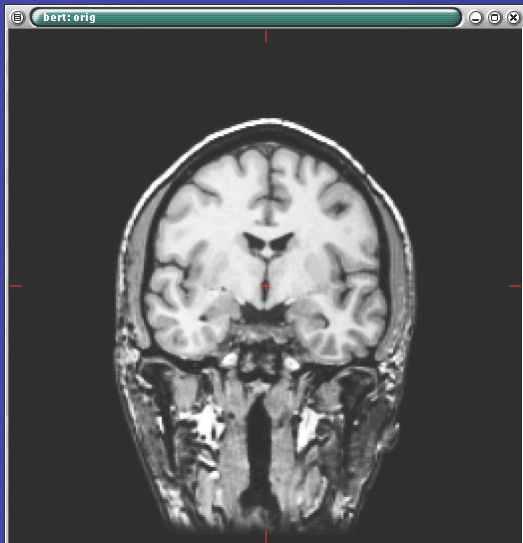
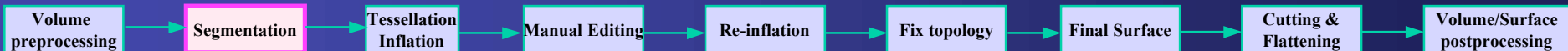
Intensity Normalization (lc\_avg/mri/T1)

Skull Stripping (lc\_avg/mri/brain)

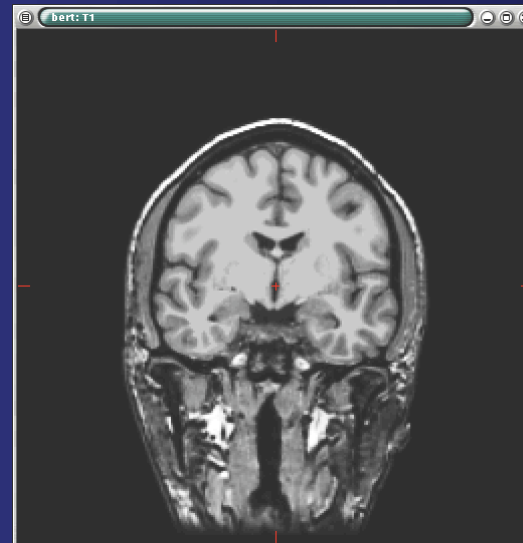
White Matter Segmentation (lc\_avg/mri/wm)

### Note:

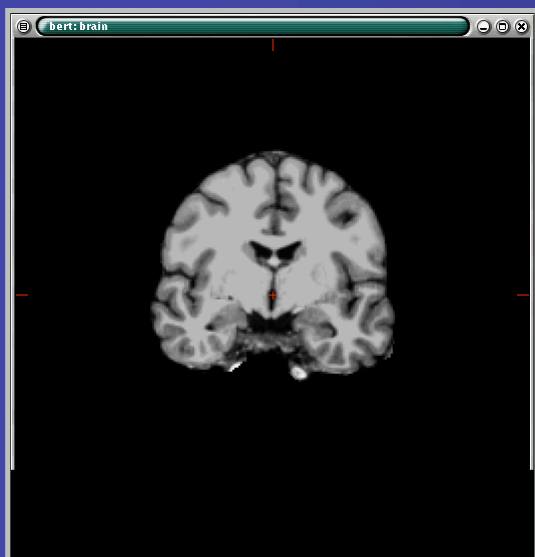
If using command line option, *segment\_subject* or *recon-all -stage2* will also do a first pass inflation of the surface.



