Surface-constrained Volumetric Registration
(SVReg)

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http://brainsuite.org/processing/svreg/

What SVReg does

- Performs Surface-Constrained Volumetric Registration of subject and an atlas.
- Anatomical Segmentation
- Morphometric measures

What SVReg is used for

- Analysis of morphometry
  - Longitudinal
    - Progression of disease
    - Brain development
  - Group differences
    - Brain disorders
    - Lesions
    - Tumors
- Registration to common atlas template
  - TBM
  - Voxel-wise analysis
  - Vertex-wise analysis
- Intersubject comparisons of other modalities (ie. fMRI, MEG, DTI)
  - T1-weighted MRI's are commonly used as the reference image for intersubject registration
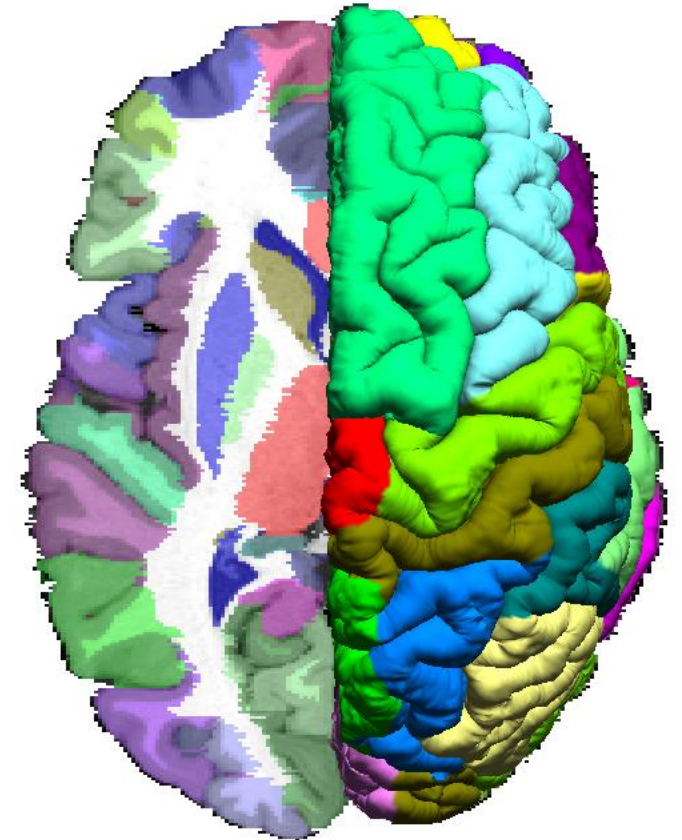
BrainSuiteAtlas1

- Single subject atlas labeled at USC by expert neuroanatomist
- 26 sulcal curves per hemisphere
- 98 volumetric regions of interest (ROIs), 35*2=70 cortical ROIs

