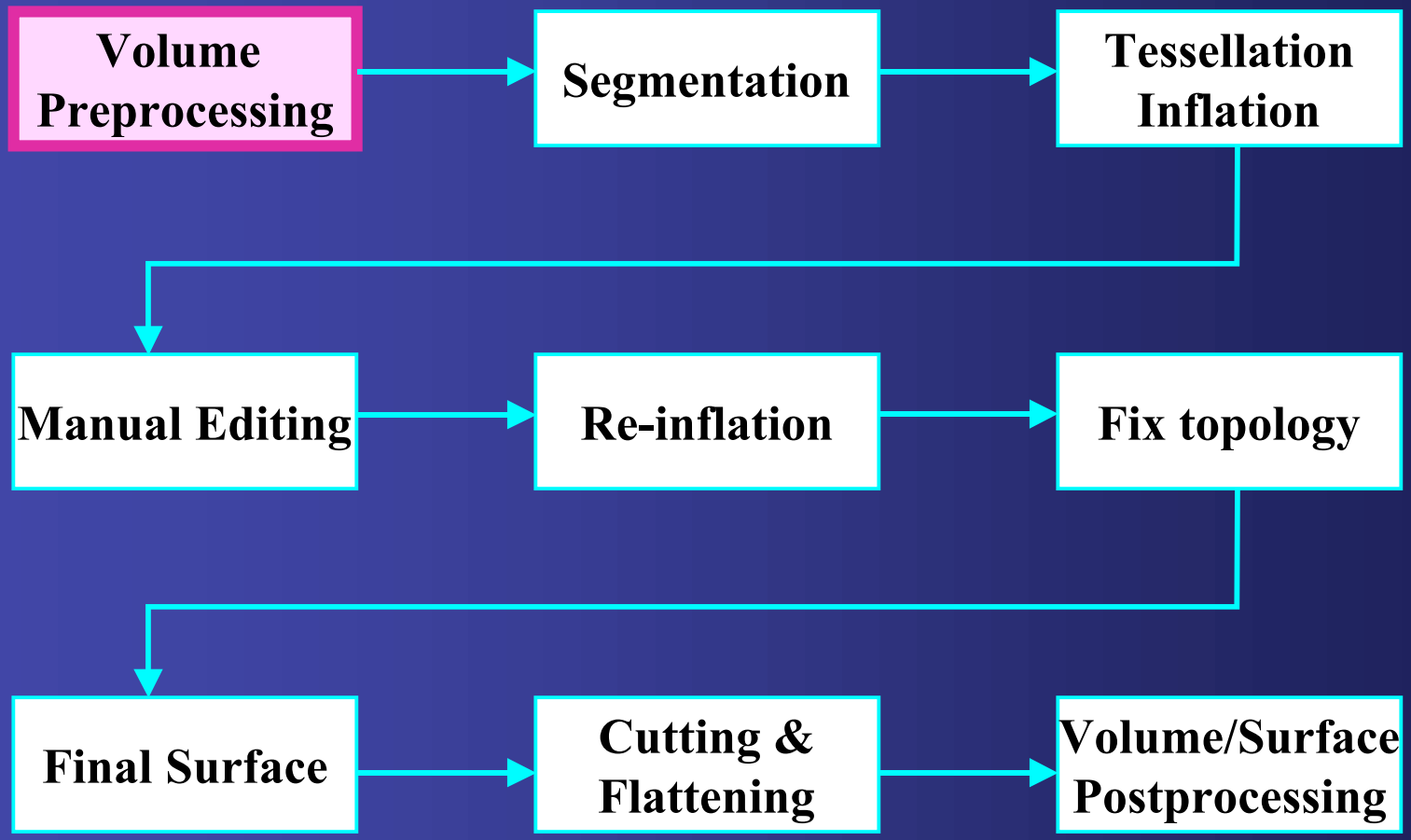
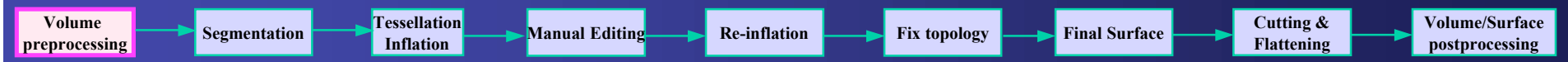
FreeSurfer Workshop - Begin the Hands-On…





1) Create AFNI dataset using *to3d*

to3d [-options] <image_files>

- Class Example (the long way):

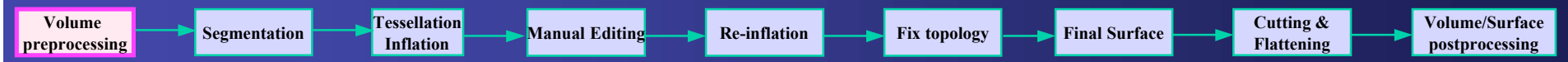
```
cd lc_play
    to3d -prefix mprage1 001/I.*
    to3d -prefix mprage2 002/I.*
    to3d -prefix mprage3 003/I.*
    to3d -prefix mprage4 004/I.*
```

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***:

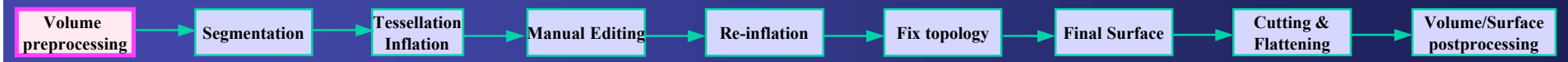
ls lc_play/

mprage1+orig.BRIK mprage1+orig.HEAD

mprage2+orig.BRIK mprage2+orig.HEAD

mprage3+orig.BRIK mprage3+orig.HEAD

mprage4+orig.BRIK mprage4+orig.HEAD

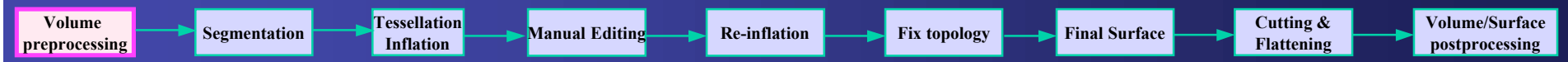


2) Perform Nonuniformity Correction on each dataset with AFNI *3dUniformize*

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

- Class Example: (from within lc_play/ directory)

```
foreach x (1 2 3 4)
        3dUniformize  -quiet  -auto_clip  -anat mprage{$x}+orig  \
                      -prefix mprage{$x}_n3
end
```

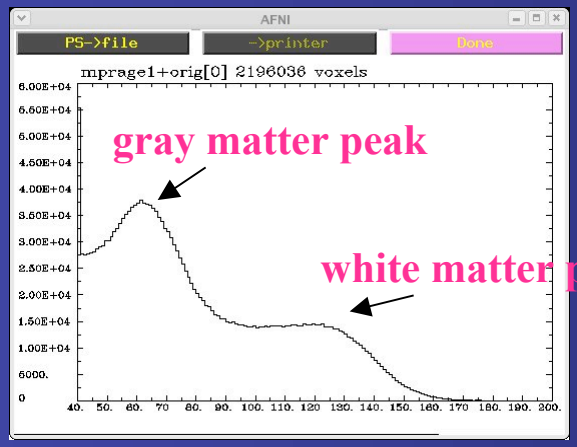


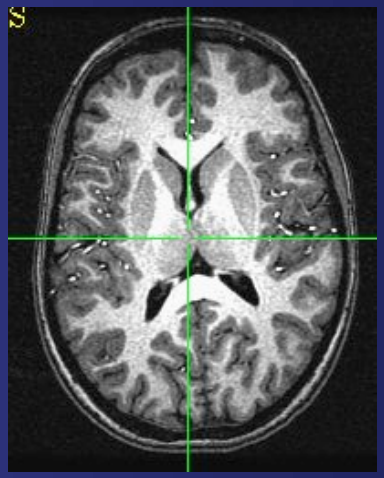
* Datasets we've created using ***3dUniformize***:

lc_play/

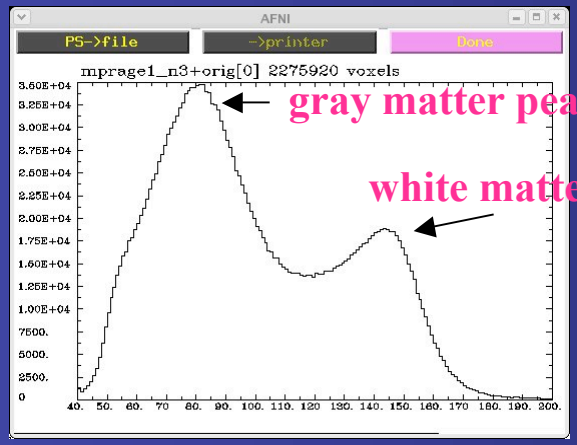
mprage1_n3+orig.BRIK	mprage1_n3+orig.HEAD
mprage2_n3+orig.BRIK	mprage2_n3+orig.HEAD
mprage3_n3+orig.BRIK	mprage3_n3+orig.HEAD
mprage4_n3+orig.BRIK	mprage4_n3+orig.HEAD

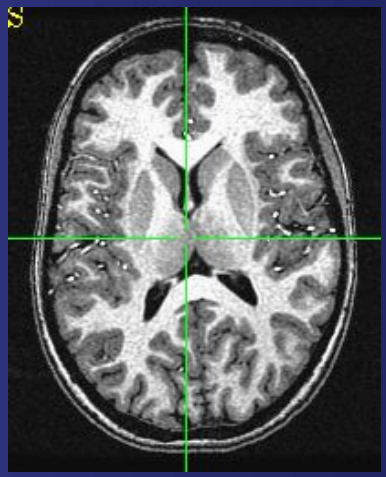
* Histogram BEFORE *3dUniformize*:

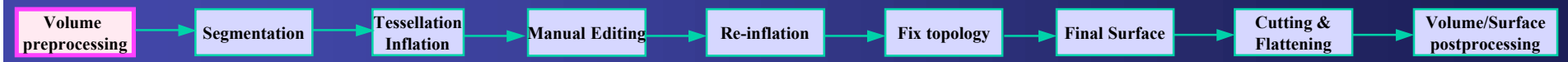




* Histogram AFTER *3dUniformize*:







3) Perform Volume Registration using AFNI *3dvolreg*

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

Base dataset:

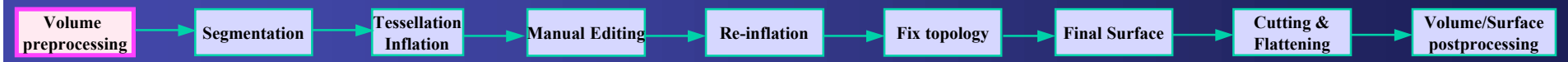
mprage1_n3+orig

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
```

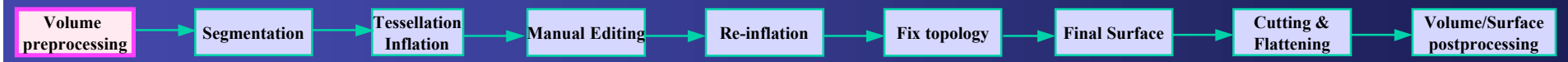
* Datasets we've created using ***3dvolreg***:

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)

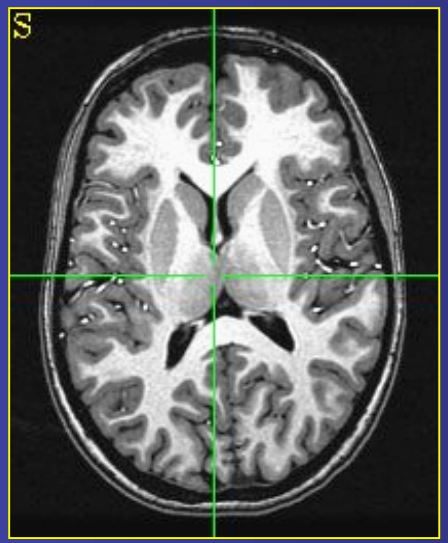
```
3dMean  -prefix mprage_avg  \
        mprage*_n3vr+orig.BRIK   mprage1_n3+orig
```

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

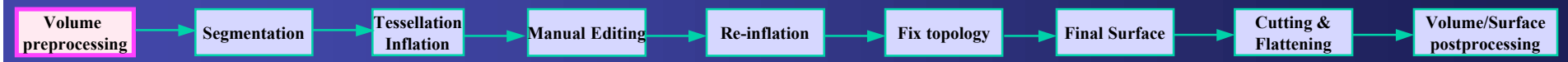
ls lc_play/

mprage_avg+orig.BRIK mprage_avg+orig.HEAD

- This dataset can be viewed in AFNI.



beautiful gray-white matter contrast!



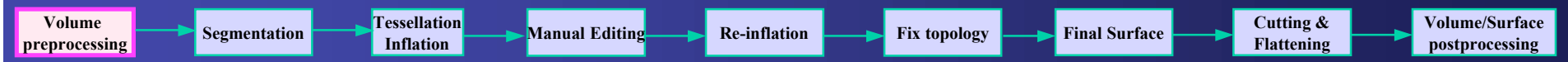
5) Create FreeSurfer directory tree using *mksubjdirs*

(note: be sure to source your .fs_login file first)

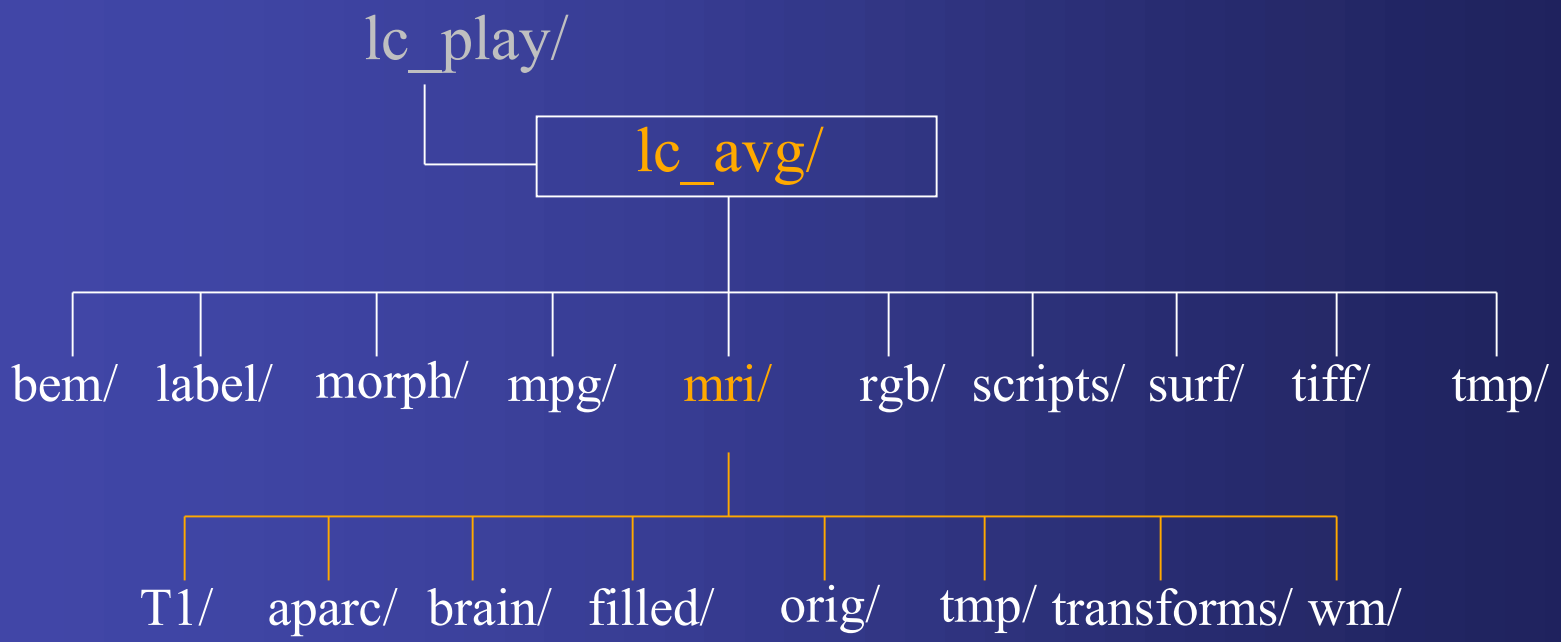
mksubjdirs <subject_name>

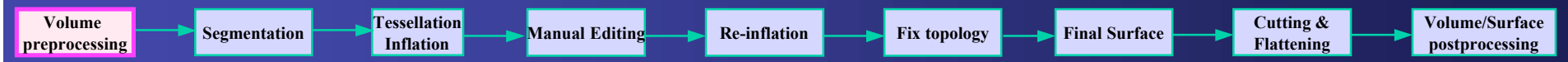
- Class Example: (from within lc_play/ directory)

  mksubjdirs lc_avg