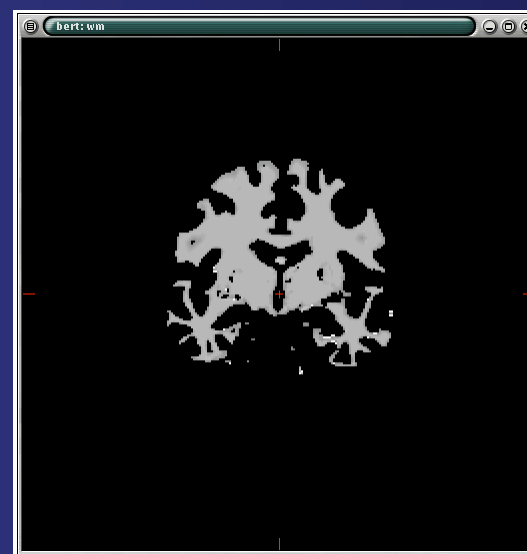
mri/orig



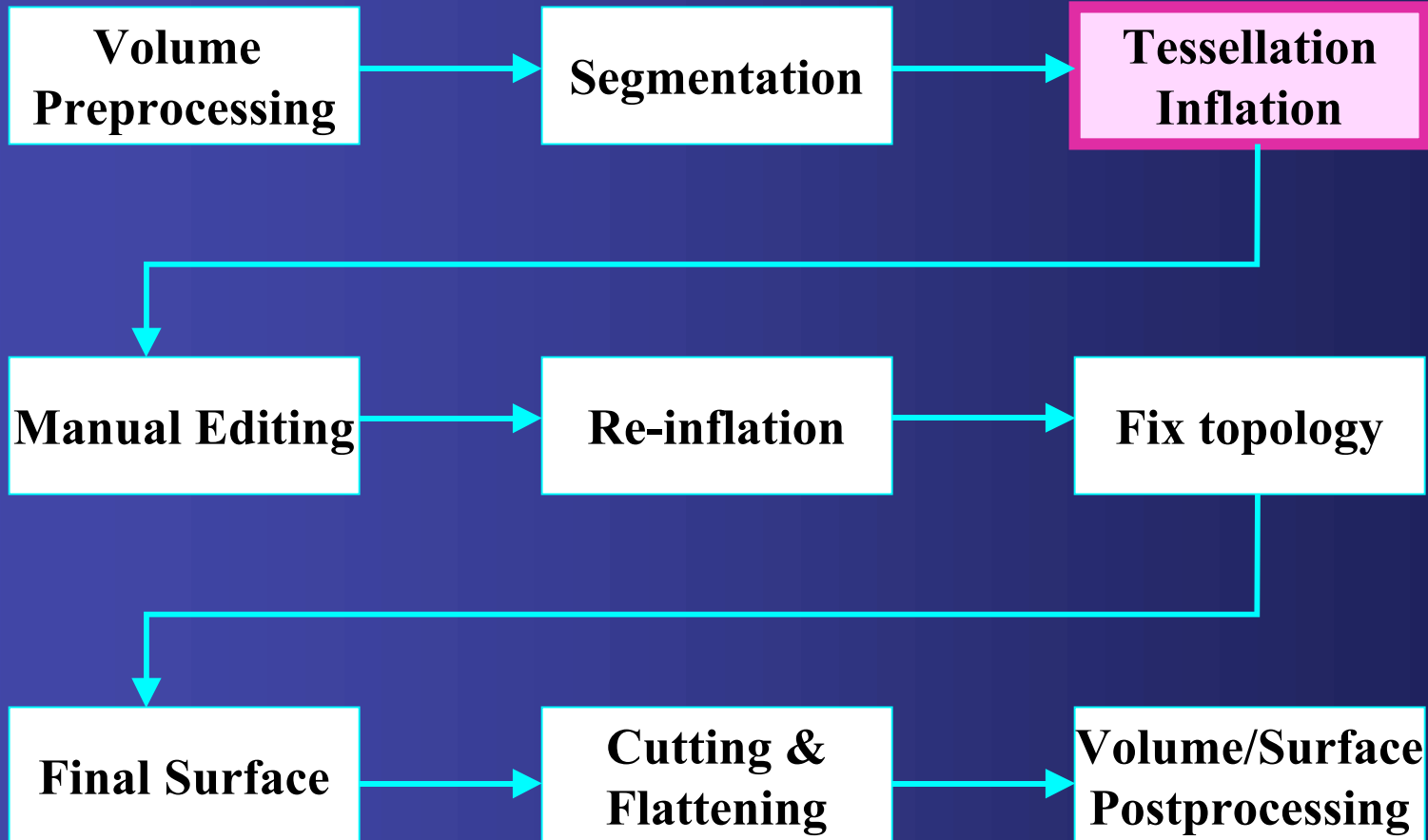
mri/T1



mri/brain



mri/wm



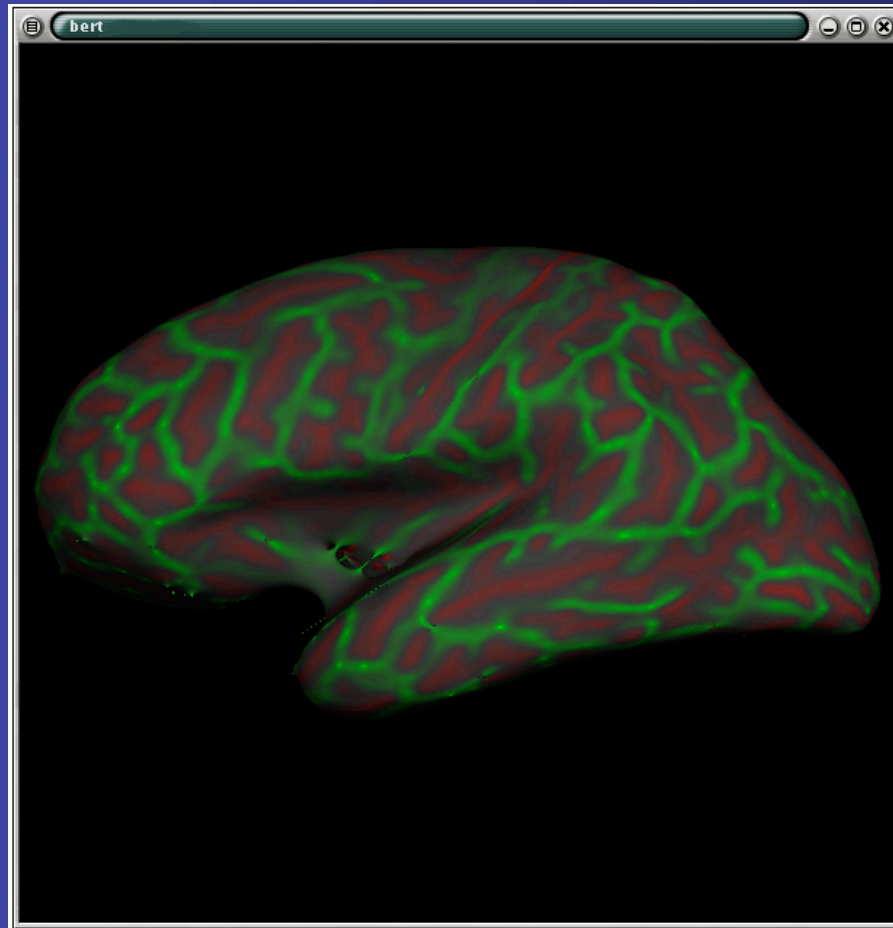


## Create an inflated surface using FreeSurfer's *inflate\_subject*

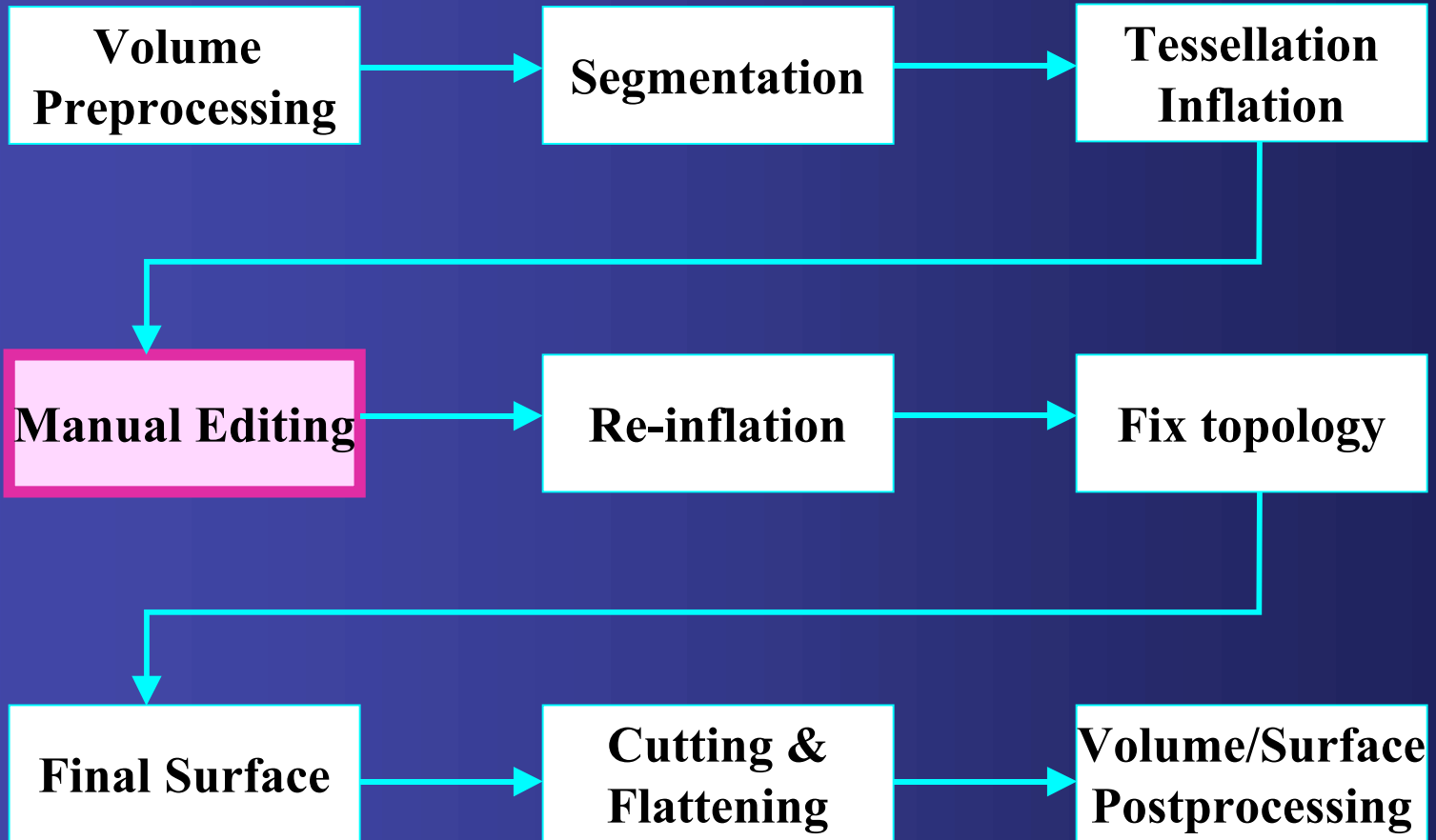
🖥️ Class Example: (from FreeSurfer GUI):

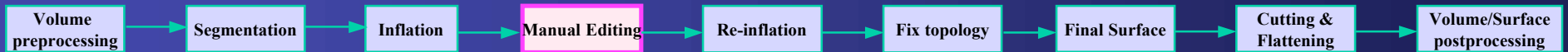
Subject Tools → Create Surface

🖥️ Command Line users: Skip this step.



Go to **TK Surfer** interface to examine the inflated surface.

