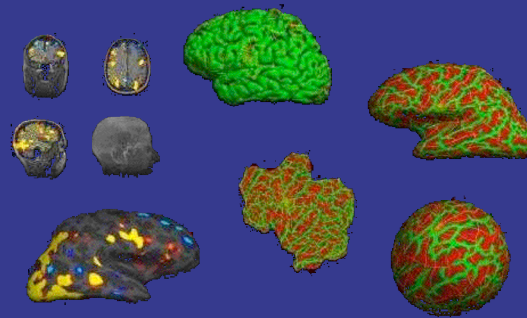


FreeSurfer



FREESURFER HANDS-ON WORKSHOP

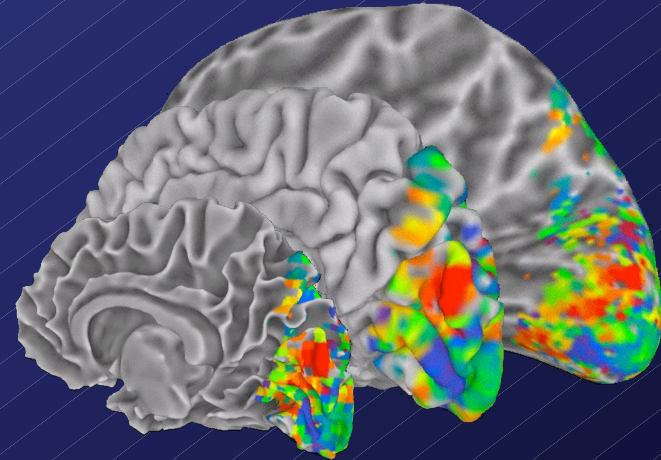
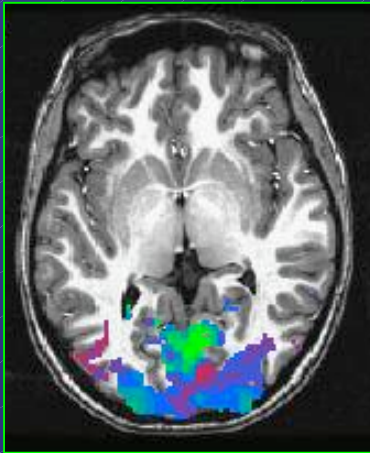
Peggy Christidis

