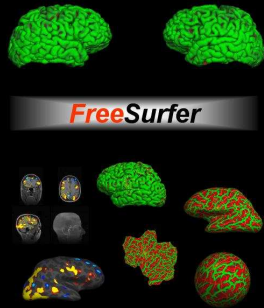
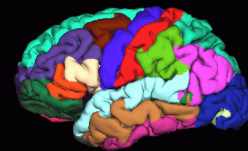


Introduction to FreeSurfer

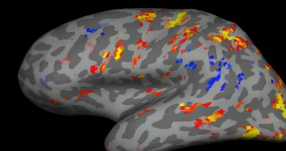
surfer.nmr.mgh.harvard.edu



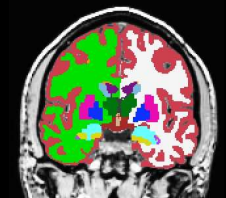
Surface and Volume Analysis



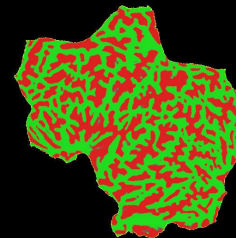
Cortical Reconstruction
and Automatic Labeling



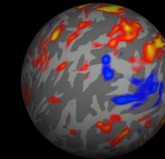
Inflation and Functional
Mapping



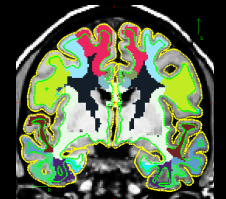
Automatic Subcortical
Gray Matter Labeling



Surface Flattening



Surface-based Intersubject
Alignment and Statistics



Automatic Gyral White
Matter Labeling

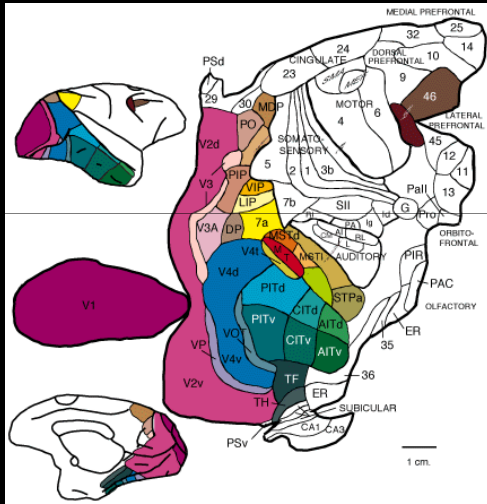
Talk Outline

1. Cortical (surface-based) Analysis.
2. Volume Analysis.

Talk Outline

1. Cortical (surface-based) Analysis.
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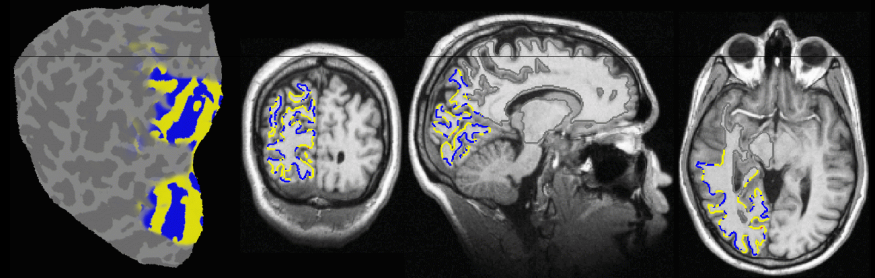
Flat Map of Monkey Visual Areas



D.J. Felleman and D.C. Van Essen, CC, 1991

Why Is a Model of the Cortical Surface Useful?