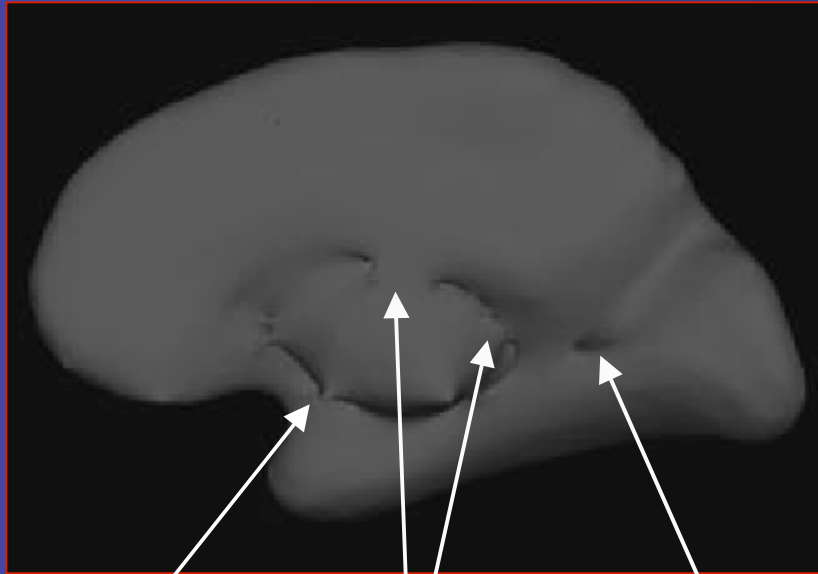




The most commonly derived defects that require manual editing:

- 🛠️ **Fornix** (handles)
- 🛠️ **Lateral Ventricle** (hole)
- 🛠️ **Basal Ganglia** (hole)
- 🛠️ **Optic Nerve** (interferes with inflation)

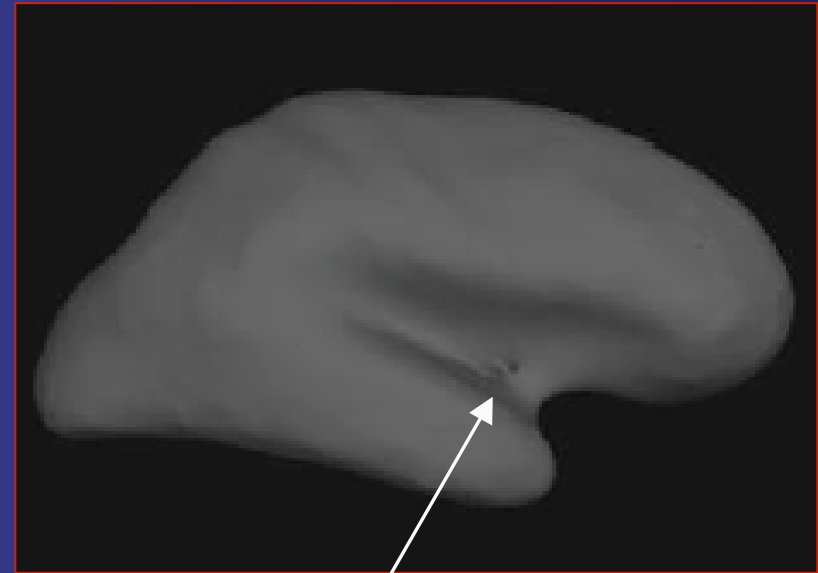




*Optic Nerve*

*Fornix*

*Lateral Ventricle*

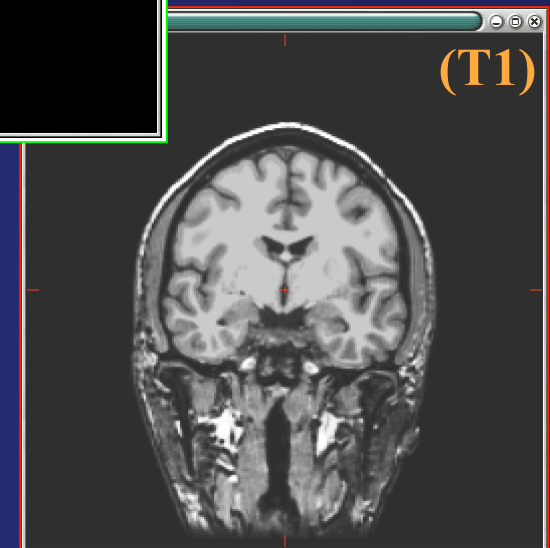
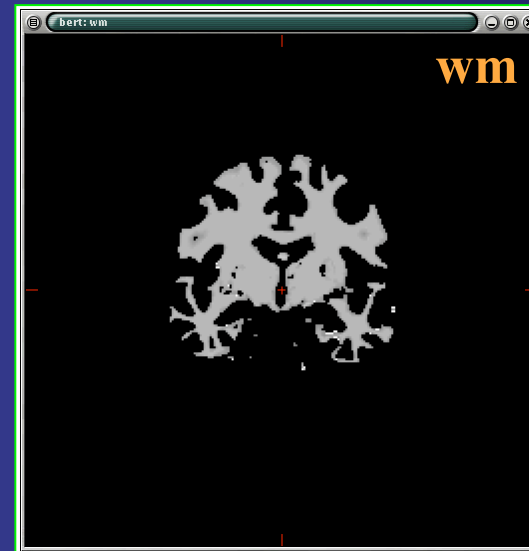


*Basal Ganglia*



Manual Editing is done in the **wm** matter volume. This is the MAIN volume.

Load **T1** as your AUXILIARY volume.



Alternate between volumes



Cursor		Mouse	
Volume index	(128, 126, 128)	Volume index	(155, 246, 128)
Talairach	(-0.3, -4.2, -1.6)	Talairach	(-35.9, -22.7, -119.4)
wm value	0	wm value	0
T1 value	49	T1 value	33

To begin manual editing:

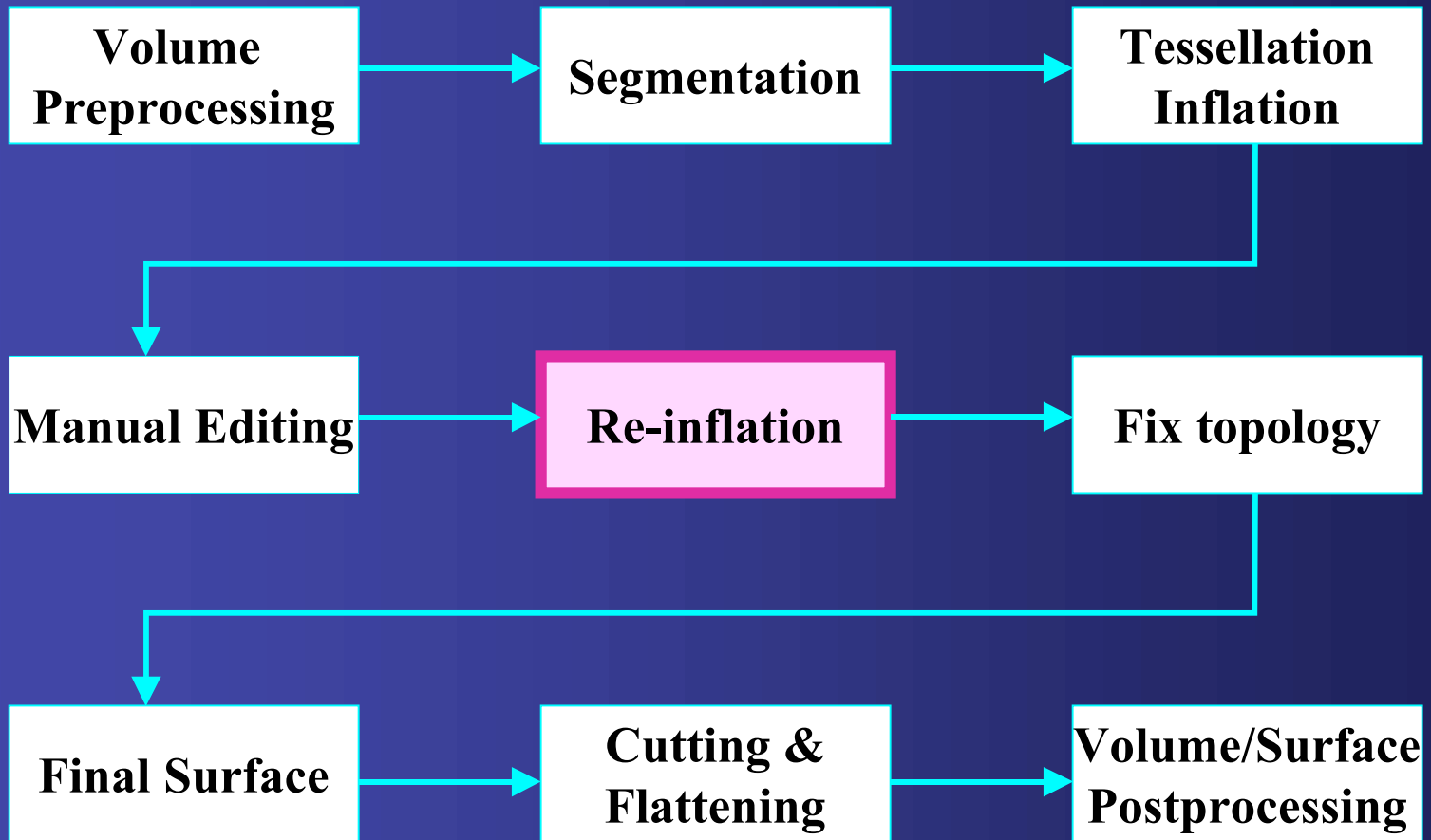
**Subject Tools --> Edit Segmentation**

This will load the wm volume and inflated surface simultaneously. The white matter outline will appear on the surface as well.

Load T1 volume as the auxillary volume:

From TKMedit (volume GUI)

**File --> Load Auxillary --> T1**





Manual editing and inflation steps should be repeated until all large topologic defects have been corrected.

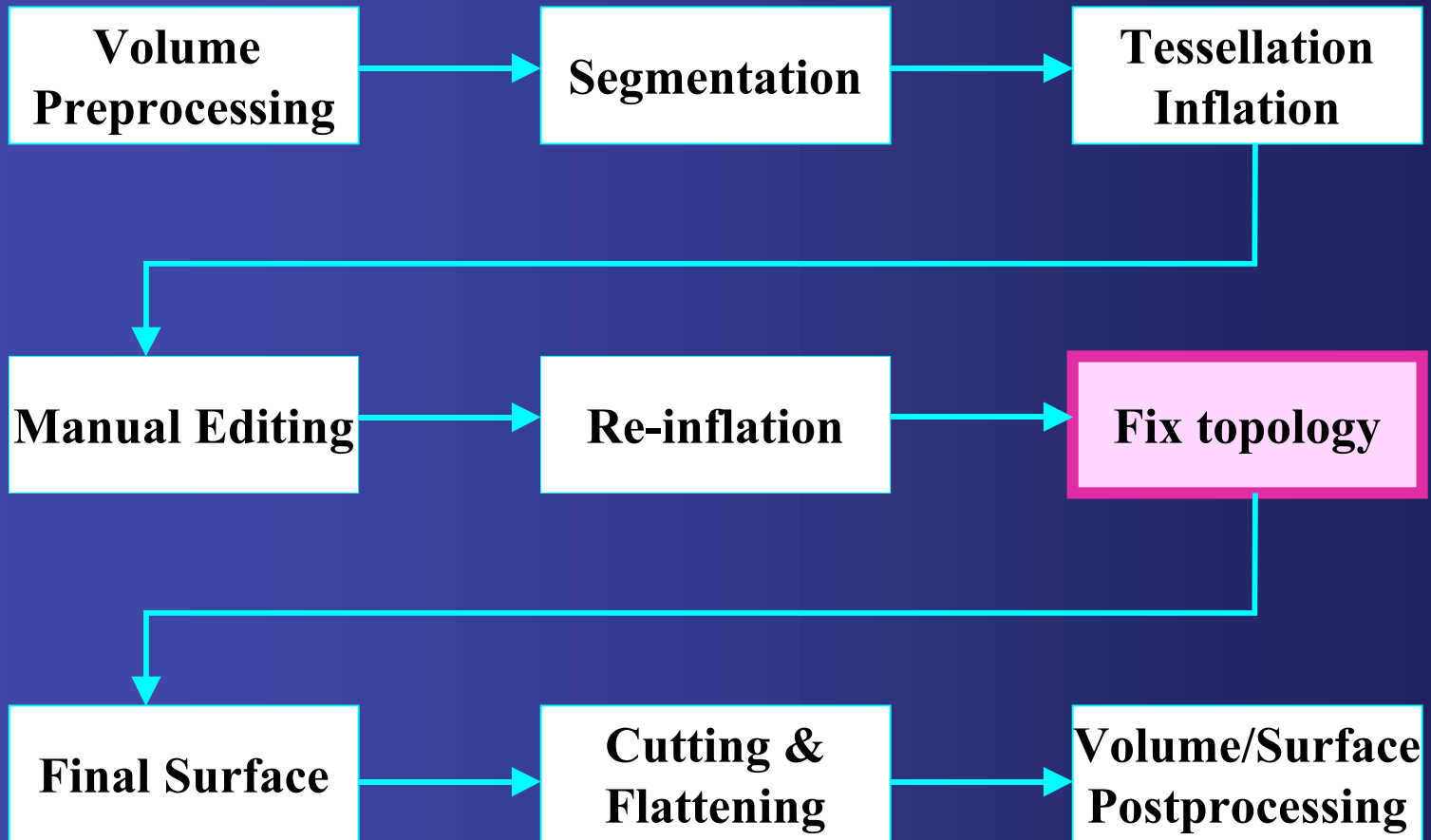
From GUI: **SubjectTools** → **Create Surface**

From Command Line: *inflate\_subject* <subject\_name>

🗄️ Class Example: (from within **lc\_play/** directory)

```
inflate_subject lc_avg
```

or... `recon-all -stage2 -subjid lc_avg`





FreeSurfer's automated topology fixer removes smaller topological defects.

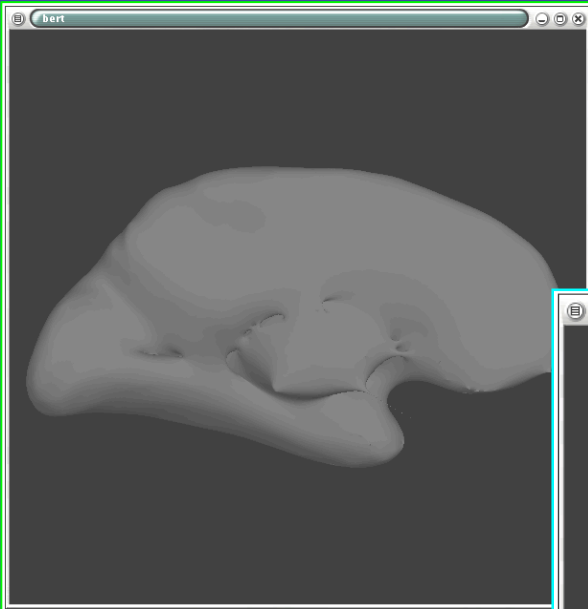
From GUI: **SubjectTools** → **Fix Surface Topology**