BCI-DNI Atlas
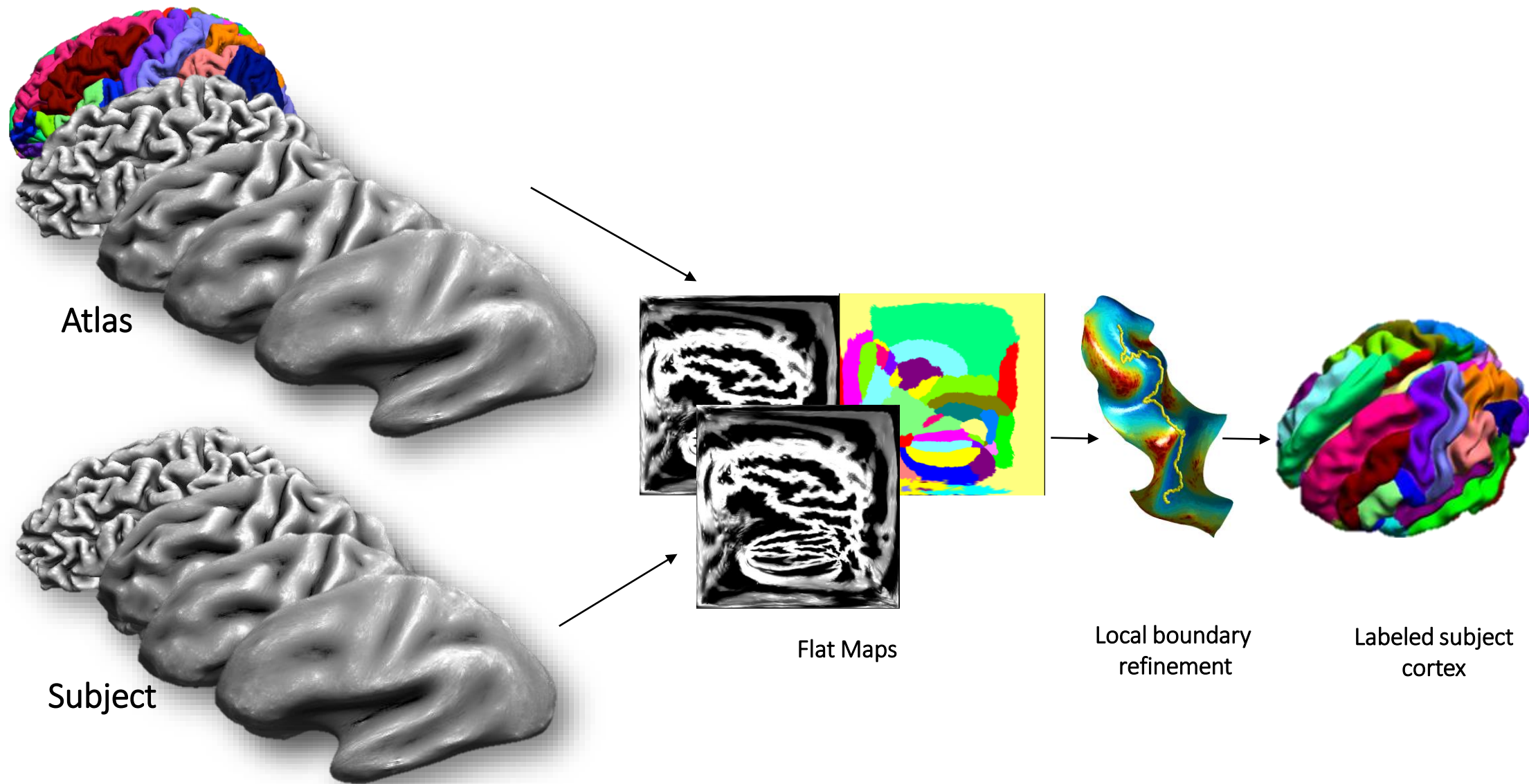
- Single subject atlas labeled at USC by expert neuroanatomist
- high-resolution (0.5 mm × 0.5 mm × 0.8 mm) 3D MPRAGE, 3T scan
- 26 sulcal curves per hemisphere
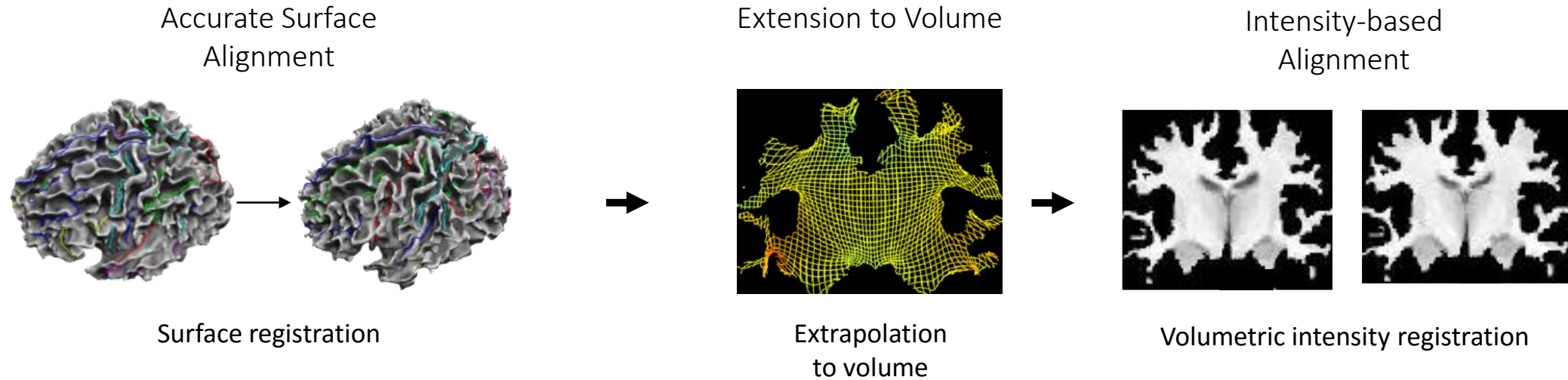- 95 volumetric regions of interest (ROIs), 33*2=66 cortical ROIs
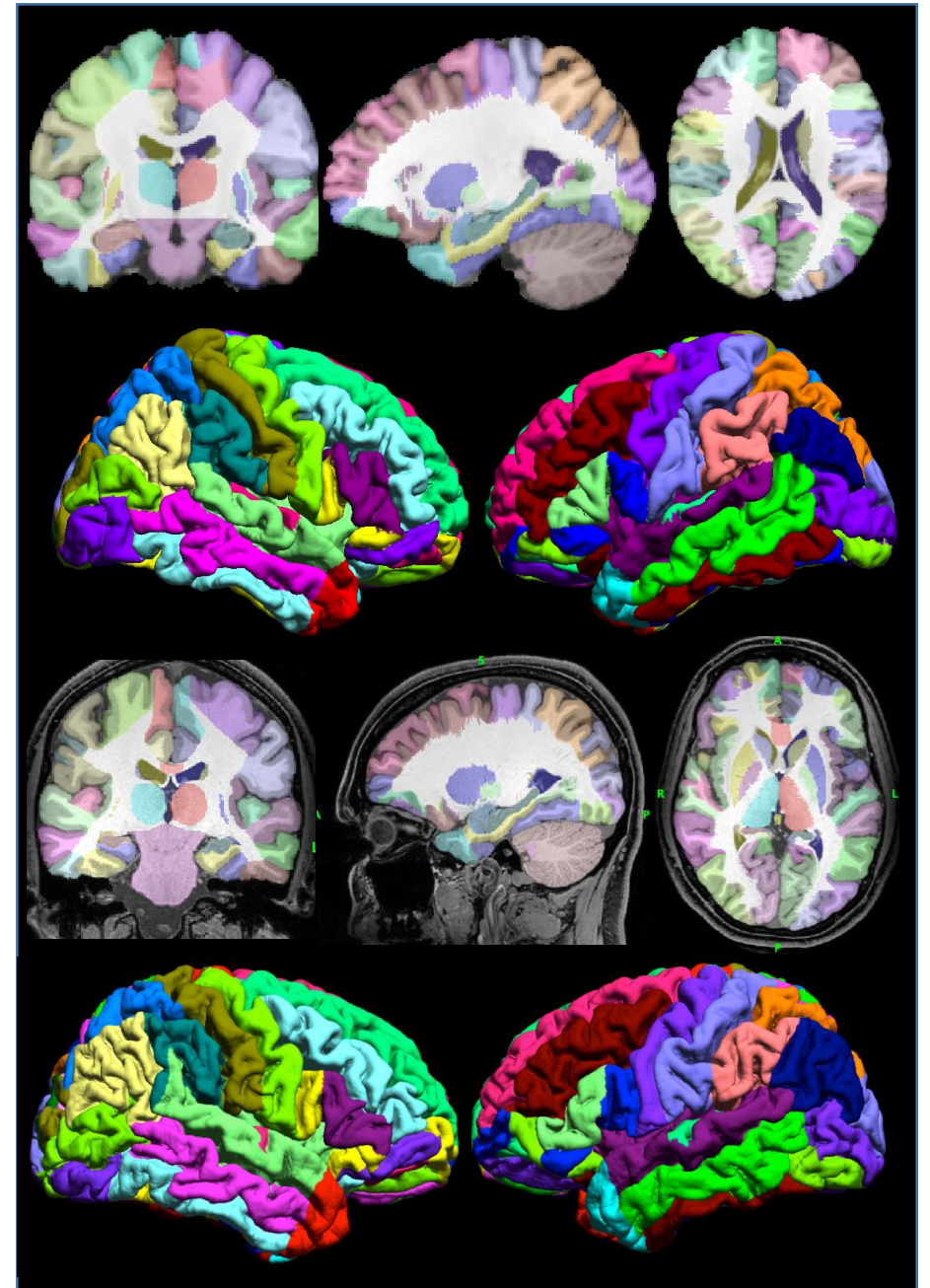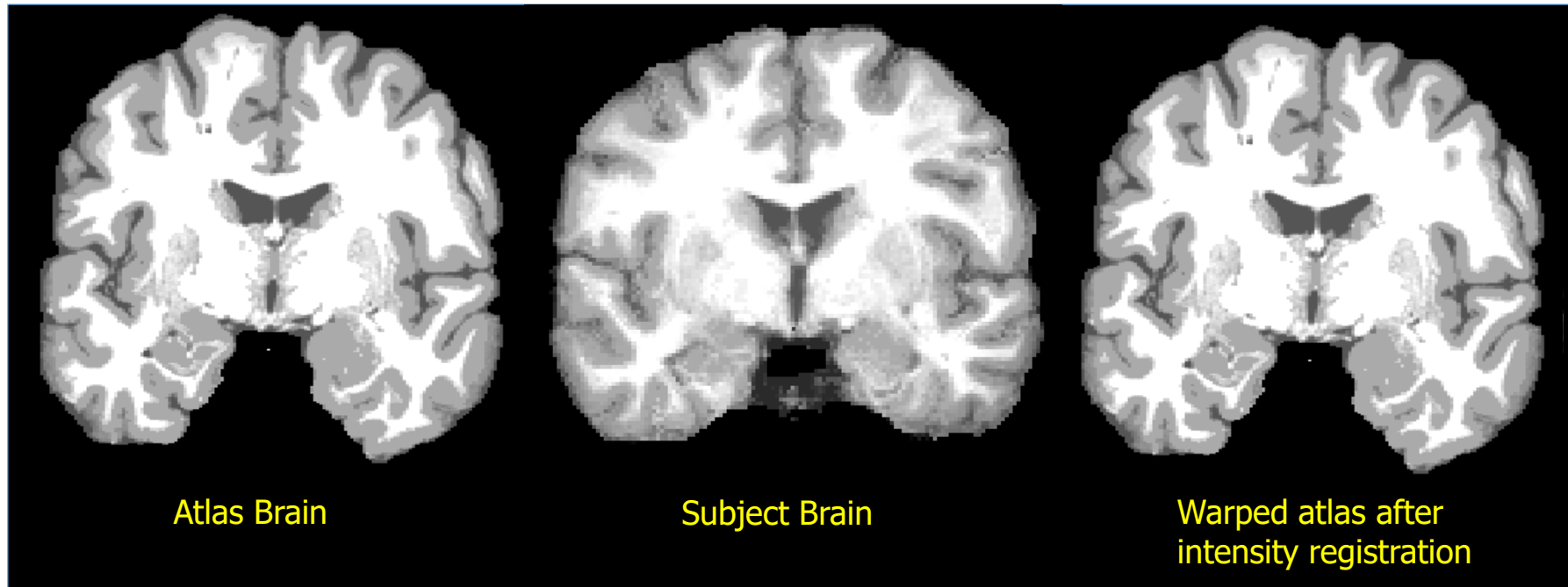
Cortical Surface Registration

