Freesurfer
and alternative solutions
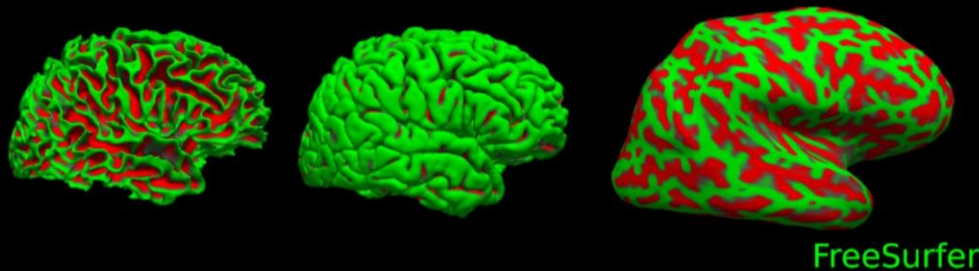
Guillaume Auzias

2022-11

Brainhack Marseille

Online videos, tutorials and courses

○ https://surfer.nmr.mgh.harvard.edu

○ https://www.youtube.com/channel/UCruQerP8aa-gYttXkAcyveA

○ https://andysbrainbook.readthedocs.io/en/latest/index.html
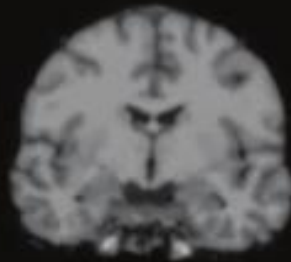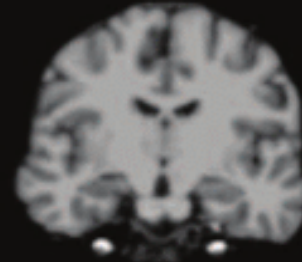
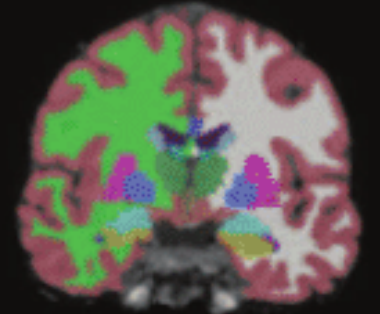# Recon-all pipeline for processing anatomical data
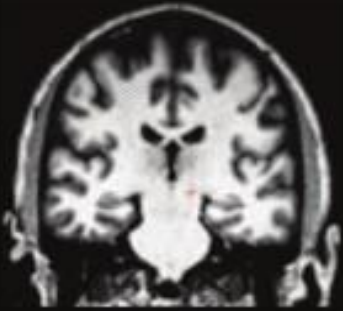
1. T1 Weighted Input

2. Skull Stripping

3. Intensity Normalization

4. Segmentation

5. Surface Extraction

6. Surface Atlas Registration

7. Gyral Labeling

Surface extraction → cortical thickness

0 ▬▬▬▬▬ 5mm

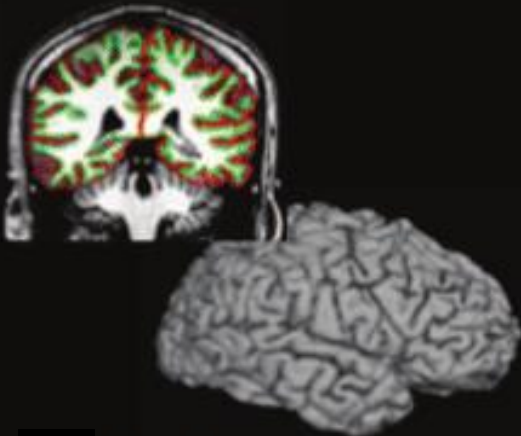# Recon-all pipeline for processing anatomical data