From Command Line: *fix\_subject* <subject\_name>

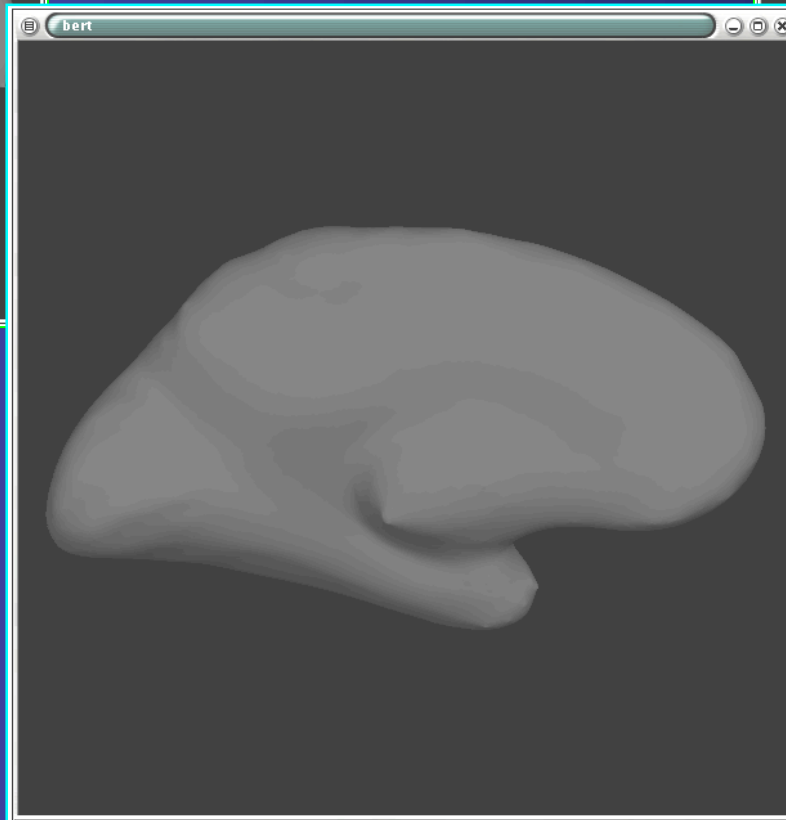
🗄️ Class Example: (from within **lc\_play/** directory)

```
fix_subject lc_avg
```

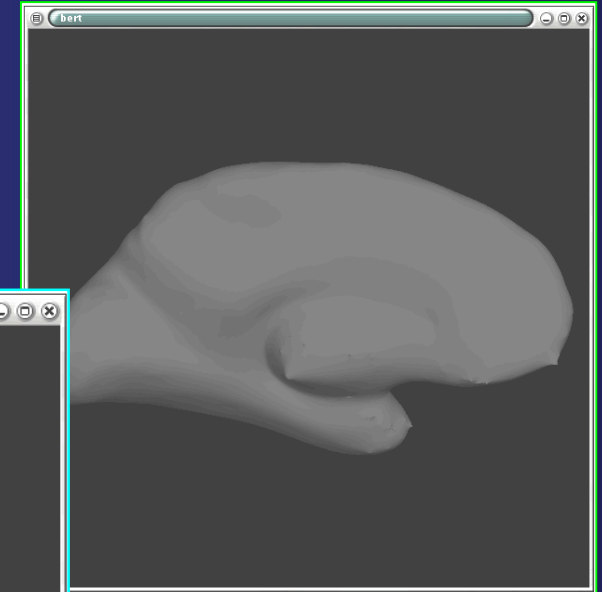
or... `recon-all -stage3 -subjid lc_avg`



Unedited

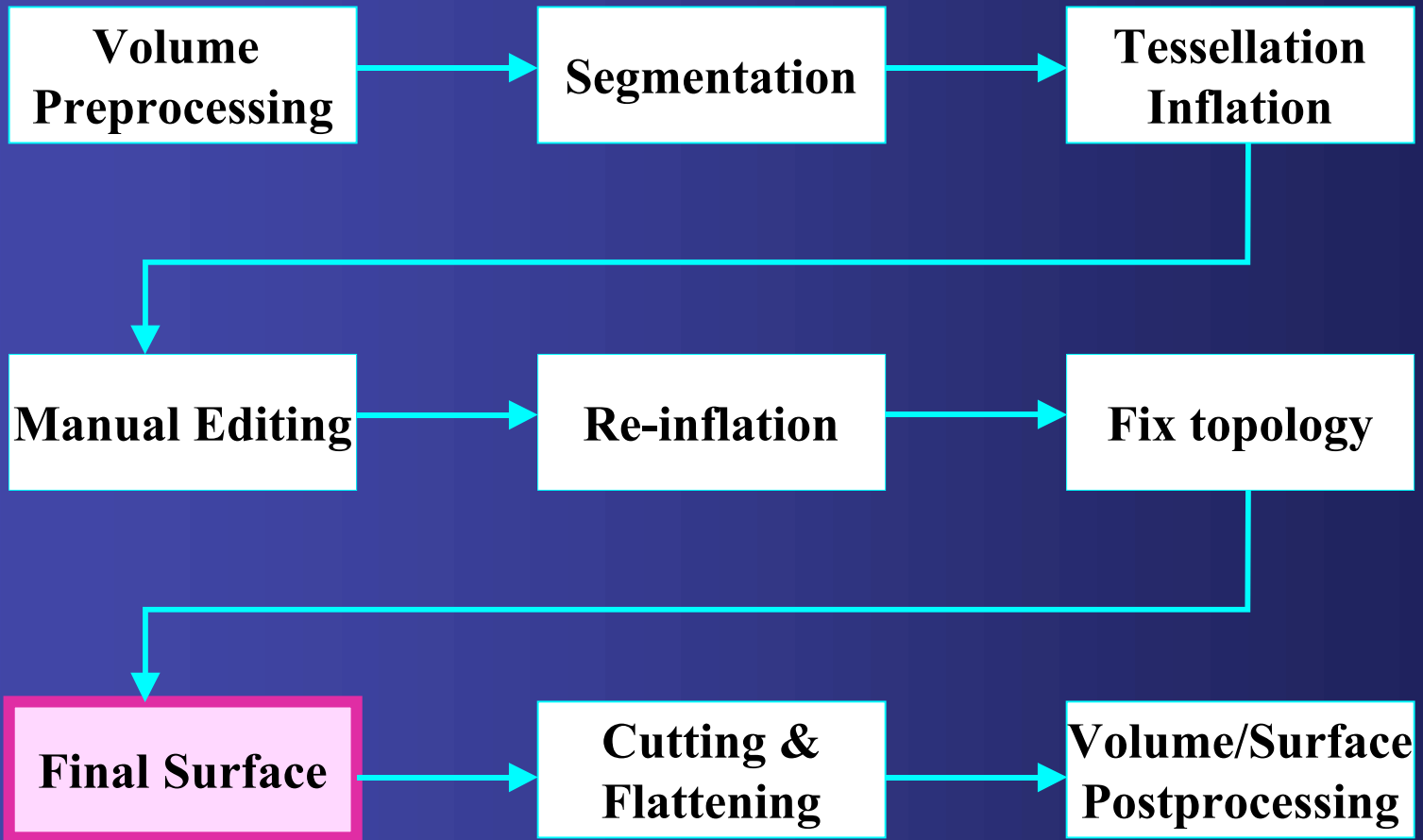


Manually Edited & 'Fix Topology'



Manually Edited







Create the final surfaces with FreeSurfer's *make\_final\_surfaces\_subject*  
(i.e., final wm outline, pial outline)