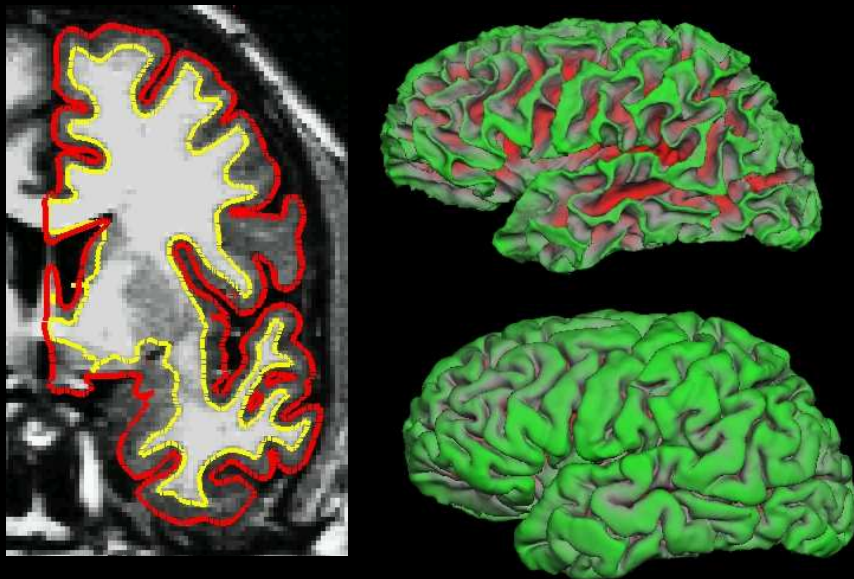
Local functional organization of cortex is largely 2-dimensional! Eg, functional mapping of primary visual areas:



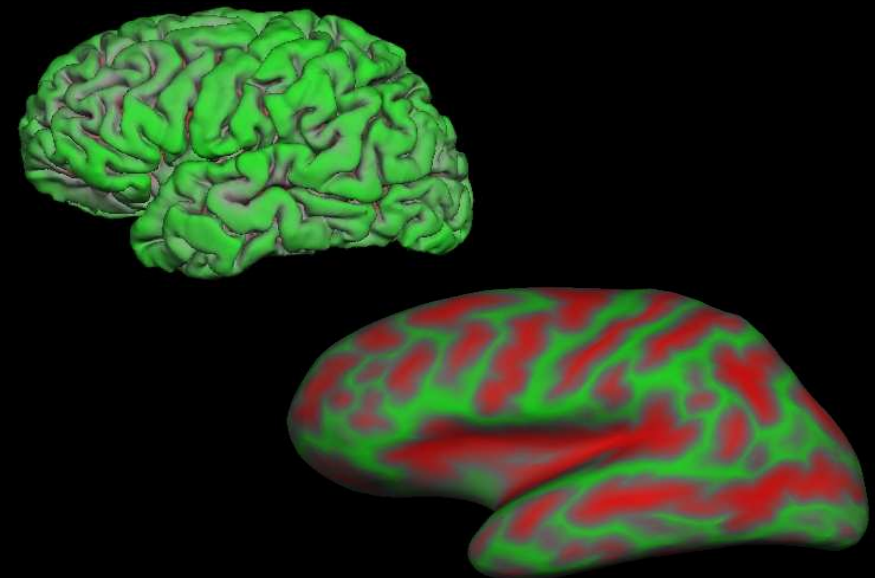
From (Serenio et al, 1995, Science).