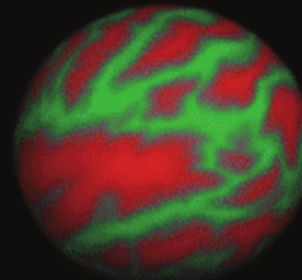

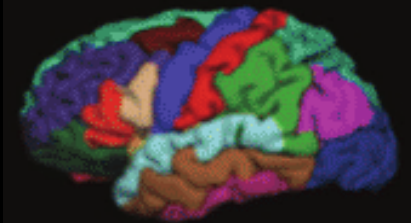1. T1 Weighted Input

2. Skull Stripping

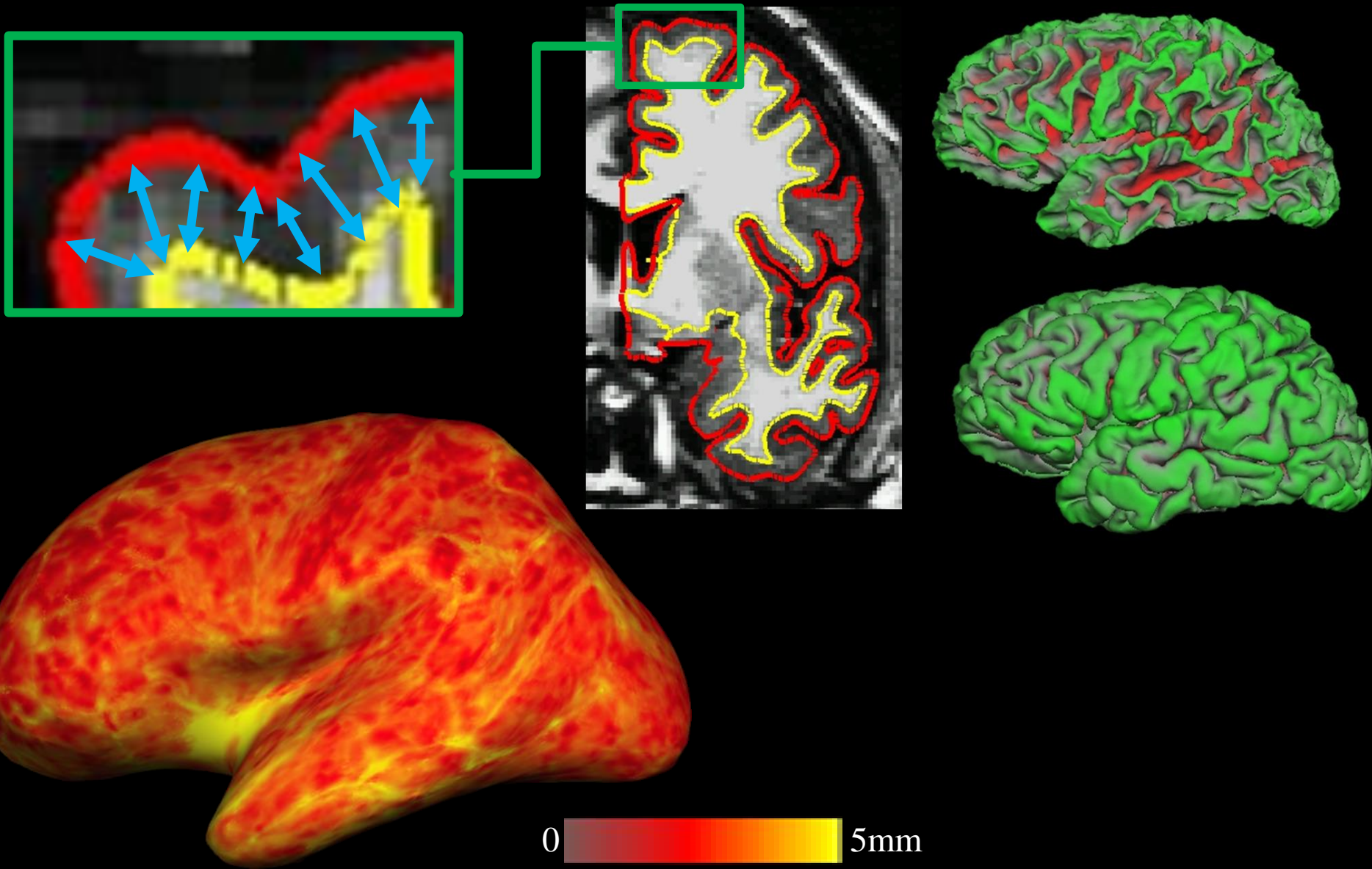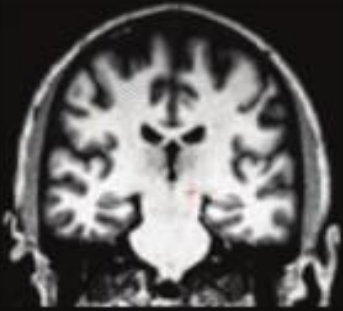3. Intensity Normalization