Smoothed surfaces

Atlas

Subject

Flat Maps

Local boundary refinement

Labeled subject cortex

Cumulative curvature computation for multiresolution Alignment

Volumetric Registration

Accurate Surface
Alignment

Extension to Volume

Intensity-based
Alignment

Surface registration

Extrapolation
to volume

Volumetric intensity registration

▶ Solves the difficult problem of surface/sulcal registration in 3D volume.

▶ Surface and Volume Registration (SVReg) method performs accurate alignment of both cortical surfaces as well as subcortical volumes.
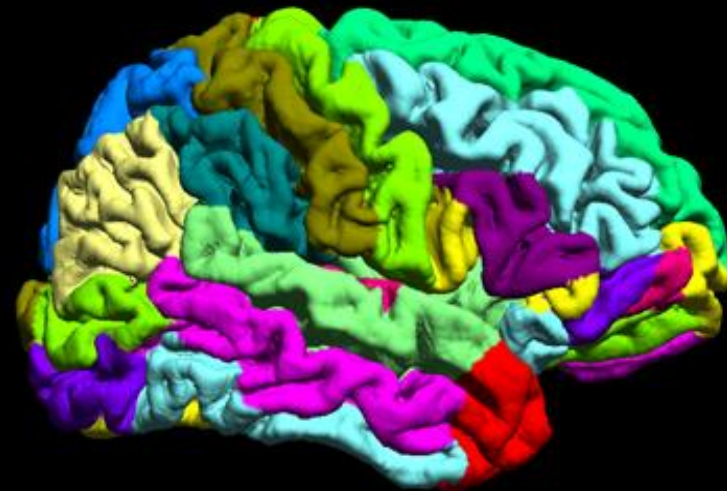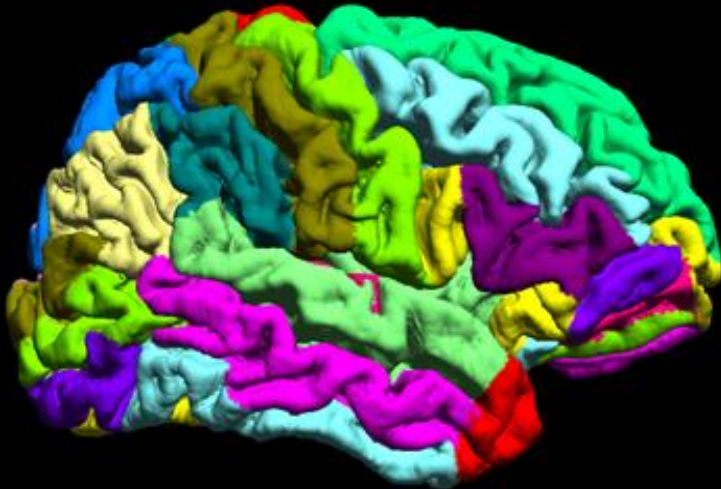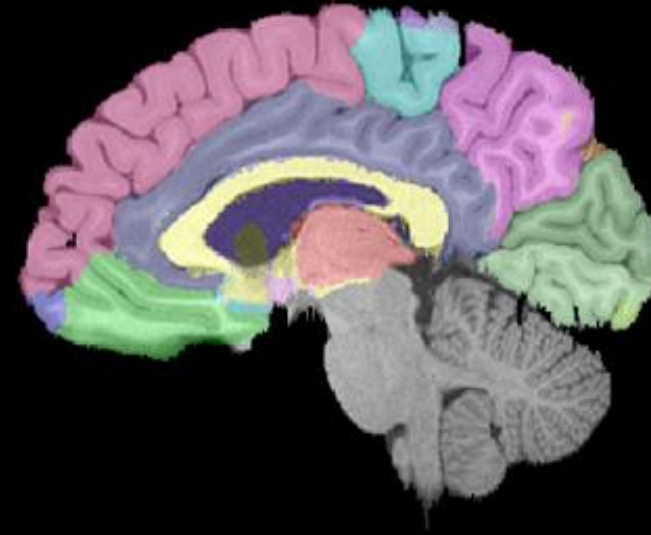
Joshi et al. (2007) IEEE Trans. Med. Imag.

Result of SVReg alignment

Atlas Brain　　　　　　　　Subject Brain　　　　　　　Warped atlas after intensity registration

SVReg performs volumetric coregistration such that cortical surfaces are matched
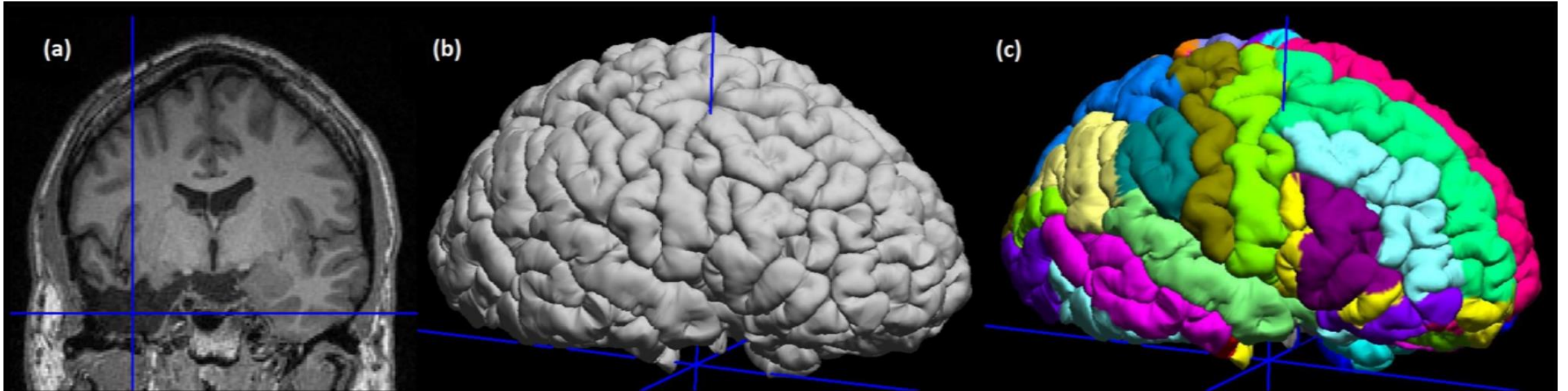
Automated vs Manual Labeling
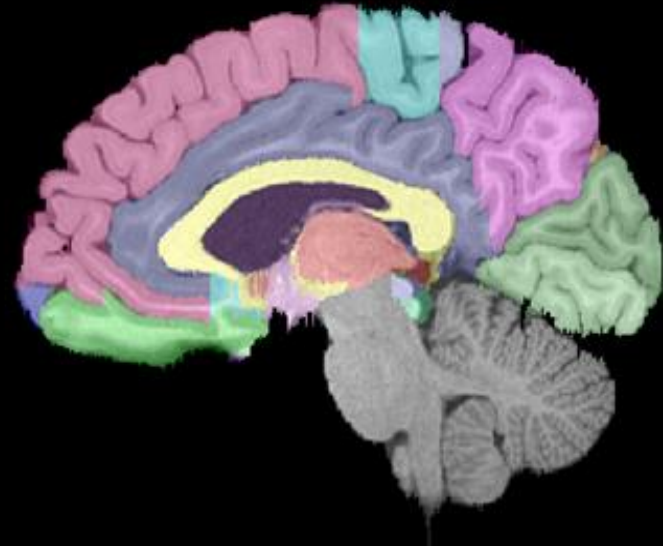
When will SVReg work?