Also, smooth along surface

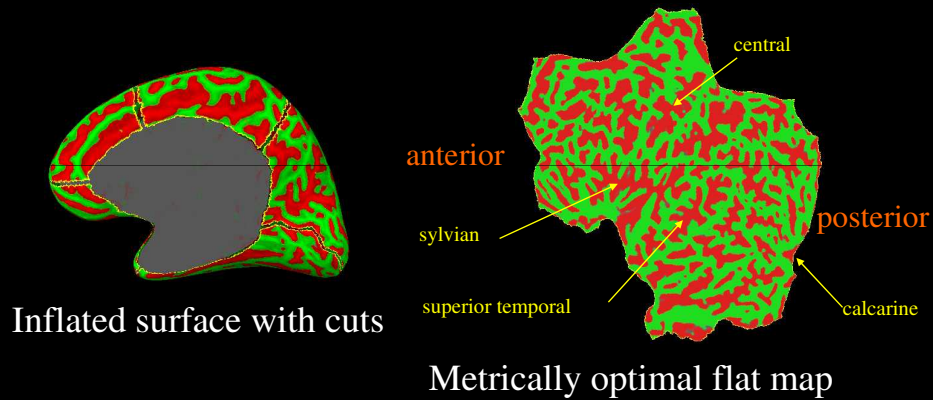
Surfaces: White and Pial



Inflation

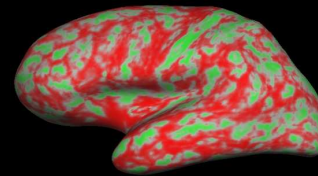


Surface Flattening – Whole Hemisphere

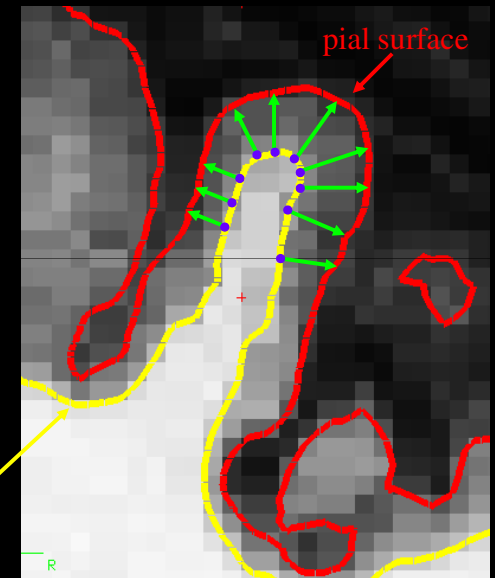


Cortical Thickness

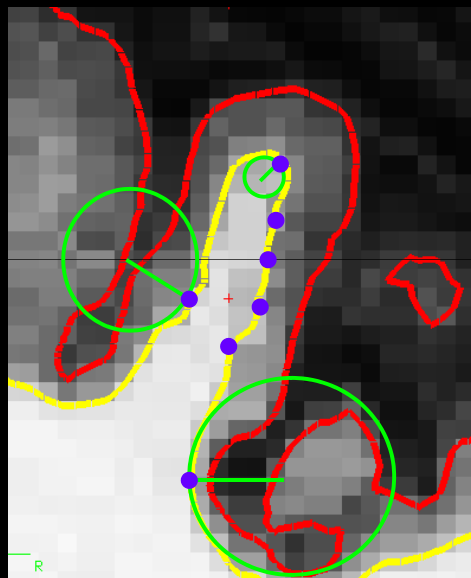
- Distance between white and pial surfaces
- One value per vertex
- Vertices much denser!



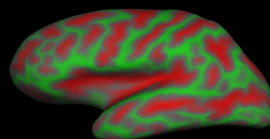
white/gray surface
lh.thickness, rh.thickness



Curvature (Radial)

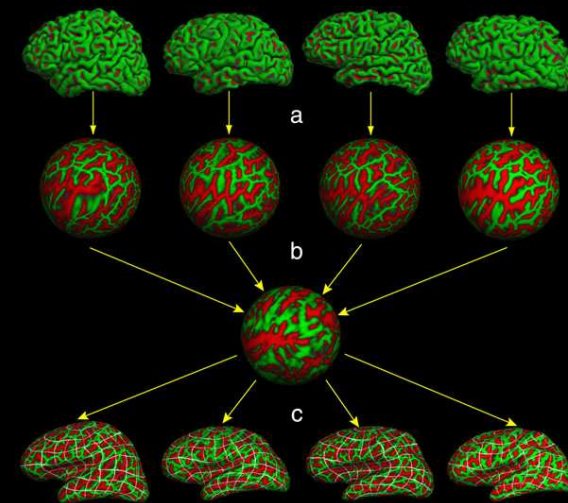


- Circle tangent to surface at each vertex
- Curvature measure is $1/\text{radius of circle}$
- One value per vertex
- Signed (sulcus/gyrus)
- Typically use mean curvature (avg of 2 principal curvatures)
- Vertices much denser!