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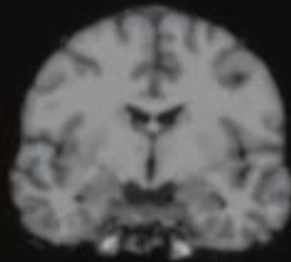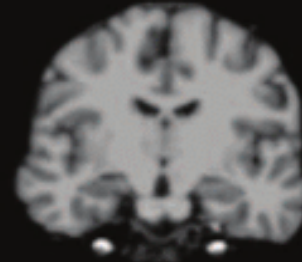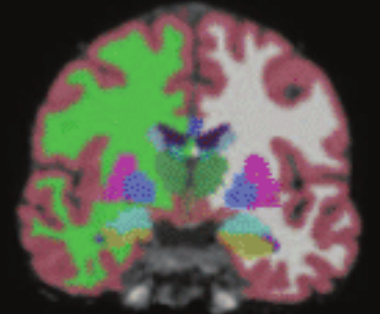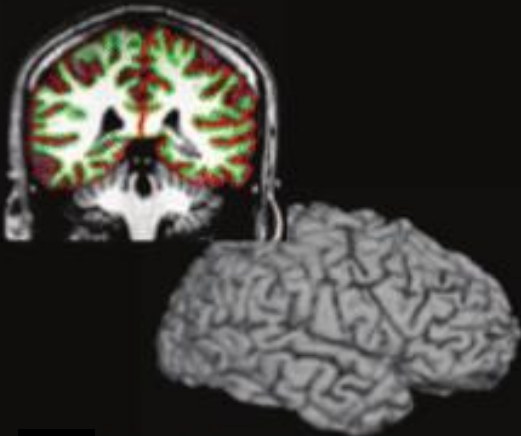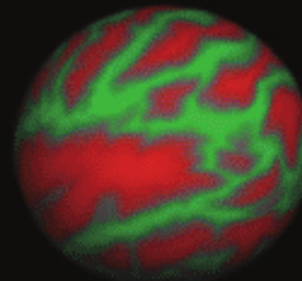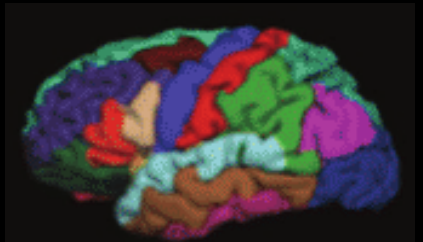
6. Surface Atlas Registration

7. Gyral Labeling

Gyral labeling via surface registration

a

b

Desikan-Killiany
(e.g., lh.aparc.annot)