From GUI: SubjectTools → Make Final Surface

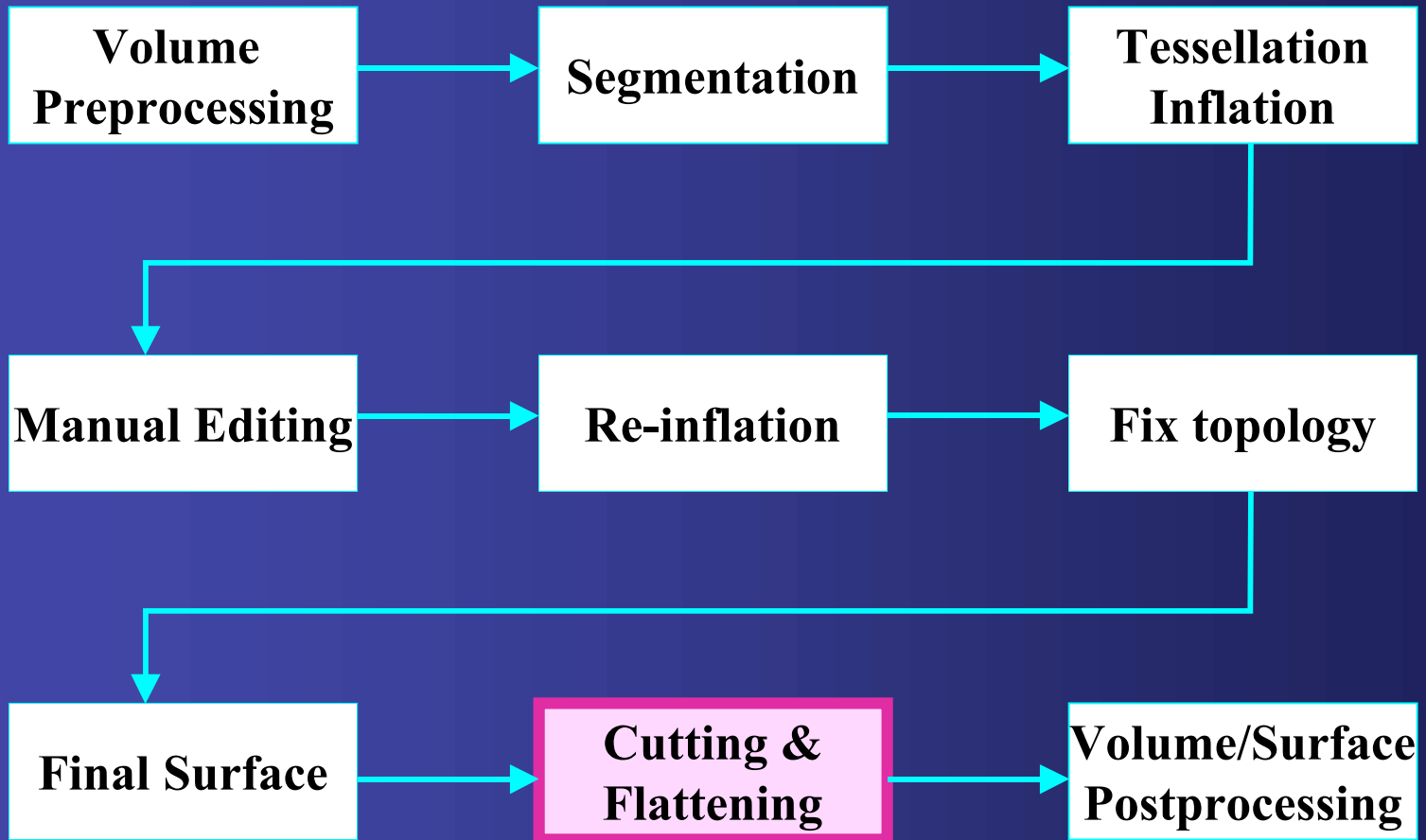
From Command Line: *make\_final\_surfaces\_subject* <subject\_name>

🗄️ Class Example: (from within *lc\_play/* directory)

```
make_final_surfaces_subject lc_avg
```

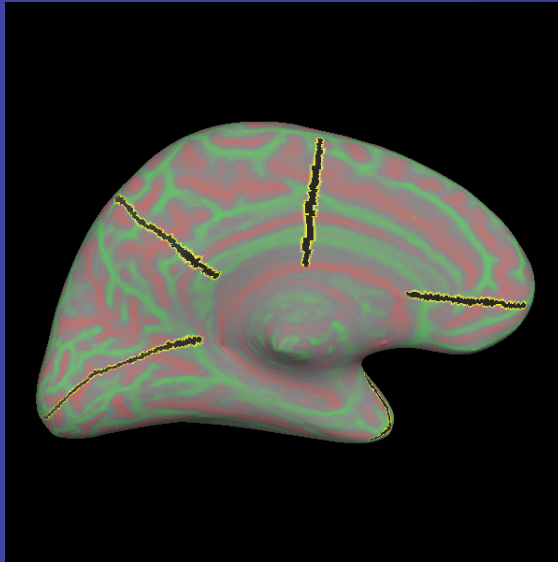
or... 

```
recon-all -stage4a -subjid lc_avg
```





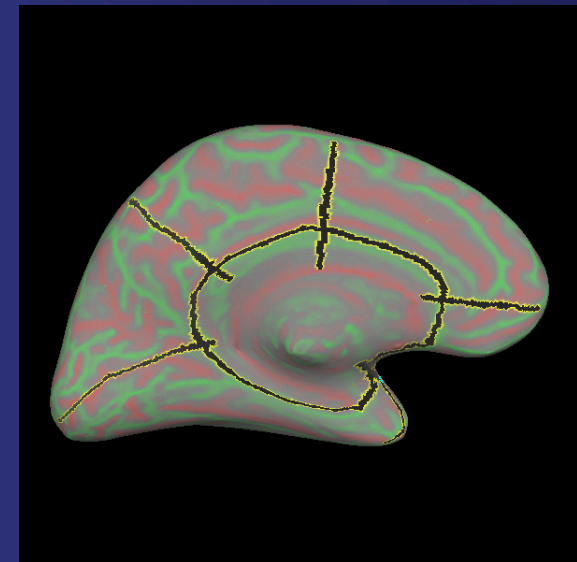
## \* For a Full Surface Patch:

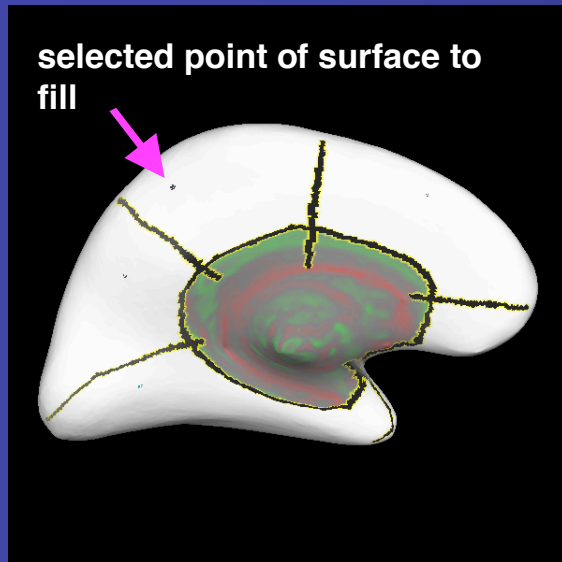


- 1) Main GUI: SubjectTools → Make Full Surface Cuts.
- 2) Make 5 “relaxation cuts” on medial side and press CUT LINE button on TK Surfer GUI.



- 3) Enclose midline region and press CUT CLOSED LINE button.

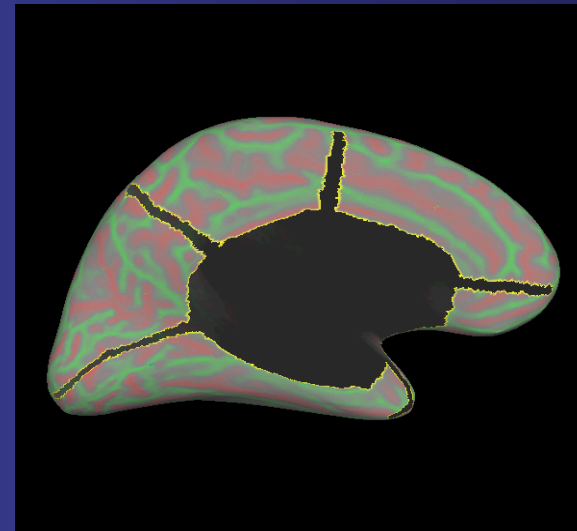




- 4) Mark a point on the region that will be saved and press the **CUT AREA** button.