- Adult T1 contrast
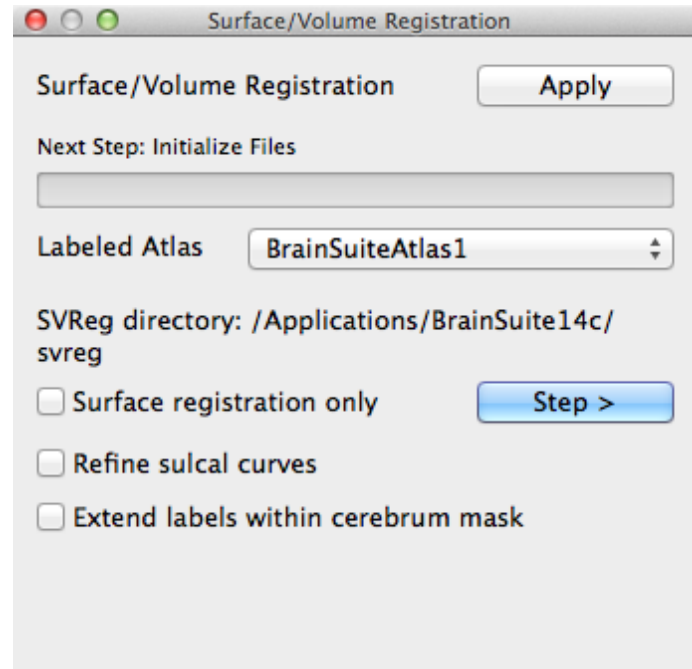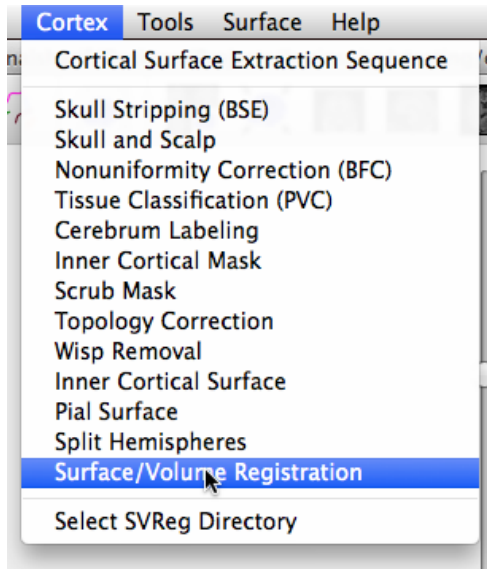   - White matter is bright and Grey Matter is dark

SVReg may work with brains with lesions or other abnormalities

(a) (b) (c)

* The results might show varying degree of accuracy depending on how severe the abnormality in the brain is

Running SVREG from BrainSuite
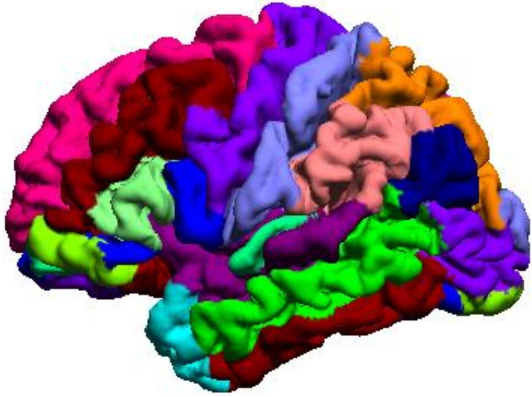
From Command Line