Result from mksubjdirs lc_avg:





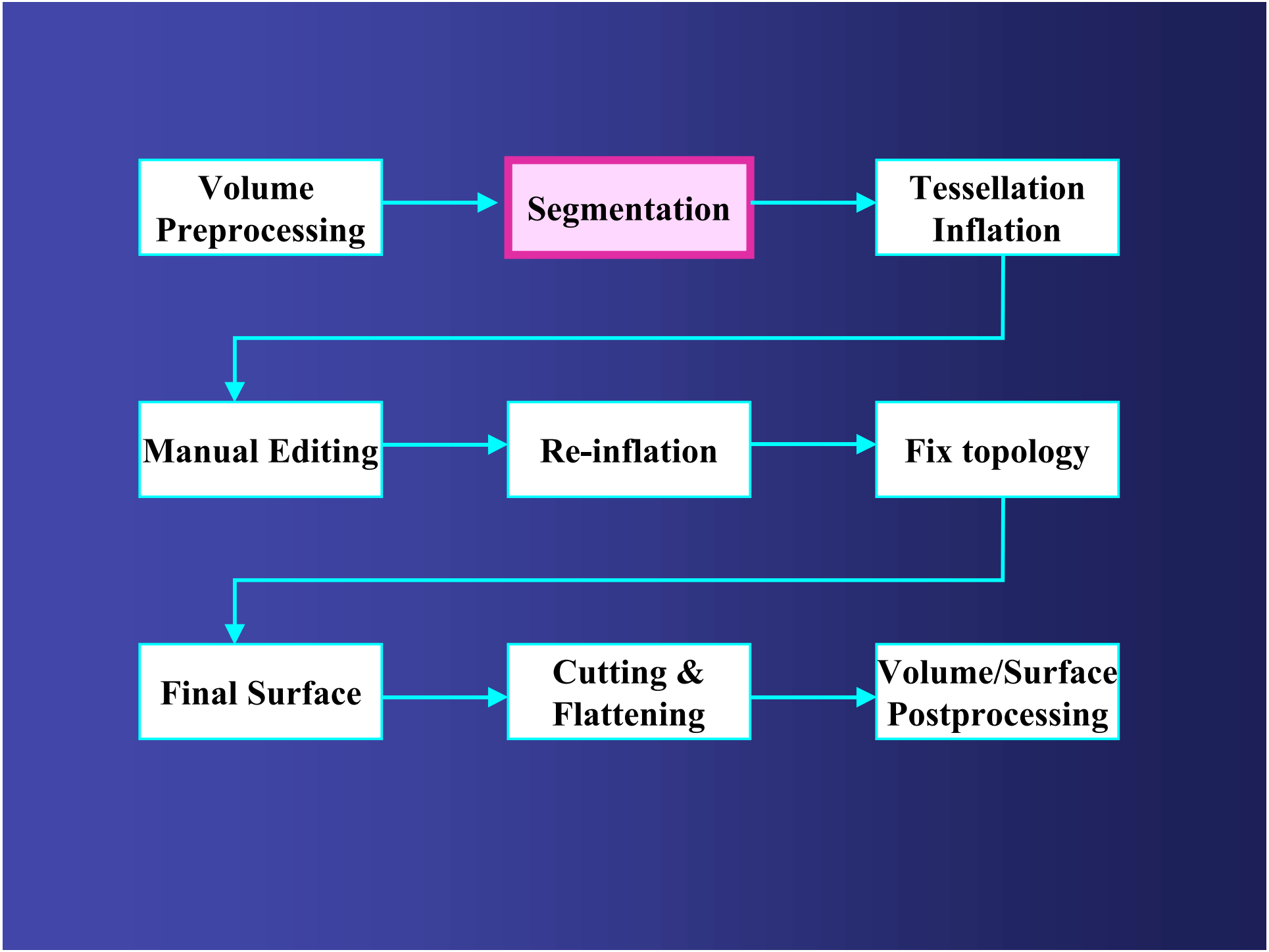
6) Convert volume dataset into *COR* format:

(i.e., 256 coronal slices, 256 x 256 in-plane, 1mm^3 voxel resolution)

mri_convert <volume_dataset>

- Class Example: (from within lc_play/ directory)

mri_convert mprage_avg+orig.BRIK lc_avg/mri/orig


Volume Preprocessing
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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 ← **This is called a "legacy command"**

or… recon-all -autorecon1 -subjid lc_avg

Result of 'Process Volume':

Intensity Normalization (lc_avg/mri/T1)

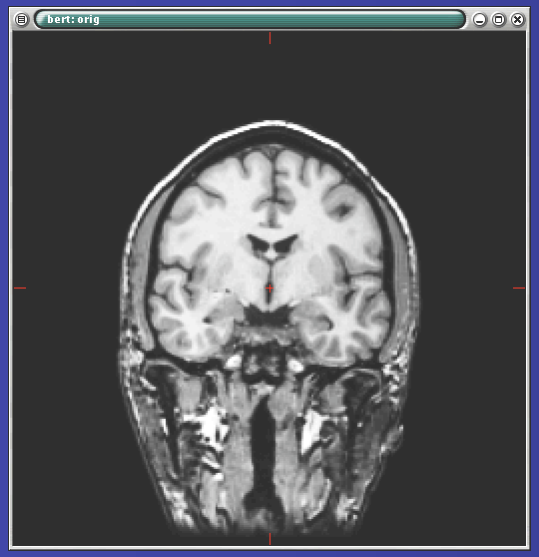
Skull Stripping (lc_avg/mri/brain)

White Matter Segmentation (lc_avg/mri/wm)

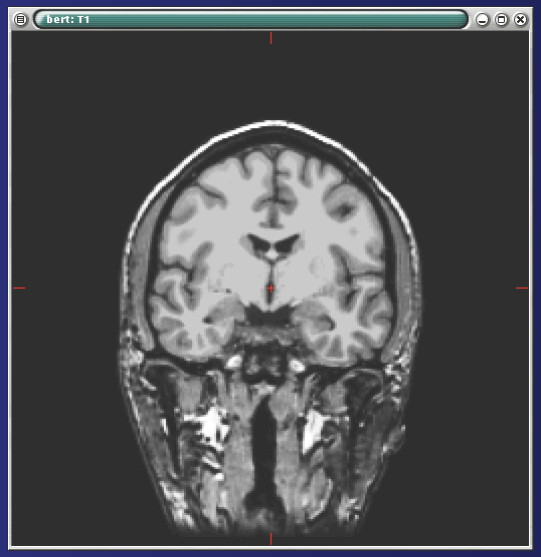
Note:

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

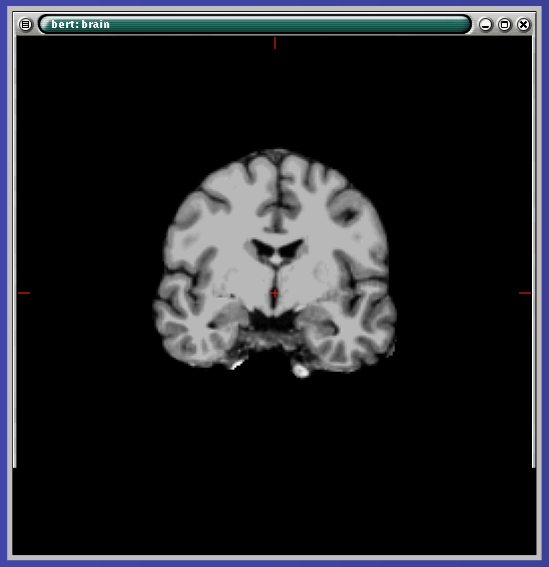
Volume preprocessing → **Segmentation** → Tessellation Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing



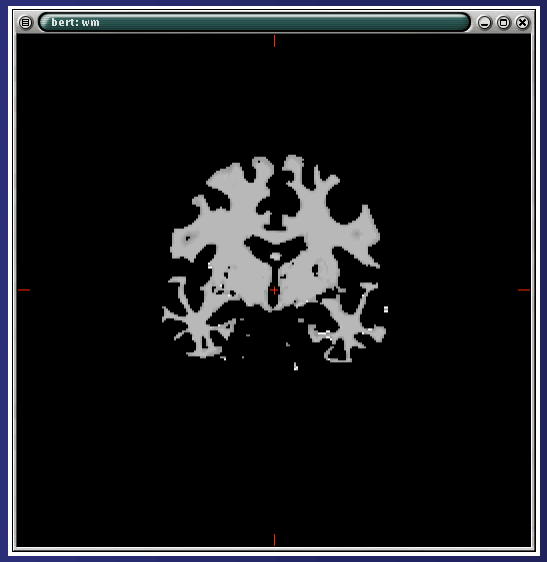
mri/orig



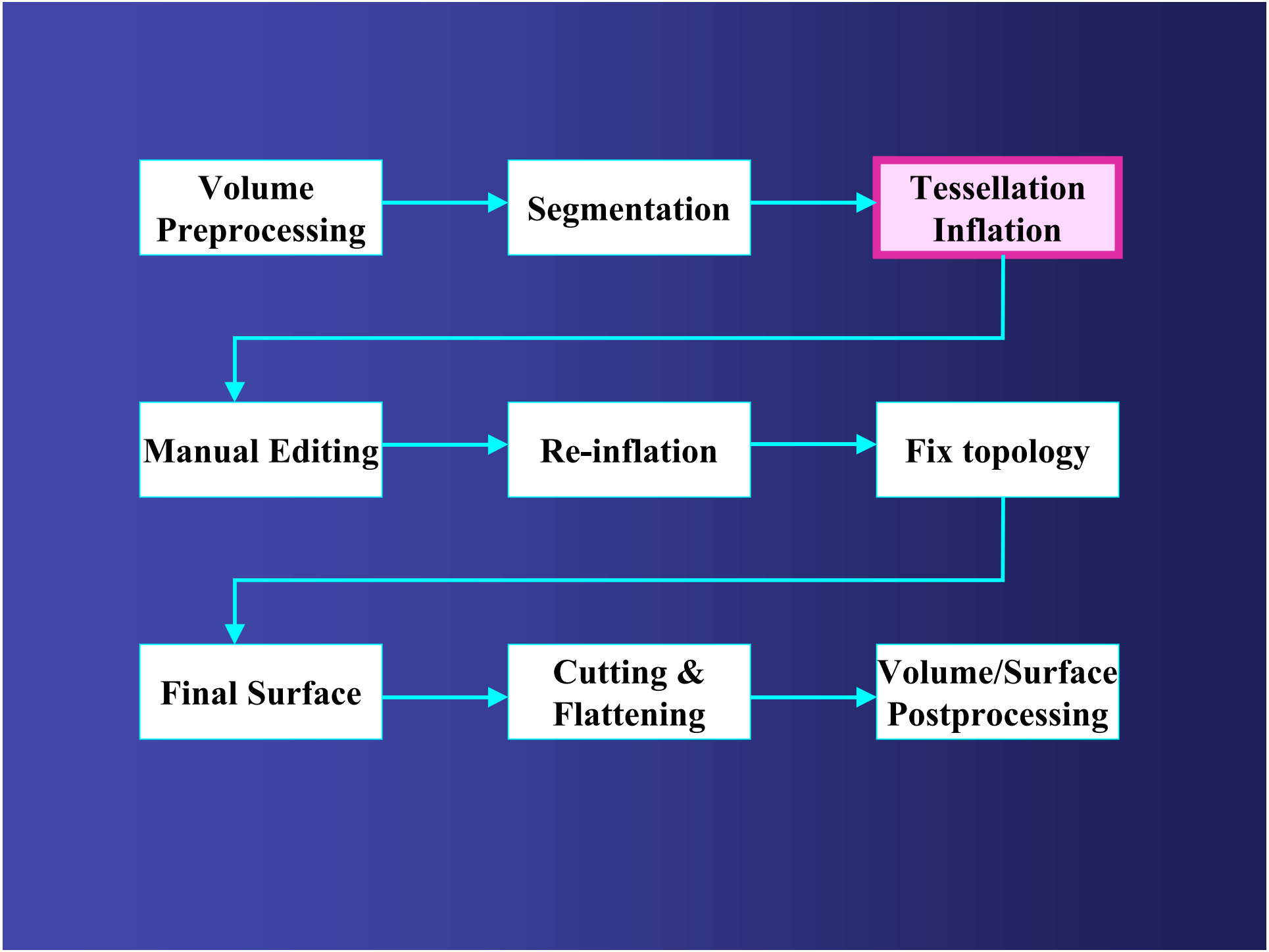
mri/T1



mri/brain



mri/wm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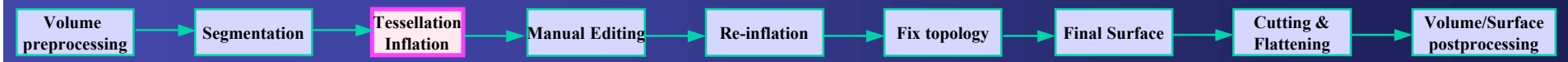
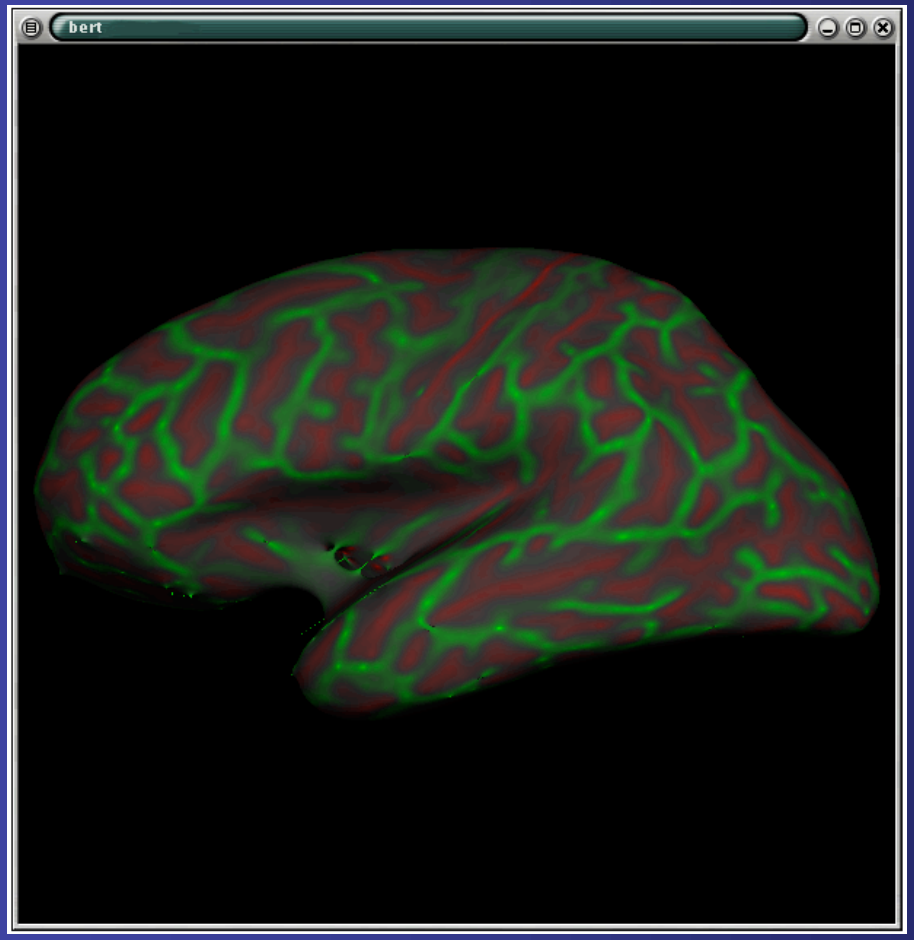


Create an inflated surface using FreeSurfer's *inflate_subject*

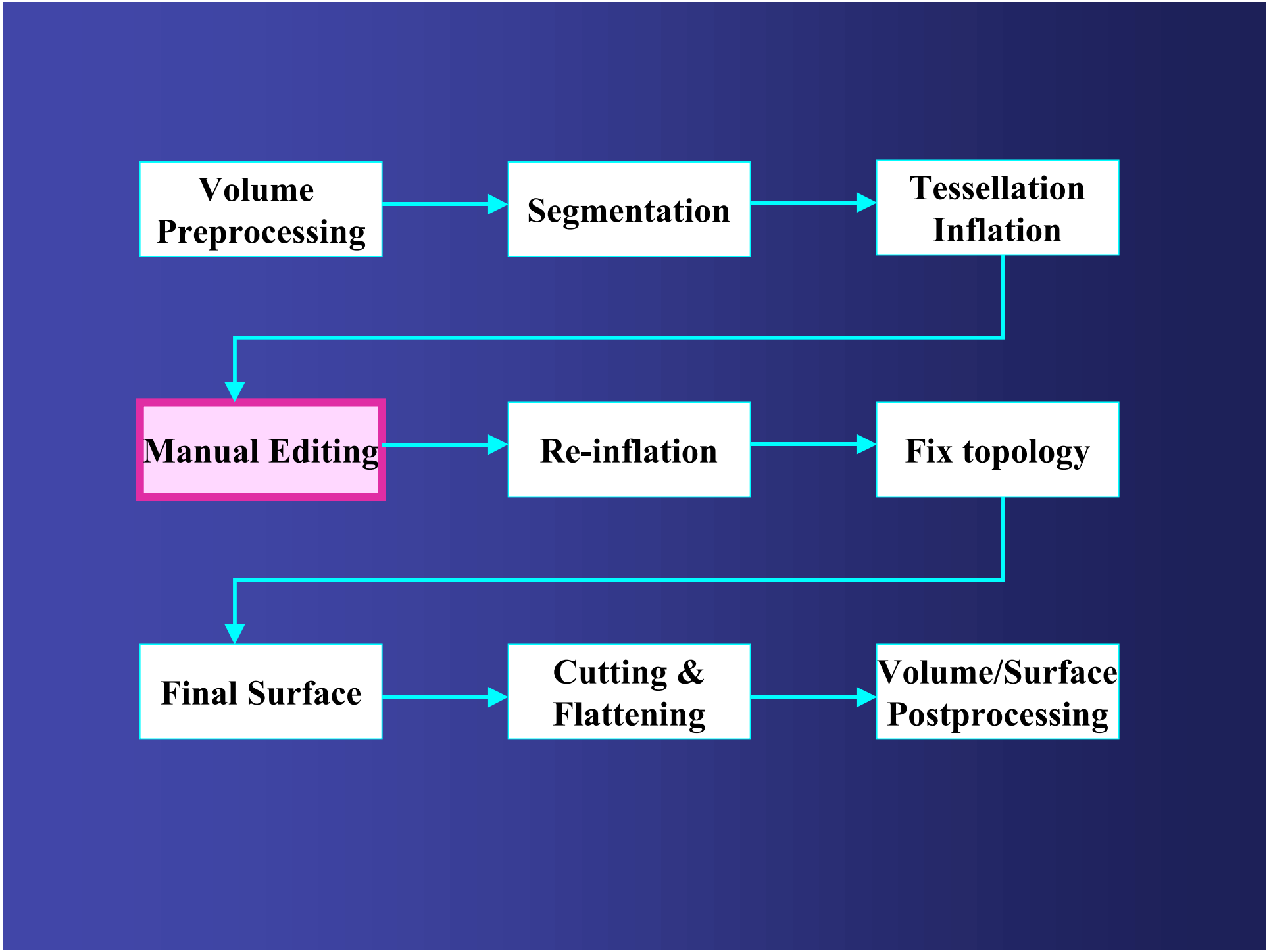
- Class Example: (from FreeSurfer GUI):

  Subject Tools → Create Surface

Volume preprocessing → Segmentation → Tessellation Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing



Go to TK Surfer interface to examine the inflated surface.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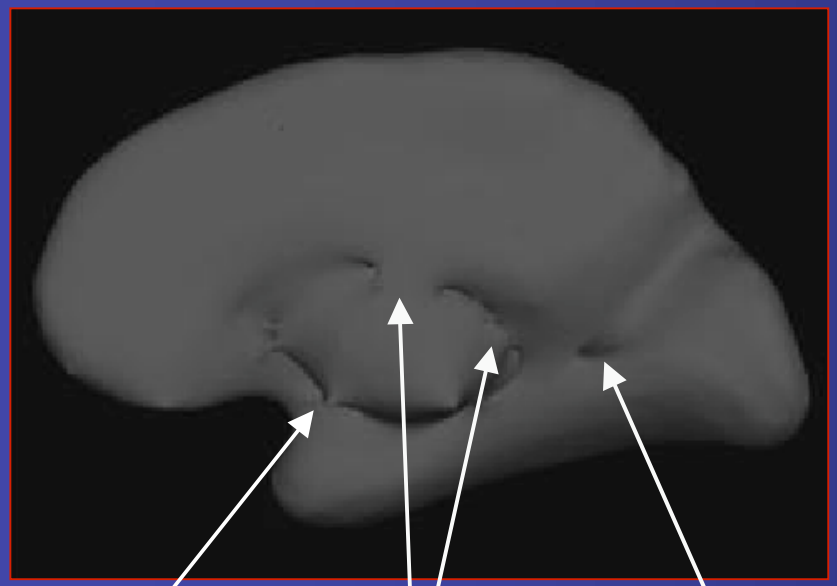
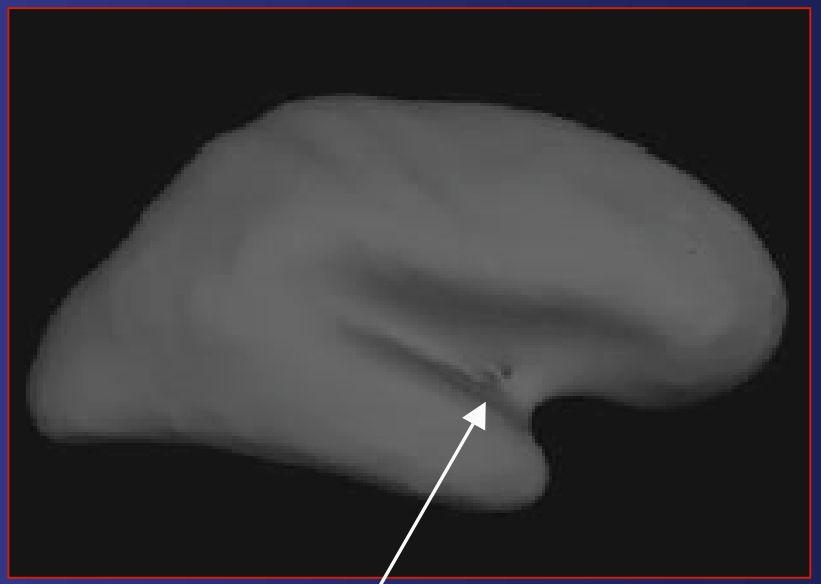
The most commonly derived defects that require manual editing:

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

Volume preprocessing → Segmentation → Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing

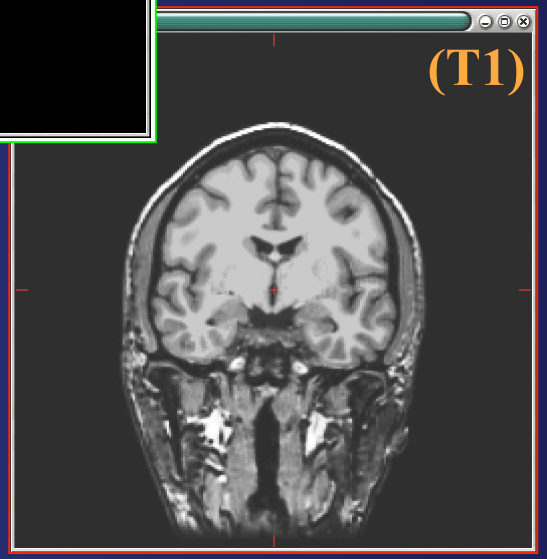


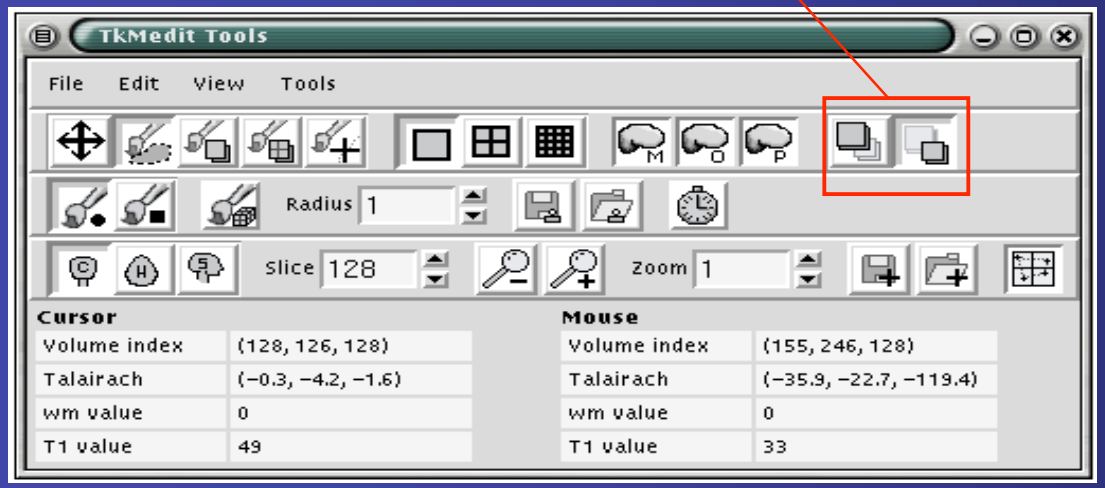


Volume preprocessing → Segmentation → Inflation → **Manual Editing** → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing

- Manual Editing is done in the **wm** matter volume. This is the MAIN volume.
- Load **T1** as your AUXILLARY volume.

Alternate between volumes





To begin manual editing:

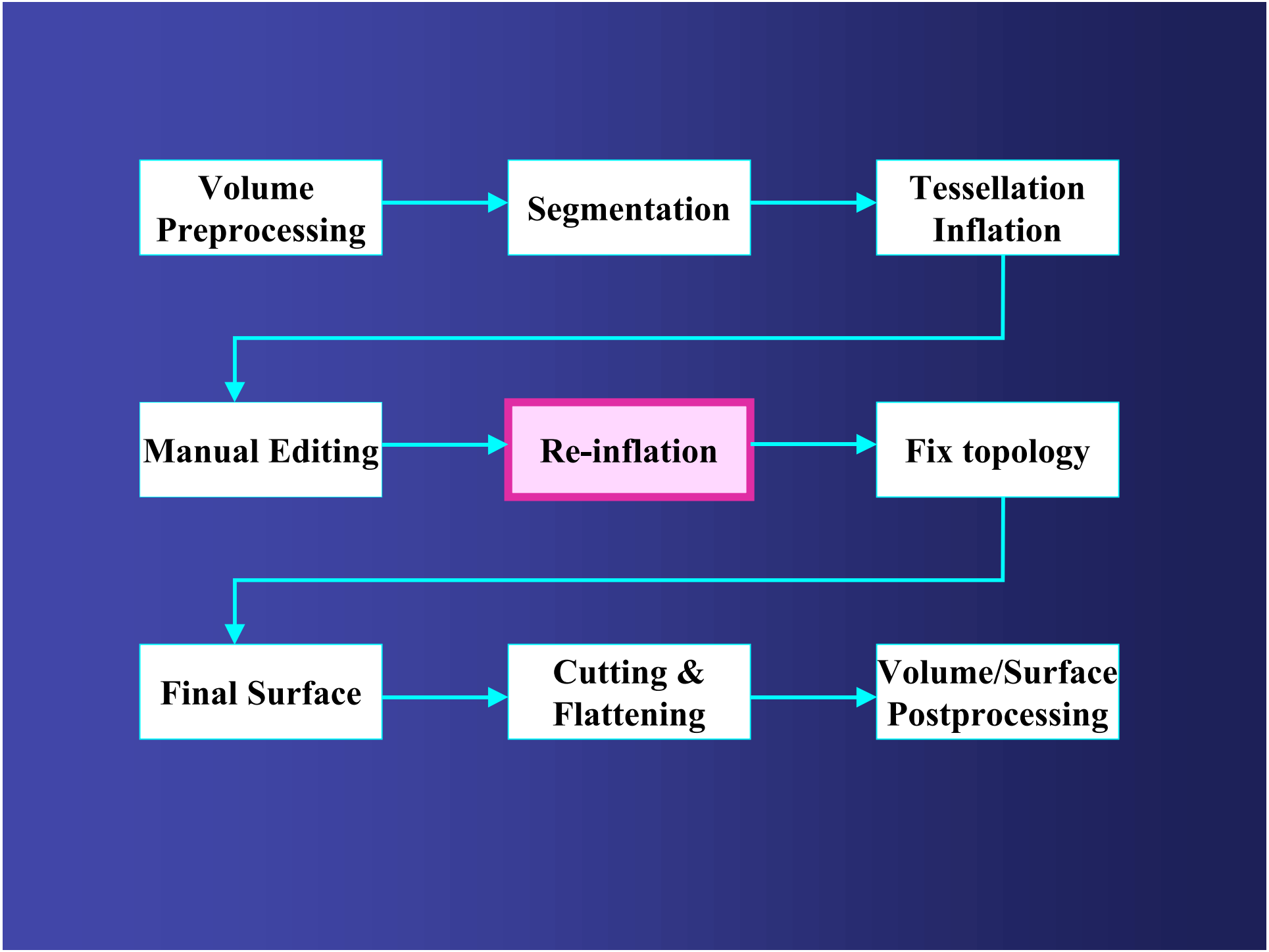
Subject Tools --> Edit Segmentation

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

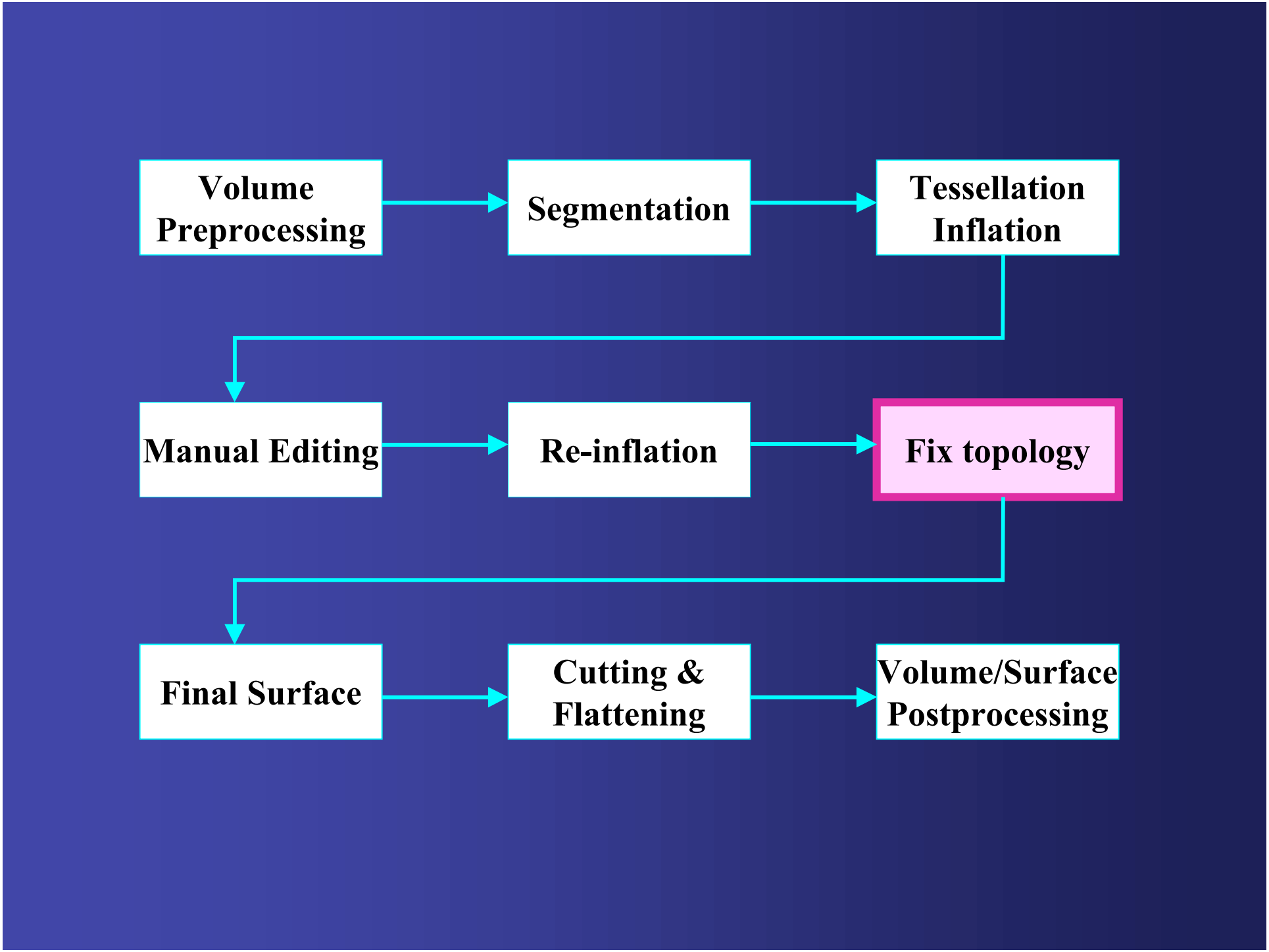
From GUI: SubjectTools → Create Surface

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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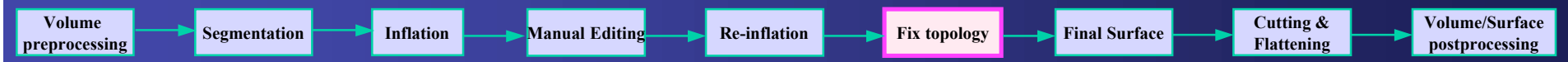


FreeSurfer's automated topology fixer removes smaller topological defects.

From GUI: SubjectTools → Fix Surface Topology

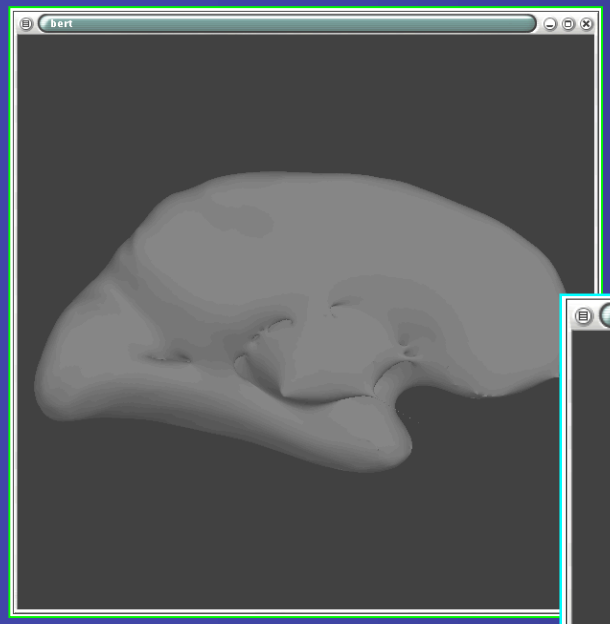
From Command Line: *fix_subject <subject_name>*