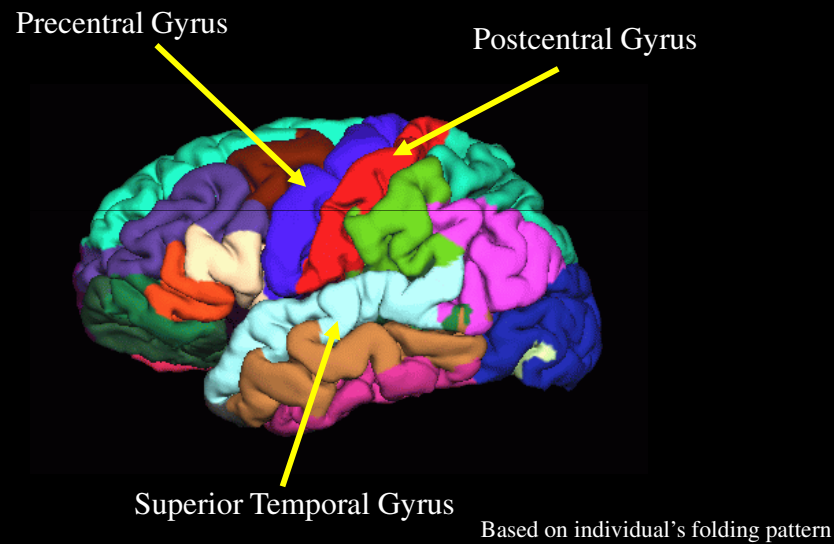


lh.curv, rh.curv

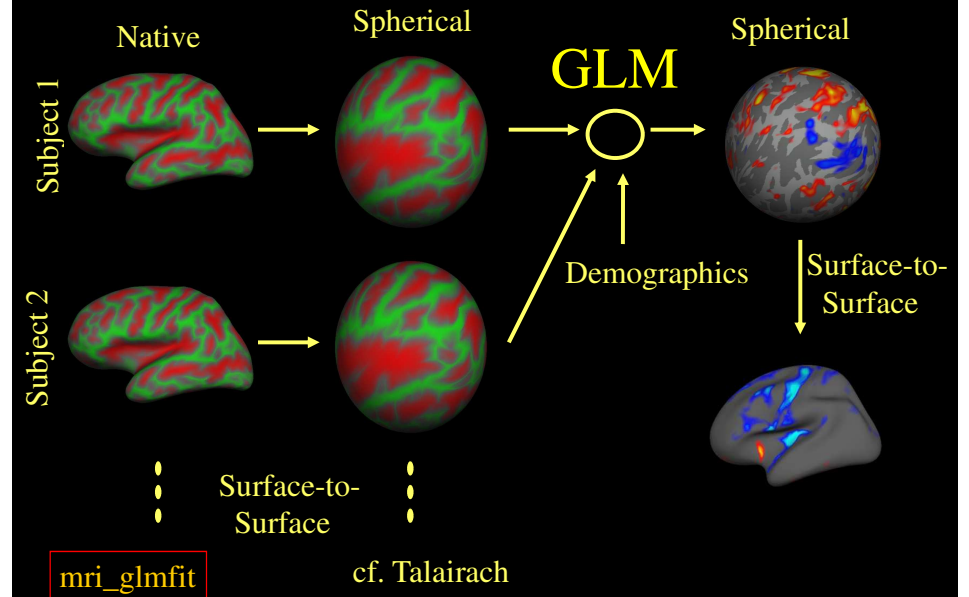
A Surface-Based Coordinate System



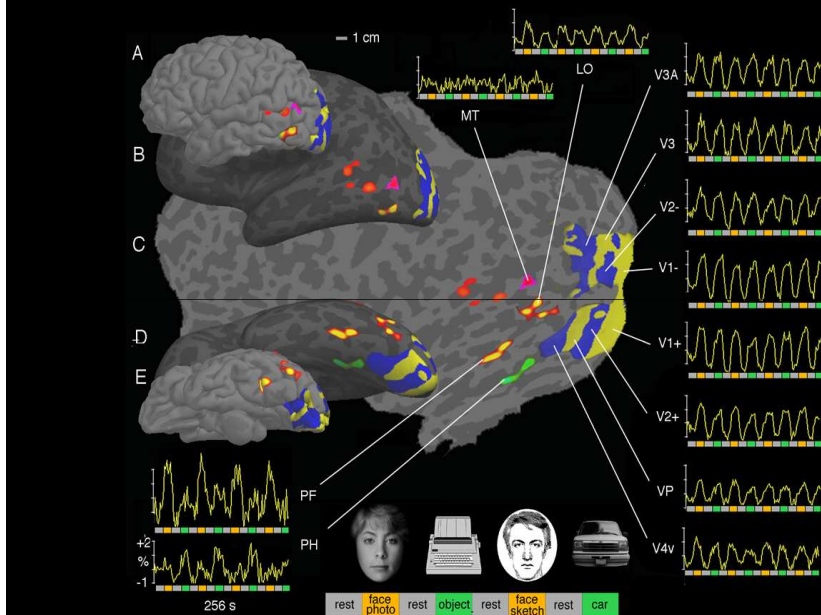