November 18, 2004

National Institutes of Health

GOAL OF WORKSHOP

Learn to create surfaces using FreeSurfer

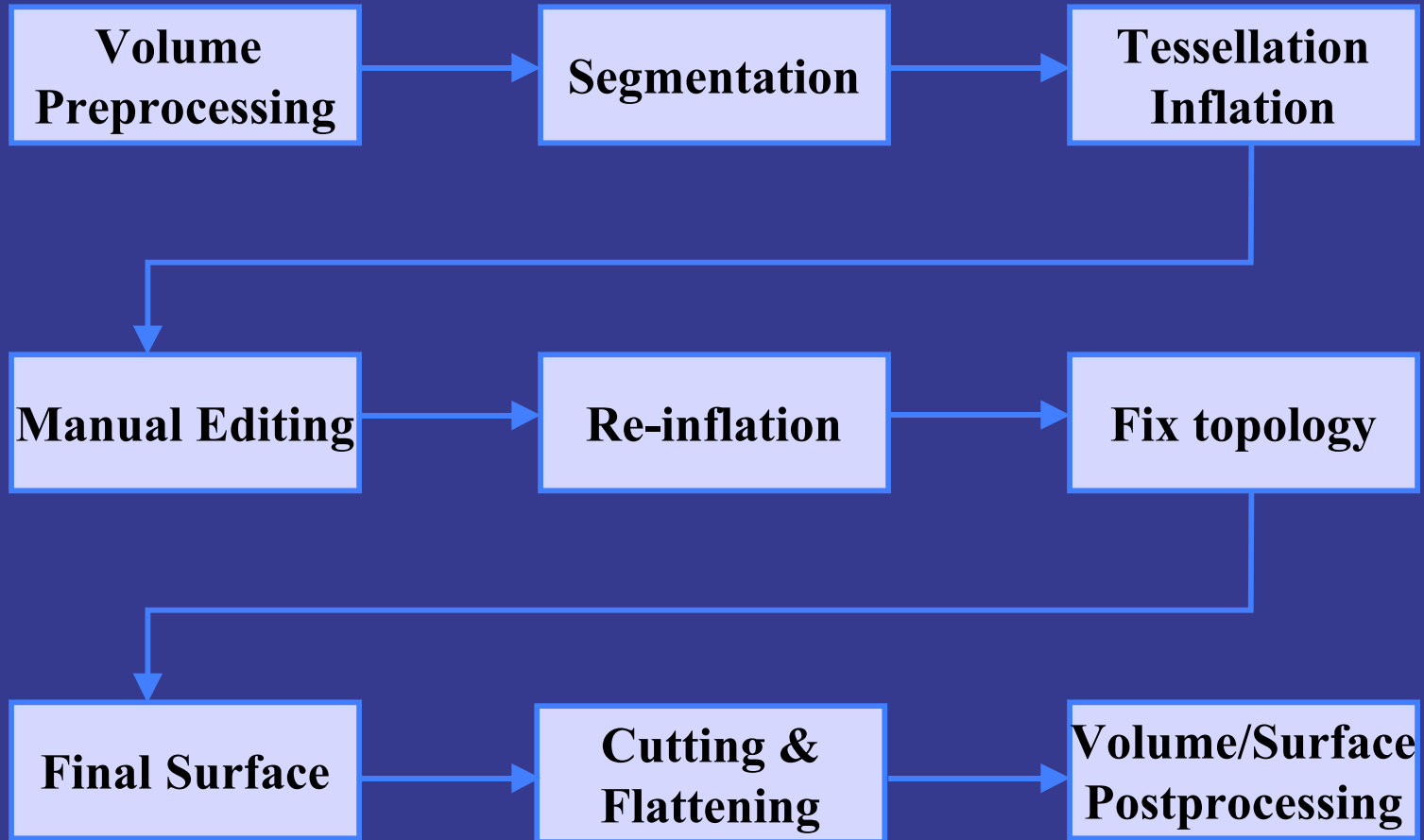


- Start with several anatomical scans (MPRAGE)
- Create surface using FreeSurfer
- Overlay functional data on surface using SUMA
(*Hands-On class for SUMA on 11-19-04*)

Agenda

- *FreeSurfer Overview*
- *Hands-On*
 - *Volume Preprocessing*
 - *Segmentation*
 - *Tessellation/Inflation*
 - *Manual Editing/Re-inflation*
- *Lunch Break*
- *Hands-Off*
 - *Fix Topology*
 - *Final Surface*
 - *Cut and Flatten*