- Class Example: (from within lc_play/ directory)

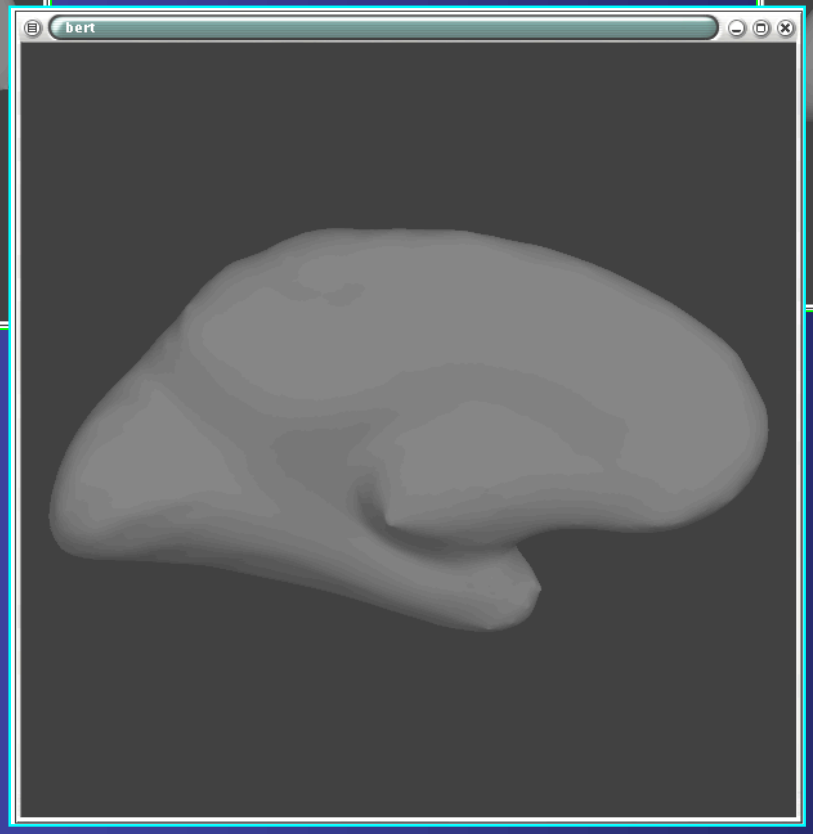
  fix_subject lc_avg

or… recon-all -stage3 -subjid lc_avg

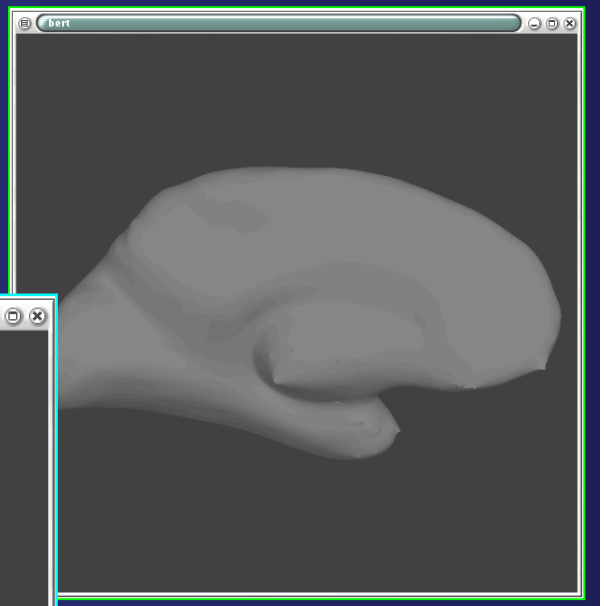
Volume preprocessing → Segmentation → Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing



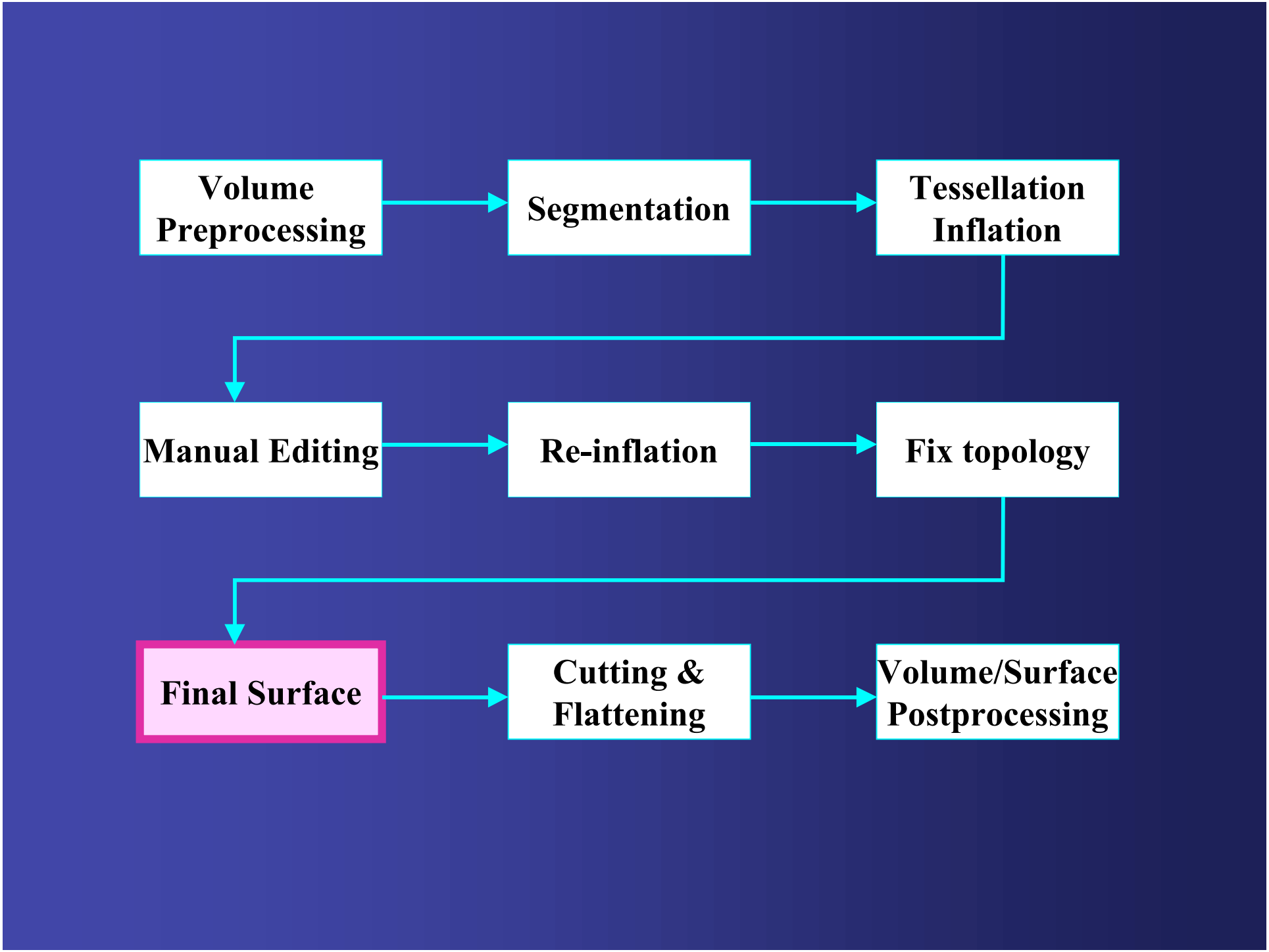
Unedited



Manually Edited & ‘Fix Topology’



Manually Edited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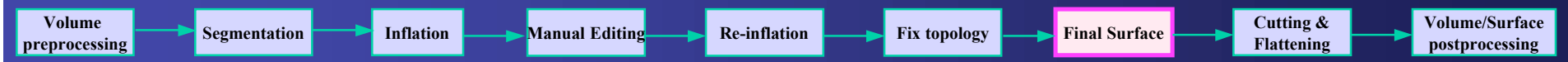


Create the final surfaces with FreeSurfer's *make_final_surfaces_subject*
(i.e., final wm outline, pial outline)

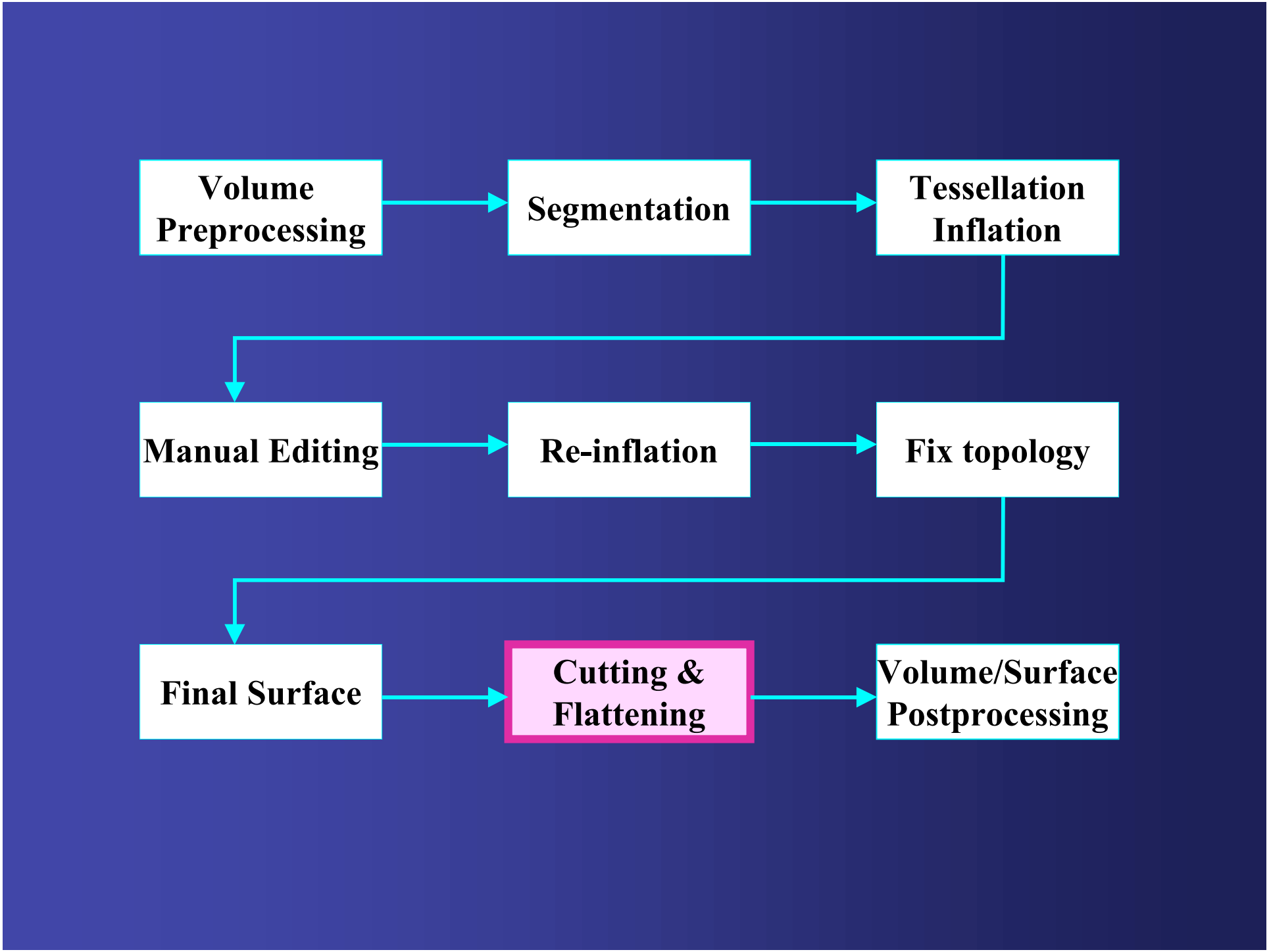
From GUI: SubjectTools → Make Final Surface

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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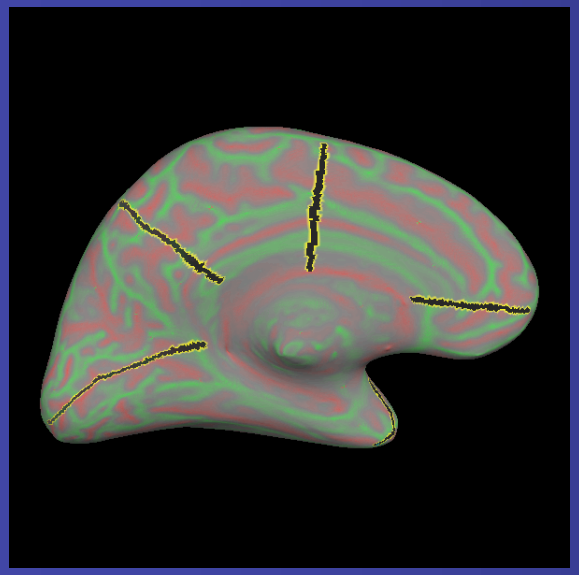
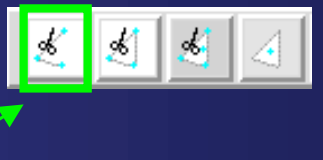
* For a Full Surface Patch:

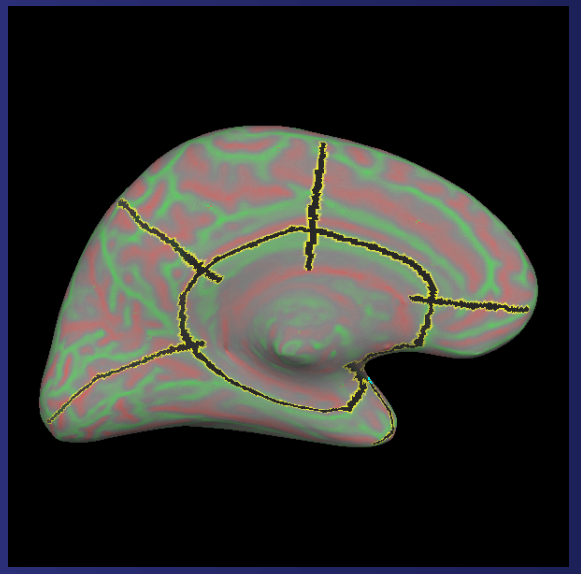