Destrieux
(e.g., lh.aparc.a2009s.annot)
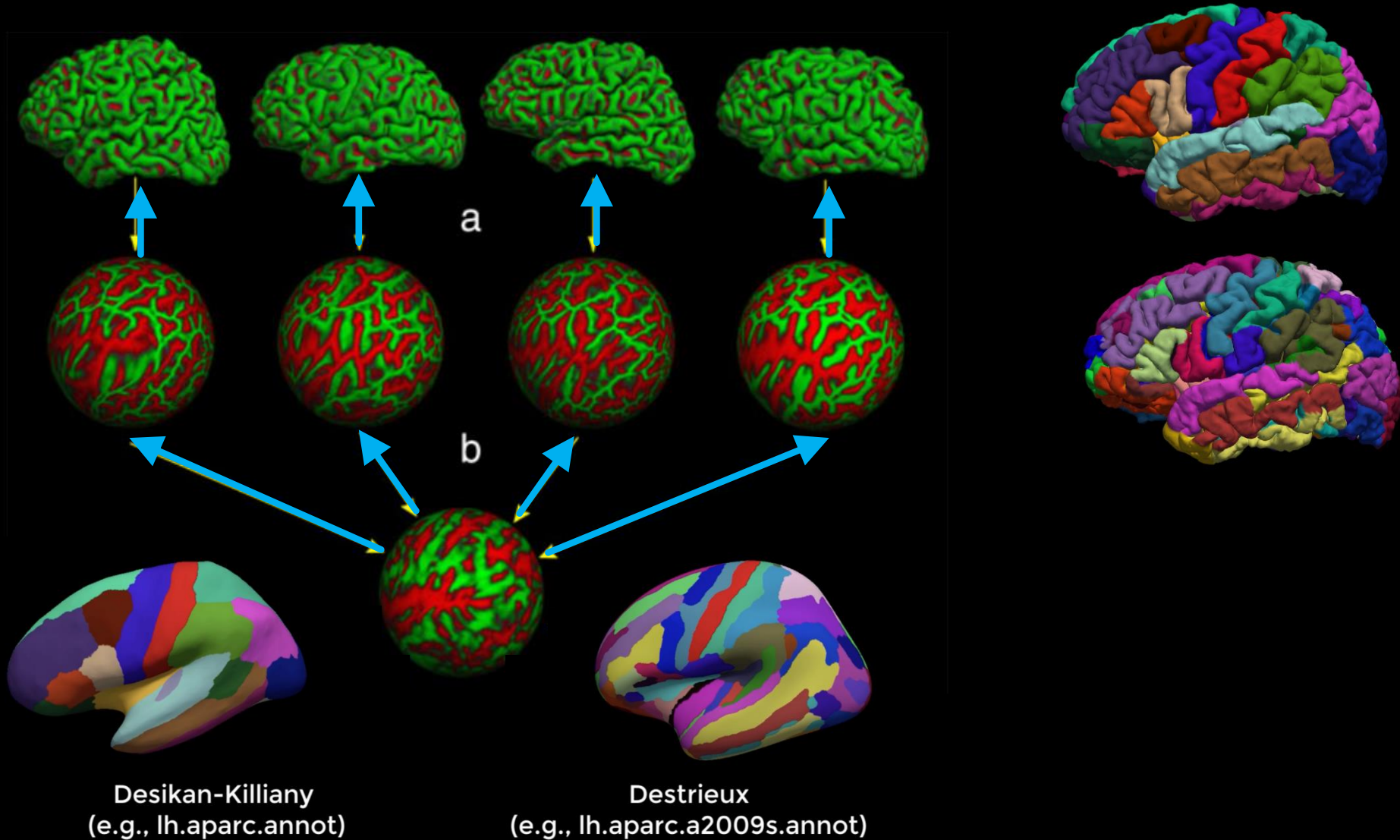
High accuracy for high quality input MRI