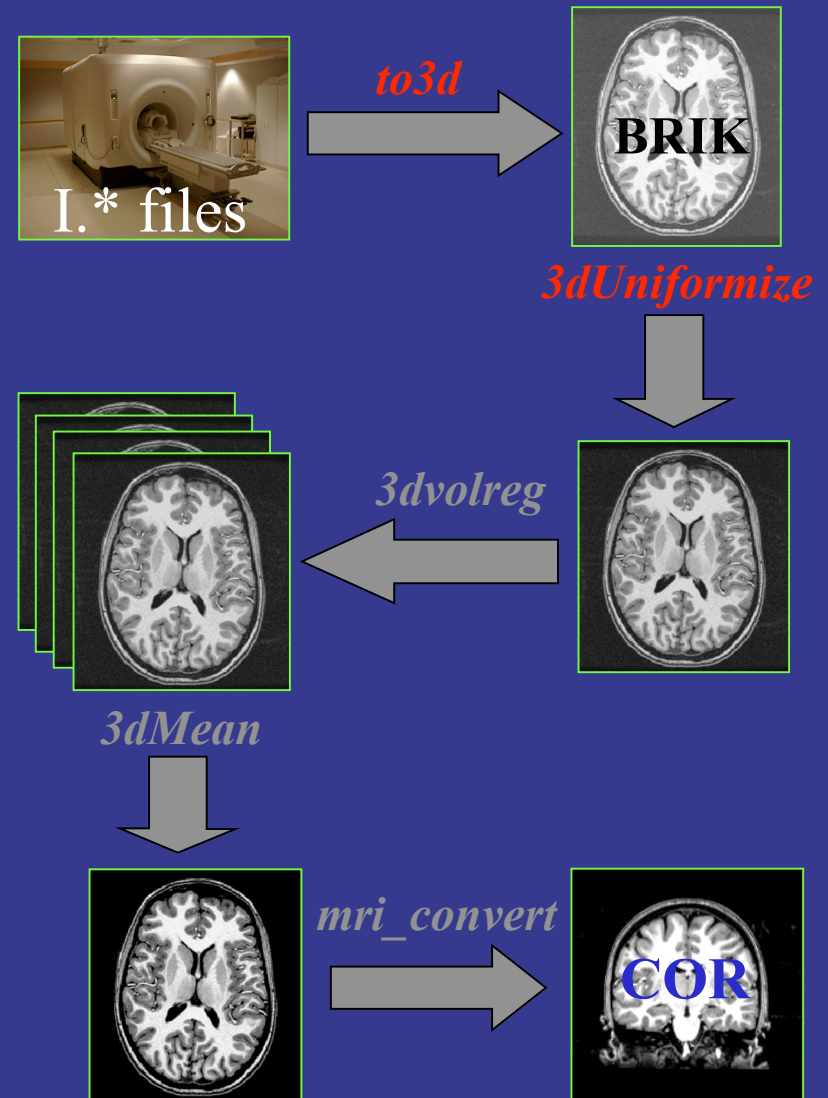
FreeSurfer Flowchart





1. Volume Preprocessing

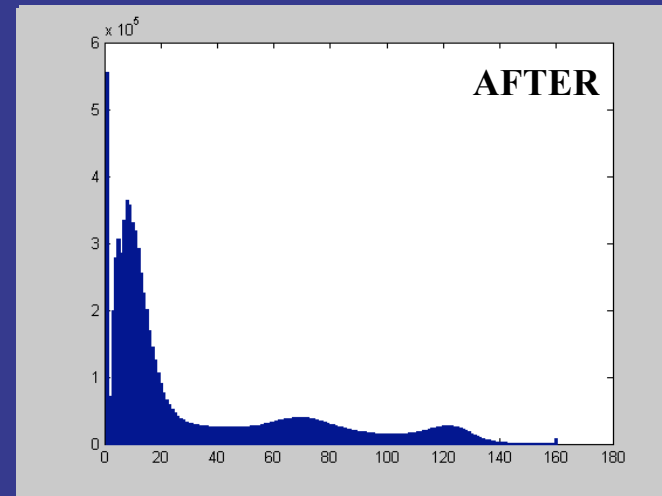
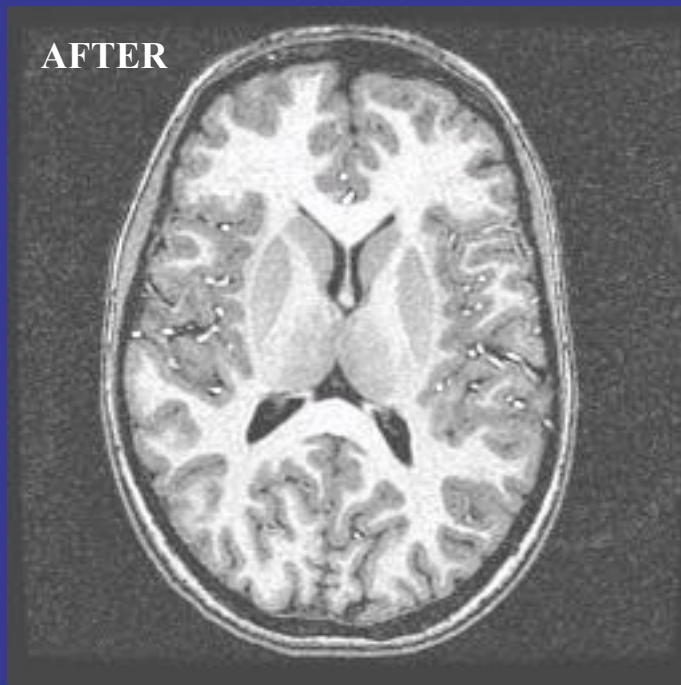
- Convert *I.** files to BRIK using AFNI *to3d*
- Perform intensity normalization using AFNI *3dUniformize*
- Register multiple volumes using AFNI *3dvolreg*
- Average the registered volumes using AFNI *3dMean*
- Convert to FreeSurfer format using FreeSurfer *mri_convert*



1. Volume Preprocessing

Intensity normalization – critical for segmentation

- Inhomogeneities in scanner fields cause gray and white matter intensities to vary as a function of their spatial location.
- Removes residual non-uniformities in gray and white matter intensity values.

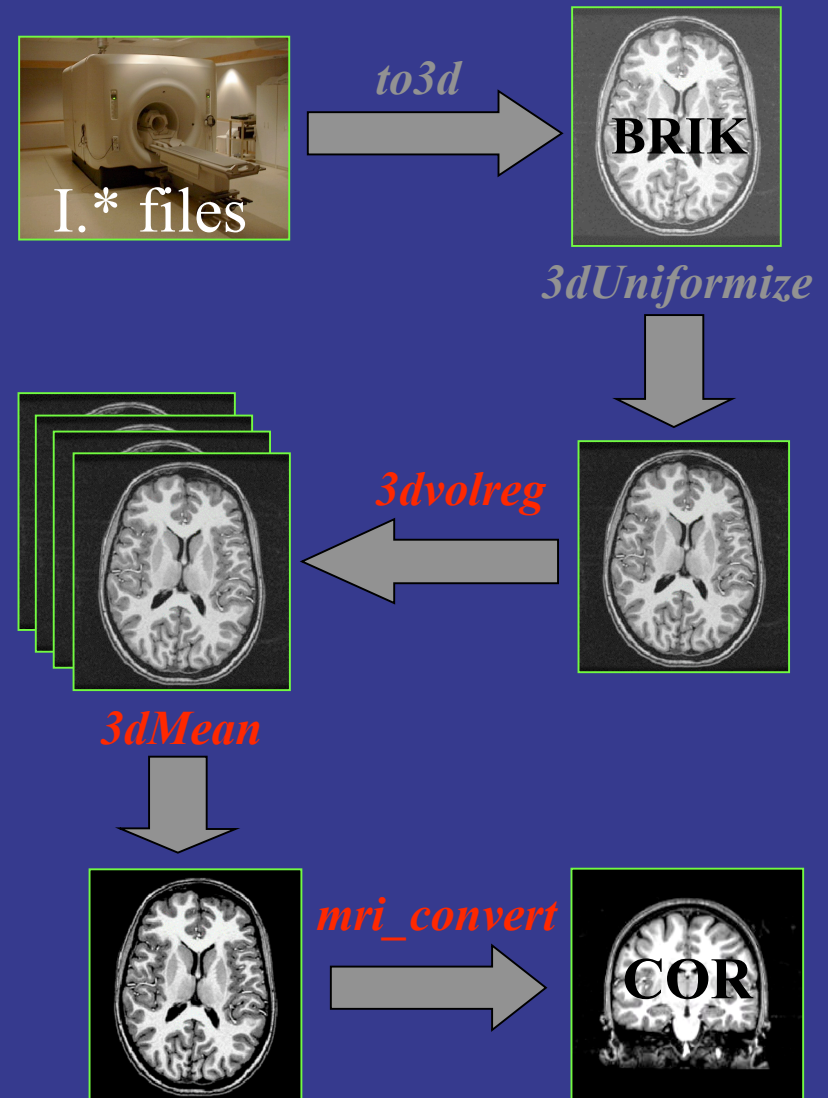


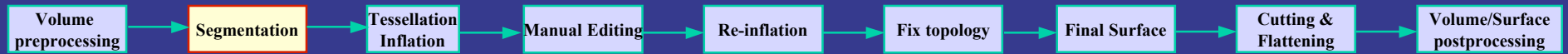
- Increases gray and white matter contrast.
- Sharpens the peaks of the two tissue classes.
- Makes the intensity distribution of gray and white matter spatially uniform.