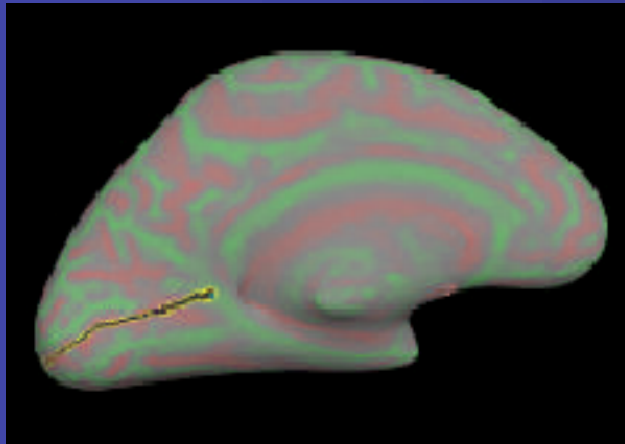


- 5) Save the patch as **?h.full.patch.3d**





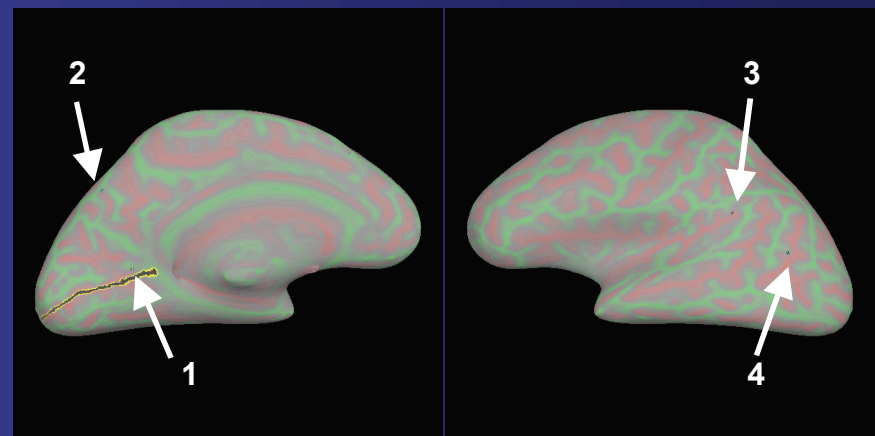
## \* For an Occipital Patch:

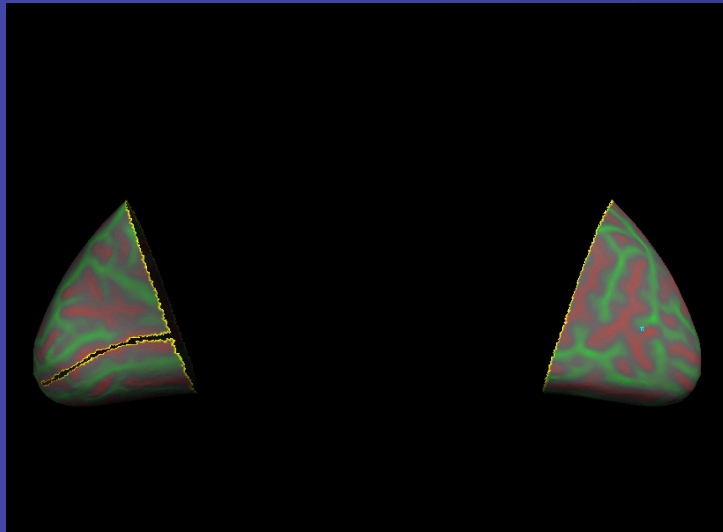


- 1) Main GUI: SubjectTools → Make Occip Surface Cuts.
- 2) Select points across calcarine fissure and press CUT LINE.

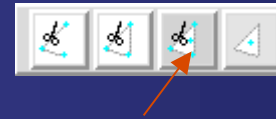


- 3) Select 3 points to define the cutting plane: 2 on medial side and 1 on lateral side.
- 4) Choose a fourth point to specify which portion of surface to keep.

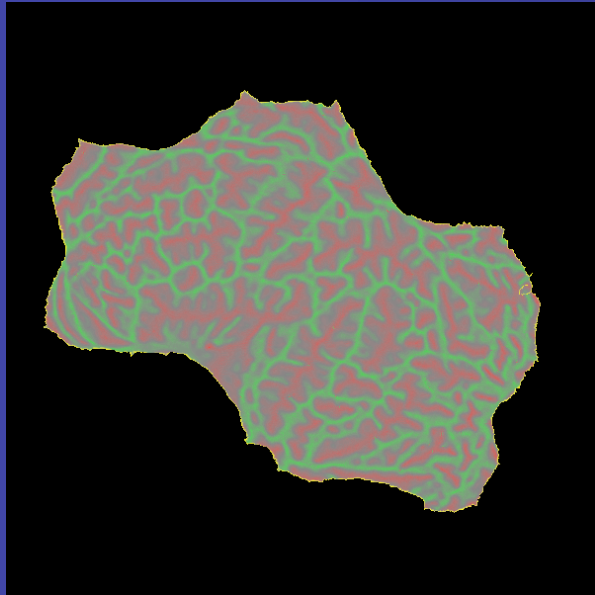




5) Press the **CUT PLANE** button to create the occipital patch.



6) Save as **?h.occip.patch.3d**



From GUI: SubjectTools → Flatten Surface

From Command Line:

*mrisc\_flatten <input patch> <output patch>*

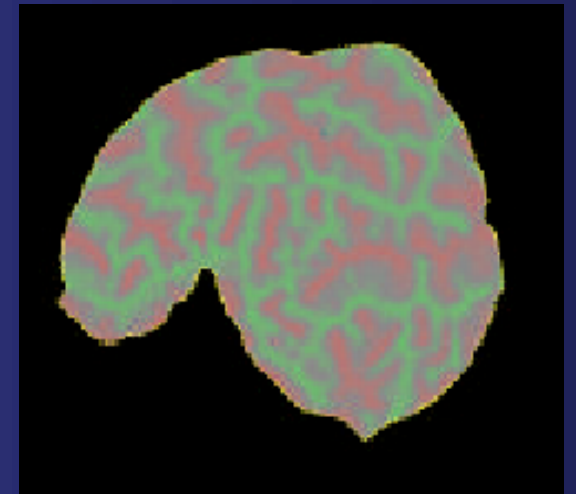
🚧 Class Example: (from within `lc_play/` directory)