Automatic Surface Segmentation



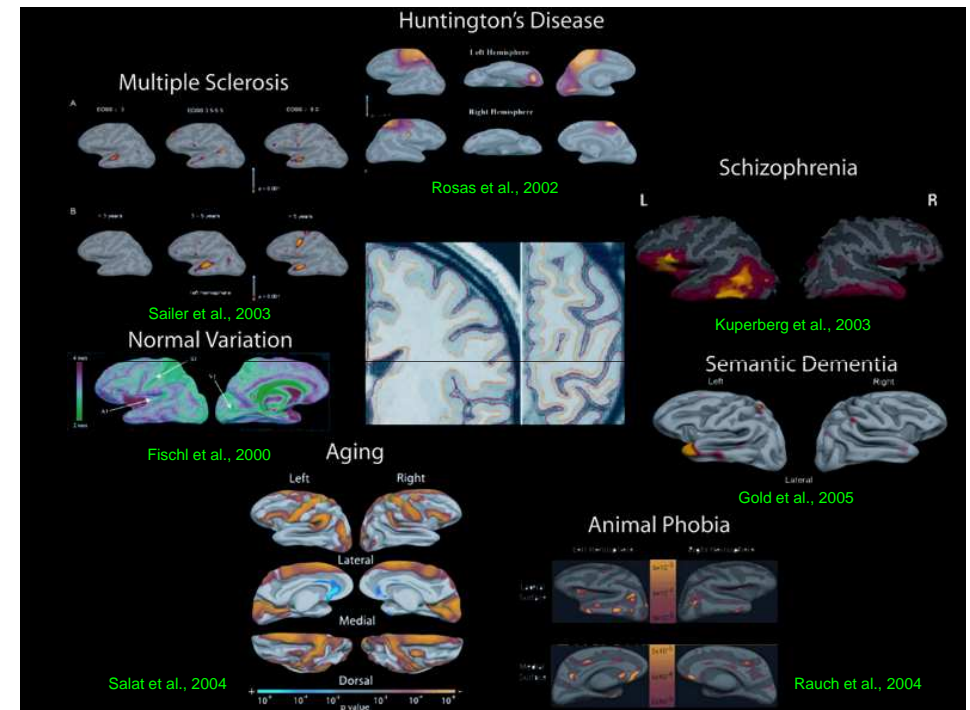
Inter-Subject Averaging



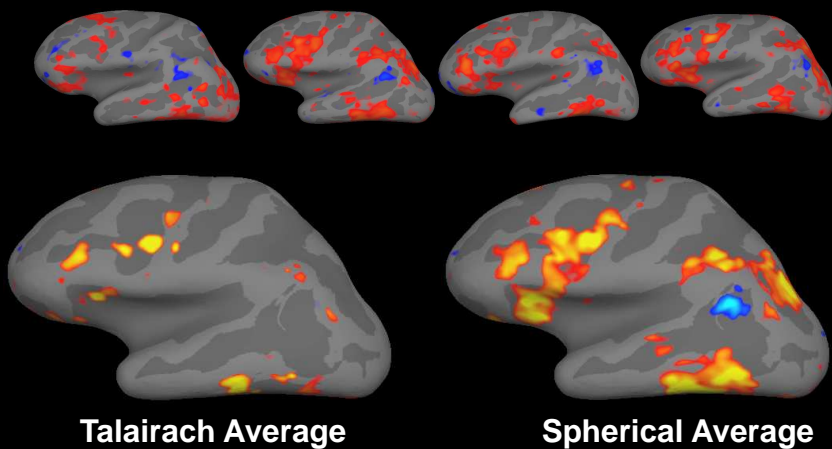
Visualization



Borrowed from (Halgren et al., 1999)