1. Volume Preprocessing

- Convert I.* files to BRIK using AFNI *to3d*
- Perform intensity normalization using AFNI *3dUniformize*
- Register multiple volumes using AFNI *3dvolreg*
- Average the registered volumes using AFNI *3dMean*
- Convert to FreeSurfer format using FreeSurfer *mri_convert*





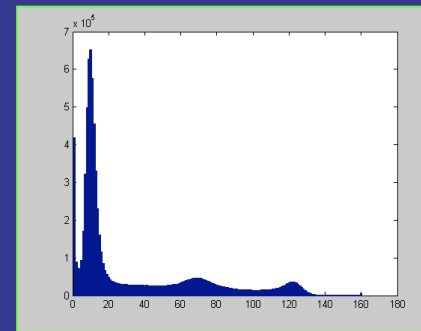
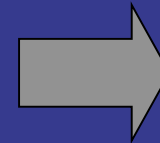
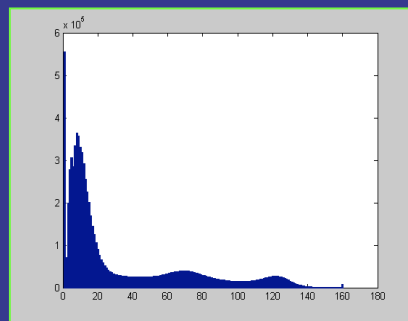
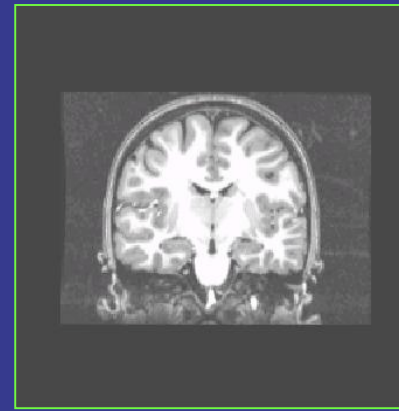
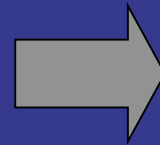
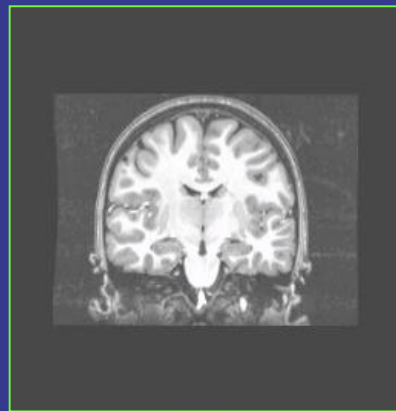
2. Segmentation

- Intensity normalization
- Skull stripping
- White matter labeling



2. Segmentation

- Intensity normalization



- Skull stripping
- White matter labeling

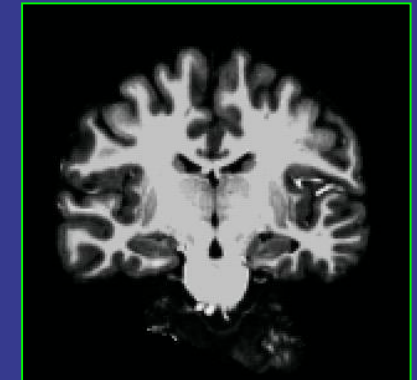


2. Segmentation

- Intensity normalization
- Skull stripping
 - Shrink-wrap algorithm
 - Start with ellipsoidal template
 - Minimize brain penetration and curvature