Gyral labeling
follows sulcal depth/curvature
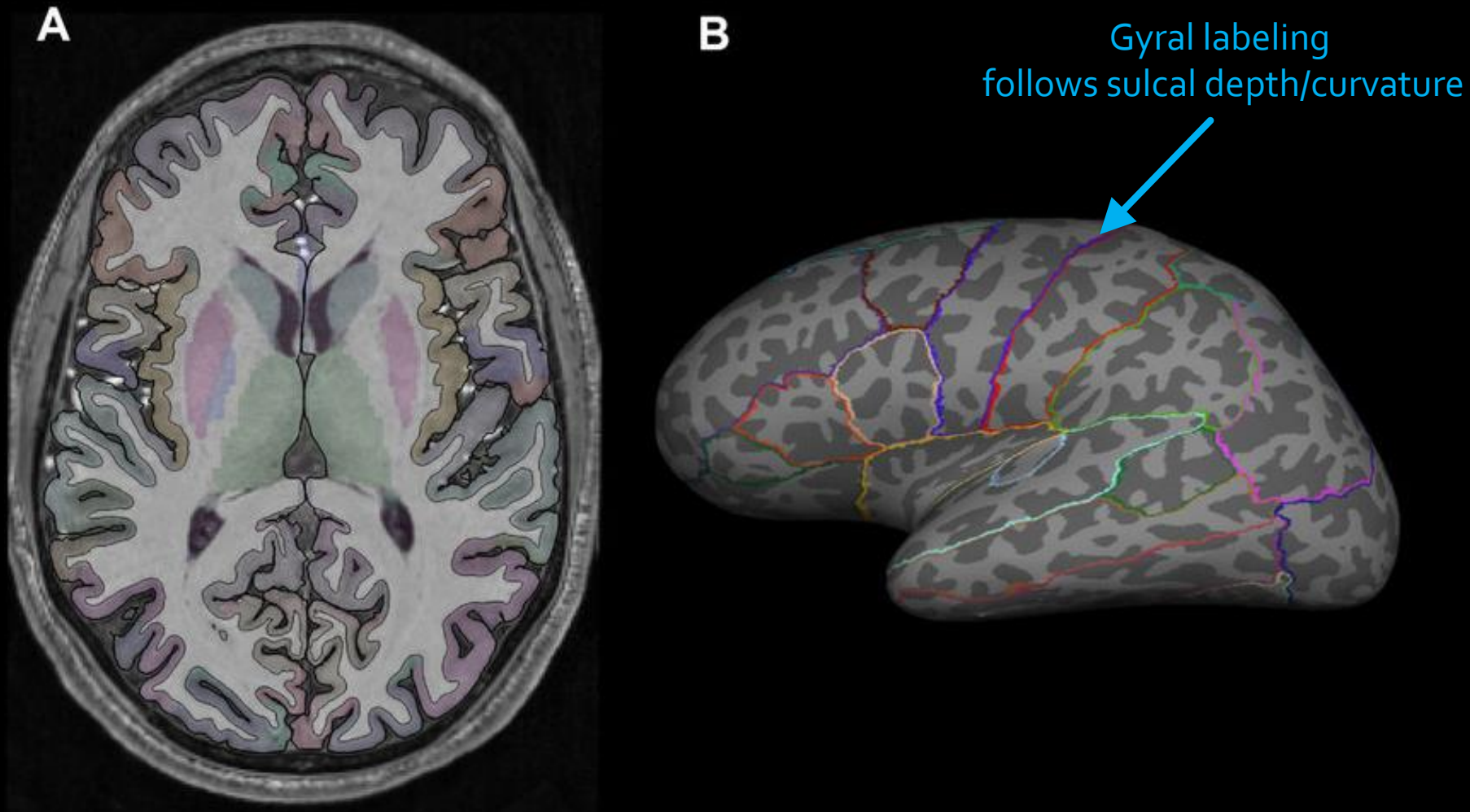
Zaretskaya, N. et al. (2017). Advantages of cortical surface reconstruction using submillimeter 7 T MEMPRAGE. NeuroImage. 165. 10.1016/j.neuroimage.2017.09.060.

Freeview

Alternative solutions

https://deep-mi.org/research/fastsurfer/

Deep Medical Imaging Lab

### FastSurfer - a fast and accurate deep-learning based neuroimaging pipeline

FastSurfer is a fast and extensively validated deep-learning pipeline for the fully automated processing of structural human brain MRIs. As such, it provides FreeSurfer conform outputs, enables scalable big-data analysis and time-critical clinical applications such as structure localization during image acquisition or extraction of quantitative measures.