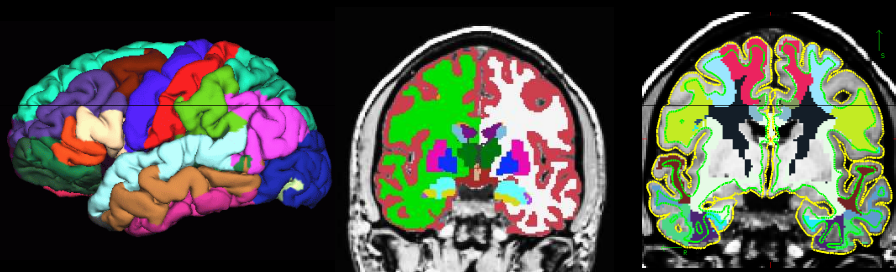
Surface-based Inter-Subject Averaging of fMRI



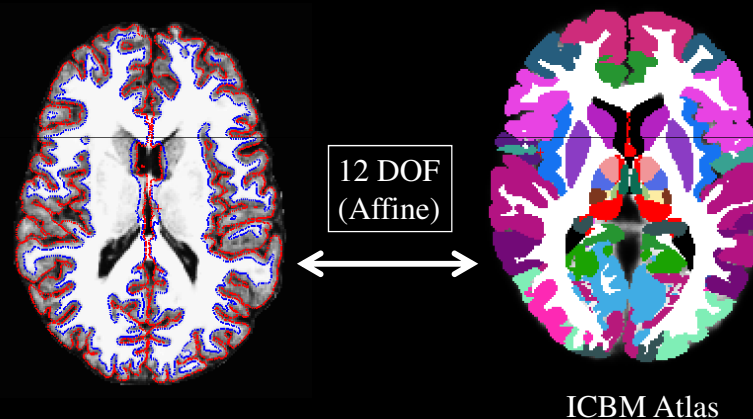
Talk Outline

1. Cortical (surface-based) Analysis.
2. Volume Analysis.

Volume Analysis: Automatic Individualized Segmentation



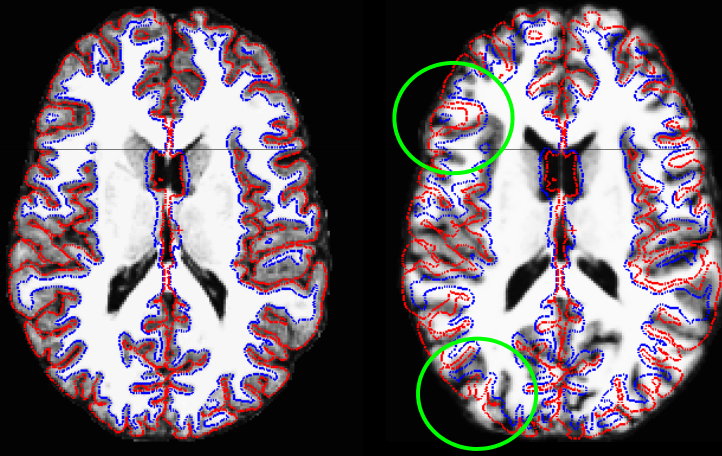
Why not just register to an ROI Atlas?



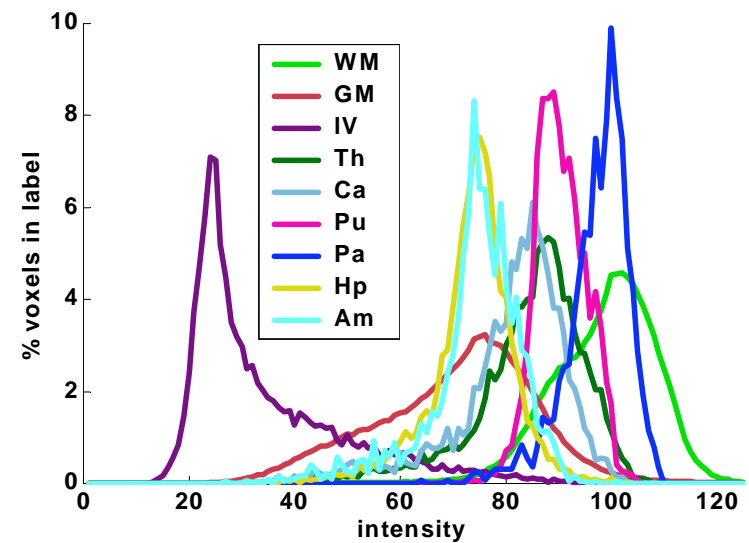
Problems with Affine (12 DOF) Registration