GUI: SubjectTools → Flatten Surface

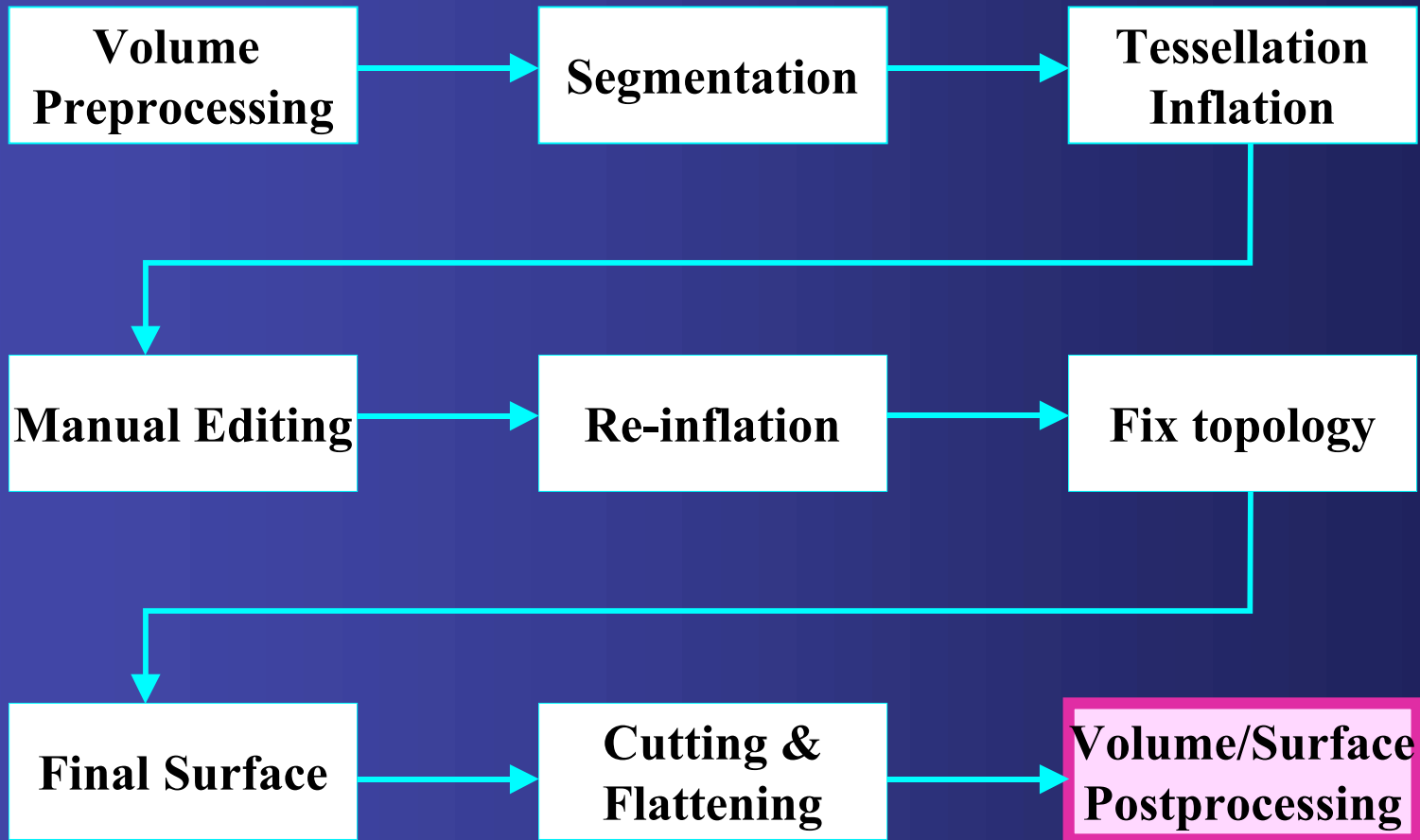
Command Line:

*mrisc\_flatten ?h.full.patch.3d ?h.full.patch.flat*

*mrisc\_flatten ?h.occip.patch.3d ?h.occip.patch.flat*

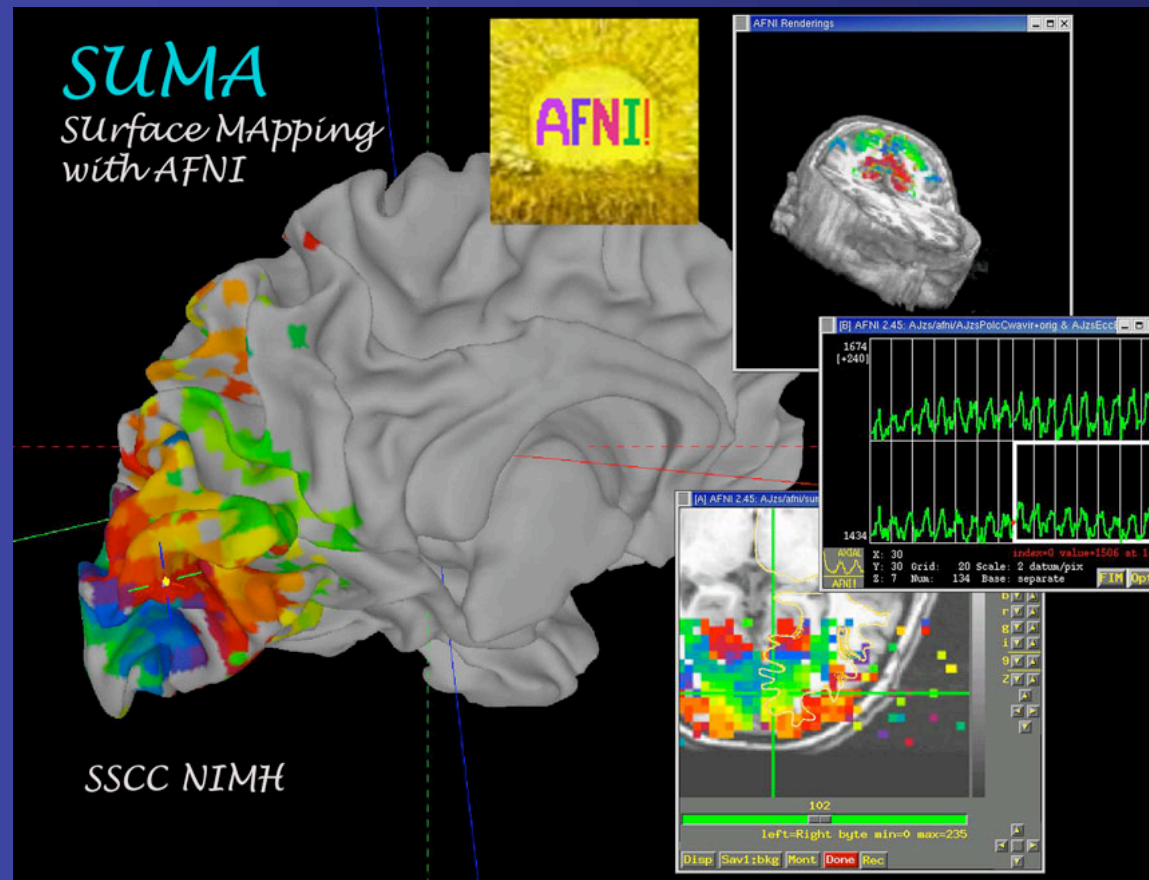


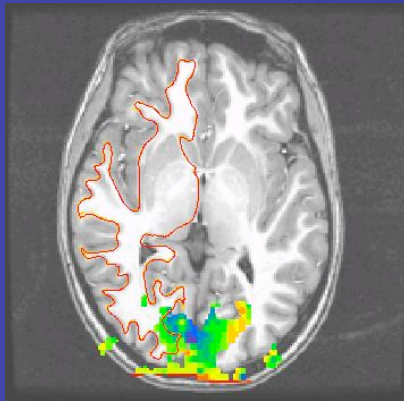




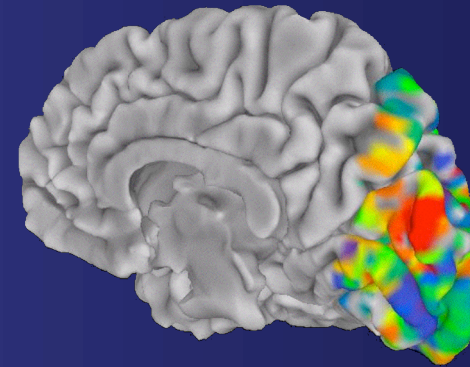


Your surfaces are now ready to be transferred over to SUMA.





AFNI



SUMA

 The AFNI SUMA hands-on is scheduled for:

FRIDAY, November 19, 2004, 8:30am-5:00pm

Instructor: Dr. Ziad Saad, NIMH

THAT'S ALL FOLKS!!!!!!!