FastSurfer consists of two main parts building upon each other:

1. FastSurferCNN - an advanced deep learning architecture capable of whole brain segmentation into 95 classes in under 1 minute, mimicking FreeSurfer's anatomical segmentation and cortical parcellation (DKTatlas)

2. recon-surf - full FreeSurfer alternative for cortical surface reconstruction, mapping of cortical labels and traditional point-wise and ROI thickness analysis in approximately 60 minutes (+ optionally 30 min for group registration).

Alternative solutions

○ ## https://mcin.ca/technology/civet/
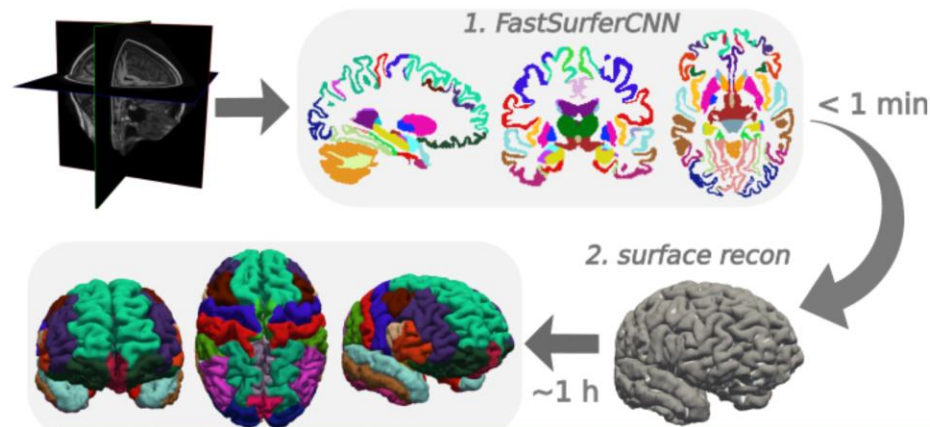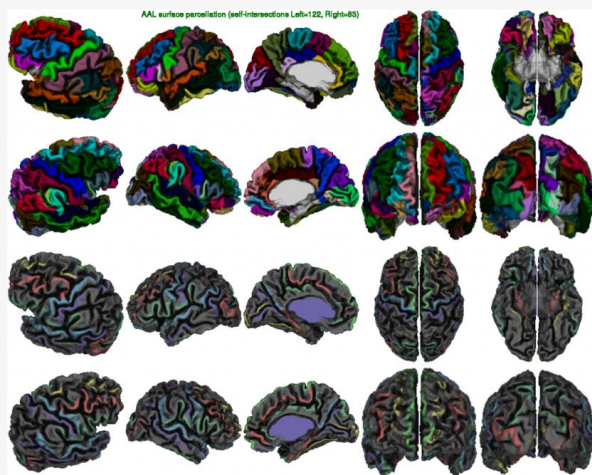
AAL Surface Paracellation

Technical Features of CIVET

CIVET is implemented with high-level scripts, primarily using the common scripting language Perl, that runs computationally efficient image processing tools mainly implemented in C/C++. CIVET extends the previous in-house pipelines by the addition of corticometry analysis tools.

CIVET analysis includes our in-house morphometric analysis tools for:

- ○ Linear and nonlinear brain registration
- ○ Classification
- ○ Partial volume correction
- ○ NonUniformity correction (N3)
- ○ Brain surface extraction (CLASP)
- ○ Surface registration
- ○ Cortical folding
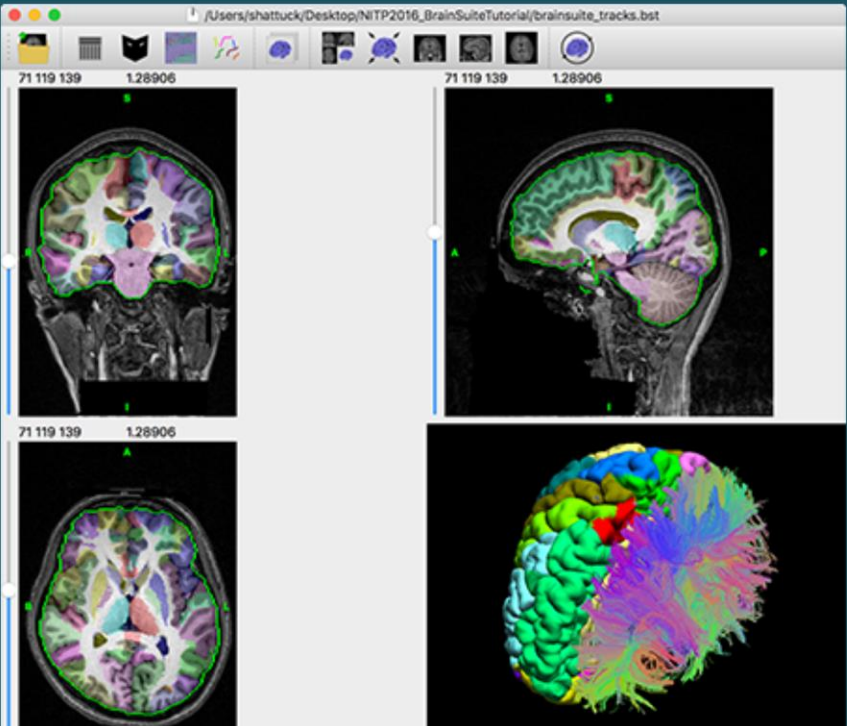
Alternative solutions