Subject 1

Subject 2 aligned with Subject 1
(Subject 1's Surface)

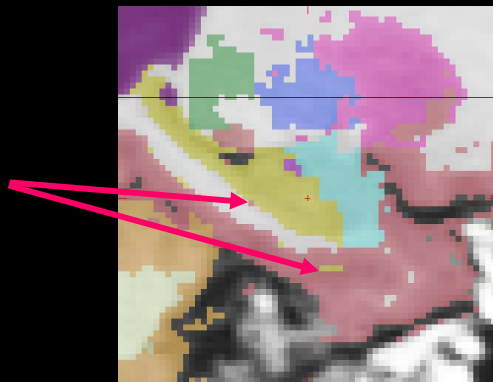


Why Segmentation is Hard!



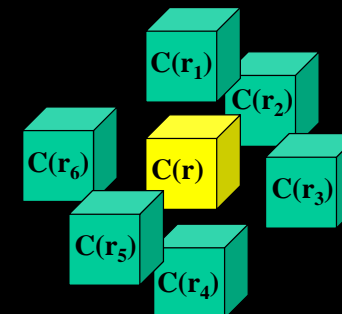
Markov Random Field: Motivation

What is the probability that cortical gray matter occurs inferior to hippocampus?



Segmentation: MRF

$p(C(r_i)|C(r), I, r, r_i)$ encodes the probability that tissue class $C(r_i)$ occurs at spatial location r_i when tissue class $C(r)$ occurred at r . The segmentation is thus modeled as an *anisotropic nonstationary MRF*.

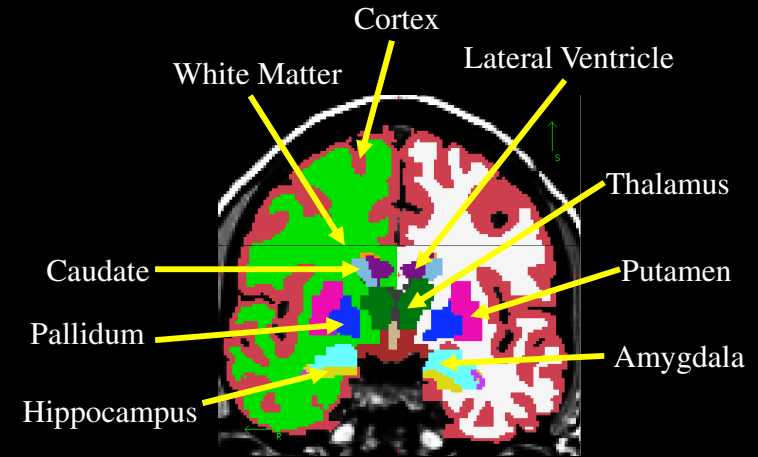


Segmentation: MRF



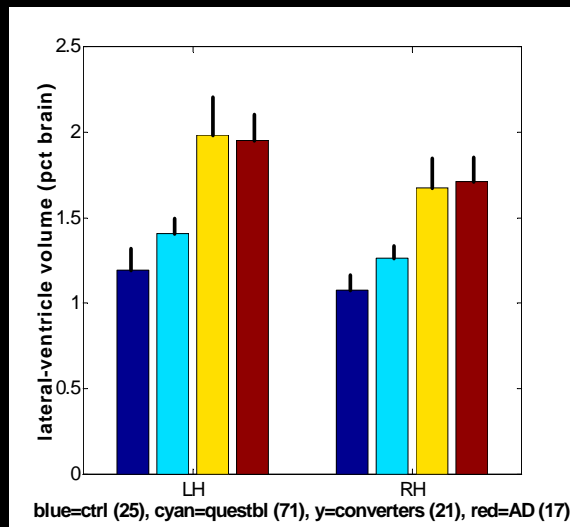
Preliminary Segmentation

Volumetric Segmentation (aseg)