Skull stripping



- White matter labeling

Skull Stripping

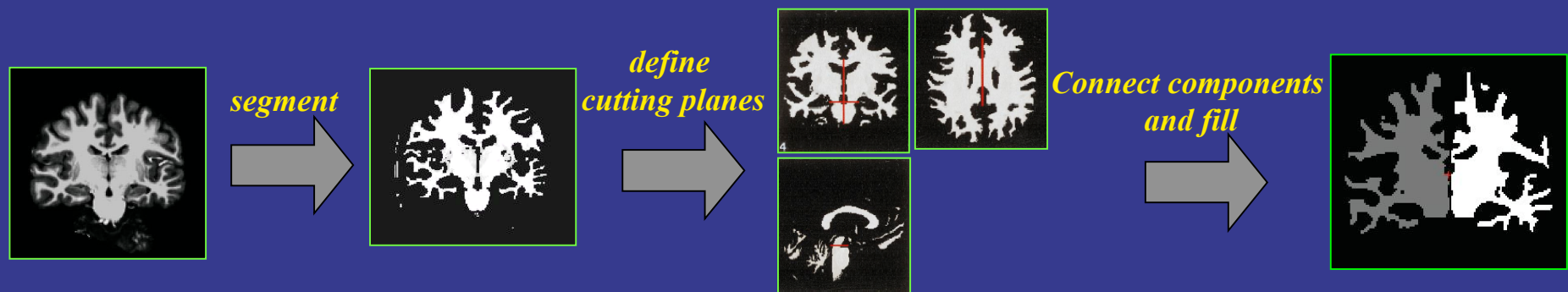


Courtesy: <http://cogsci.ucsd.edu/~sereno/movies.html>



2. Segmentation

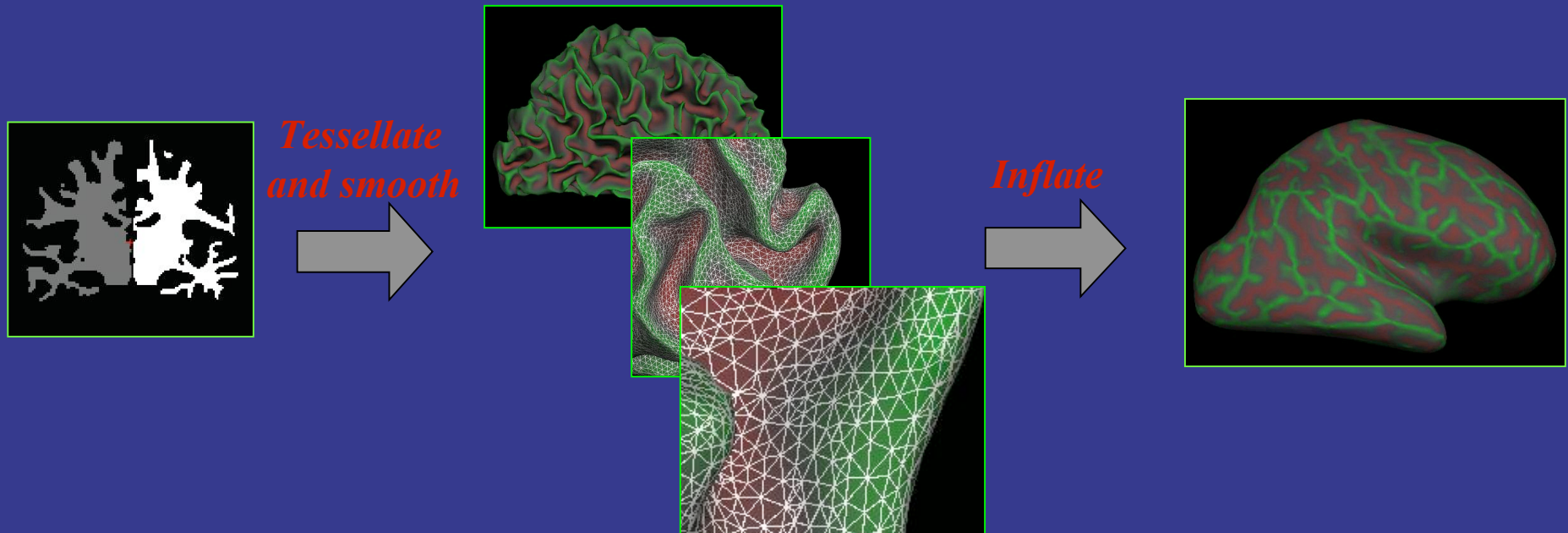
- Intensity normalization
- Skull stripping
- White Matter labeling
 - Preliminary classification solely intensity based
 - Relabeling of mislabeled voxels based on neighborhood information
 - Define cutting planes
 - Find connected components and fill