http://brainsuite.org/

Alternative solutions

○ https://brainvisa.info/web/

Emphasis on **sulcal anatomy**

CAT12

- https://neuro-jena.github.io/cat12-help/
- https://andysbrainbook.readthedocs.io/en/latest/CAT12/CAT12_Overview.html#what-is-voxel-based-morphometry
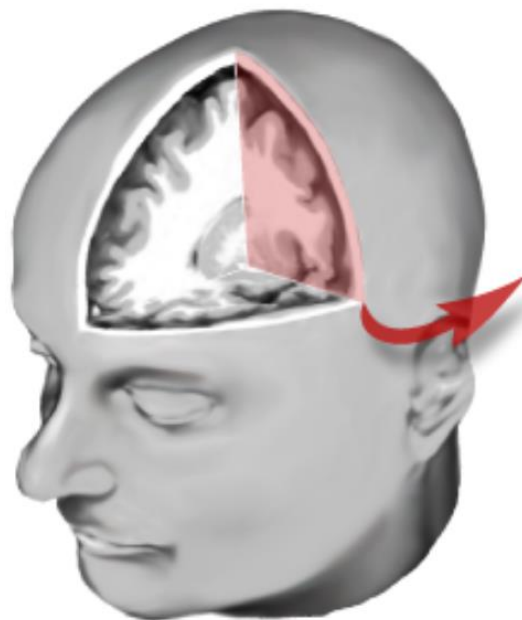
coronal slice of the left hemisphere
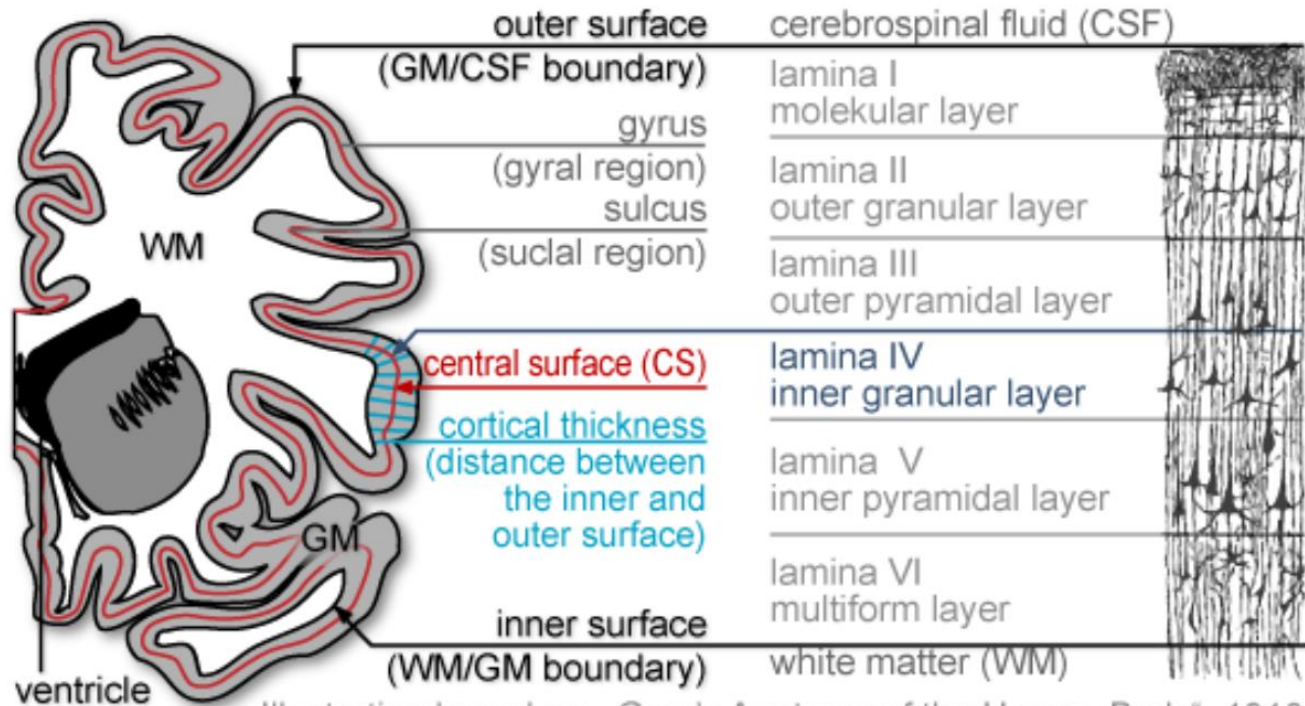
outer surface (GM/CSF boundary) — cerebrospinal fluid (CSF)
gyrus (gyral region)
sulcus (suclal region)

lamina I molekular layer
lamina II outer granular layer
lamina III outer pyramidal layer

central surface (CS)

lamina IV inner granular layer

cortical thickness (distance between the inner and outer surface)

lamina V inner pyramidal layer

lamina VI multiform layer

inner surface (WM/GM boundary) — white matter (WM)

ventricle

WM

GM

Illustration based on „Gray's Anatomy of the Human Body", 1918

HCP workbench

○ https://humanconnectome.org/software/connectome-workbench
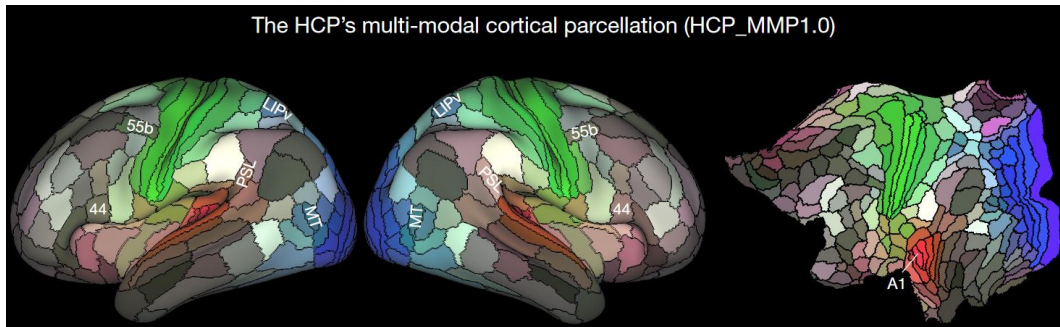
Glasser et al., Nature, 2016