Unix Command Line

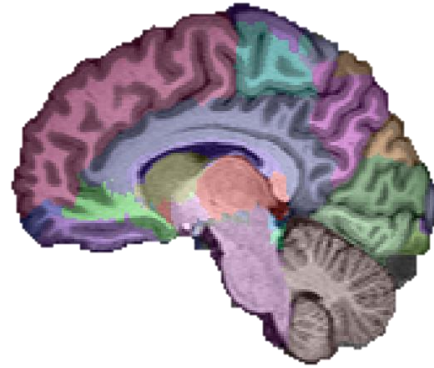svreg.sh <subject_file_prefix> [<atlas_file_prefix>] [-<flags>]

Number of flags and options are available.
-H more iterations of intensity alignment
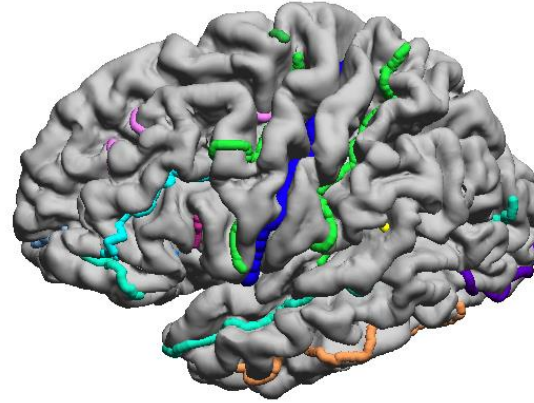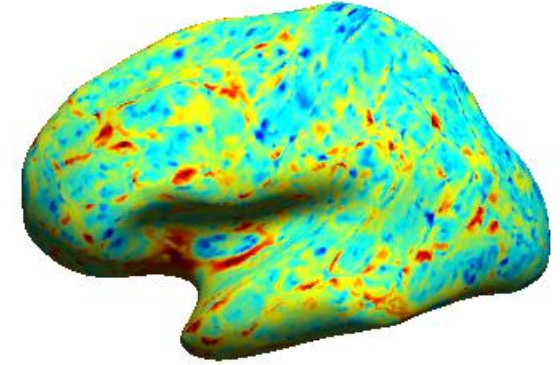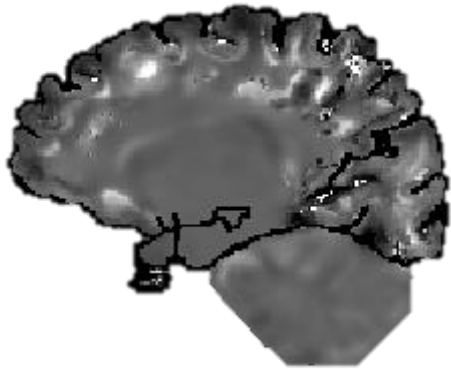-P multithreading