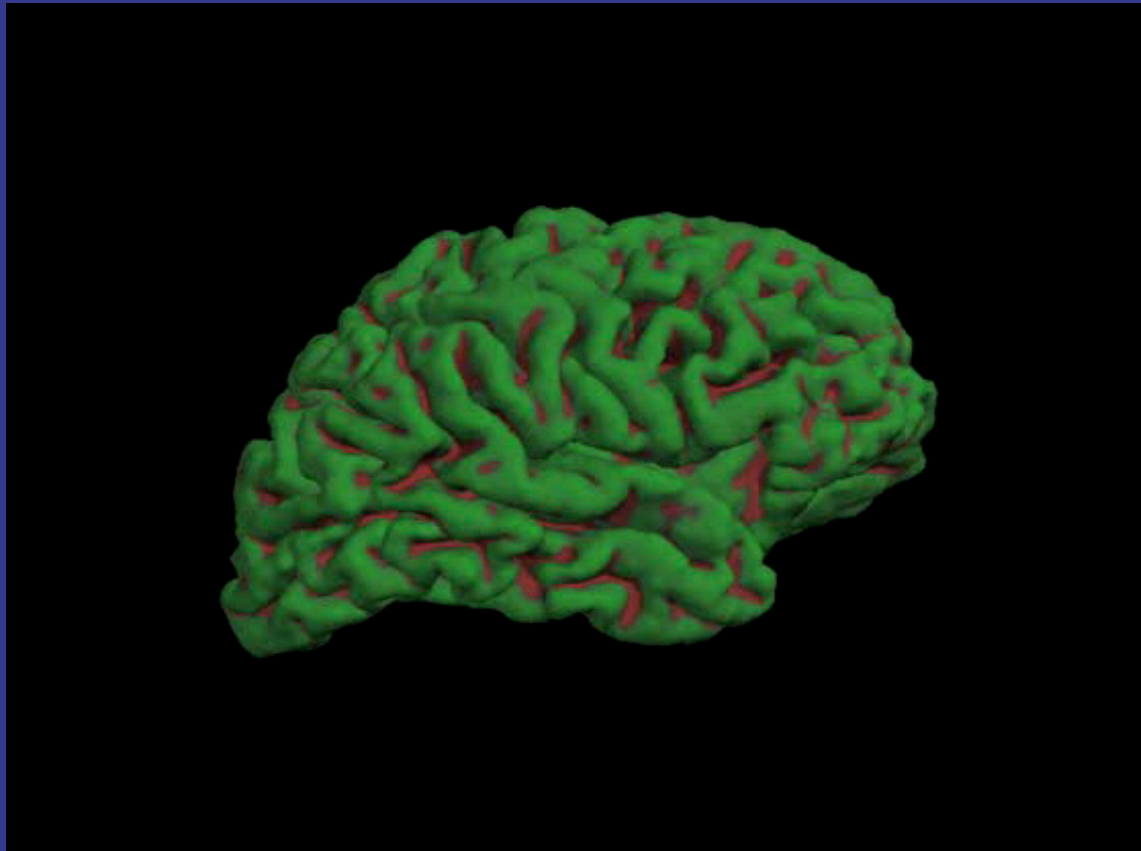


3. Tessellation and Inflation

- Surface Tessellation
 - Use two triangles to represent each face separating white matter voxels from other voxels
 - Smooth initial tessellation with a deformable surface algorithm
- Surface Inflation
 - Retain shape and metrics while making the interior of sulci visible



Inflation

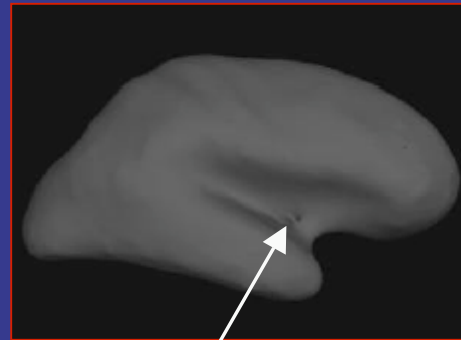


Courtesy: <http://cogsci.ucsd.edu/~sereno/movies.html>

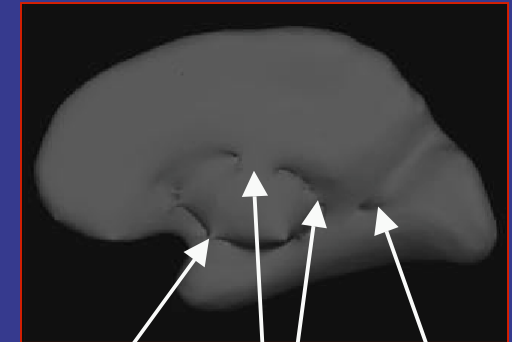


4. Manual editing

- Examine surface for defects
 - manually reclassify voxels in the following areas:
 - Lateral ventricle
 - Fornix
 - Optic nerve
 - Basal ganglia
 - Other defect areas



*Basal
Ganglia*



*Optic
Nerve*

Fornix

*Lateral
Ventricle*

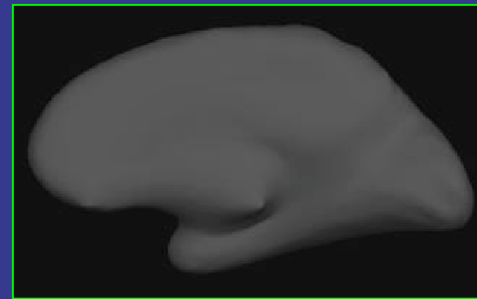
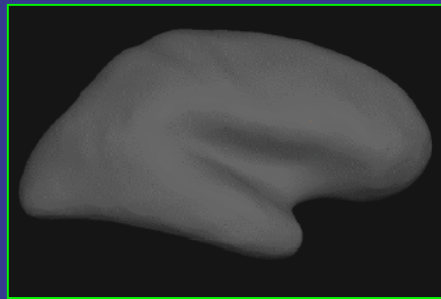
5. Re-inflation





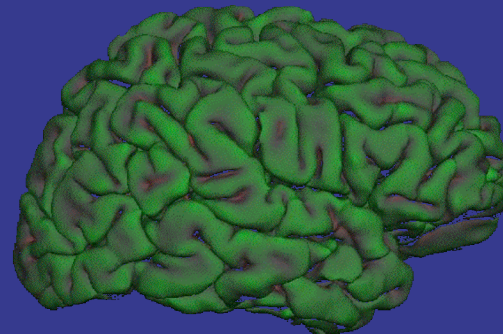
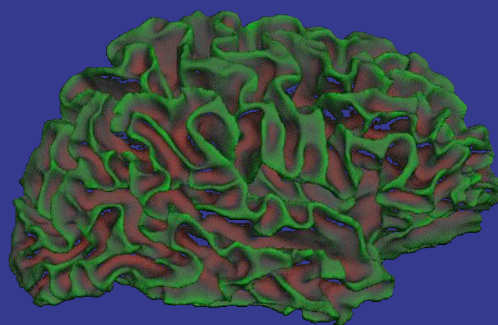
6. Fix topology

- Automatic defect removal algorithm that removes minor defects ensuring that the surface is topologically correct.