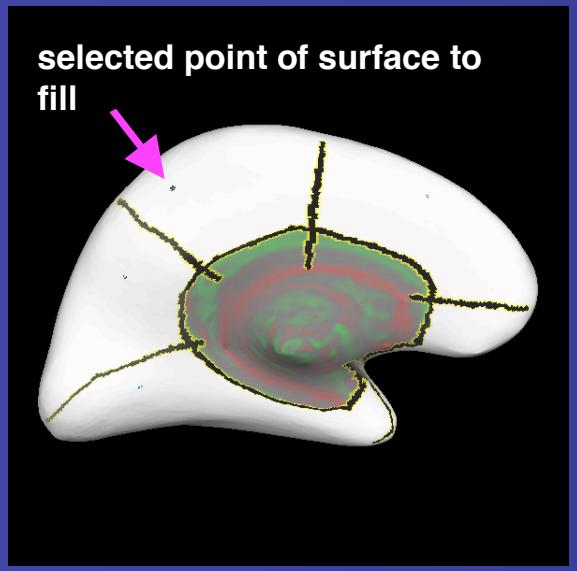
1) Main GUI: SubjectTools → Make Full Surface Cuts.

2) Make 5 "relaxation cuts" on medial side and press CUT LINE button on TK Surfer GUI.

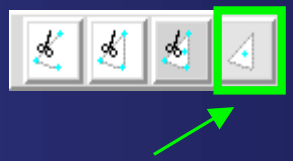


3) Enclose midline region and press CUT CLOSED LINE button.

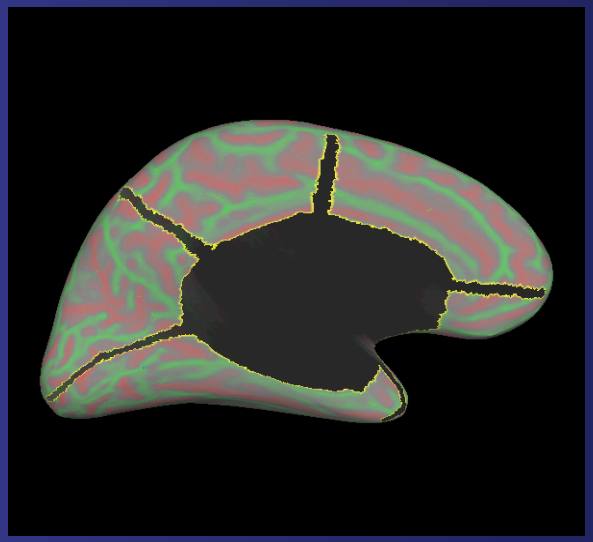




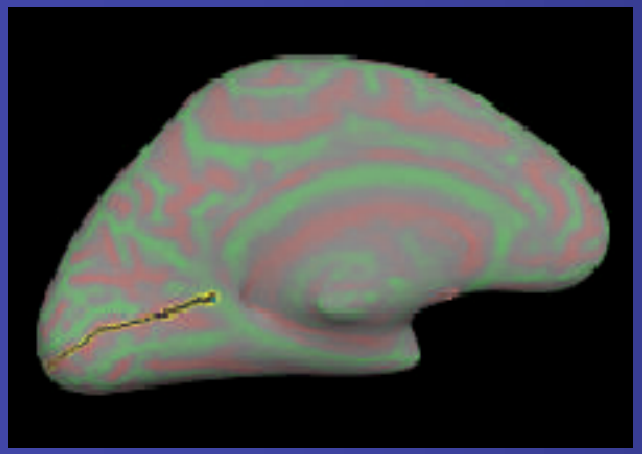
4) Mark a point on the region that will be saved and press the CUT AREA button.



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



* For an Occipital Patch:

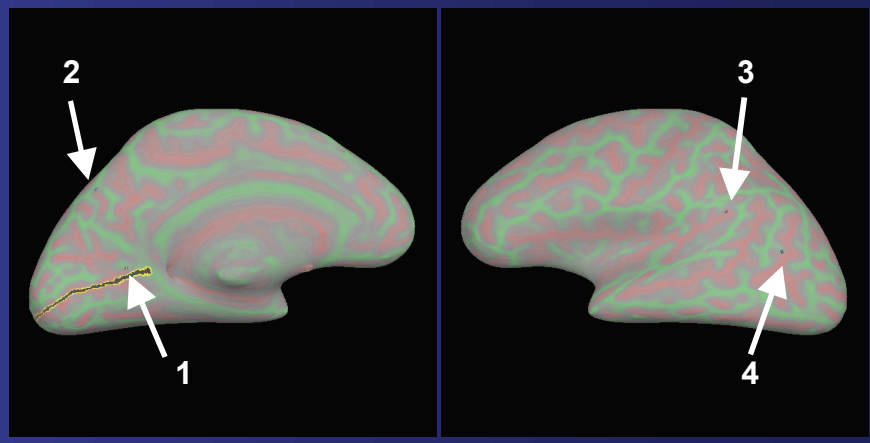


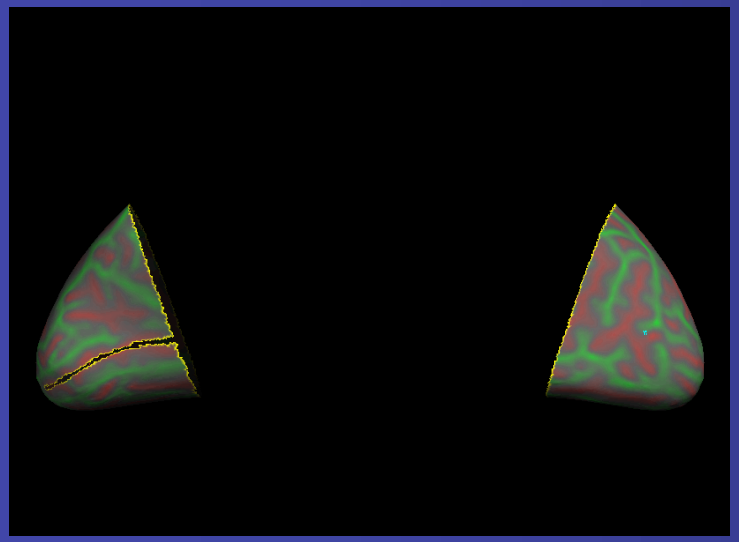
1) Main GUI: SubjectTools → Make Occip Surface Cuts.

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.

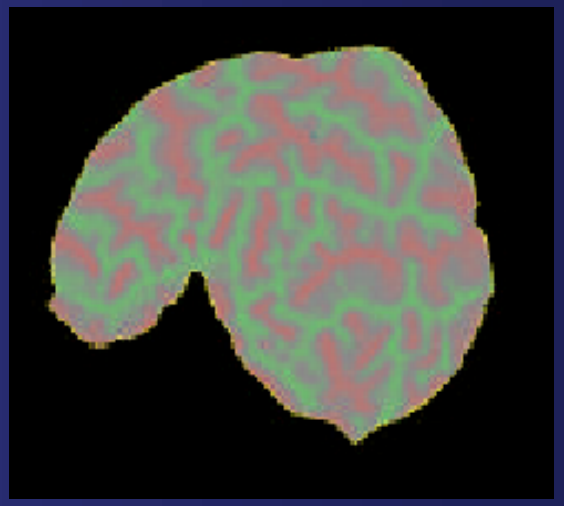
6) Save as ?h.occip.patch.3d

Volume preprocessing → Segmentation → Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing

From GUI: SubjectTools → Flatten Surface

From Command Line:

mris_flatten <input patch> <output patch>



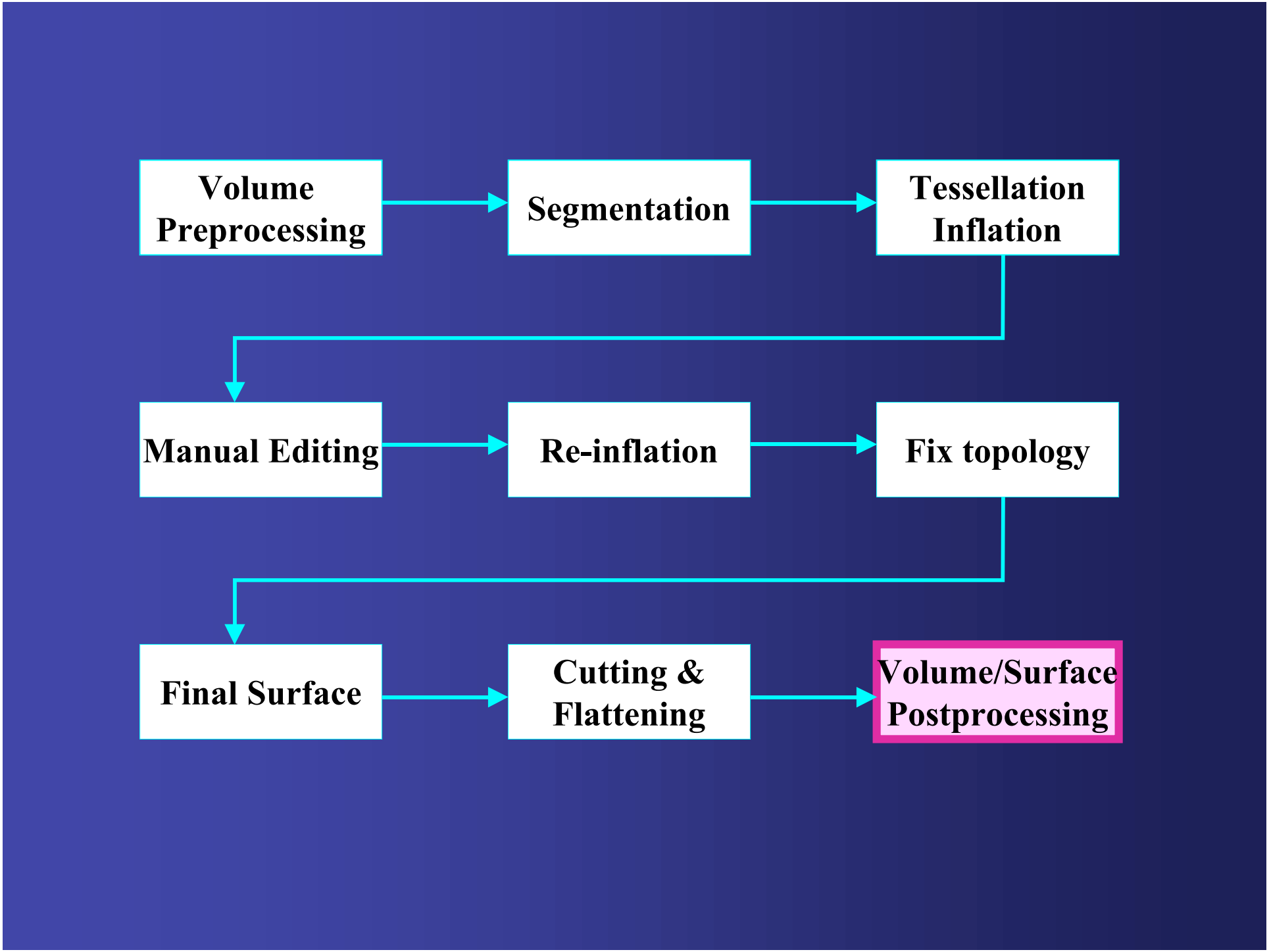
- Class Example: (from within lc_play/ directory)

GUI: SubjectTools → Flatten Surface

Command Line:

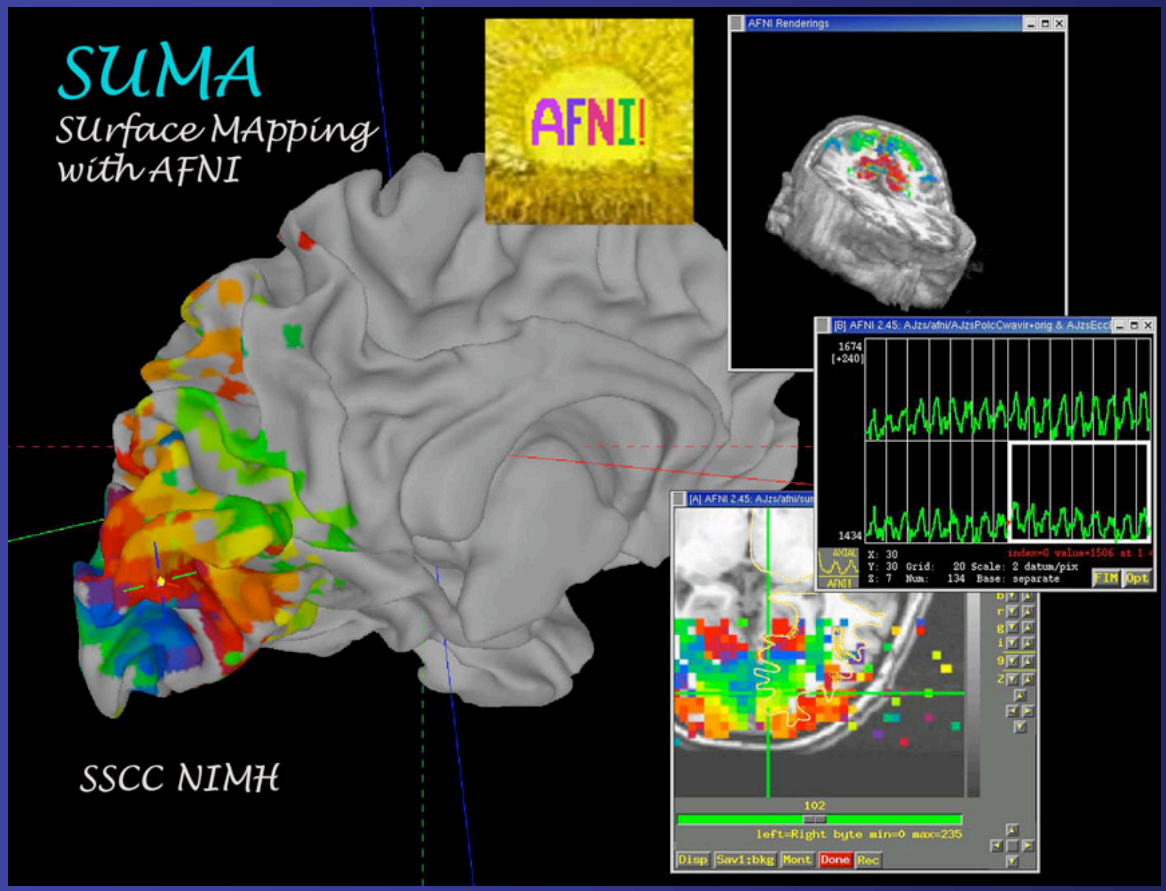
mris_flatten ?h.full.patch.3d ?h.full.patch.flat

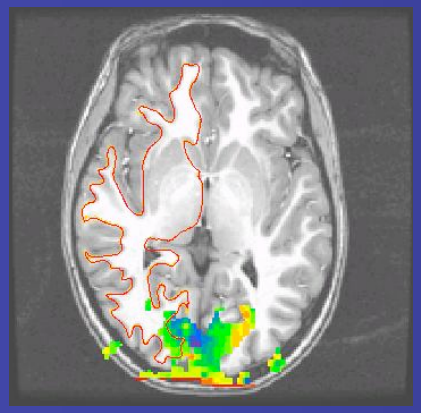
mris_flatten ?h.occip.patch.3d ?h.occip.patch.flat


Volume Preprocessing
Segmentation
Tessellation Inflation
Manual Editing
Re-inflation
Fix topology
Final Surface
Cutting & Flattening
Volume/Surface Postprocessing

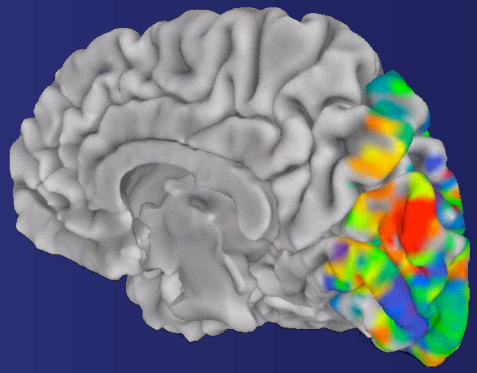
Volume preprocessing → Segmentation → Inflation → Manual Editing → Re-inflation → Fix topology → Final Surface → Cutting & Flattening → Volume/Surface postprocessing

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





AFNI



SUMA

- The AFNI/SUMA hands-on is scheduled for:

FRIDAY, November 9,2004, 9:30am-5:00pm

Instructor: Dr. Ziad Saad, NIMH

THAT’S ALL FOLKS!!!!!!!!