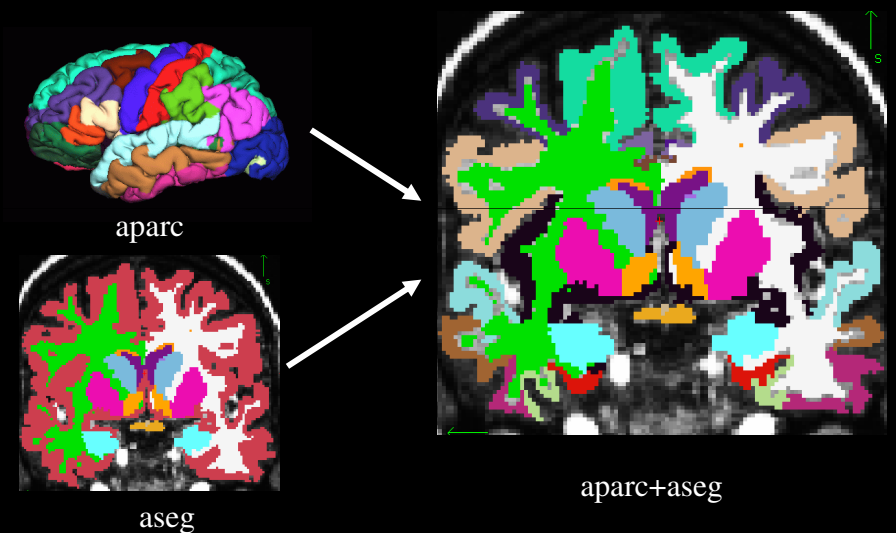
Not Shown:
Nucleus Accumbens
Cerebellum

Volume Differences Predictive of AD



Data courtesy of Drs Marilyn Albert Ron Killiany

Combined Segmentation



Gyrus White Matter Segmentation

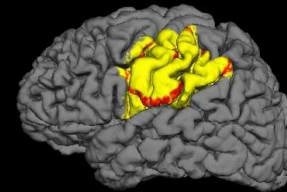


Nearest Cortical Label

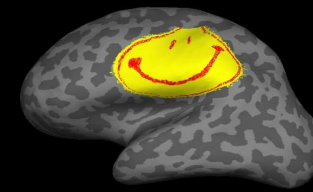
Summary

- Why Surface-based Analysis?
 - Function has surface-based organization
 - Visualization: Inflation/Flattening
 - Cortical Morphometric Measures
 - Inter-subject registration
- Automatically generated ROI tuned to each subject individually

Use FreeSurfer



Be Happy



Segmentation: MRF

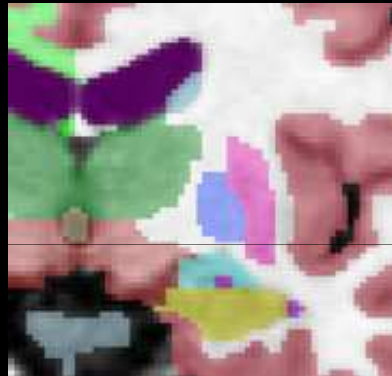


Preliminary Segmentation

Segmentation: MRF

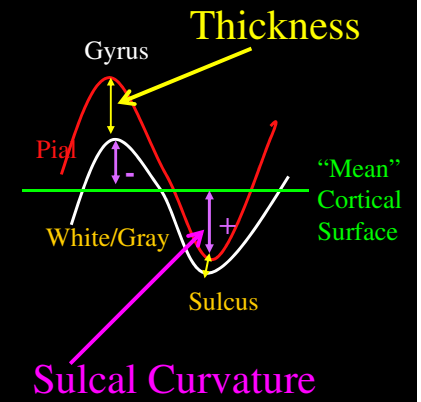
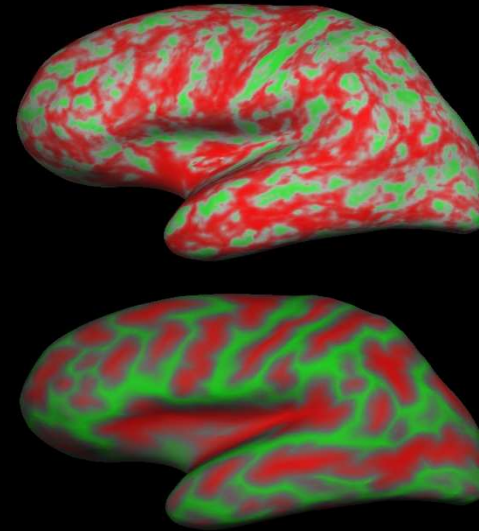


Preliminary Segmentation



Final Segmentation

Cortical Morphometry



Visualization