7. Make final surface

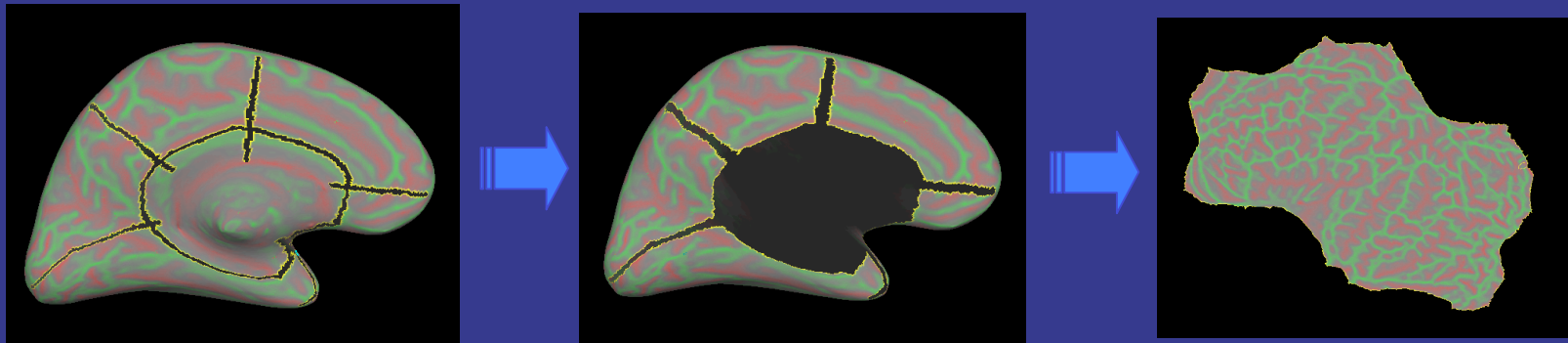
- Final gray/white boundary (white)
- Final gray/csf boundary (pial)