SVReg Outputs

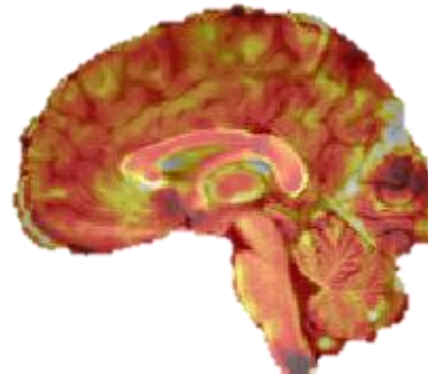
Labeled Surface

Labeled Volume

Sulcal Curves

Cortical Thickness

Subject to Atlas
and Inverse maps

Surface Jacobian

Volumetric Jacobian
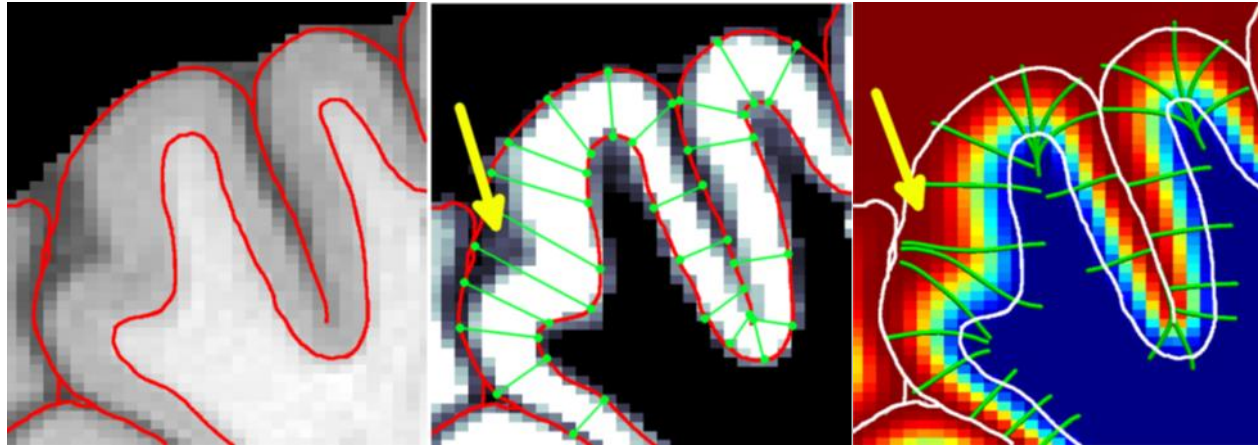

ROIwise
Morphometric Measures
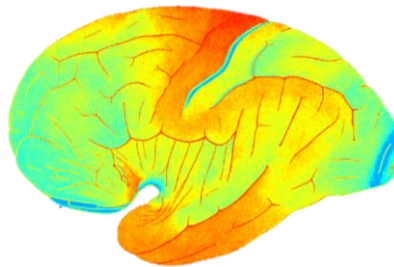
Cortical Thickness computation

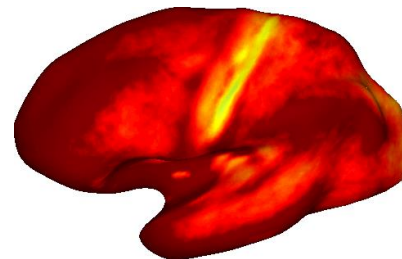Inner and Pial Surface   Linked Distance (default)   Anisotropic Laplace Equation
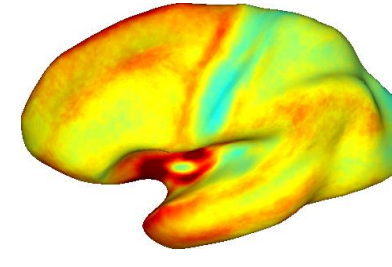
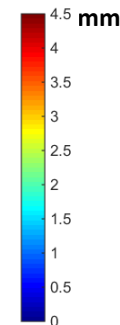## Average Cortical Thickness for N=194

Histology based (von-Economo)   Linked Distance   Anisotropic Laplace Equation
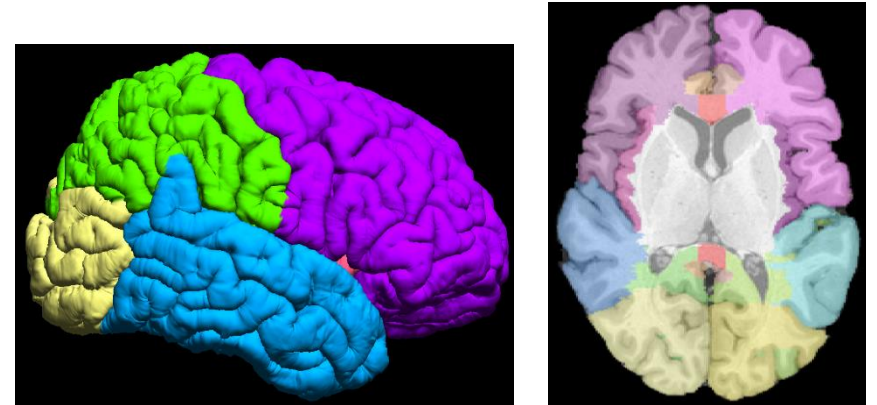
Features

- Invariant to smoothing
- Avg thickness is more consistent with literature

Utilities for Data Processing

- Smoothing functions on surfaces.

- Labeling of surfaces and volumes based on manually drawn cortical ROIs.

- Make your own atlas

- Computing surface and volume stats for arbitrary ROIs.

- Bias field correction tool for severe cases

Available for Download

http://brainsuite.org/processing/additional-tools/

Sample custom atlas