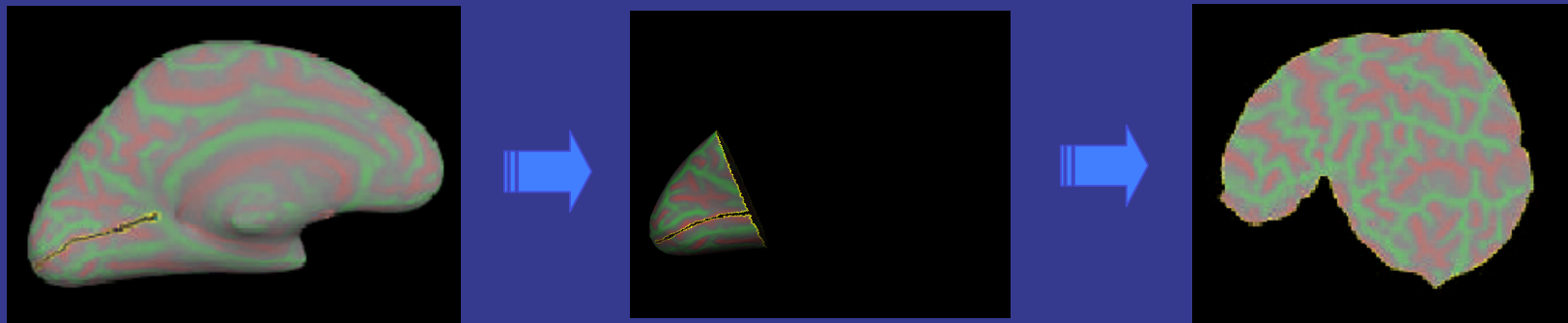


8. Cutting and flattening

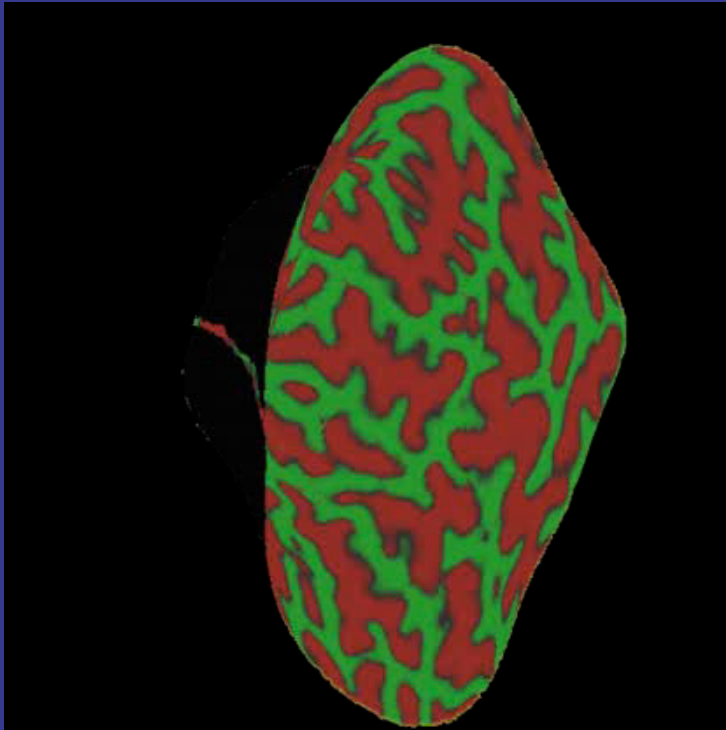
- For a full surface patch



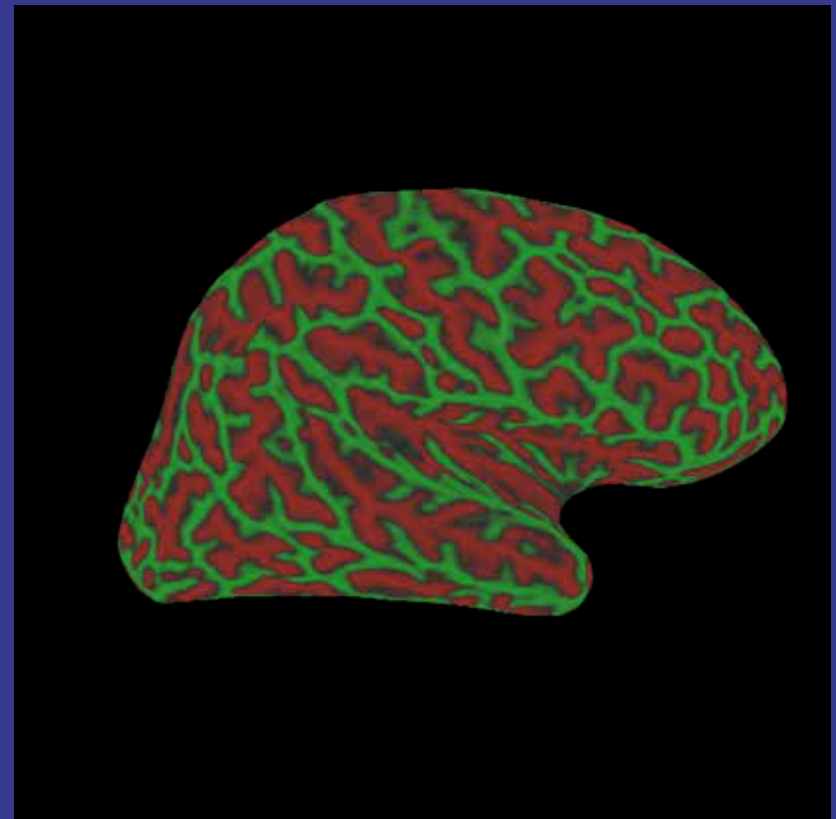
- For occipital patch



Flattening of occipital patch



Flattening of full surface

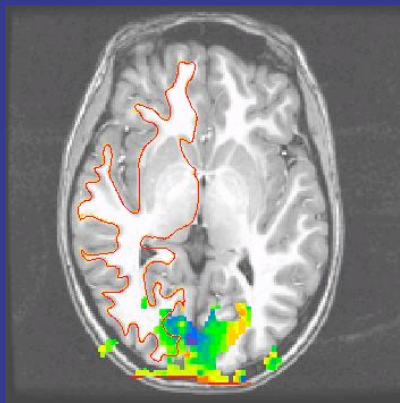
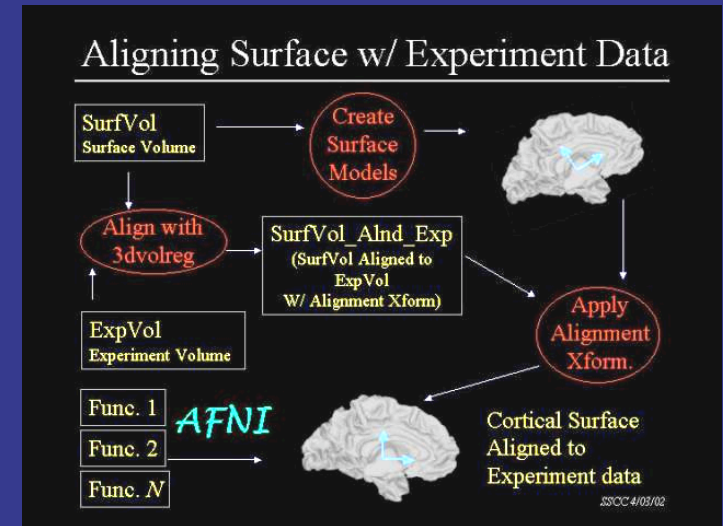


Courtesy: <http://cogsci.ucsd.edu/~sereno/movies.html>

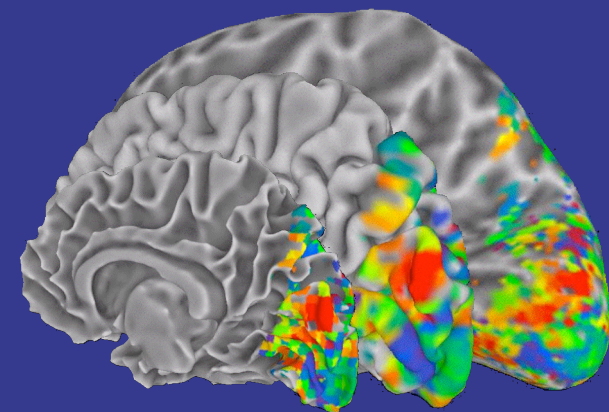


9. SUMA (Hands-On class 11-19-04)

- Convert surfaces to ASCII format
- Align surface volume to experiment volume
- Overlay functional data onto surface
- Create link between AFNI and SUMA
- View function on volume and surface simultaneously
- Visit SUMA website for details:
 - <http://afni.nimh.nih.gov/ssc/ziad/SUMA/>



AFNI



SUMA

FreeSurfer Links

FreeSurfer Website (articles, download, docs, FAQ):

<http://surfer.nmr.mgh.harvard.edu>

Mail Archives:

www.mail-archive.com/freesurfer@mail.nmr.mgh.harvard.edu

Acknowledgements

- Alex Clark
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